

Springer Series in Design and Innovation 19

Nuno Martins
Daniel Brandão *Editors*

Advances in Design and Digital Communication II

Proceedings of the 5th International
Conference on Design and Digital
Communication, Digicom 2021,
November 4–6, 2021, Barcelos, Portugal

Springer Series in Design and Innovation

Volume 19

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Nuno Martins · Daniel Brandão
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ISSN 2661-8184

ISSN 2661-8192 (electronic)

Springer Series in Design and Innovation

ISBN 978-3-030-89734-5

ISBN 978-3-030-89735-2 (eBook)

<https://doi.org/10.1007/978-3-030-89735-2>

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This Springer imprint is published by the registered company Springer Nature Switzerland AG
The registered company address is: Gewerbestrasse 11, 6330 Cham, Switzerland

Preface

This book gathers the proceedings of Digicom 2021—the 5th International Conference on Digital Design and Communication: 56 best papers were selected out of 128 submissions, upon a rigorous double-blind peer-review process. Digicom was held on 4–6 November 2021 in hybrid format, at Teatro Gil Vicente, Barcelos, Portugal, and also online.

Digicom is an annual event organized by the Design School of the Polytechnic Institute of Cavado and Ave, and by ID+, Research Institute for Design Media and Culture, in cooperation with CECS-UM, which has been bringing together researchers, academics and designers from around the world.

“Digital” is becoming increasingly ubiquitous and prevalent in our networked and global society. Digicom has aimed to be a space for reflection and analysis on the constant challenges digital communication poses to society, institutions and brands. Despite its strong focus on the area of communication design, the objective of the conference—which is very much reflected in the present book—is the promotion of an open, broad and plural discussion, aggregating different areas of knowledge, namely arts, technology, communication sciences, education sciences and branding, among others. The conference thus seeks to stimulate interdisciplinary relationships that contribute to a solid development of the scientific activity.

Digicom 2021 received four keynote speakers:

Rachel Cooper is founding Director of ImaginationLancaster, <http://imagination.lancaster.ac.uk>. Her research interests cover design thinking; design management; design policy and across all sectors of industry. She has published extensively on these topics, including books, “Designing Sustainable Cities” and “Living in Digital Worlds; designing the digital public space”. She is Series Editor of the Routledge series Design for Social Responsibility. She was founding Editor of The Design Journal and also founding President of the European Academy of Design. She is President of the Design Research Society. Currently, she is one of the leading investigators on PETRAS <https://petras-iot.org>, a national research centre for research into IOT and AI at the edge.

Ana Correia de Barros is Senior Researcher at Fraunhofer Portugal AICOS and Head of the Human-Centred Design Department. She conducts design research strongly informed by qualitative fieldwork. With a background in industrial design, she worked in a design studio prior to earning a PhD in industrial engineering and management from UBI. She was Researcher at UNIDCOM-IADE, led the research and innovation area at a rehabilitation centre (CRPG) and lectured at different universities. Her research interests include assistive products (chronic disease and disability), usability and inclusive design.

Francisco Paiva is Associate Professor at the University of Beira Interior, in which structure he directs the Doctoral Programme in Media Arts. He holds a PhD in Fine Arts from the University of the Basque Country, a degree in Architecture from the University of Coimbra and a degree in Design from the University of Lisbon. He was Visiting Researcher at the University of Bordeaux. He has coordinated the Multimedia Design course for 7 years and now coordinates the Arts Group at LABCOM—Comunicação e Artes/UBI. He publishes and exhibits regularly and is Scientific Coordinator of DESIGNA, International Conference on Design Research, of the Research Days in Arts and the Magic Mountain * Art and Landscape platform. He is Member of CooLabora, Social Intervention Cooperative and is Executive Director of Covilhã’s Candidacy for UNESCO Creative City in Design.

In addition to the guest speakers, we also had the opportunity to attend a set of approximately 80 communications, strictly selected by Digicom’s Scientific Committee, from different international researchers and designers.

The three-day event resulted in extensive debate sessions, where the participants’ personal and professional perspectives and experience came together in a friendly environment, thus stimulating extensive exchange of ideas, start of new collaborations and demonstrating therefore the importance of this kind of events in promoting research advances.

The promotion of a panoramic vision of digital design and communication is a trademark that Digicom has been affirming and reinforcing through its five editions and that organizers and participants will continue to build and consolidate in their future works and the upcoming conference editions.

With this book, we would like to transmit this message to a broader audience and to attract contributors who share our vision and/or are willing to join our discussion in future conference editions. We would also like to acknowledge all those who have believed in Digicom so far and contributed to its success in many ways.

Again, a big thanks to all participants of Digicom 2021 and to all the readers of this book, hoping that you will enjoy and find it useful for your future research.

Looking forward to seeing you next year!

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Digital and Interaction Design



Narrative Infusion in Web Design

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Abstract. This paper investigates the contribution of narrativised interface design to the overall narrative expressivity of this work. A close reading of the graphic interactive novel *The Boat* reveals the reliance on a narrativised interface throughout the experience. The narrativised interface increases the impact of the work, as the user's navigation of the plot brings the story to life. The collaged visual presentation format both reinforces the story's overall emotional tenor and focuses the user's attention on the component micronarratives. This dynamic collage aesthetic creates a postmodernist artefact by mixing, sequencing, and superimposing media forms: illustrations, panels, text, photographs, and video. We argue that the narrativised interface elements intensify cognitive interactivity and increase immersion into the story as it unfolds. This narrative expressivity accentuates the perception of the storyworld. We also observe that the multi-mediated collage aesthetic bridges the digital and real worlds, leading to a hypermediated yet engaged experience. The work balances ambiguities and dualities - such as reality/imagination, photography/drawing, motion/still, sound/image. This unconventional and active interface design ruptures any passive reader experience. The resulting narrative texture supports an ongoing dialectic of immediacy and hypermediacy. This dialectic both draws the viewer into the ongoing story of *The Boat*, and highlights the work's higher-level themes: the fragility of life and the solitary nature of survival in a threatening world.

Keywords: Interface design · Narrativised interface · Focalisation · Collage

1 Introduction

“The narratives of the world are without number...the narrative is present at all times, in all places, in all societies” [1]. These narratives define our selves, our nations, and our cultures, and they can be found in all media forms [2]. *The Boat* is an exemplar for the power and relevance of narrative. The impact of this narrative of flight and diaspora in Vietnam is being relived in Afghanistan as we write this paper.

Our goal is to understand this work on its own terms. A narrative approach to media considers what stories can be told, why they are told and how they are told [3]. For interactive narrative, many variables can impact how the story is told. In his analysis of the interactive work *Ceremony of Innocence*, Bizzocchi highlights the narrativized interface, identifying both the widespread diffusion of narrative texture throughout the

work, and the more tightly focused narrative expressivity embedded within the centre of the interactive process- the interface itself [4].

Bizzocchi [4, p. 2] defines “narrative texture” as the “broad infusion of the sensibilities of the narrative across the entire... experience.” Narrative texture is relied upon by many media: cinema, sound-based storytelling, and various interactive multi-mediated forms. Environmental story spaces also explore narrative texture. We see this in amusement parks or location-based entertainment centres, where the story elements are infused into and across the physical space [5]. In web design, the screen opens a window to a virtual space. In this space, the narrative texture might create a homogeneous space [5] where all elements work in synchrony for expressivity. Indeed, Jenkins [6] argues that environmental storytelling embeds narrative information within mise-en-scene to sustain an immersive narrative. This experience reinforced by a narrativised interface that incorporates narrative elements and sensibilities within the design of the interface itself [7].

A narrativised interface can also reduce the gap between immediacy [a direct engagement and immersion within the storyworld] and hypermediacy [the awareness of mediation and media design] [7, 8]. Likewise, a web page may incorporate narrative within its interface to decrease any contradiction between story immersion and the conscious awareness of interaction options. Zimmerman maintains that interaction can assume different forms [9, p. 4]. He described four modes of interactivity: cognitive, functional, explicit and beyond-the-object. Each artefact may support different degrees of engagement by exploring these modes. For example, a graphic novel supports cognitive interactivity, while an interactive graphic novel supports cognitive, functional, and explicit interactivity.

We argue that a central contribution of a narrativised interface is to increase the story’s emotional appeal within the context of the interactive design. In this spirit, we investigate how both narrative texture and the narrativized interface support the emotional experience of a web artefact. This artefact is a graphic interactive novel, *The Boat*, which tells the story by Nam Le, adapted by Matt Huynh and produced by SBS.

2 The Boat

The Boat is an interactive graphic novel about escaping after the Vietnam War based on the short story by Nam Le. SBS Movies launched it to mark the 40th anniversary of the fall of Saigon. Le tells the story of 16-year-old Mai, whose parents decide to send her alone on a boat to Australia. The conditions in the boat are inhumane, and a storm makes things even worst. Mai gets sick, and her fever-soaked memories help the reader to understand her past. During this journey, Mai meets Quyen and her son Truong - who falls ill and dies just before the boat gets to Australia.

Matt Huynh, whose parents, like Le’s, fled Vietnam after the war, illustrates the interactive graphic novel. His adaptation relies strongly on comics and illustrations, which are informed by Sumi-e painting and Shodo calligraphy.

The Boat is structured as a “one-page” template, which remediates the papyrus scroll metaphor. This structure means that the lexia and imagery are arranged in a single webpage. The narrative arc is presented by scrolling down, with only limited options for

“side-story” events or information. This relatively linear template favours storytelling presenting the original plot as conceived.

The text was divided into six chapters, with some of the original text was omitted [10, pp. 230–276]. Images translate some of the text. For example, “the boat begins to rock” was omitted, but the animation shows the boat rocking. So, *The Boat* is also a visual narrative perceived by two approaches [11]: what a written image is (visual dimension) and how images can narrate. Bal examines the latter through the concept of focalisation, which denotes the perspectival restriction of narrative information relative to the point of view.

3 Focalisation

Focalisation examines a narrative’s representation by identifying the perspective that channels the expression of the text events by the narrators [11]. For Bal [12], focalisation is the relationship between the “vision”, the agents that see and that which is seen. The subject of focalisation (focalizer) is the point from where the scene is viewed.

Jahn [13] explains the three major focalisation types described by Genette: zero, internal and external. Type zero means that events are narrated from an omniscient point of view. Internal focalisation presents the events from a local perspective of a focal character. External focalisation offers what would be visible to a camera.

Niederhoff [14] expands this definition and argues that internal focalisation, for example, means not only to tell a story from the characters point of view but also to present the events as they are felt, interpreted and evaluated by the character. Other authors also contributed to the understanding of focalisation in a broader perspective.

For instance, Horstkotte and Pedri [15, p. 331] argue that “optical perspectivation is only one dimension within a broader category of focalisation that also includes aspects of cognition, ideological orientation and judgment”. These authors are also concerned with the intrinsic and distinct focalisation-marking resources of visual media.

Jahn’s model of “windows of focalisation” emphasises the cues in the text that transfer the viewer into the storyworld and considers characters’ perceptual, ideological and moral orientation. This is closely related to what Palmer describes as the aspectuality of a character’s subjective experience and what Horstkotte and Pedri [15] relate to focalisation. Palmer understands that the whole consciousness’s of characters can be expanded to include descriptions of aspects of the storyworld seen from their perceptual, cognitive, and evaluative views. For Palmer, whenever events occur in the storyworld, they are experienced from within a particular vision which he refers to as aspectuality [16].

Thus, focalisation is a productive analytical category in a graphic narrative for Horstkotte and Pedri [15]. They highlight the necessity of identifying medium-specific discourse markers signalling focalisation. They propose a conception of focalisation as a cognitive operation related to aspectuality. They signalled three to highlight focalisation in a graphic narrative: through shifts in visual vocabulary, repetition/shading, and multi-stage braiding of identical visual material.

4 Methodology

Through a close reading of the interactive graphic novel *The Boat*, we investigate how a narrativised interface increases the emotional appeal. In addition, we explore how narrative texture contributes to narrative expressivity.

Close reading is a classic methodology for Humanities scholarship and research. A close reading is a rigorous and detailed analysis of the original text. Van Looy and Baetans maintain that “...when close reading, the eyes of the reader are almost touching the words of the text. Nothing is to escape the attention of the meticulous scholar.” [17]. This methodology was developed in the context of poetry and other print-based text, but it has been successfully utilized across a variety of media including cinema, interactive narrative, and electronic games [18]. In the Humanities tradition, close reading takes its place as an evidence-based form of scholarship that “...appeals to intersubjectively available data that are in principle amenable to alternative explanation...” [19].

To understand the interactive graphic novel, we compared this work with the original short story [10] and marked the removed text to map what was left as text and what was depicted. In addition, using an informal notational system, we deconstructed the narratorial units of the interactive graphic novel in two dimensions: content and effects. These dimensions were discussed in terms of the narrativised interface [20].

These dimensions were revisited several times, and a more complex notational system was drawn. The readings were focused on different interactivity modes that could be perceived. Using Zimmerman’s interactivity model, we analysed the work in terms of cognitive, functional, explicit interactivity and beyond-the object interactivity.

5 The Interactive Graphic Novel Close Reading

It is expected that the reader of an interactive graphic novel becomes “an active, creative proponent in construction meaning rather than a passive recipient” [21, p. 24]. This entails a similar problem faced by game designers: the potential inconsistency between the experience of the story and the process of interaction [22]. Bizzocchi [7] suggests two design strategies to draw this problem: the broad infusion of “narrative texture”, and the more focused design of a narrativised interface. Narrative texture implies the use of the expressive capabilities of a given medium to express and reinforce narrative concerns (such as emotion, character, storyworld and story progression) across the entire work (sound, imagery, graphics, motion design, etc.). The more specific narrativized interface incorporates narrative element within the design of the interface itself.

Bizzocchi, Lin and Tanenbaum [20] identified four approaches to designing a narrativised interface:

- 1 The look and feel of the interface – incorporation of narrativised elements within the basic aesthetic of the interface
- 2 Narrativised perspective – the role of point-of-view (POV)
- 3 Behavioural mimicking and behavioural metaphors – user interaction is evocative of the behaviour of their character
- 4 Bridging and mixing realities – the real world becomes part of the game interface

We maintain that in this work, the first two approaches - the look and feel of the interface and the narrativised perspective – work together to create immersion while the other two approaches - behavioural mimicking and bridging and mixing realities – are used to facilitate hypermediation.

We first identified how the interface incorporates narrative. Second, we discussed how the narrativised interface highlights the expressivity, especially emotional appeal. The narrativised perspective explores focalisation, and we seek to identify medium-specific discourse markers signalling focalisation. Horstkotte and Pedri [15] argued that these focalisation-marking resources indicate the aspectuality of a subjective filtering mind.

The behavioural mimicking equates to how graphic effects contribute to narrativity. Finally, the bridging and mixing realities consider how history and story are intermixed.

5.1 Narrative Infusion

Narrative texture – reinforcements of overall theme, arc, storyworld, character – is infused across all the creative channels of the work. *The Boat*'s interface incorporates a variety of different media forms: drawing, photography, 2D animation, text and sound (see Fig. 1). The individual design elements distributed across these forms combine over time and reading to infuse an ongoing and pervasive narrative texture. This wash of narrativity across the work expresses a very depressing, hopeless and painful storyworld.

The audio design, by Sam Petty, supports immersion by reflecting and accentuating the dynamics of the visuals. Petty uses an overall ambient sound (storm, waves, wind), more punctuated foley sounds (birds, steps, match, footsteps) and story-based diegetic sound (Vietnamese song). The audio channel is important to the work, and the website suggests the use of headphones so the sound can be fully appreciated.



Fig. 1. Screenshot of the boat (<http://www.sbs.com.au/theboat/>) © SBS

The font style of the on-screen text varies depending on the nature of the source: narration, speech balloon, or song lyric. The Shodo calligraphy used for the headings and links imposes a dramatic scent. Shodo calligraphy is a form of artistic writing used for writing the Japanese and Chinese language. More than calligraphy, Shodo can be seen as a martial art that brings self-coordination, order and calm [23].

The typeface used for narration text prioritises legibility and balloon speeches is about expressivity. The cursive typeface simulates natural speech and gives voice to the letters.

The drawings and animation are embedded with narrative, enhanced by Sumi-e painting. Sumi-e is the Japanese word for black ink painting. Emphasis is placed on the beauty of a few individual strokes that summarise the complex scene.

The foreground objects are the panel's illustrations, speech balloon and text. Part of the text is illustrated. Many of these illustrations are panels, which means that the drawings are visualisations of the narrative. The use of panels reinforces that the characters are trapped in a narrow and crowded space.

Sumi-e reflects suffered characters lost in their fear, and their blurred forms are fused with the background. This boat-characters fusion stresses the characters soulless, hopeless and how disposable they are.

This infusion of narrative texture across all the component media of *The Boat* reinforces the chilling dramatic mood of the plot and the storyworld. Characters' suffering is explicit in the plot, and the readers can feel this sorrow reflected and amplified through the design of the sound, painting style, colour, graphic motion, and typography.

5.2 Narrativised Interface

Narrative is infused across *The Boat* in all these media channels, and more specifically, it is embedded directly in the aesthetic of the interface itself. The exercise of user interface control both guides the interactive progress, but also reflects narrative and storyworld sensibilities.

While the background design reinforces the narrative's mood through the look and feel of the interface, the foreground objects express the narrative more directly through mimicking behaviour, narrativised perspective and bridging and mixing realities, which are discussed as follows.

The Look and Feel of the Interface. The story is portrayed in a black and white Sumi-e painting style, which emphasises the darkness and sadness of the characters. Colour is used only to draw the arrow that shows the diversion point and to portray flowers (intradiegetic objects) in the background. These flowers become grey as Mai's memories fade away and she faces reality again.

The background assumes two forms: one form is an environmental ambience, as when the plot focuses on the outside of the boat. The other form is more neutral (white, black or with some abstract drawings), and is used when the plot focuses on the character.

The environmental background is a narrativised interface, composed of a 2D animation of a storm. The background incorporates the narrative by animating a night and a heavy storm (lightning and rain) that makes the fragile boat adrift.

Where panels are incorporated into the layout, 38% of the panel transitions are what McCloud would term "moment-to-moment" [24, p. 70]. These transitions show only slight changes from one panel to the next. McCloud asserts that such moment-to-moment transitions do not require much work for reader closure and understanding, but easily allow the full appreciation of the character's suffering.

Narrativised Perspective. We identified one medium-specific discourse marker signalling focalisation: distortion sequence, which could be considered a particular case of repetition [15].

The character's mental chaos, fears, solitude and sadness are signalled verbally and visually throughout the graphic narrative. Figure 2 shows two of a four panel sequence of the protagonist state of mind or protagonist's aspectuality.

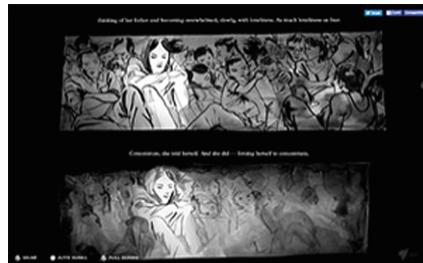


Fig. 2. Screenshot of two (out of four) panels that represent the emotional state of the protagonist. © SBS (<http://www.sbs.com.au/theboat/>)

Each panel reinforces her depression and solitude because the drawing loses details of others and focuses on her that gradually becomes blurred. The blurred images tell readers to construct the final image as inflected by Mai's focalisation of her state of mind: she is lost, afraid, alone.

The interval between panels represents the time she took to forget where she was and become a "human cocoon". The changes from one panel to the next express the constriction and withering of her emotional perspective on her life.



Fig. 3. Screenshot of the Truong sickness sequence. © SBS (<http://www.sbs.com.au/theboat/>)

A more appealing sequence appears in the story when Truong is very sick. Figure 3 shows the series of images that might be understood as Truong's focalisation of his health. Each successive drawing shows less visual embellishment, and a bit more of his actual body, implying his return from sickness back to his normal healthy state. These images move around the screen following the rhythm of Truong's breath.

The rowing sequence in Sect. 3 shows two simultaneous focalisations of the same action (see Fig. 4). While the animated background shows the boat crossing the screen from left to right, a panel shows a passenger's perspective. He considers the match being lit, which is also seen at the faraway boat.

The speech balloons that pop up in sequence establish the reading order and are also used to change focalisation. Sometimes the character who speaks is not visible, which urges readers attention to understand the voices dance.

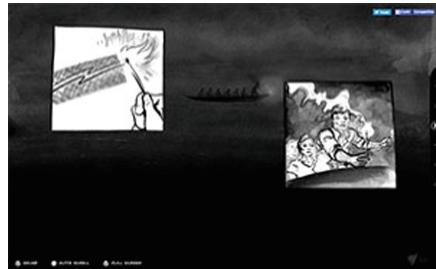


Fig. 4. Screenshot of the rowing sequence. © SBS (<http://www.sbs.com.au/theboat/>)

Behavioural Mimicking. The interface becomes more narrativised to narrate the effects of the storm on people. Figure 5 shows a screenshot of the panels and text thrown against the screen's border, mimicking the behaviour of the bodies in the boat. This effect reinforces the storyworld – the reader is situated directly within the multimodal sensory experience of the narrative. In addition, these narrativised elements within the aesthetic of the interface intensify cognitive interaction by arousing emotions [9]. It is used to accentuate the perception of the storyworld. Another example of the narrativised interface is the text blown away from the page, as it suffers the wind effect.



Fig. 5. Screenshot of the panels. © SBS (<http://www.sbs.com.au/theboat/>)

These examples remediate our expectations of screen-based space. The elements behave unexpectedly, and in these moments, the reader will experience the hypermediation of surprise. This remediation of screen-space expectations is consistent with Eisenstein's use of "sensual or psychological impact" [25, p. 66].

The narrative is also embedded in the moment-to-moment transition panels that show a body being thrown in the water (see Fig. 6). The movement is reinforced by the positions of the boards that mimic the body's trajectory.



Fig. 6. Screenshot of the moment-to-moment transition panels that show the body being thrown in the water. © SBS (<http://www.sbs.com.au/theboat/>)

Bridging and Mixing Realities. Explicit interactivity [25] is also used to deviate the plot for a parallel plot or analepsis. A dynamic collage is composed of a thought bubble; a drawing and an arrow signalled these diversion points (see Fig. 7). The thought bubble creates a bridge to the character's memories. It is a subtler example of a mixed-realities interface approach to construct a narrativised interface.

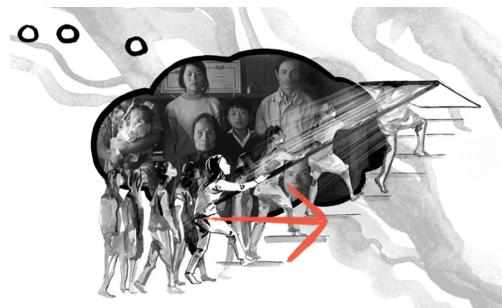


Fig. 7. Photo collage used as a diversion point. © SBS (<http://www.sbs.com.au/theboat/>)

As Bizzocchi, Lin and Tanenbaum [20] pointed out, the resulting boundary between plot and reality becomes blurred, and the narrative's emotional appeal intensifies. The collage decision point allows the reader to hypermediate so she can make a conscious choice whether to divert or not. This decision, however, does not derail the main plot. When the reader returns from the parallel story, they come back to the same point from which they left the original plot. Deviating from "auto-scroll" to examine these diversion points acts as a bonus rewarding active participation by the reader.

The pages of the diverted story also exhibit a collaged aesthetic. The background is composed of "real" photographs that are closely related to the text. For instance, when the story is about Quyen's husband that escaped to a refugee camp, the photos show these camps. The pictures support the story's veracity and are shown as backgrounds of the characters' memories. This combination of diversion and detail reinforces the reader's sense of suspension of disbelief [26].

6 Considerations

The narrative infusion for The Boat shapes the overall graphic treatment applied to create the interface. The result is a visual identity that can be perceived throughout the interface. Every detail was considered under this identity, which presents a sad, depressing, deadly, hopeless world. This broad infusion of narrative texture serves as a bridge to guide the reader into the storyworld.

The narrativised interface completes the reader's immersion. The extensive use of moment-to-moment panels transitions establishes the reading rhythm, which does not ask the reader to work for closure, but instead directly engages the reader's emotional involvement. Cognitive interactivity is the core participation the system presents to the reader so that the plot can be intensely constructed into a story.

This extensive use of a narrativised interface compensates for the missing text from the original short story. Many of these missing passages are embedded directly within the interface screen. In addition, while reading the short story, the reader needs time to construct the storyworld but interacting with the graphic novel, the storyworld is already built, which impacts the reader in a direct and profound way. The reader is captured by the beauty of the interface and can immediately feel the pain, the fear, the inhumane conditions that the characters feel.

Different focalizers interplay between what an outsider sees in the boat and what the main characters are feeling - creating a stronger sense of reality. The narratorial focalisation of Mai's sickness turns into an internal focalisation of Mai's pain. A similar shift in focalisation takes place when Truong is sick. An internal focalizer pleads for readers' empathy in a more persuasive form than an external focalizer.

A more striking example of narrativised interface concerns the sequence of panels detailing the effect of the storm on the boat. The reader is caught off a surprise by this web media specificity and asked to surrender to the characters' agony. The reader is not expected to be a voyeur of a self-enclosed storyworld but is absorbed within the story, to feel it and perceive it in its multisensory complexity.

The "attraction" created is reinforced by the dynamic collage elements, which mix our sense of reality and bridge the narrative's present to its past (analepsis). The aesthetic of these collage plays with the strange, creating a shock to the senses and impacting the reader. In these moments, she must actively construct the meaning of the work—the real photographs used in these collages bring their own sense of reality and history. Gunning [27, p. 46] argued that the picture can make the reader imagine something else. The reader might relate the people on these photos to someone who survived this journey or fill in missing details about the storyworld. The photographs also increase story complexity on the emotional level - the reader may be compelled to directly feel the horror these people suffered. This happens because of the photographs' ability to put the reader in the presence of its reference, and with the details come the suffocating sense of reality [27, p. 47].

The narrative texture that springs from The Boat is the result of story elements infused into space [5]. In this space, a pervasive narrative texture creates a homogeneous space [6] where all components work in synchrony to maximize expressivity and sustain an immersive narrative.

But this state of immersion into the storyworld (immediacy) is counterbalanced by hypermediacy: behavioural mimicking and mixing realities (see Fig. 8). These design strategies create moments of mediated awareness that can both guide the reader's progress, and shock her sensibilities.

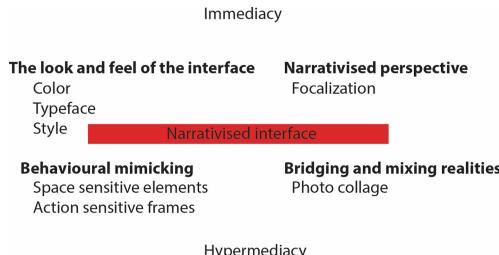


Fig. 8. Summary of the interface elements and narrativised interface

Throughout this artefact, the reader faces some opportunities to become active. Some of these opportunities are straightforward, such as buttons so the reader can choose an alternative side path (explicit interactivity), and some are designed to involve the reader psychologically, emotionally and intellectually (cognitive interactivity) [25]. In addition, the “one-page” template, which remediates the papyrus scroll metaphor, is a simple functional interactive design that privileges linear storytelling. The reader can establish the pace, but the order of the pages is fixed, which support the sequence of the story.

The narrative texture presents the reader with a collage of animation, comics, illustration, photography, video and text - creating a postmodernist hypermediated work. In this sense, the artefact balances ambiguities and dualities, such as reality/imagination, photography/drawing, motion/stillness, sound/image. Its unconventional interface behaviour ruptures any reliance on passive reader behaviour. In addition, the plot is constructed in pieces, with fragments of journeys represented as panels or as flashbacks. There is no single narratorial authority, and the change of focalisation makes that clear. Another characteristic of its postmodernism style is the overall irony of this piece, that in this case, incorporates the reality of death. The journey repeatedly takes the lives of those who fled in order not to die.

7 Conclusion

Narrativised interface design is a quality that can be observed in many electronic games. However, it is not designed as deeply into many web interfaces. The Boat interactive graphic novel is one example that explores the four elements of a narrativised interface described by Bizzocchi, Lin and Tanenbaum [20].

Other examples found address the narrativized interface to a lesser degree, either through the interaction mechanism or elements imbued in narratives, such as videos. The Dead Pirates website [28], explores the cursor form to a more immersive design,

which is an instance of the look and feel of the interface. The “After the Storm” [29] website appeals to video to increase story complexity.

The lack of narrativised interfaces is due in part to the orientation of many websites to information rather than narrative - such as those that display products or services. Other websites may incorporate narrative more directly – using the simple presentation of video, animation or illustration - which visually illustrate a narrative without a reliance on interaction or interface.

As web design moves toward more aggressive remediation of older media, its visual vocabulary explores new possibilities in the emergent potential of a vigorous multimedia aesthetic. We believe that the design of the more complete narrativised interface will find its place in an advanced and interactive audio-visual web vocabulary.

References

1. Barthes, R.: Introduction to the structural analysis of the narrative. Discussion Paper, University of Birmingham, Birmingham (1966)
2. Polkinghorne, D.E.: Narrative and self concept. *J. Narrative Life Hist.* **1**(2), 135–153 (1991)
3. Ryan, M.-L.: Story/worlds/media tuning the instruments of a media-conscious narratology, In: *Storyworlds Across Media: Toward a Media-Conscious Narratology*. University of Nebraska Press, Lincoln (2014)
4. Bizzocchi, J.: Ceremony of innocence: a case study o the emergent poetics of interactive narrative. Master thesis, MIT Press, Cambridge (2001)
5. Manovich, L.: *The Language of New Media*. The MIT Press, London (2002)
6. Jenkins, H.: Game design as narrative architecture. In: *First Person: New Media as Story, Performance, and Game*, pp. 118–130. MIT Press, Cambridge (2004)
7. Bizzocchi, J.: Game and narrative: an analytical framework. *J. Can. Games Stud. Assoc.* **1**, 1–10 (2007)
8. Bolter, J.D., Grusin, R.: *Remediation*. MIT Press, Cambridge (1999)
9. Zimmerman, E.: Narrative, interactivity, play and games. In: *First Person: New Media as Story, Performance, and Game*, pp. 154–164. MIT Press, Cambridge (2004)
10. Le, N.: *The Boat*. Alfred A. Knopf, New York (2008)
11. Bal, M.: Visual narrativity. In: *Routledge Encyclopedia of Narrative Theory*. Routledge, London (2010)
12. Bal, M.: *Looking in the Art of Viewing*. G+B Arts International, Singapore (2001)
13. Jahn, M.: Focalization. In: *Routledge Encyclopedia of Narrative Theory*. Routledge, London (2010)
14. Niederhoff, B.: Focalization. In: *The Living Handbook of Narratology*. Walter de Gruyter, Hamburg (2011)
15. Horstkotte, S., Pedri, N.: Focalization in graphic narrative. *Narrative* **19**(3), 330–357 (2011)
16. Palmer, A.: *Fictional Minds*. University of Nebraska Press (2004)
17. Van Looy, J., Baetens, J.: *Close Reading New Media: Analysing Electronic Literature*. Leuven University Press, Leuven (2003)
18. Bizzocchi, J., Tanenbaum, T.: Well read: applying close reading techniques to gameplay experiences. In: *Well-Played 3.0*, pp. 218–315. ETC Press, Pittsburgh (2011)
19. Bordwell, D.: *Poetics of Cinema*. Routledge, New York (2007)
20. Bizzocchi, J., Lin, M.B., Tanenbaum, J.: Game, narrative and the design of interface. *Int. J. Art Technol.* **4**, 460–479 (2011)
21. Maud, L.: *Cut with the Kitchen Knife: The Weimar Photomontages of Hannah Hoch*. Yale Univiversity Press, New Haven (1993)

22. Bizzocchi, J.: Ceremony of innocence and the subversion of interface: cursor transformation as a narrative device. In: Digital Arts and Culture Conference Proceedings Melbourne, Australia (2003)
23. Manghani, S.: Ink and wonder. Times Higher Educ. Supplement **1943**, 40, 15 (2010)
24. McCloud, S.: Understanding Comics. Harper Perennials, New York (1994)
25. Gunning, T.: The Cinema of Attractions, in Early Cinema: Space, Frame, Narrative, pp. 63–70. BFI Publishing, London (1990)
26. Engell, J., Bates, W.J.: The Collected Works of Samuel Taylor Coleridge. Princeton, Biographia Literaria (1983)
27. Gunning, T.: What's the point of an index? Or faking photographs. NORDICOM Rev. **5**(1/2), 39–49 (2004)
28. McBess: The Dead Pirates, 05 July 2016. <http://www.overthetinyhills.com/>. Accessed 14 Apr 2016
29. Beck, A.: After the Storm, Helios Design Labs (2016). <http://www.pbs.org/independentslens/interactive/after-the-storm/#/dear-future-disaster-survivor>. Accessed 4 Apr 2016



Building a Privacy Oriented UI and UX Design: An Introduction to Its Foundations and Potential Developments

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Abstract. This paper, which is part of an ongoing PhD research in design, ethics, and privacy, discusses the foundations for implementing a privacy oriented UI in digital design. Assuming that the UI is the visible layer in the relation between the user and the service provider, we denounce that the current paradigm in design is to capture users' personal data for (commercial) surveillance reasons, irrespective of the existing legal requirements, and often through unethical tools such as dark patterns. The research presented in this paper is based on a literature review and on a qualitative survey of websites and apps accessible from the EU. The objective is to present bad and good practices, and to define a set of guidelines to design an accessible, user-friendly, and privacy oriented UI. In the last section of the paper, we introduce our current and future research aimed to set up solid grounds to establish and implement UX design for users' privacy.

Keywords: UX design · UI design · Privacy · Ethics

1 Introduction: The Layered Relation of Privacy, UI Design, and UX Design

Humans live in complex environments made of natural materials and artificial devices, but also of immaterial bits; that is, of information. While writing these lines we were both present in the physical world (we were sitting at our desk staring at a monitor and tapping on a keyboard) and in the digital one (we were transforming our keystrokes into characters that "live" only as zeroes and ones somewhere in "the cloud"). Italian philosopher Luciano Floridi (2014) coined the term "infosphere" to characterise the global territory of organised information that we inhabit as hyperhistorical beings—i.e., beings whose livelihoods largely depend on information technologies. In Floridi's view, our circumstances can no longer be neatly separated into online and offline: as in our example above, we are simultaneously on the physical and informational environments; hence, what we do online is inseparable from what we do offline.

Nowadays, there are increasingly fewer moments in which we are genuinely offline: e.g., when we are "off the grid" on top of a mountain or in the middle of a forest without

access to the GSM network. We are constantly (consciously or unconsciously) immersed in the infosphere and all the while we are sharing our personal information to buy things, to sign up for a service, to participate in a conference, or simply while aimlessly browsing the Internet or scrolling through an app.

Users' personal data represent one of the main pillars of the infosphere. Moreover, some scholars agree that we are now living in the era (and are victims) of "surveillance capitalism". This expression was coined by Foster and McChesney (2014) and has since then been expanded and popularised by Shoshana Zuboff (2019).

Surveillance capitalism is a complex and controversial notion: some authors argue that the problem it characterises is intrinsic to capitalism itself, therefore adding the term "surveillance" is tautological (Couldry and Mejias 2020). Furthermore, while the moniker "surveillance capitalism" may grasp the monitoring efforts of Western capitalist states and private companies, can we say that the type of surveillance carried out in China or North Korea is less nefarious than the one carried out by Western governments or corporations such as Google or Facebook? We are inclined to say it is not. In the case of China, for example, mass surveillance is organised by the State but largely aided by private companies (DeBrabander 2020).

For the time being, and without assuming a definite position for or against capitalism, we believe the term "surveillance" alone is sufficient to describe the massive collection and processing of personal data by governments and companies for political and business purposes regardless of the political status of the country. Essentially, we are of the opinion that surveillance, carried out through information technologies, is dangerous because it erodes our free will through powerful yet subtle persuasion mechanisms (Doctorow 2020; Zuboff 2019).

Governments and companies are eager to collect and store increasingly more data about every aspect of people's lives. The reason being that "data is cheap to aggregate and store, and both proponents and opponents of surveillance capitalism have assured managers and product designers that if you collect enough data, you will be able to perform sorcerous acts of mind control" (Doctorow 2020, p. 48). While any claim that mind control can be achieved through "data science" should be taken with a grain of salt, a considerable amount of literature describes the dangers of privacy loss and the consequences for users and citizens in terms of political manipulation and economic control (Bowles 2018; Couldry and Mejias 2020; DeBrabander 2020; Doctorow 2020; Falbe et al. 2020; Monteiro 2019; O'Neil 2016; Solove 2006; Vélez 2020; Waldman 2018). Less privacy means less freedom to make political and economic decisions; such limitation of human liberties is a threat to the well-being of societies at large.

Privacy is a complex and recent concept; its meaning is heavily influenced by the social and political contexts in which it is used. Brandeis and Warren (1890) first characterized privacy as "the right to be left alone" in the late 19th century. Nowadays, especially in Europe, scholars and legislators characterize privacy in terms of *data protection*, as a defence of personal information. Whereas in the US, the dominant term continues to be privacy, but also encompassing "data privacy". For the sake of clarity, in this paper when we mention privacy, we are referring mainly to data protection.

While privacy has traditionally been regarded as legal issue, we contend that it should also be a main concern for the people who make the instruments that collect personal

information; that is, designers. For a while, designers could claim that their job was merely to create usable, useful, and delightful products; however, it has become clear that this also means making sure that users are treated with respect (Monteiro 2019), and in today's reality it means ensuring people's rights are protected. This is a tremendous responsibility and it can cause grave damages when not taken seriously (Papanek 2019).

In this paper, which is part of a PhD research project about design, ethics, and privacy, we introduce the relationship between privacy and user experience (UX) design, mainly through the lens of user interface (UI) design. Defining and conceptualising UX design is not easy. UX design focuses on "understanding products not just from "the outside"—i.e., in terms of form and function, but mainly "from the inside" of the experience of humans interacting with them in specific social and cultural circumstances" (Hernández-Ramírez 2019, p. 84). Therefore UX design may be seen as a process for crafting optimal experiences for users through products, services, or even entire organisations (Buchanan 2005) by always keeping human needs as a priority. In other words, by following a Human-Centred Design (HCD) approach.

HCD is an umbrella term that characterises both a design "philosophy" and a set of methods based on "a good understanding of people and the needs that the design is intended to meet" (Norman 2013, p. 9). A case can be made that a correct application of HCD ensures that "people's needs are met, that the resulting product is understandable and usable, that it accomplishes the desired tasks, and that the experience of use is positive and enjoyable" (Norman 2013, p. 219).

Our analysis focuses on UX in digital products and services, such as websites and apps. However, given the complexity of the topic, our contribution is limited to establishing some preliminary remarks and conclusions that will be further expanded in upcoming research. The relationship between UX design and privacy may be regarded in terms of two layers: (1) a visible layer, which comprises the visual, interactive elements of the user interface (UI) through which users surrender their personal data to digital service providers; and (2) an "invisible" layer, comprising the design patterns that either make the user experience privacy-friendly or invasive. This paper focuses on layer (1): it outlines the main features of a privacy-friendly UI. Layer (2) will be briefly discussed in the last section of the paper, where we will introduce our ongoing research in the field of ethical UX design. The methodology we used is based on a literature review and a qualitative assessment of good and bad practices in the real world, through a survey of 90 popular websites and apps accessible from the territory of the European Union (EU), run by European and non-European companies.¹

2 Layer One: A Privacy-Friendly UI

The interaction between users and digital products happens through interfaces. We call the UI the visible layer of the UX. Through the UI the user is invited (or forced, as we will see below) to "share" her personal data with the service provider. Although the UI is visible, the mechanism through which data is collected is not necessarily perceptible.

¹ In total, we assessed 80 websites and 10 apps, across various business sectors and countries. All websites and apps were accessed from Portugal between 15 December 2020 and 5 May 2021.

Personal information can be collected through the UI without consent thanks to tracking cookies and pixels (also known as web beacons), and similar technologies. When we talk about UI and privacy, the most important things are (1) properly informing users about the type and amount of data that is collected when they use the service; and (2) obtaining their consent to do so. Whether informed consent happens or not largely depends on the existing legal framework. Since our analysis was performed in Europe and the websites and apps we analysed are subject to the European Union (EU) 2016 General Data Protection Regulation (GDPR),² we will take into account primarily the reality and requirements in the EU.

The GDPR has been defined as a set of guidelines for a better and more authentic user experience (Ghazaryan 2018). Ideally, the GDPR offers design principles and guidelines that would lead to privacy-friendly UIs. However, complying with a complex legislation containing hundreds of articles, can become an obstacle for a good UX. For example, merely copying and pasting parts of the GDPR in a privacy notice may be enough, legally speaking, but for the average user having a modal window or overlay filled with legal jargon is both meaningless and annoying and does little to clarify what actually is going to happen with her data. From the outset, this approach to information disclosure violates Nielsen's second usability heuristic: matching the system to the real world (Nielsen 1994). Meaning that the UI should use words, phrases, and concepts familiar to the user, not jargon. Instead, however, privacy notices are so complex and long that only highly educated users with considerable free time can read them (Litman-Navarro 2019).

When users access a website for the first time, they are confronted with a cookie consent notice. HTTP cookies are strings of text that web servers send to users' browsers when they visit a web page and are stored on users' devices (Khosrow-Pour 2007). HTTP cookies store information such as a time stamp, a unique identification number, domain, internet address, and any other information used to identify users. Some information is stored for the best interest of the user (e.g., remembering the language settings), whereas other types are simply used to spy on users' activities. Currently, there are four main categories of cookies: 1) necessary or essential cookies (i.e., session cookies that identify the user and store information such as products added to shopping carts and user logins); 2) functionality cookies (used to store users' preferences such as language); 3) performance cookies (used to monitor and improve how a website runs); and 4) advertisement cookies. This last category includes mostly third-party cookies that are often used "to control the number of times an add is shown to a particular user" on a website, and are employed "for affiliate and retargeted marketing" (Falbe et al. 2020, p. 258–259). Advertising cookies can also track users across multiple websites, thus increasing the ability of companies to profile users based on their behaviour and preferences. Browsers such as Firefox and Safari (and soon, Chrome) block most third-party cookies by default to enhance users' privacy. However, some authors claim that blocking only third-party cookies is a power move rather than a privacy move, because it limits the ability of

² Regulation (EU) 2016/679 of the European Parliament and of the Council of 27 April 2016 on the protection of natural persons with regard to the processing of personal data and on the free movement of such data, and repealing Directive 95/46/EC (General Data Protection Regulation), OJ 2016 L 119/1.

smaller companies to compete online with giants such as Apple or Google (Geradin et al. 2020).

According to the 2002 ePrivacy Directive,³ all users within the EU must give their informed consent before cookies are installed on their devices, except for necessary or essential cookies. Nevertheless, digital service providers use various methods to make sure that users install advertisement cookies. These methods are called “dark patterns”, “evil design”, or “black hat UX”; they are “deceptive patterns that benefit the creator more than the user” (MacDonald 2019, p. 202). Ultimately, the goal of dark patterns is to invade users’ privacy; hence, “cookie consent dialogs almost universally employ manipulative design to increase the likelihood of users consenting to tracking” (Narayanan et al. 2020, p. 11), irrespective of what the applicable legislation says.

2.1 Unethical UI and Dark Patterns in Websites

During our qualitative research every commercial website we visited resorted to some form of dark pattern to nudge users to accept cookies. The degree of malice varies greatly: some websites allow users to accept all cookies, refuse all cookies, or personalise the settings, *although* not presenting all choices in an equal, neutral way. In the case of Air France, the option “Agree” is styled as a primary action in red, whereas “Reject” is styled as a secondary action. The nudging on this system-initiated modal window is strengthened by its position (at the centre of the page and in the foreground) and by the fact that navigation on the site is prevented until the user chooses either option.

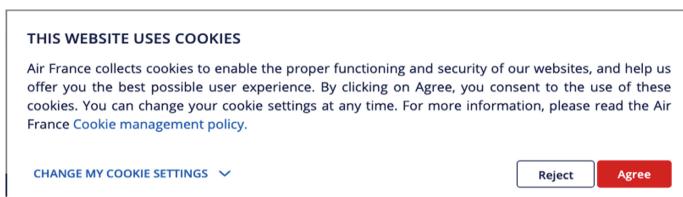


Fig. 1. Airfrance.com cookie consent banner: users are nudged to accept all cookies by clicking on the red button

Other websites show more intrusive dark patterns, where the user does not have a clear, immediate option to refuse all cookies. Instead, the modal window has further navigation nested, usually in the form of a settings management panel where the user is forced to select or deselect specific cookies. Figure 2 shows Facebook’s main cookie banner. As in the previous case, the cookie consent modal appears in the foreground preventing users from navigating the site until they select an option, and the primary action nudges users to “Accept All” cookies instead of directing them to “Manage Data Settings”. The “Accept All” button is styled as every other primary action button in the site.

³ Directive 2002/58/EC of the European Parliament and of the Council of 12 July 2002 concerning the processing of personal data and the protection of privacy in the electronic communications sector, OJ 2002 L 201/37.

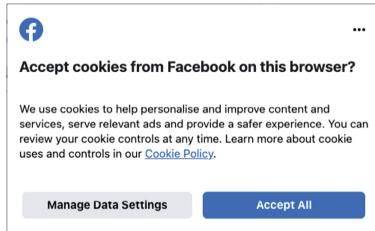


Fig. 2. Facebook.com cookie consent banner: again, users are pushed to accept all cookies through the different design of the action buttons of the cookie consent modal

A pervasive pattern in unethical cookie modals is that some options, usually the least privacy-friendly ones, are pre-selected (see Fig. 3) forcing the user to actively opt-out (Falbe et al. 2020; Ghazaryan 2018). Showing pre-selected check box elements to users is illegal in the EU, because the ePrivacy Directive makes mandatory for service providers to obtain users' consent to install cookies except for the strictly necessary ones. This principle has been recently reinforced by the Court of Justice of the European Union (CJEU) in the Planet49 case.⁴ According to the ruling, “it would appear impossible in practice to ascertain objectively whether a website user had actually given his or her consent to the processing of his or her personal data by not deselecting a pre-ticked checkbox nor, in any event, whether that consent had been informed.” Notwithstanding existing clear rules in the EU, pre-selected check box elements remain common in cookie consent modals.

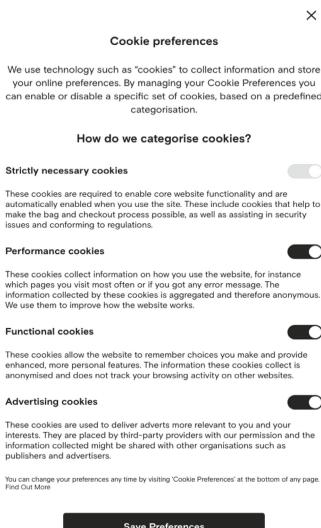


Fig. 3. Farfetch.com cookie preferences menu: pre-selected options to capture users' personal data are highly unethical (and illegal) dark patterns

⁴ Planet49, Case C-673/17, [2019], ECR (ECLI:EU:C:2019:801), at para. 55.

All the previous examples show the poor experience users are subjected to when interacting with modal cookie windows. Being forced to accept all cookies or to navigate into complex data settings tabs before having access to the contents of a site is frustrating. In the example below (Fig. 4), taken from the Italian newspaper *Il Sole 24 Ore*, users who reject all cookies need to go through several (rather confusing) tabs and click at least 20 checkboxes before being allowed to browse the website. Specifically, the user must click on the plus symbol (“+”) next to every set of cookies to reject the processing of her personal information, based on legitimate interest (which is illegal) or by third parties (unchecked pre-selected boxes, which is also unlawful). Notwithstanding the legal issues, this process clearly affects the website’s UX and it contradicts the principle that “windows, menus, and content should be simple, effective, and to the point” to avoid information overload (Coleman 2017, p. 92)—unless the user agrees to surrender her personal data by accepting all cookies.

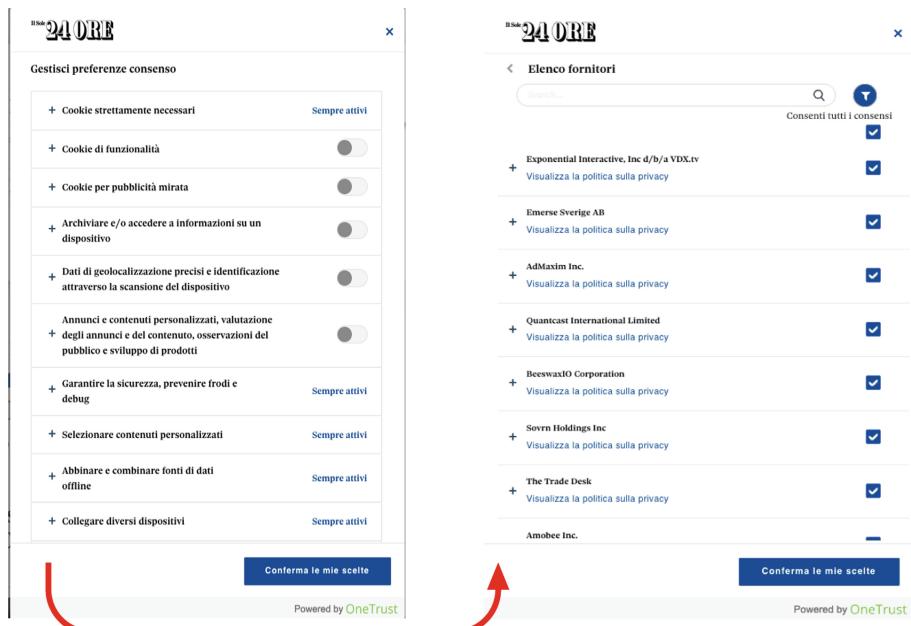


Fig. 4. Examples of option tabs from the ilsole24ore.com cookie consent modal: users are requested to click on several checkboxes to restrict the amount of personal data captured by the website and by third parties, thus jeopardising the overall UX

To provide a good experience when creating a cookie consent modal, UI designers need to consider mainly three elements:

1. Concise and clear text to explain users what cookies are used and for which purposes. Special attention should be given to the typeface, its size, line height, and kerning: the text should be not only visible but also *readable* (Coleman 2017; Pater 2016).

2. The options (to accept or refuse any cookies except necessary ones) must be presented in equal terms, without nudging them by making the “Accept all cookies” option the primary action. All options should be assigned the same colour because they are grouping related elements (Marcus 2013). Users should also have the possibility to manage their preferences more in detail, e.g., by accepting certain kind of cookies while refusing others. The laws of gestalt should be respected, in particular the rules of proximity and symmetry (Coleman 2017): the “Accept all” button should not be made prominent by separating it from the other options.
3. The cookie modal should be designed to be visually appealing: it should attract users and help them understand what it does (Coleman 2017). In addition, the modal should not prevent users from seeing the contents of the website, so that they can decide whether they want to continue browsing it and thus accept the necessary cookies. As shown in Figs. 1, 2, and 4, a cookie modal at the forefront and in the middle of the page is a mark of poor UX. Ideally, the cookie modal should be displayed at the top or bottom of the page, or on the left or right sides so that it is clearly visible, but not obstructive. UI designers should consider that, in most Western countries, users read a website from left to right and from top to bottom (Pernice 2017). In the example below (Fig. 5), it is likely that the cookie banner is the first thing users will see (Fig. 6).

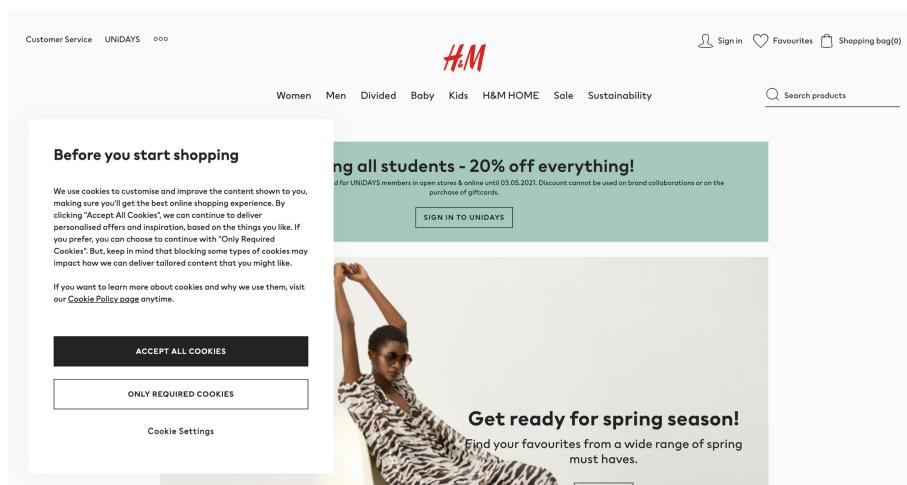


Fig. 5. Homepage of the website hm.com: good for its visibility, but still with a dark pattern (once again, users are nudged to accept all cookies)

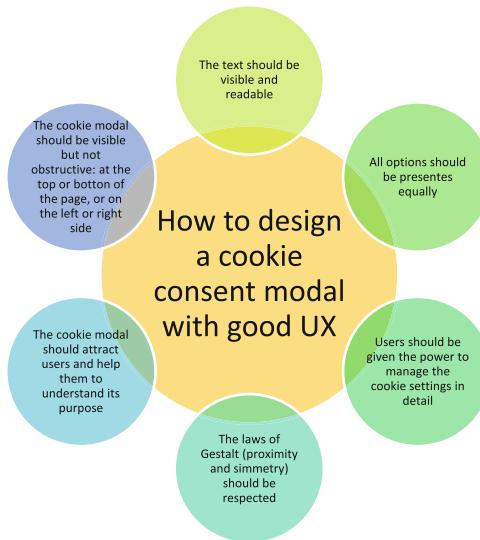


Fig. 6. Recommendations on how to design a cookie consent modal for websites with a good UX

2.2 Deceptive UI Practices in Mobile Apps

Mobile applications are also an important place for privacy violations. A recent study by US and Canadian researchers revealed that the Android Software Development Kit (SDK) “Jiguang” sends “consumers’ precise GPS coordinates over the Internet to servers in China, without any security precautions to prevent eavesdropping”. Furthermore, this SDK “is particularly concerning because this code can run silently in the background without the consumer ever using the app in which it is embedded” (Reardon et al. 2020, p. 5). The billions of users affected worldwide never agreed to such privacy invasions.

Privacy information and consent in apps is subject to specific constraints, typically related to the limited screen size of devices, its resolution and processing capacity. Nonetheless, even though the ePrivacy Directive only mentions cookies, according to article 5(3) of the ePrivacy Directive, consent is *always* required when a digital service or tool collects information of any kind and when they access data stored within users’ devices. When an SDK collects data stored in a mobile device, e.g., about other apps installed on the device (like Jiguang does), explicit and informed consent is required.

From an UI perspective, consent should be collected by the app provider *before* the app starts collecting personal data. In general, the first thing that users should be asked to do is accepting the terms of the legal agreement governing the provision of service. According to the GDPR, privacy terms should be presented in a clear way and separately from the other terms and conditions. Merging the privacy consent clause(s) with the other legal terms is not a legally viable option for service providers. However, the user should not be overwhelmed by the number of legal conditions she has to agree to. Some services use browse-wrap agreements, i.e. when the user needs to search for the legal terms and conditions in the app, which is a common technique and implies a tacit agreement by the user (Hamilton 2015). However, this solution is not fully compliant

with the EU's legal requirements, and it should be avoided. Instead, clickwrap, in which “the user has to *explicitly* click a check box or button with the words “I agree” on it” (Hamilton 2015) should be preferred. Figure 7, for example, illustrates a common type of clickwrap, used by apps that refer to their terms of service and privacy policy at the *end* of the registration form.

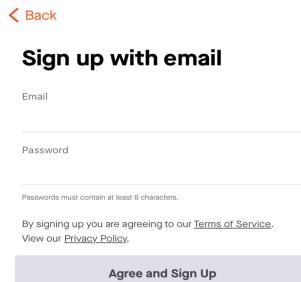


Fig. 7. Strava app registration form: users are presented with the option to read the Terms of Service and Privacy Policy, but they can agree and sign up without opening the links and actually reading the legal documents

In this case, only one option is available: agreeing to the Terms of Service and Privacy Policy. Our research revealed that this is a common pattern found in apps that require users to register. However, dark patterns are also found in apps that do not require users to sign up. The example below (Fig. 8) shows the privacy consent modal used by The Guardian's mobile app. This app uses mechanisms similar to cookies—although, they

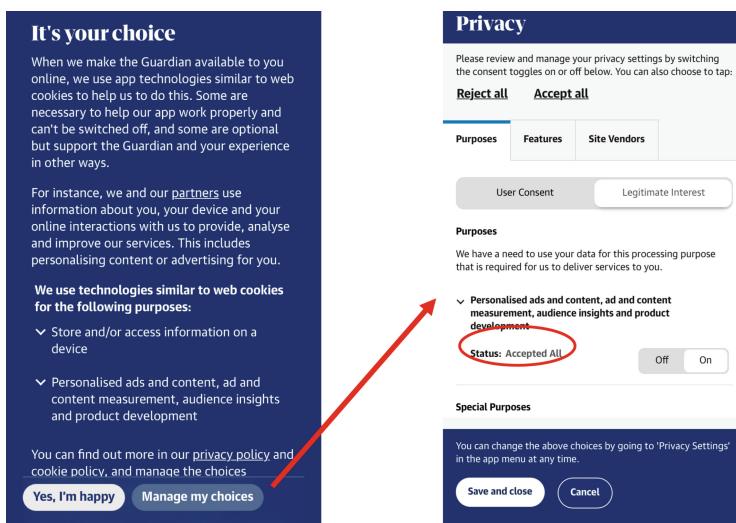


Fig. 8. The Guardian app privacy consent banner: users do not have the right to be unhappy and to refuse all cookies

are not explicitly mentioned—that collect users’ personal data for different purposes, including marketing and advertisement. The privacy consent modal is presented to users before they can browse the app’s content. An initial exploration of this modal reveals 3 major dark patterns:

1. Users are presented with only two options: ‘Yes, I’m happy’ and ‘Manage my choices’: ‘No, I’m not happy’ is not available.
2. The option ‘Yes, I’m happy’ is presented as a primary action.
3. If users want to manually manage their choices, all options related to the processing of personal data based on legitimate interest are pre-selected.

Unethical design such as dark patterns is a serious concern. Given its ubiquity, we wonder whether designers still know how to create digital products that respect users and their data. We conclude this section with a case that shows how an app, “Immuni”, created by the Italian Health Ministry as part of the effort to deal with the COVID-19 pandemic, properly informs users about the type of data collected and processed, through a clever use of text and symbols (Figs. 9 and 10).



Fig. 9. Immuni app privacy information screen: apps should use symbols that are easy to read and understand to explain how personal data is collected and processed

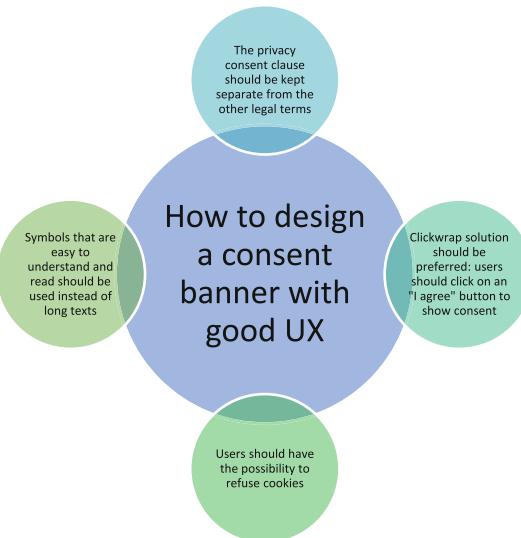


Fig. 10. Recommendations on how to design a cookie banner for apps with a good UX

3 Conclusions: Designing an Ethical UX Design

In the previous section we discussed how the current paradigm of UI design is seriously affected by ethical and legal issues. The use of dark patterns is the rule rather than the exception. The underlying problem is that aggregated personal data became an asset that can be collected, stored, and traded by companies and organisations. Moreover, data “can be sold over and over again without loss of its intrinsic value” (van Lieshout 2015, p. 5). However, data is also a potential liability: data breaches can be costly for companies (due to the fines from the regulators, loss of clients and business, and statutory or contractual compensation to affected parties). Consequently, personal data is in many ways a potentially toxic asset (Véliz 2020).

Power is the other side of the coin: the mechanisms and tools (e.g., forms) used by service providers to collect users’ data are designed “not just looking at legibility and functionality”, but they use “colours, graphic elements, and typefaces that create the appropriate identity of authority. Forms are a very direct visualization of a power structure” (Pater 2016, p. 170). These opaque power and authority schemes generate profit for service providers. They operate according to a hidden business agenda that, when discovered by users, should weaken their reputation and respectability. Why should a reader have to click more than 20 times to manage her privacy settings preferences but only once to surrender her personal data to a newspaper like Il Sole 24 Ore? Why should a user spend precious minutes of her time going through the privacy tabs of The Guardian and uncheck numerous pre-ticked boxes that otherwise take for granted that the reader agrees with the transfer of her personal data to third parties?

Lack of transparency is alarming as far as media companies are concerned: the sale of audiences’ personal data contributes to finance the activities of media companies. Who are the buyers? How much do they pay per year? Are contracts with buyers properly

disclosed and the corresponding revenues clearly described in the balance sheets of the media company? Are buyers able to influence, directly or indirectly, the editorial line of the newspaper or magazine? Similar concerns arise in other sectors too. More and better regulation can help to solve these problems (Véliz 2020). However, laws tend to add layers of complexity, they have loopholes, and are not stable in time (Taleb 2018). The literature agrees that purely legal approaches are not likely to solve privacy issues (Couldry and Mejias 2020; DeBrabander 2020; Solove 2006; Zuboff 2019). The answer should come from various disciplines, including privacy law, competition regulation (Doctorow 2020), applied ethics and, more important for our case, design.

Our ongoing research focuses on the ethical dimension of design in the privacy context; we argue that designers should contribute to the development and implementation of ethical, privacy oriented UX design. As introduced in the first section of this paper, UX design, intended as the creation of the experience for the user, is an invisible layer: the user does not know *how* and *for which purposes* the experience has been designed. In the case of the media mentioned above, have the experience and the product (website and app) been designed exclusively or mainly to provide the user with meaningful content, or also to capture her personal data for profit in surreptitious ways?

UI design is the visible side of the experience: although more research in this field is necessary, we expect that ethically oriented UIs correspond to an overall ethical design of the user experience. In other words, UI design is a tool to reach some pre-determined goals. Our current and future research efforts are devoted to understanding how designers should translate ethically minded objectives into UX design products and how the UI should reflect it. We are aware that these issues transcend the traditional borders of UX and UI design; however, these concerns are truly design concerns. If the scope of design is “to create knowledge in a physical, tangible way” (Zurlo 2019, p. 18), and assuming that design products are also the organisations (Buchanan 2005) that decide to capture (or not) personal data, we realise that designers are best positioned to lead the ethical, privacy oriented transformation of and within companies and society at large. Change implies creativity: designers’ imagination “provides an add-on aspect to other corporate cultures by acting as a tool for reforming the prevailing organizational culture” (Zurlo 2019, p. 17). It is time for designers to use their creativity and skills to plan, build, and execute a better world where users’ privacy is finally respected and enhanced.

Acknowledgements. This study was supported by UNIDCOM under a Grant by the Fundação para a Ciência e Tecnologia (FCT) no. UIDB/DES/00711/2020 attributed to UNIDCOM/IADE – Uni- versidade Europeia, Lisbon, Portugal.

References

- Bowles, C.: Future Ethics. NowNext Press, London (2018)
- Buchanan, R.: Design ethics. In: Mitcham, C. (ed.) Encyclopedia of Science, Technology, and Ethics, vol. 2, pp. 504–510. Thomson Gale (2005)
- Coleman, C.V.: Visual Experiences: A Concise Guide to Digital Interface Design. Taylor & Francis, CRC Press, Boca Raton (2017)
- Couldry, N., Mejias, U.A.: The Costs of Connection: How Data Is Colonizing Human Life and Appropriating It for Capitalism (2020). <https://doi.org/10.1515/9781503609754>

- DeBrabander, F.: *Life After Privacy: Reclaiming Democracy in a Surveillance Society*. Cambridge University Press, Cambridge (2020)
- Doctorow, C.: *How to Destroy Surveillance Capitalism*, 1st edn. Medium Editions, New York (2020)
- Falbe, T., Andersen, K., Frederiksen, M.M.: *Ethical Design Handbook*. Smashing Media AG, Freiburg (2020)
- Floridi, L.: *The 4th Revolution: How the Infosphere is Reshaping Human Reality*, 1st edn. Oxford University Press, Oxford (2014)
- Foster, J.B., McChesney, R.W.: Surveillance capitalism: monopoly-finance capital, the military-industrial complex, and the digital age. *Monthly Rev.* **66**(3) (2014). <https://monthlyreview.org/2014/07/01/surveillance-capitalism/>
- Geradin, D., Katsifis, D., Karanikioti, T.: GDPR Myopia: how a well-intended regulation ended up favouring Google in Ad Tech. *SSRN Electron. J.* (2020). <https://doi.org/10.2139/ssrn.3598130>
- Ghazaryan, A.: UX Design and GDPR: Everything You Need to Know. Designmodo, 23 May 2018. <https://designmodo.com/ux-gdpr/>
- Hamilton, L.: Laws of Design: How to Display Your Legal Agreements in Your Mobile App. *Interfaces & Interactions*, 15 July 2015. <https://medium.com/ui-collection/laws-of-design-how-to-display-your-legal-agreements-in-your-mobile-app-8dd09556bd48>
- Hernández-Ramírez, R.: On the origins and basic aspects of user-centered design and user experience. In: Ayanoğlu, H., Duarte, E. (eds.) *Emotional Design in Human-Robot Interaction*. HIS, pp. 71–92. Springer, Cham (2019). https://doi.org/10.1007/978-3-319-96722-6_5
- Khosrow-Pour, M.: *Dictionary of Information Science and Technology*, vol. 1. Idea Group Reference (2007)
- Litman-Navarro, K.: We Read 150 Privacy Policies. They Were an Incomprehensible Disaster. [The New York Times]. The Privacy Project, 12 June 2019. <https://www.nytimes.com/interactive/2019/06/12/opinion/facebook-google-privacy-policies.html?mtrref=undefined&assetType=REGIWALL>
- MacDonald, D.: Practical UI Patterns for Design Systems: Fast-Track Interaction Design for a Seamless User Experience. Apress (2019). <https://doi.org/10.1007/978-1-4842-4938-3>
- Marcus, A.: Color my UX readable. *Interactions*, 15 March 2013. <http://interactions.acm.org/blog/view/color-my-ux-readable>
- Monteiro, M.: Ruined by design: How designers destroyed the world, and what we can do to fix it (2019)
- Narayanan, A., Mathur, A., Chetty, M., Kshirsagar, M.: Dark patterns: past, present, and future: the evolution of tricky user interfaces. *Queue* **18**(2), 67–92 (2020). <https://doi.org/10.1145/3400899.3400901>
- Nielsen, J.: Enhancing the explanatory power of usability heuristics. In: Proceedings of the SIGCHI Conference on Human Factors in Computing Systems, pp. 152–158 (1994). <https://doi.org/10.1145/191666.191729>
- Norman, D.A.: *The Design of Everyday Things* (Revised and expanded edition). Basic Books, New York (2013)
- O’Neil, C.: *Weapons of Math Destruction: How Big Data Increases Inequality and Threatens Democracy*, 1st edn. Crown, New York (2016)
- Papanek, V.: *Design for the Real World*. Thames & Hudson, London (2019)
- Pater, R.: *The Politics of Design: A (Not so) Global Manual for Visual Communication*. BIS Publishers, Amsterdam (2016)
- Pernice, K.: F-Shaped Pattern for Reading Web Content: Misunderstood, But Still Relevant (Even on Mobile). Nielsen Norman Group, 12 November 2017. <https://www.nngroup.com/articles/f-shaped-pattern-reading-web-content/>

- Reardon, J., Good, N., Richter, R., Vallina-Rodriguez, N., Egelman, S., Palfrey, Q.: JPush away your privacy: a case study of Jiguán's Android SDK (2020)
- Solove, D.J.: *The Digital Person: Technology and Privacy in the Information Age*. New York University Press, New York (2006)
- Taleb, N.N.: *Skin in the Game: Hidden Asymmetries in Daily Life*, 1st edn. Random House, New York (2018)
- Lieshout, M.: The value of personal data. In: Camenisch, J., Fischer-Hübel, S., Hansen, M. (eds.) *Privacy and Identity 2014*. IAICT, vol. 457, pp. 26–38. Springer, Cham (2015). https://doi.org/10.1007/978-3-319-18621-4_3
- Vélez, C.: *Privacy is Power: Reclaiming Democracy in the Digital Age*. BANTAM Press, London (2020)
- Waldman, A.E.: *Privacy as Trust: Information Privacy for an Information Age*. Cambridge University Press, Cambridge (2018)
- Warren, S., Brandeis, L.: The right to privacy. *Harv. Law Rev.* **4**, 193–220 (1890)
- Zuboff, S.: *The Age of Surveillance Capitalism: The Fight for a Human Future at the New Frontier of Power*, 1st edn. PublicAffairs, New York (2019)
- Zurlo, F.: Designerly Way of Organizing. II Design dell'Organizzazione Creativa | Designerly Way of Organizing. *The Design of Creative Organization*. Agathon **5**, 11–20 (2019). <https://doi.org/10.19229/2464-9309/522019>



Search Engine Interfaces for Sign Languages: Designing a Multilanguage Questionnaire to Collect Signers' Perception of Handshapes Similarities

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Abstract. Sign language search engine interfaces in dictionaries are different from spoken languages', as they have numerous visual elements representing its phonological parameters in the design. One of these parameters is called handshape. In this study, we address the process of designing a questionnaire to assess handshapes similarity, as the understanding of how signers perceive these similarities is an important step towards using design principles for supporting innovative ways of displaying handshapes on search engine interfaces. We start by presenting sign language handshapes and their use on search engine interfaces. Next, we describe the development of a multilanguage questionnaire to assess handshapes similarities. This process consists of designing handshapes similarity questions, running a focus group, redesigning the questions, and translating from English to four target languages (Libras, NGT, Portuguese, and Dutch). Having finished the questionnaire design, we started collecting data from Brazilian and Dutch signers. Results reveal some of the complexities involved when approximating design and sign language linguistics in the development of digital interfaces. Beyond reassuring the importance of responsive content in the questionnaire's interface design and having the end-user participate in the process, which are already points of convergence in the research literature, our study reveals a possible influence of 'orientation' in handshape similarity assessment.

Keywords: Sign language dictionaries · Visual search interfaces · Handshape similarity

1 Introduction

Organizing information in systematic and meaningful ways is a core aspect of interface design. Spoken language search engine interfaces may function with only a few visual elements, as their fundamental form is a text field for inserting keywords and/or characters.¹ Sign language search engines, however, use numerous visual elements, attempting

¹ Examples: <https://www.google.com/> <https://www.bing.com/> <https://www.baidu.com/> <https://www.yahoo.com/>.

to represent the intricacies of its phonological parameters. These interfaces can be found, for example, in online dictionaries when searching for the meaning or translation of a given sign.² Using these sign language-based interfaces is an experience that can result in frustration, with users sometimes stopping their efforts during the process.

Sign languages are like spoken languages in many ways, but their words are not composed of consonants and vowels but simultaneously organized parameters. Basic descriptions distinguish the handshape, movement and location of the hands; and whether a sign is one-handed or two-handed. Sign language dictionaries are always bilingual, between a spoken language and a sign language. While searching via the spoken language can happen through the writing system, sign languages are unwritten languages. Although orthographies for sign languages have been developed, they are not in common use in any deaf community.

One phonological parameter frequently found composing sign language search engine designs is handshape. On these interfaces, handshapes are usually organized by alphabetical order or by the number of selected fingers. These criteria for designing information meet the abstract categorizations of sign language linguistics theory as well as the logic of computers and, as a consequence, systems work. Including handshapes images in addition to or substituting their names is an important step into designing interfaces more coherent with deaf users, as it allows them to interact with systems using their mother language. Simultaneously, it further explores human visual perception – the perceptual organization process – as it is far faster than the thinking process. Hence, Design, as a discipline that watches over human aspects of interfaces – Inclusive Design, Design for all, Universal Design, Human Centered Design, Design thinking – is invited to investigate how handshapes can be organized according to users' visual perception. A better understanding of this relation can provide new insights for designers to improve usability and accessibility, and, consequently, to develop more intuitive inclusive interfaces.

Handshapes can assume many configurations, some being very similar and some radically different from one another. These different levels of similarity, in this approach, become clues for shifting the focus from abstract classifications and representations, such as letters or names, to the actual nature of visual stimuli, in layout design decision making. Therefore, further understanding of how signers perceive these similarities is an important step towards using design principles for supporting innovative ways of displaying handshapes.

In this paper, we examine the process of developing a questionnaire to collect data from Brazilian and Dutch signers about handshape similarity. This questionnaire is the first step of performing a multidimensional scaling analysis to identify unrecognized evaluative dimensions of handshape properties. These dimensions, in turn, can be applied in future projects as guidelines for experimenting with innovative handshape layouts possibilities.

² Examples: <https://www.britishsignlanguage.com/>, <https://www.british-sign.co.uk/british-sign-language/dictionary/>, <http://dicto.lsfb.be/>, <https://glossario.libras.ufsc.br/>, <https://www.handspeak.com/word/asl-eng/>, <https://www.nzsl.nz/>, <http://sematos.eu/>, <http://slinto.com/jp/>, <http://suvi.viittomat.net/signsearch.php>, <http://tegnsp.org.dk/>.

2 Background

2.1 Sign Language Handshapes

In the world, there are 70 million deaf people and more than 300 different sign languages [1]. Unlike spoken languages, which are assumed to be descended from a common great-grandparent spoken among early humans, sign languages emerge in communities where there are sufficient deaf people living together [2]. Deaf communities are linguistic and cultural minorities in the countries they reside in and usually only include deaf people who are fluent users of sign languages. Their values and traditions; cultural expressions through theatre, poetry, storytelling, events, and media; and deaf education are permeated by sign language. The use of sign language, however, is not restricted to deaf communities. A broader group is also composed of hearing sign language users such as hearing children of deaf adults (codas), hearing parents of deaf children, interpreters, second-language speakers, and deafblind people using tactile sign language [3].

In scientific research, the fact that sign languages are natural languages was established in 1960, when William Stokoe published the first analysis of the phonological structure of American Sign Language [4]. At the phonological level, the sublexical structure of signs, that is, the formal aspects of signs below the syllabic level, can be described and analyzed. Originally, these aspects were defined as *designator* (articulator/handshape), *tabula* (place of articulation/location), and *signation* (movement). Analyses carried out after Stokoe's added another two distinct aspects, one referring to the hand orientation and the other to non-manual aspects of the signs, like facial and body expressions [5]. Thus, five aspects, also known as phonological parameters, are considered in the structure of a sign: handshape, location, movement, orientation, and non-manual components. In this paper, we examine 'handshape', as it is the most complex parameter in terms of internal structures and visual components. Linguistic analyses have further spelled out handshape regarding constituent properties like selected fingers and finger configuration, but these are rarely included in search interfaces.

Handshape (or designator) is the configuration of the hand or hands which make a movement in a location [4]. A sign language inventory consists of many handshapes, while a number of these can be found across distinct languages. Brazilian sign language – Libras –, to illustrate, has 46 distinct handshapes [6] and Sign Language of the Netherlands – NGT – has 31 [3]. A handshape can be used to compose signs (phonemic handshape), to represent a letter of a written alphabet (manual alphabet), or a number (numeric system). It is essential to distinguish between these because although sometimes handshapes in different groups overlap, there can be specific sets of handshapes for each group in a sign language. Note that all of these handshapes must somehow be available on search engine interfaces.

Fingers in a handshape can assume several configurations, some being similar and some radically different from one another. In this sense, strategies for categorizing recurring features of handshapes were developed by sign language linguists. An example of how a set of handshapes can be documented on a digital system is found in the Global SignBank – an international lexical database for sign languages, which hosts 19 distinct datasets [7]. It uses seven different classifications, namely:

- curved, if the handshape is curved, rounded or clawed;
- bent, if bent at the base joints;
- baby-, if produced with one selected finger (and opposed thumb);
- 2, if produced with two selected fingers;
- –open and –closed, if the thumb opposes the selected finger(s); and
- –spread, if the selected fingers are spread.

In sign language, signs are made using one or two hands. Two-handed signs can be divided into symmetrical, where hands have the same handshape and make the same movement, and asymmetrical, where the non-dominant (weak) hand functions as the place of articulation for the dominant (strong) hand [3].

2.2 Hanshapes in Search Engines

A search engine is “a program that searches for and identifies items in a database that correspond to keywords or characters specified by the user [...]” [8]. The main search engine currently used on the web is Google search, which from November 2019 to October 2020 held 83,56% of the market, considering access via desktops/laptops, mobiles and tablets [9]. The design of this system interface is simple and emphasizes the text field to insert keywords and/or characters. For users who know a spoken language, the interface has features that enable a search, as information can be entered by typing or vocalizing terms. For deaf users who know a sign language, however, the interface does not present any alternative option.

As suggested by [10], the ideal solution to make the internet and all web content accessible for deaf people would be “an automatic, spontaneous translation of all content, the deaf user is interested in and wants to find out about. The other way round SL-input had to be recognized (e.g. via webcam), and translated into written language”. Despite the advances in research fields like computer image recognition and artificial intelligence, such systems are not yet a reality in deaf people’s lives. As [11] mention, automatic signal recognition systems are changing from small artificial vocabularies to large and closer to real-world ones. However, they stress, realistic scenarios are still quite challenging for current algorithms.

An alternative to overcome this problem is the use of sign language’s phonological parameters on search engine interfaces, allowing users to search for signs while inputting information using features of a sign such as handshape, movement, location, facial expression, among others. In this context, handshapes become images representing specific hand configurations, organized so that each of them can be found quickly. Although the most common way of displaying handshapes in search engines is alphabetical order, following a long tradition of spoken languages dictionaries structure, alternative approaches are available. By way of illustration, the New Zealand Sign Language dictionary offers the possibility to search from a drop-down menu, with handshapes organized into groups. Accordingly, using a distinct approach, there is the SLinto dictionary for Japanese sign language, which organizes handshapes in the logic of a virtual keyboard (Fig. 1).



Fig. 1. Examples of handshapes layouts on search engine interfaces.

In the research literature, there are only a few studies relating sign languages to search engine usability. For example, when searching for evidence in the past decade using the terms usability, accessibility, evaluation, analysis, study, method, sign language, handshape, and search engine; connected by Boolean operators, only six publications could be found [12]. Furthermore, none of these publications focuses on examining the design of handshapes layouts.

3 A Multilanguage Questionnaire to Assess Handshapes Similarity

This research originates from the need for creating an order of objects (images) based on the perception of a specific audience (signers), and, for this purpose, performs a multidimensional scaling analysis. Multidimensional scaling, according to [13], is a procedure that allows a researcher to determine the relative perceived image of a set of objects, with the objective of transforming consumers' judgment regarding similarity or preference in distances represented in a multidimensional space. This analysis is divided into three basic steps. The first is to collect data about objects' similarities. The second is using multidimensional scaling techniques to estimate objects' relative positions in a multidimensional space. Finally, the third is to identify and interpret the multidimensional space. The ultimate goal for performing a multidimensional scaling analysis is to identify unrecognized evaluative dimensions that affect behavior. For designers, these previously unrevealed dimensions used to evaluate similarity can be applied, in future projects, as guidelines.

The procedures of this multidimensional scaling analysis are based on the decision-making diagram suggested by [13]. To fulfil the first basic step of the analysis, to collect data about handshapes similarity, we developed a multilanguage questionnaire. This process consisted of designing handshapes similarity questions, performing a focus group, redesigning the questions, and translating from English to four target languages (Libras, NGT, Portuguese, and Dutch). Having finished the questionnaire design, we started collecting data from Brazilian and Dutch signers, as they represented signers from two unrelated sign languages.

3.1 Designing Handshapes Similarity Questions

The method for collecting similarity data was the comparison between pairs of objects. In this method, each of the handshapes in the studied group must be compared to all

others. As we had two distinct sign language datasets, Libras and NGT, the number of possible combinations to be assessed was too high relative to the number of expected participants. For this reason, we established ‘frequency’ as a criterion to decide what handshapes would be selected. Frequent handshapes appear in many signs and, hence, users are more likely to search for them. In this sense, a search engine interface should facilitate, at least, those contrasts. Therefore, the first issue we addressed was to determine the frequency of every handshape in the datasets. In his case, we considered:

- the number of times it was registered in the Strong Hand category;
- the number of times it was registered in the Weak Hand category; and
- the information about handedness, i.e. if the sign was one-handed or two-handed, and in the case of two-handedness, whether the sign was symmetrical or not.

The information about handedness allowed separating the strong hand from the weak hand occurrences and find out which and how many handshapes were used in each class. Also, it allowed detecting those cases where a handshape would be counted twice for the same sign. As symmetrical signs have the same handshapes simultaneously used by the signer, they were counted as one handshape appearance. Thus, the frequency (F) a handshape appeared in a dataset was determined by summing one-handed (a), two-handed asymmetrical (b), two-handed symmetrical signs (c) divided by two, and cases in which handedness information was not applicable (d): $F = a + b + c/2 + d$.

This approach led to creating two separate data tables, one for NGT and one for Libras. The NGT dataset initially had 4121 entries and resulted in 82 different handshapes detected, while Libras had 3086 entries and resulted in 386 handshapes detected.³ After having the information from both datasets independently, a third table was created. It contained 18 handshapes found in both datasets with frequencies greater than 50 in at least one of them. As this number generated a yet considered, wide range of combinations, we opted for selecting every other handshape on the list. The sample resulted in nine different handshapes with frequencies ranging from 700 to 70.5. At the end of this process, two handshapes were added to represent those with fewer occurrences in the datasets. These handshapes also were present in both datasets and had a similar total number of occurrences, namely eight and seven. The 11 selected handshapes resulted in 55 possible combinations. The final sample, relating handshapes and their frequencies, is expressed in Table 1.

³ The datasets showed a great difference in numbers of handshapes detected, while NGT’s had 82 entries Libras’s had 386. This difference could result from the use of too detailed descriptions or from a slightly different way of making the records in the Libras dataset.

Table 1. Selected handshapes and their absolute frequencies in NGT and Libras.

Handshape	NGT	Libras	Cumulative frequency
B	459	241	700
S	229	101	330
C_spread	127	84.5	211.5
V	124.5	71.5	196
C	105	51.5	156.5
Baby_C	84.5	38.5	123
B_bent	76.5	39	115.5
Y	47.5	57	104.5
Beak_open	58.5	12	70.5
Beak2_open_spread	3	5	8
5r	5.5	1.5	7

Knowing what handshapes would take part in the questionnaire led to the production of their images. These images were conceived to enhance the shape of the hand, therefore information such as colors and backgrounds were removed. Different orientations of the hand were used during the image capturing section, so that handshape's main features and details became visible (Fig. 2).

**Fig. 2.** Selected handshapes' images.

When images were ready, it was time to start building the questionnaire's first version. This version was in English and carried illustrative videos to simulate sign language texts. There were four texts in total, one for welcoming the participant and explaining the research's background, one for asking about participants' relationship with the language, one for explaining the similarity questions, and finally, one for thanking participants.

The technique used to approach perceptual mapping was the decompositional method, where measures are obtained by a general assessment of objects' similarities. Proximity data was designed to be of similarity, meaning that high values represent small distances and low values large distances between objects, e.g., a similarity value equal to 1 means objects were evaluated to be far from one another.

As the input data for similarity was metric, questions laid out a five-point horizontal scale ranging from 'not similar' on the left to 'very similar' on the right. Above the scale, there were two handshape images vertically aligned—this layout optimized visualization on mobile devices. One more observation about structuring the questions is that while arranging pairs of handshapes we paid attention to change the order that a specific image would appear in every other combination, i.e. when one handshape appeared on the top

position in a question, in its next occurrence we made sure it was on the bottom, and vice versa (Fig. 3).



Fig. 3. Example of a question design

Thereafter finishing the first version, the questionnaire was taken to be evaluated by a focus group.

3.2 Focus Group

A focus group is a qualitative method used to measure opinions, feelings, and attitudes about the questionnaire design. According to [14], the power of focus groups lies in the dynamic created by a group of well-chosen people under the guidance of a skilled moderator. This environment encourages participants to share their experiences, stories, memories, perceptions, desires, needs, and fantasies. Therefore, when analyzing this data, it is important to revisit the logic participants used to arrive at conclusions and look for recurrent topics to find specific trends.

Usually, a setup for a focus group involves people sitting in a room around a table. However, due to recent measures towards social interactions, because of the coronavirus pandemic situation, this focus group was held online by video conference. The group met on February 23rd from 13 h30 to 15 h (in UTC+01:00) and was composed of seven people plus one of the researchers, the moderator, and two sign language interpreters (NGT – English). Among participants, there were three deaf people and four hearing people, all native or fluent signers. In addition, the group was composed of sign language linguists, being three senior researchers and four postgraduate students. The meeting started with a presentation made by the researcher about the questionnaire design – questions, flow, texts, and interface. When this presentation ended, the moderator managed to start discussions, which lasted for about one hour.

The content of discussions was registered by the researcher during the meeting and was later analyzed. Results are as follows:

- Placing images top-bottom instead of side-by-side was not an issue that would influence the evaluation process. Furthermore, it established an axial contrast with the five-point scale, which was a good strategy to help overcome biased assessment.
- Image scaling was satisfactory, providing good visualization of essential features of the handshapes.
- The five-point scale was assessed as providing poor options for the participant to precisely represent its opinion.

- The criterion used for deciding handshapes orientations in the pictures was an issue raised by the group; it could influence how participants read handshapes and, therefore, the way they judge similarity.

These analyses entailed two modifications to the original questionnaire version. First, two more points were added to the five-point scale. There was no more room available to add more points and allow an even more precise scale, as it would compromise question visualization on mobile devices. Second, two additional questions were added to serve as an initial investigation of orientation and handshape representation. A combination of two handshapes with some shape similarity – C and Baby_C – was selected and mirrored. The three combinations of the same pair of handshapes are presented in Fig. 4. We intend, with these questions, to understand if orientation plays a role in the visual perception of handshapes similarity.

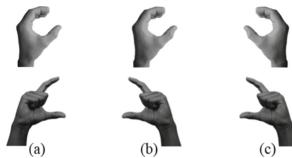


Fig. 4. Combining different orientations for the same pair of handshapes.

With these modifications made and the final set of questions determined, we then started the translation process.

3.3 Translations

All the texts used in the questionnaire were available in four languages: Libras, Portuguese, NGT, and Dutch. Libras and Portuguese were available in one version, while NGT and Dutch in another version. Sign language texts were emphasized by appearing before the written texts and providing good visualization with large video windows on the interface. To ensure sign language videos would be entirely visible on different screen resolutions a Cascading Style Sheets (CSS) code was written, making content responsive.

The translation flow occurred as illustrated in Fig. 5. First, the initial English version was translated into Portuguese and Dutch. Following, these texts were passed to interpreters who produced the sign language texts.

While spoken language translations were made by researchers, contextualized with texts' themes and finalities, sign language translations demanded interaction between researchers and interpreters to ensure quality. This strong interaction between designers and interpreters is commonly noticed in projects of bi-lingual bi-modal interfaces and has already been integrated with some design methodologies, e.g. [15].

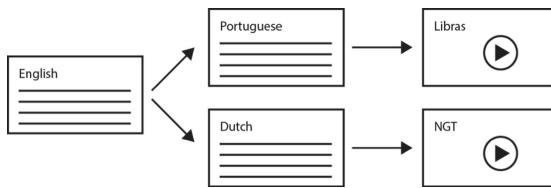


Fig. 5. Translations flow

3.4 Collecting Data About Handshapes Similarity

An anonymous link to the questionnaire website was available for participants from April 19th until May 4th, 2021. Libras and NGT signers were invited to answer it, as having signers from two unrelated sign languages broadened the population and increased the sample's heterogeneity. As a whole, these participants profiles are intended to support formulations capable of being implemented on international applications, such as the Global SignBank. To reach participants, we established the following strategies: to email researchers personal contacts fitting the profile; to post invitations on social media; and email research groups related to Libras and NGT.

When accessing the link, participants started a procedure constituted of five parts or blocks. Initially, they read a text explaining the research theme and background. At the end of this section, there was a text field where participants could leave an email address if they were interested in receiving results. These emails were not linked to participants names, nor were they used for other purposes than offering feedback.

Subsequently, participants were asked if they considered sign language their mother language. In case of a negative answer, meaning he or she was not a native signer, a question about what year they had started learning sign language followed. This particular flow permitted to record data from a broader spectrum of signers, natives and non-natives while maintaining the possibility of using filters and work with specific samples within this group in the future.

Reaching the third block a text explaining the similarity question was presented. The questions with pairs of handshapes to be assessed were in the following block. Considering respondents may vary in the dimensionality they use to form their perceptions, which associate varying levels of importance to one dimension and that their judgments need not to remain stable, that is, the same perceptions cannot be expected to be maintained for long periods; only half of the total number of combinations available were assessed by each participant, i.e. 28 of the 57 available pairs were randomly selected from the database and composed every new questionnaire. Finally, participants advanced to the last block, containing acknowledgements.

4 Methodological Issues in the Questionnaire's Design

In total, 94 people started to participate in this study. Twenty-four participants quit before the similarity question, eight of which were native signers. Therefore, 70 participants completed the entire process, being 29 native signers and 41 signers, with the years they started learning sign language ranging from 1986 to 2019. Participants took an average

of five minutes to complete the procedures. Forty-four participants used desktops, and 26 used mobile devices, with 28 different screen resolutions, to answer the questions. Finally, 51 participants left their email addresses, interested in receiving results.

The variety of devices and screen resolutions participants used to complete questionnaires emphasize the importance of making responsive content when working with sign language. Video windows, unlike sentences or paragraphs, cannot be divided and rearranged to fit a screen. When a signer has parts of his or her body outside screen limits, parts of the text are lost. Of course, users can always re-locate the video window to centre it to the screen, but having to pause workflow to perform this task may affect usability's quality components such as learnability, errors, and satisfaction [16]. Furthermore, in some cases, even when performing this action, the signer's body may not fit into screen limits.

Another issue worth discussing is the change in traditional focus group configuration described by [14] as having participants in a room sitting around a table. In our experience, making the focus group in a virtual room to analyze a digital interface let participants evaluate the object closer to a real environment. In addition, as it is reported in the literature, we found that focus group composition was a fundamental part of the success of this group. The presence of native and non-native fluent signers created a space where sign language was simultaneously a medium and an object of discussion. In an environment permeated with sign language, participants felt comfortable about expressing their ideas.

A point of discussion raised by the focus group was about orientation, which led to the inclusion of two new questions in the questionnaire. Results to these questions, displayed in Table 2, demonstrate participants evaluating differently the three pairs of handshapes shown in Fig. 4, in which the same handshapes are compared in different orientations. Signers' perceptions of handshapes similarities, hence, were influenced by changes in orientation. This influence, in turn, could suggest that orientation is a factor that must be considered when designing handshapes in search engines.

Table 2. Mean values for similarity perceptions of handshapes exploring different orientations.

Handshapes	Libras	NGT	Average
Pair (a)	5	4	4.5
Pair (b)	3.6	4.33	3.965
Pair (c)	4.1	4.75	4.425

The concept of orientation can be found in both fields, design and linguistics. For example, in design sketching, orientation refers to the position of an object in space, and it is a vital concept for product representation, as the relation between orientation and viewpoint determines the way we perceive objects [17]. Simultaneously, in linguistics, orientation can be found as a phonological parameter, defined by the direction in which the hands palms are facing, and can theoretically be described as having infinite possibilities [18].

In our sample, six handshapes were represented in the forward orientation, two to the right, one to the left, and two needed angles so all their features could be clearly read. In linguistics, there are standardized orientations, e.g. in Libras, there are six: upwards, downwards, towards the body, forward, to the right and to the left [5]. From a design perspective, it seems interesting to embrace this classification, customizing it by adding classifications for the angled perspectives. By doing this, choosing an orientation for a handshape design would not be left entirely to intuition.

5 Conclusion

The development and application of a questionnaire to assess handshapes similarities revealed some of the complexities involved when approximating design and sign language linguistics. Beyond reassuring the importance of making responsive content in the questionnaire's interface design and having the end-user participate in the process, already points of convergence in the research literature, our study revealed a possible influence of 'orientation' in handshape similarity assessment. This influence, in turn, could suggest the existence of a design parameter to support decisions previously based only on talent and/or intuition.

The questionnaire developed and discussed is the first basic step of performing a multidimensional scaling analysis. Hereafter, the database it created will be used to estimate handshapes relative positions in a multidimensional space. Having handshapes laid out on space will enable identifying and interpreting dimensions of handshape properties. These dimensions will, then, lead to guidelines for experimenting with innovative handshape layouts possibilities.

This study concerns about visual impressions of articulations of the hand, leaving out elements of visual perception and design such as color, scale, texture, transparency, movement, grid, layers, as well as principles like proximity, similarity, closure, gradation, radiation, concentration, among others, that also can be fundamental for designing easy to use interfaces. All these aspects are yet to be investigated in the context of handshapes representation and layout, hence, configuring a new and open field for future research.

To conclude, our sample was based on frequencies of handshapes appearances in datasets; however, it would enrich this research perspective to compare to similar studies using other ways for selecting them, e.g. manual alphabets or handshapes representing selected fingers. There is a need for more studies in this field to uncover the intricacies found in the relationship between sign language and technology.

Acknowledgements. We thank the interpreters Dr Márcia Felício Scolari and Tom Uittenbogert for the sign language translations used in the questionnaires. This study was financed in part by the Coordenação de Aperfeiçoamento de Pessoal de Nível Superior - Brasil (CAPES) - Finance Code 001.

References

1. World Federation of the Deaf. <https://wfdeaf.org>. Accessed 29 Mar 2021

2. Hiddinga, A., Crasborn, O.: Signed languages and globalization. *Lang. Soc.* **40**(4), 483–505 (2011). <https://doi.org/10.1017/s0047404511000480>
3. Klomp, U.: A descriptive grammar of sign language of the Netherlands. Doctoral dissertation, Universiteit van Amsterdam (2021). LOT. https://www.lotpublications.nl/Documents/585_fulltext.pdf
4. Stokoe, W.C.: Sign language structure: an outline of the visual communication systems of the American deaf. *J. Deaf Stud. Deaf Educ.* **10**(1), 3–37 (2005)
5. Quadros, R.M., Karnopp, L.B.: Língua de sinais brasileira: estudos lingüísticos. Artmed, Porto Alegre (2004)
6. Ferreira Brito, L.: Por uma gramática de língua de sinais. Babel, Rio de Janeiro (1995)
7. Crasborn, O., Zwitserlood, I., Kooij, E., Schüller, A.: Global SignBank manual. Radboud University, Nijmegen (2018). <https://www.researchgate.net/publication/324808574>
8. Oxford University Press: Definition of search engine. In Lexico.com. https://www.lexico.com/definition/search_engine. Accessed 31 Mar 2021
9. Netmarketshare – Search engine market share. <https://netmarketshare.com>. Accessed 23 Apr 2021
10. Möbus, L.: Making web content accessible for the deaf via sign language. *Library Hi Tech* **28**(4), 569–576 (2010). <https://doi.org/10.1108/07378831011096231>
11. Bragg, D., et al.: Sign language recognition, generation, and translation. In: The 21st International ACM SIGACCESS Conference on Computers and Accessibility, pp. 16–31. ACM, Pittsburg (2019). <https://doi.org/10.1145/3308561.3353774>
12. Scolari, S.H.P., Braviano, G.: Usabilidade no design de sistemas de busca em línguas de sinais: Revisão Sistemática da Literatura. In: DIGICOM, 4th International Conference on Design and Digital Communication, pp. 179–190. IPCA - Instituto Politécnico do Cávado e do Ave, Barcelos (2020)
13. Hair, J.F., Anderson, R.E., Tatham, R.L., Black, W.C.: Análise multivariada de dados, 6th edn. Bookman, Porto Alegre (2009)
14. Martin, B., Hanington, B.: Universal Methods of Design: 100 Ways to Research Complex Problems, Develop Innovative Ideas, and Design Effective Solutions. Rockport Publishers, Beverly (2012)
15. Saito, D.S., Scolari, S.H.P., Felício, M.D.: O design de material didático e o processo de tradução/interpretação (Libras/Português): uma aproximação possível. In: Proceedings of the 17th Brazilian Symposium on Multimidia and the Web, pp. 35–38. SBC Brazilian Computer Society, Florianópolis (2011)
16. Nielsen Norman Group – Usability 101: introduction to usability. <https://www.nngroup.com/articles/usability-101-introduction-to-usability/>. Accessed 14 May 2021
17. Henry, K.: Drawing for Product Designers. Laurence King Publishing Ltd, London (2012)
18. Crasborn, O., Kooij, E.: Relative orientation in sign language phonology. *Linguistics in the Netherlands* **14**, 37–48 (1997)



How Usability and User Experience Vary Among the Basic m-Commerce, AR and VR Based User Interfaces of Mobile Application for Online Shopping

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Abstract. Now a days, augmented reality (AR) and virtual reality (VR) based user interfaces allow the consumers to buy product over the internet using browser or mobile application. A limited number of mobile application use the AR, VR, or the both technologies simultaneously. Again, usability and user experience of using AR and VR based user interfaces to buy/sell product online were not well explored. Therefore, the objectives of this research are to design and develop a mobile application using the AR and VR technologies and to explore the usability and user experience of using the basic m-commerce, AR and VR based user interfaces of mobile application for shopping product (furniture) online. To attain these objectives, a mobile application was designed and developed for selling/buying product (furniture) online that includes the facilities of interacting with both AR and VR based user interfaces. The application provides the attractive features like viewing a specific product directly in user's own space by augmenting the 3D model and allow users to design virtual room in their own preferable way by placing the selected furniture and other products in a VR environment. The developed system was evaluated with 60 participants through the System Usability Scale (SUS) method to explore how usability and user experience vary among different options (basic m-commerce system, AR, and VR based user interfaces) of the developed application. The study results showed that better user experience and usability were observed for AR based shopping followed by using the basic m-commerce feature. The VR showed less usability and user experiences since the users were not well familiar with the uses of VR and required much training to learn how to interact using VR in mobile application.

Keywords: Augmented reality · Virtual reality · e-commerce · m-commerce · Mobile application · Usability · User experience · System Usability Scale (SUS)

1 Introduction

E-commerce is a remarkable invention in today's modern world, while the internet has become an inseparable part of everyday life. E-commerce started its journey in 1991

[31]. Since that time thousands of businesses have started website based business strategies. In the beginning, Electronic Data Interchange (EDI) and Electronic Fund Transfer (EFT) were used to exchange business information and electronic transactions which was known as e-commerce [3]. After the development of internet security protocols like HTTP a large number of business companies started their services in the World Wide Web [18]. Now a days, importance of e-commerce is undeniable that facilitate to explore a variety of products at the shortest time, reaching different kinds of customers for selling, lowering cost than traditional shopping and selling, personalize customer experience, transparent business system, advertising and marketing options and many more [28]. There are approximately 2.05 billion online shoppers which is 26% of the overall population over the world in 2020 [8]. Online shopping has become preferable to many customers nowadays because of convenience, price comparison, observing customer review, no need for physical travel and simplicity of the system [9, 20].

Switching from wired to wireless networks, the latest buzzword in the industry is mobile commerce or m-commerce which is a part of e-Commerce. The term “m-commerce” means the set of applications and services people can access from their Internet-enabled mobile devices [7, 29]. Widespread availability of more powerful mobile devices, the handset culture, the service economy, vendors’ push, the mobile workforce, increased mobility, improvement of bandwidth are the main driver’s for m-commerce. Some of the advantages of m-commerce are convenience, flexible accessibility, easy connectivity, personalization, and time efficiency [24]. Because of these benefits, many e-commerce owners are now building their mobile shopping site to target mobile customers. By 2021, m-commerce is projected to generate 54% of total e-commerce sales [2].

In spite of many advantages, there are limitations regarding product examination in online platforms. Inability to experience products with interaction sometimes discourage customers to shop online. The consumers mostly purchase clothes online, comprising 50.7% of the population [4]. Most of the time they do not prefer buying home decorating products and furniture in online because of the limited interaction with products (e.g., better visualization of a furniture for specific context home environment). However, with the help of product image, product video, augmented reality (AR) and virtual reality (VR) technology such limitations could be reduced or addressed to some extent [15, 30].

Augmented reality and virtual reality introduced a new level of shopping experiences in e-commerce. Online retailers are now looking forward to building up virtual showrooms as it can give customers to have in-store like experience virtually. It also enables shoppers to experience and visualize the product in their own environment. Three dimensional views in augmented reality helps the customer to feel the product with better understanding of its size, shape and texture [1]. As a result, AR and VR technology has become more popular among online retailers. Some augmented reality furniture apps are IKEA, Wayfair, roOomy etc provide opportunity in interaction with the products by placing virtually from their stores website in users own space for better product examination. Younger generations, who occupy a great percentage of total online consumers, will be more responsive to the AR and VR technologies, if these are introduced on a large scale in online platforms.

Therefore, the objective of this research are to design and develop a mobile application for selling product (furniture) online using the AR and VR technologies; and to compare among the basic m-commerce, AR and VR based user interfaces of the developed application for shopping product (furniture). The rest of the paper is organized as follows. Section 2 briefly presents the related work. Section 3 describes the conceptual design and development. The evaluation study with the findings are discussed in Sect. 4. Finally in Sect. 5 presents the summary of the study findings and highlights the limitations and opportunities for future work.

2 Literature Review

This section briefly discussed the studies related to augmented reality, virtual reality and traditional E-commerce systems.

Khuong et al. [17] evaluated the efficacy of an AR-based context-aware assembly support framework with the suggested AR visualization modes in object assembly. In another study, Rauschnabel [27] proposed and empirically tested a framework that theorizes how consumers perceive and evaluate the benefits and augmentation quality of AR apps, and how this evaluation drives subsequent changes in brand attitude, While Lu et al. [21] presented how AR can be used to overcome the limitations and enhance e-commerce systems. Again, Lu et al. [21] highlighted the development of a working AR e-commerce assistant system following the user-centered design principles and the realistic application of AR in e-commerce. In this vein, Lu et al. [21] found that the developed AR e-commerce assistant system can provide more direct product information to the consumers than traditional or VR e-commerce systems and thereby help them making better purchasing decisions. Similarly, Chatzopoulos et al. [6] suggested a dual route of influence of VR on consumers' purchase intention in virtual stores.

Again, an experiment was conducted by Kerrebroeck et al. [32] to explore the potential of a relaxing Virtual Reality (VR) experience in a shopping mall and found that the beneficial effects of VR are most pronounced in case of high perceived crowding. Similarly, a state-of-the-art view is provided related to the consumer acceptance and customer motives, applications and implementation of AR and VR by retailers in [5], while Li et al. [19] proposed an approach to feature point correspondence of image sequence in AR E-commerce applications. In another study, Zhang et al. [35] described the development of a direct marketing system that uses AR technology.

Pereira et al. [26] showed virtual fitting rooms using AR techniques for e-Commerce, while the effectiveness of different VR formats and devices in a virtual store environment, namely V-commerce is showed by Martínez et al. [22]. Again, Yim et al. [34] evaluated the effectiveness of AR as an e-commerce tool by analysing the participants' subjective opinions about AR. In another study, Noordin et al. [25] proposed a new virtual fitting room model based on the Unified Theory of Acceptance and Use of Technology (UTAUT), which consists of usability and profound emotional constructs. Welivita et al. [33] described an approach of building a mobile augmented reality application that enables the users to virtually try out facial accessories such as eye wear. The virtual try-on solution was tested using the System Usability Scale (SUS) and the User Experience Questionnaire (UEQ) to collect subjective data in order to measure the user

engagement. As outcome, they found that the participants preferred to use the mobile augmented reality try-on solution over physically visiting the eye-wear shops.

In sum, the literature review highlighted that AR and VR are innovative technology which has great impact on electronic or mobile commerce by increasing its potentiality with great effort. Again most of the studies highlighted the benefits of AR and VR technologies; and the factors affecting the e-commerce business for the adoption of AR and VR technology. Although advantages of AR and VR are addressed on e-commerce in general, no study is conducted yet regarding the utilization of AR and VR and its impact in any particular e-commerce (or m-commerce) industry e.g. clothing, furniture etc. Again, a limited article has been conducted focusing to measure the usability issues of e-commerce applications adopted the AR and VR technologies. Apart from these, no study has been conducted yet to explore how usability and user experience of customers with AR and VR compared to traditional (mobile and web) applications for selling products online. This study thus focused on the design, development, usability evaluation of AR and VR based m-commerce mobile application and comparing the usability and user experiences among the basic m-commerce, AR and VR based user interfaces of the developed application for shopping product (furniture) online.

3 Design and Development

In order to develop augmented and virtual reality based e-commerce application for furniture industries, a conceptual diagram is proposed as presented in Fig. 1. The proposed AR and VR based m-commerce system may facilitate users to buy and sell products (furniture) online like basic m-commerce system; explore any product in a real-world environment using AR option of the proposed system, and design a virtual room with the chosen products using VR option of the proposed system.

As presented in Fig. 1, using the proposed system -

- User can login or sign up to the e-commerce system ; user can view products without signing in.
- User login information will be stored secured on Server-1
- After login session, user can choose and buy product using the basic m-commerce system.
- In order to use AR, user may choose particular product to view in 3D mode which will be augmented in real world.
- Products of 3D model stored in Server-2 and that product will be augmented from the server, can be move and placed anywhere.
- In order to use virtual reality, VR mode can be activated.
- In VR mode, user can design room according to his/her own choice, moreover user can buy products using virtual reality.
- Related tutorials and demos are provided within the system for using the AR and VR modes.

A few screenshots of the developed application are shown in Fig. 2. After logging into the application user will be able to see the homepage as shown in Fig. 2a where

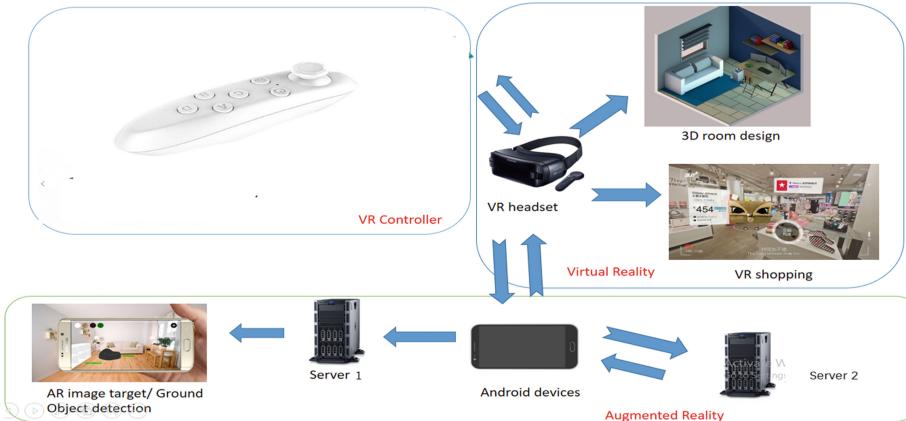


Fig. 1. A conceptual diagram for the mobile application

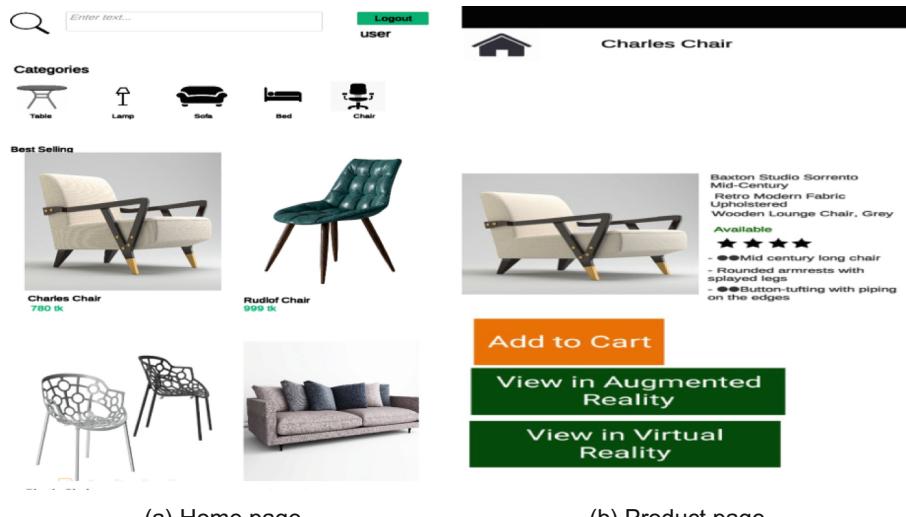


Fig. 2. Screenshots of the developed mobile application

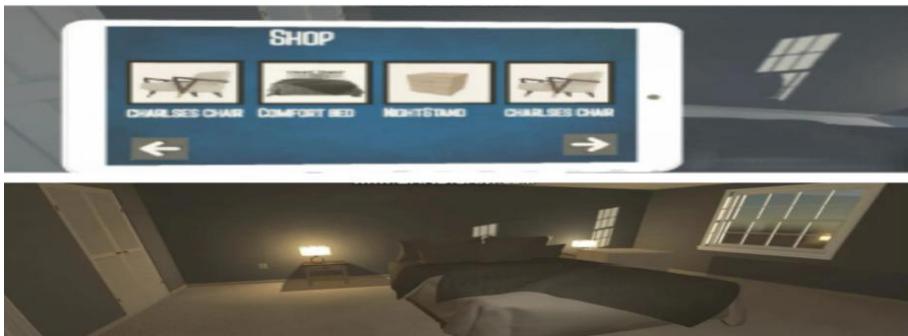
users will be able to choose products like any traditional m-commerce based mobile application. Whenever any user chooses any product from the homepage then the user will be able to see another page as shown in Fig. 2b showing the detailed information about the selected product, add to cart option and options to see the product in AR mode or in VR mode.

Whenever any user chooses the option “View in Augmented Reality” then the camera of the user’s mobile will be turned on and the user will be able to drag the chosen product’s 3d model on the ground as shown in Fig. 3a. Similarly, after choosing the option “View in Virtual Reality”, a new page will be opened as shown in Fig. 3b. User manual will be shown just after choosing that button so that any user can easily use the VR box and the

controller. If any user doesn't want to see the user manual, there is a button to skip the user manual.



(a) Augmented Reality



(b) Virtual Reality

Fig. 3. Screenshots of augmented reality and virtual reality module

The mobile application was developed using Unity and C# programming language. For the authentication system Firebase cloud platform was used. The product details were also stored on Firebase. For the AR feature Vuforia SDK was used, while Google Cardboard SDK was used for the virtual reality support. All the 3d models were stored into the AssetBundle server where the server stores mesh data of the 3d objects. If any user chose a product from the user interface, the 3d model will be fetched from the server and display on the mobile screen.

4 Evaluation of the System

Usability and user experience are the key quality attribute of any application [10, 11, 14] and same as for AR/VR based e-commerce application. The usability and user experience of the developed application was measured using the System Usability Scale (SUS) [23] as adopted to evaluate other mobile applications [13, 16]. This section will briefly discuss the profile of the participants, study procedure and the study findings.

4.1 Participants Profile

A total of 60 participants (35 male and 25 female) were recruited who were familiar with smartphone applications especially to internet browsing, android applications, online shopping etc. Participants average age was 28.25 (SD = 5.29). About half of the participants ($n = 32$) were not familiar with accessing AR and VR based systems for shopping.

4.2 Study Procedure

The test session was held at a software engineering lab where all the participants were invited. A short briefing was delivered to the participants to introduce to the mobile application and its functionalities. The application has three options to purchase furniture online, that includes: (a) basic m-commerce, (b) augmented reality, and (c) virtual reality. A short demonstration of the applications was given to participants and asked to explore the application for 10 min. A set of questions was prepared based on the SUS questionnaires and each participant were asked to answers these questionnaires separately for the three options (m-commerce, AR, and VR) of developed application. The SUS questionnaires include [23]: I would recommend this app to a friend (Q1), I found the system unnecessarily complex (Q2). I thought the system was easy to use (Q3). I think that I would need the support of a technical person to be able to use this system (Q4). I found that various functions in this system were well integrated (Q5). I thought there was too much inconsistency in this system (Q6). I would imagine that most people would learn to use this system very quickly (Q7). I found the system very cumbersome to use (Q8). I felt very confident using the system (Q9). I needed to learn a lot of things before I could get going with this system (Q10). Here, the positive statements are all odd-numbered questions and negative statements are all even-numbered questions.

4.3 Study Findings

The SUS scores were calculated for each individual for each type of user interfaces (options) and then average SUS scores were measured for each of the option (m-commerce, AR, VR). The SUS scores for the basic m-commerce, AR and VR shopping were 69.78, 71.86, 67.798, respectively. According to [12, 23], SUS scores 0–64 are not adequate, while 65–84 are suitable and 85–100 are out-standing. Thus the study results indicated that the VR based shopping showed less usability; may be because of being new technology. Again, participants found AR based shopping is more usable than the traditional e-commerce while purchasing furniture online.

5 Conclusion

With the technological advancement, online shopping has became more popular among the various consumers. Even if online shopping became preferable over offline because of its convenience and avoidance of the physical hassle of travelling from market to market. However, due to the limited interaction facility, customer can be confused in choosing

products online. Thus, a mobile application is developed integrating the facility of AR and VR for selling and purchasing furniture online. Due to the AR feature, using the developed application the virtual furniture can be displayed and modified in real time on screen of a digital device, allowing the user to have an interactive experience with the virtual furniture in a real-world environment. Again, due to the VR features, the application enables user to choose a model room for perspective and then design the room by placing the chosen 3D furniture in the room. A SUS based evaluative study was also conducted which revealed that the users prefers well in terms of usability and user experience while using the AR options than the basic m-commerce option. Again, the VR showed the less preference may be due to the users unfamiliarity with the uses of VR technology. However, the application provides a realistic feeling of online shopping because of the use of AR and VR technologies.

This research has a few limitations. Firstly, for experiencing virtual reality, VR devices like Google Cardboard is required which may not be available among the user because of it's costliness. Secondly, Android API level 5 is required for experiencing augmented reality and ARCore supported devices are mandatory for using the ground detection feature. Finally, only SUS based evaluation was conducted to evaluate and compare the usability and user experience. Therefore, evaluation study in a larger scale with different approach will be conducted in future to legitimize the end result of this research. Moreover, the features of the applications will be enriched to give users a more realistic experience of online shopping.

References

1. Abehsara, M.: 3 ways virtual reality will transform ecommerce, August 2017
2. Amery, A.: What is m-commerce and how to create a great mobile experience. <https://www.become.co/blog/what-is-m-commerce/>
3. Awais, M., Samin, T.: Advanced swot analysis of e-commerce. Int. J. Comput. Sci. Issues (IJCSI) **9**(2), 569 (2012)
4. Bhavsar, H.: E-commerce in our daily life. <https://www.linkedin.com/pulse/e-commerce-our-daily-life-dash-technologies-inc>
5. Bonetti, F., Warnaby, G., Quinn, L.: Augmented reality and virtual reality in physical and online retailing: a review, synthesis and research agenda. In: Jung, T., tom Dieck, M.C. (eds.) Augmented reality and virtual reality. PI, pp. 119–132. Springer, Cham (2018). https://doi.org/10.1007/978-3-319-64027-3_9
6. Chatzopoulos, D., Bermejo, C., Huang, Z., Hui, P.: Mobile augmented reality survey: from where we are to where we go. IEEE Access **5**, 6917–6950 (2017)
7. Coursaris, C., Hassanein, K.: Understanding m-commerce: a consumer-centric model. Q. J. Electron. Commer. **3**, 247–272 (2002)
8. Gupta, P.: Comparative study of online and online shopping: a case study of Rourkela in Odisha. Ph.D. thesis (2015)
9. Hoque, S., Sharmee, S.S., Islam, M.N., Shahrin, D., Kabir, F.: Ponno Aalap: an interactive web portal for improving consumer experience. In: 2020 IEEE Region 10 Symposium (TENSYMP), pp. 1770–1774. IEEE (2020)
10. Islam, M.N., Bouwman, H.: Towards user-intuitive web interface sign design and evaluation: a semiotic framework. Int. J. Hum.-Comput. Stud. **86**, 121–137 (2016)
11. Islam, M.N., Bouwman, H., Najmul Islam, A.K.M.: Evaluating web and mobile user interfaces with semiotics: an empirical study. IEEE Access **8**, 84396–84414 (2020)

12. Islam, M.N., Karim, Md.M., Inan, T.T., Najmul Islam, A.K.M.: Investigating usability of mobile health applications in Bangladesh. *BMC Med. Inform. Decis. Mak.* **20**(1), 1–13 (2020)
13. Islam, M., Khan, S., Islam, N., Rezwan-A-Rownok, M., Zaman, S., Zaman, S.: A mobile application for mental health care during COVID-19 pandemic: development and usability evaluation with system usability Scale. In: Suhaili, W.S.H., Siau, N.Z., Omar, S., Phon-Amuaisuk, S. (eds.) CIIS 2021. AISC, vol. 1321, pp. 33–42. Springer, Cham (2021). https://doi.org/10.1007/978-3-030-68133-3_4
14. Islam, M.N., Tetard, F.: Integrating semiotics perception in usability testing to improve usability evaluation. In: Cases on Usability Engineering: Design and Development of Digital Products, pp. 145–169. IGI Global (2013)
15. Kannaiah, D., Shanthi, R.: The impact of augmented reality on e-commerce. *J. Market. Consum. Res.* **8**, 64–73 (2015)
16. Khan, S.R., Rezwan-A-Rownok, Md., Prithula, S.R., Rifat, F.Y., Islam, N.N., Islam, M.N.: mVote: a mobile voting system to conduct election during covid-19 pandemic. In: 2020 IEEE International Women in Engineering (WIE) Conference on Electrical and Computer Engineering (WIECON-ECE), pp. 235–238. IEEE (2020)
17. Khuong, B.M., Kiyokawa, K., Miller, A., La Viola, J.J., Mashita, T., Takemura, H.: The effectiveness of an AR-based context-aware assembly support system in object assembly. In: 2014 IEEE Virtual Reality (VR), pp. 57–62 (2014)
18. Laudon, K.C., Traver, C.G., et al.: E-commerce: business, technology, society (2016)
19. Li, X., Chen, D.: Augmented reality in e-commerce with markerless tracking. In: 2010 2nd IEEE International Conference on Information Management and Engineering, pp. 609–613 (2010)
20. Liao, Z., Cheung, M.T.: Internet-based e-shopping and consumer attitudes: an empirical study. *Inf. Manag.* **38**(5), 299–306 (2001)
21. Lu, Y., Smith, S.: Augmented reality e-commerce assistant system: trying while shopping. In: Jacko, J.A. (ed.) HCI 2007. LNCS, vol. 4551, pp. 643–652. Springer, Heidelberg (2007). https://doi.org/10.1007/978-3-540-73107-8_72
22. Martínez-Navarro, J., Bigne, E., Guixeré, J., Alcañiz, M., Torrecilla, C.: The influence of virtual reality in e-commerce. *J. Bus. Res.* **100**, 475–482 (2019)
23. McLellan, S., Muddimer, A., Peres, S.C.: The effect of experience on system usability scale ratings. *J. Usability Stud.* **7**(2), 56–67 (2012)
24. Nirajanamurthy, M., Kavyashree, N., Jagannath, S., Chahar, D.: Analysis of e-commerce and m-commerce: advantages, limitations and security issues. *Int. J. Adv. Res. Comput. Commun. Eng.* **2**(6), 2360–2370 (2013)
25. Noordin, S., Sahari, N., Wook, T.S.M.T., et al.: A proposed model for virtual fitting room based on usability and profound emotional elements. *Int. J. Adv. Sci. Eng. Inf. Technol.* **8**(6), 2332–2340 (2018)
26. Pereira, F., Silva, C., Alves, M.: Virtual fitting room augmented reality techniques for e-commerce. In: Cruz-Cunha, M.M., Varajão, J., Powell, P., Martinho, R. (eds.) CENTERIS 2011. CCIS, vol. 220, pp. 62–71. Springer, Heidelberg (2011). https://doi.org/10.1007/978-3-642-24355-4_7
27. Rauschnabel, P.A., Felix, R., Hinsch, C.: Augmented reality marketing: how mobile AR-apps can improve brands through inspiration. *J. Retail. Consum. Serv.* **49**, 43–53 (2019)
28. Rukhsara, L., Aklam, F., Nawer, T., Chauhan, N.S., Islam, M.N.: A conceptual cloud-based model for developing e-commerce applications in context of bangladesh. In: 2016 5th International Conference on Informatics, Electronics and Vision (ICIEV), pp. 117–121. IEEE (2016)
29. Sadeh, N.: M-commerce: Technologies, Services, and Business Models. Wiley, Hoboken (2003)

30. Sharif, A., Anzum, F., Zavin, A., Suha, S.A., Ibnat, A., Islam, M.N.: Exploring the opportunities and challenges of adopting augmented reality in education in a developing country. In: 2018 IEEE 18th International Conference on Advanced Learning Technologies (ICALT), pp. 364–366. IEEE (2018)
31. Tian, Y., Stewart, C.: History of e-commerce. In: Electronic Commerce: Concepts, Methodologies, Tools, and Applications, pp. 1–8. IGI Global (2008)
32. Van Kerrebroeck, H., Brengman, M., Willems, K.: Escaping the crowd: an experimental study on the impact of a virtual reality experience in a shopping mall. *Comput. Hum. Behav.* **77**, 437–450 (2017)
33. Welivita, A., Nimalsiri, N., Wickramasinghe, R., Pathirana, U., Gamage, C.: Virtual product try-on solution for e-commerce using mobile augmented reality. In: De Paolis, L.T., Bourdot, P., Mongelli, A. (eds.) AVR 2017. LNCS, vol. 10324, pp. 438–447. Springer, Cham (2017). https://doi.org/10.1007/978-3-319-60922-5_34
34. Yim, M.Y.-C., Chu, S.-C., Sauer, P.L.: Is augmented reality technology an effective tool for e-commerce? An interactivity and vividness perspective. *J. Interact. Market.* **39**, 89–103 (2017)
35. Zhang, X., Navab, N., Liou, S.-P.: E-commerce direct marketing using augmented reality. In: 2000 IEEE International Conference on Multimedia and Expo. ICME2000. Proceedings. Latest Advances in the Fast Changing World of Multimedia (Cat. No.00TH8532), vol. 1, pp. 88–91 (2000)



The Design Process of Variable Fonts: A Prospective Survey-Based Investigation with Type Designers

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Abstract. The design practice has undergone several transformations due to technological innovations. One of the areas on which this practice is based is typography, which is responsible for studying the processes of creation and application of character and glyph systems for the visual composition of texts. With the computerization of this area, several font files have been created to enable improvements aimed at digital media. Hence, variable fonts were launched in 2016 and have presented several benefits, such as greater flexibility and use of types. Therefore, this study aims to identify specifics and elements of the variable font design process. To this end, a prospective survey was conducted based on a questionnaire applied to type designers and specialists in variable fonts. For data treatment, the content analysis method and the categorical analysis technique were used with the aid of qualitative data analysis software ATLAS.ti. The results of the research allowed the identification of elements of the variable fonts design process according to their relevance for this practice organized in main elements (tests, design space and font context of use), secondary elements (process steps and distribution) and tertiary elements (research, typographic characteristics, file preparation and disclosure).

Keywords: Variable fonts · Design · Process

1 Introduction

The scope of design has undergone several transformations due to technological innovations, both concerning the design process and products developed by its professionals. Design is an area of knowledge that explores the relationship between humans, artifacts and languages. With it, it is possible to conceive technologies and meanings that influence society's daily life.

Different areas of study based on the practice of design, such as the typography field, in which history, practice and process of creation and application of orthographic and para-orthographic symbols are studied [2]. In the process of creating these symbols, the terminology "type design" was agreed. For Scaglione [3], typography plays a central role in graphic design since most graphic communication pieces require, to a greater or lesser extent, the use of written words to fulfill their function and typography to systematize writing.

From the advancement of digital technologies, the number of typefaces available for designers and other users of fonts increased rapidly, providing new types with different characteristics to meet new audience demands and adapt to new informational support [4]. With computerization, the typographic scope has undergone changes and has been driven by the use of digital tools [5]. For that, font formats started to be developed with the objective of allowing greater possibilities of use and storage capacity [6, 7].

In order to provide more flexibility to types and to make better use of them in digital media, variable fonts were launched in 2016. They consist of a new technology in which different widths, weight, slant and many other variations are incorporated into a single file. That is, if in a traditional typeface each variation corresponds to a different file, in the variable fonts, all variations will be in only one file, allowing the user to choose what is the most suitable for their needs.

Variable fonts also differ from traditional typefaces in that they save storage space since several variations are allocated in a single file [8]. With the lower weight of the files, the variable fonts still contribute to faster loading of *online* systems and require less network bandwidth for such access. Therefore, they present several benefits for designing digital products since they can be used in different ways on screens with different shapes and sizes and can automatically adapt to their context [9].

There are many highlights about variable fonts and their potential compared to other typefaces [8, 10–12]. However, studies that point out the purposes, the development processes and the use of variable fonts are still scarce. Therefore, the present study aims to identify specifics and elements of the design process from variable fonts based on a qualitative prospective approach based on the practice of type designers.

2 Digital Type Design Process

The introduction of digital technologies has allowed the type design process to become more accessible. However, even with the ease provided by type development tools and *software*, the process is yet complex and requires different steps for a consistent result. According to Smeijers [10], although it seems that the type designer's job is to make new characters, the real goal is to create new word images with different qualities from what is already available. For the author, a type designer should have something to say and a good reason to draw another type. There may be various reasons, but the designer must know the existing types and fonts. In this way, it is possible to identify which needs have not yet been met and know all the parts that involve a typeface. According to Mena [13], in order to find an appropriate shape for the characters of a typographic project, one must follow a process with an adequate structure, in which the guidelines lead to the necessary decisions for the project.

When starting a typographic project, it is necessary to define a concept. For that, it should start from a simplified definition, such as the decision to develop a text typeface for books, or more specifically as “a text typeface to compose books about Mexico's history, particularly in Latin, Spanish and Nautical” [14]. In addition, it is possible to consider the target audience in the project definitions. This audience can be divided into two: the font user, the designers who will apply it to their projects, and the user of the messages, that is, the readers and their possible limitations. In this sense, Henestrosa

[14] suggests that a problem must be found to be solved, as in other design projects. This problem can be defined by the type designer, based on personal motives, visual inspiration, as well as historical, intellectual and cultural investigations, or even by an external agent, such as a client, as in custom fonts design, which can be summarized as a custom typographic project according to the needs of the client or company [4].

Cheng [4] points out that there is no single or correct process for creating a typeface. For the author, each methodology is as unique and varied as the letter designs themselves. Regardless of the sequence of typefaces development, Scaglione [3] points out that the type design is a slow and painstaking task, and the process can take months or even years, depending on the perseverance, the daily time of dedication and rigor of tests and corrections. In this sense, Meseguer [15] suggests that, among the several factors that will influence the time required for developing a type design project, the most relevant are the level of complexity of the typeface and the number of glyphs and characters.

Despite the different perspectives needed to create types, Scaglione [3] reinforces that defining a flow, a process, or adopting a methodology for developing a type design project makes the job faster, avoids redundant work, and adds to the process, systematizing the design decision making.

When viewing methods, processes and academic reports of the development of typefaces and variable fonts, it is possible to notice that they go through similar phases and step sequences to achieve their creative and strategic purposes. In a broad view, it is possible to identify three major stages in the development of a digital and variable font. The first stage concerns the elucidation of the problem, the search for references and materials, their analysis and the type's purpose definition. Next, the exploration of the shape of the letters begins, with manual or digital drawings, until obtaining the desired result for the main characters of the font, that is, those that have distinctive stems and parts and that serve as a basis for the construction of the other font glyphs. In the same way, the metric of the font is identified, which will guide the design of the other characters. With this, the character set is elaborated in its entirety, spacing, *kerning*[1], and *hinting*[2] are adjusted (which can be done automatically with the help of *software*). And finally, there is the time to generate the font file, test it on operating systems to prove its effectiveness, and develop a specimen, a document that presents a summary of the font, to present possible users with its potential.

3 Methodological Procedures

This research adopts a qualitative approach since it is related to a complex and particular situation, namely the design process of variable fonts, as well as subjectivity, samples selected for accessibility and data treated in an interpretative way [16].

Data collection took place by applying a questionnaire with type designers and specialists in variable fonts. To this end, the following steps were performed:

1. Questionnaire elaboration.
2. Referral of ethical issues.
3. Participants selection.
4. Application of questionnaires.

5. Organization and treatment of data.
6. Results and discussions.

Participants' selection was due to their proximity to the type design practice. Those who have already published variable fonts, have already been awarded for their fonts, or work in prominent companies in the scenario of digital font production were invited to participate. Moreover, the "snowball" strategy was used, which consists of asking the research participants to indicate potential new participants [17]. Therefore, the invitation to participate was sent to 18 type designers between June and October 2020.

For the analysis and synthesis of the data obtained in the questionnaire, the content analysis method and the categorical analysis technique, proposed by Bardin [18], were used, with the aid of the Atlas.ti software. According to Bardin, these techniques make use of coding, classification and categorization processes based on breaking down the text into units and codes, which are then classified and grouped into categories based on analogies. This process explores the subject in a deductive way in order to determine broader classes within a theme. Therefore, the participants' responses were coded. Based on their similarity and proximity, it was possible to categorize the codes into groups.

4 Results and Discussions

From the strategies adopted, nine responses were obtained. Initially, the questionnaire sought to understand the profile of the participants and their experiences with type design. Regarding professional training, two participants mentioned Type Design itself, two mentioned training in Graphic Design, two mentioned training in Arts, one mentioned Graphic and Typographic Design, one mentioned the training in Political Sciences, and one mentioned Islamic Studies. On the other hand, in relation to the time working with type design, five have been working with it for 7 to 30 years and the other four for more than 30 years. The Fig. 1 summarizes each of the survey respondents' profiles: time and place of work and examples of fonts published by them.

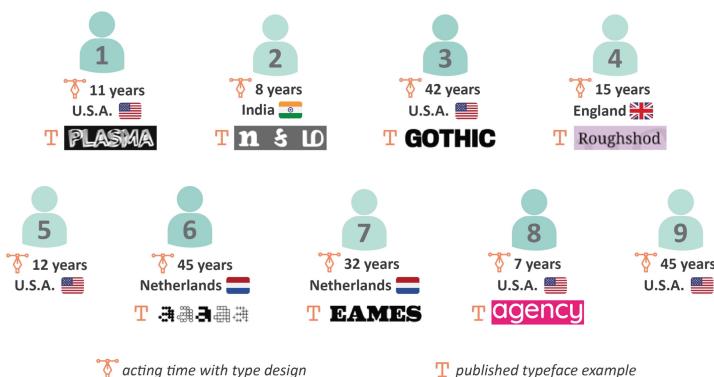


Fig. 1. Research participants' profile

Subsequently, the questionnaire aimed to identify specifics of the variable font design process. Therefore, a skimmed reading of the data collected was done to identify possible codes, followed by new readings to carry out the coding. Next, these codes were categorized into groups of codes according to their theme and similarities between them. For data treatment, the questionnaire questions were organized into five themes, and the participants' statements generated 34 codes and 9 groups of codes related to each other, as shown in Fig. 2.

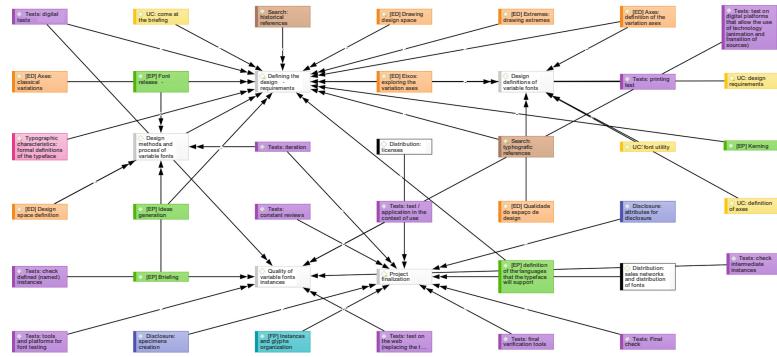


Fig. 2. Relationship between the codes of the participants' responses and the themes from the questions

The first theme identified was related to the use of **methods and processes for the design of variable fonts**. No participant mentioned a specific sequence. Four of them mentioned that the processes vary without explaining how the development is done. Concerning this aspect, participant 06 justifies that “*Design and development by definition are never predefined. At the same time the process is never created from scratch. Designing the right mixture and balance is an intrinsic part of the process*”.

In this question, three participants mention the following specifications of Google Fonts without reporting the implications of this in the process. In addition, one participant mentioned the software used by him for the development of variable fonts, and another addressed some stages of the process, but not all. In this theme, four codes were identified, as shown in Fig. 3.

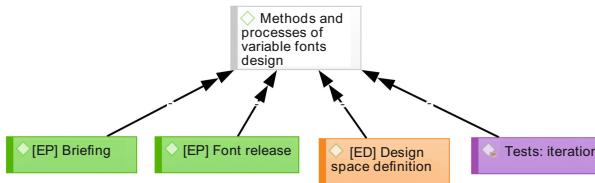


Fig. 3. Aspects related to the design methods and processes of variable fonts mentioned by the participants

Regarding the criteria used to **define the requirements** of a variable font design, the participants mentioned 12 topics related to the design space, typographic characteristics, research, use of the font and process steps, as shown in the following Fig. 4.

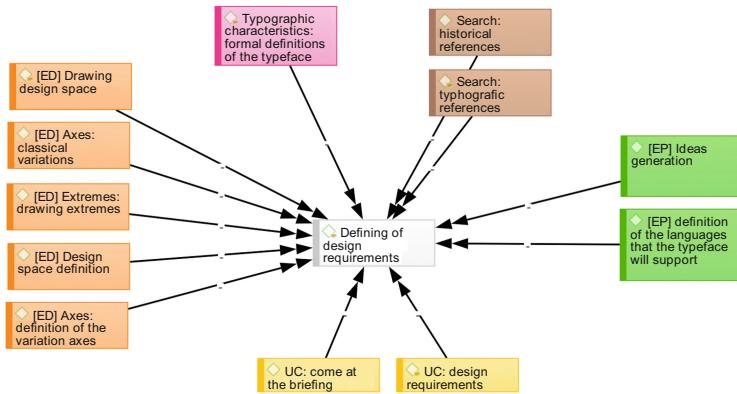


Fig. 4. Topics considered in the definition of design requirements in the design of variable fonts

Among these topics, the most recurrent was the use of the font mentioned by seven participants. For six of them, the application of the font must support the definition of the project requirements. According to Participant 06 “*Type design only works with context. Otherwise, it is an art project*”. Moreover, three participants mentioned that the use of the font appears in the project briefing, which third parties can request it.

Next, in many citations, five respondents mentioned the design space as a criterion for defining the design requirements, such as the drawing of design space, the number of variation axes, the variations and the drawing of the extremes of each axis. Moreover, the process steps were mentioned by three participants; they acknowledged the generation of ideas and the language definition that the font may attend. The researches and definitions of typographic characteristics were addressed by one participant each.

Regarding **specific issues of variable fonts of design projects**, implications have been raised regarding the design space (mentioned by seven participants) and the use of the variable fonts (reported by four respondents), as shown in the following Fig. 5.

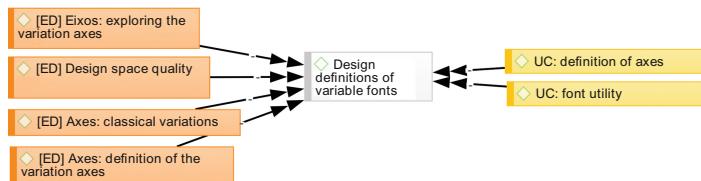


Fig. 5. Aspects considered in the design definitions of variable fonts

With respect to the design space, the choice and definition of the axes that the variable font will have was the most recurring aspect, cited by four participants. Moreover,

two participants cited the consideration of classic variations, as users are already more familiar with them. Still concerning the axis, one participant mentioned the exploration of variable axis and the inclusion of many axes to match and select those to be used in the project. In addition, one participant acknowledged the quality of the design space. According to Participant 06, “*the most important issue is to ensure that all the design space works correctly*”.

Concerning the use of the variable font, two participants reinforced that the font’s application fully implies the choice of the variable font axes. This is complemented by the second aspect mentioned, also by two participants, when raising the usefulness of the font. In this sense, Participant 01 stated, “*I try to define axes that are functionally useful for the user to control, or give the design a wide range of customizable personality*.”

As for the processes that lead to the **qualities of the variable fonts instances**, all ten respondents cited aspects related to the tests, as shown in Fig. 6. Among them, the most cited was the use of digital tools and platforms for testing the variable fonts, mentioned by four participants.

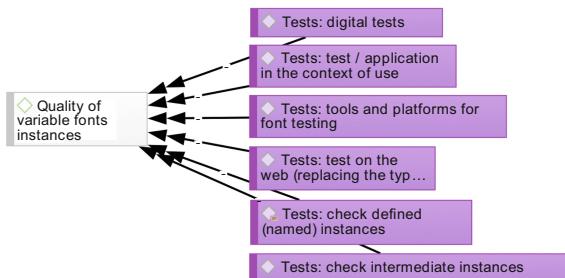


Fig. 6. Processes that lead to the quality of variable font instances

Afterwards, the verification of the named instances was mentioned by three professionals. Moreover, one respondent cited the verification and testing of randomly selected instances, as proposed by a method called “*simulated annealing*,” which tests the validity of options in infinite spaces. Also, participants mentioned evidence checking in digital visualization, mobile devices, replacing the font on web pages to verify its behavior and applying the font in the context of use defined on the project.

When asked about the process of **finalizing** a variable font design project, participants explored implications regarding disclosure, distribution, file preparation and testing, illustrated by the following Fig. 7.

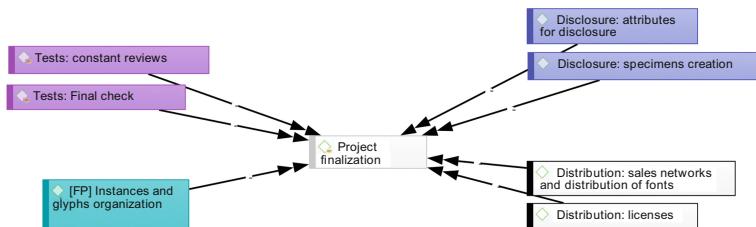


Fig. 7. Aspects considered when finalizing design projects of variable fonts

The questions regarding testing and distribution were the most addressed, with seven citations each. Among the tests, five participants mentioned doing final checks. For Participant 08, at the time of project completion, “*all fonts should undergo rigorous font testing.*” In addition, two professionals mentioned constant revisions, suggesting that these revisions should be done until the objectives for the character set and the design space are fulfilled.

Regarding distribution, six respondents mentioned using sales and distribution networks to make the variable font available for the public. Moreover, one participant brought up the discussion about licenses for variable fonts. For Participant 05, the licenses for variable fonts “*are very hard to work with, and the EULAs are too complicated and restrictive for the average user*”.

In turn, issues related to the disclosure of variable fonts were mentioned by two professionals. One of them acknowledged issues related to the attributes for disclosure since they must meet the project's objectives and needs. The other respondent cited the creation and sale of printed specimens to disseminate the fonts. Finally, file preparation concerning instances organization and glyphs was also addressed by one participant.

4.1 Discussions

As it is possible to notice in the results, some codes were recurrent in the professionals' answers, and thus, it was possible to create code groups. When relating the groups generated to the main themes addressed in the research, it was possible to visualize the influence of each group according to the subject treated, as shown in the Table 1.

Table 1. Occurrence of code groups in the participants' responses

The aspects taken into consideration by the participants in each theme and code were synthesized, combining the occurrence of thematic families with the questionnaire themes, as shown in Fig. 8.

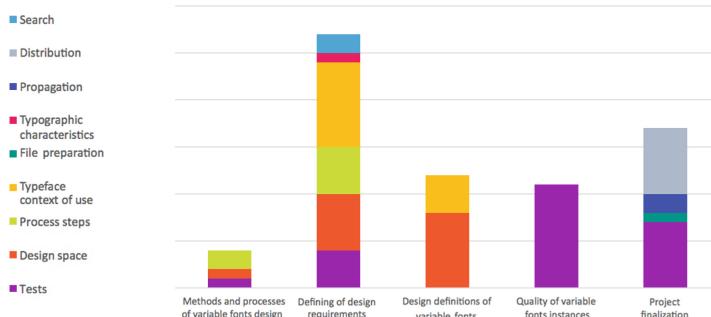


Fig. 8. Relationship between the aspects addressed by the professionals and the main themes of the research

By analyzing each code group, it was noticed that the code ‘tests’ was mentioned in more themes covered in the research – four of the five themes related to the variable fonts design process – as shown in Fig. 9.

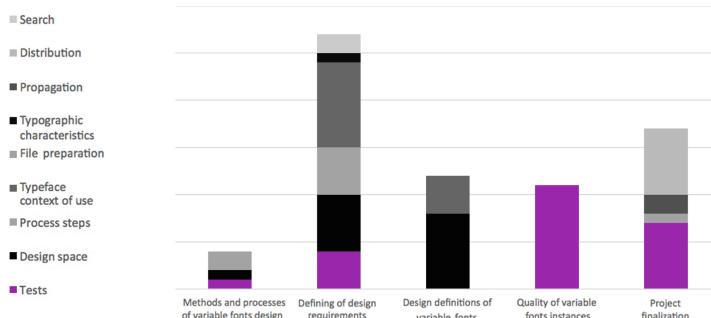


Fig. 9. Recurrence of tests during the variable fonts design process

Therefore, in addition to being addressed in the theme of methods and design process of variable fonts, according to the participants, the **tests** are taken into account when defining the project requirements and finalizing them. On the other hand, the higher recurrence is in the influence of tests for the quality of variable font instances.

It is also observed that the tests and being addressed in more themes were also addressed in more citations. Considering the above, it was understood that testing and verifying during the design project of variable fonts must be done throughout the course of the project, which is fundamental to provide a quality result.

Next, the design space appears in three of the five themes covered in the questionnaire, as shown in Fig. 10.

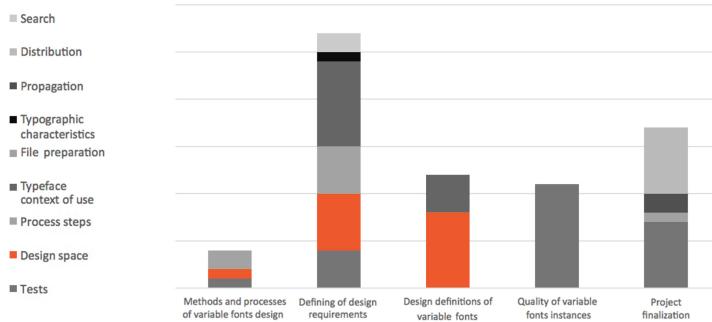


Fig. 10. Recurrence of design space during the process of variables fonts design

In this sense, it is noteworthy that the **design space** was addressed concerning methods and processes, design requirements and the design definitions of variable fonts. This topic was the second most discussed during the research in relation to the recurrence in the participants' responses. However, it is little explored in the literature, not being highlighted as part of the process in the methods, processes, and academic reports of typefaces and variable fonts development as consulted before this survey.

The code group that appears in two of the five themes explored in this research are **process steps** and **context of use**, as shown in Fig. 11.

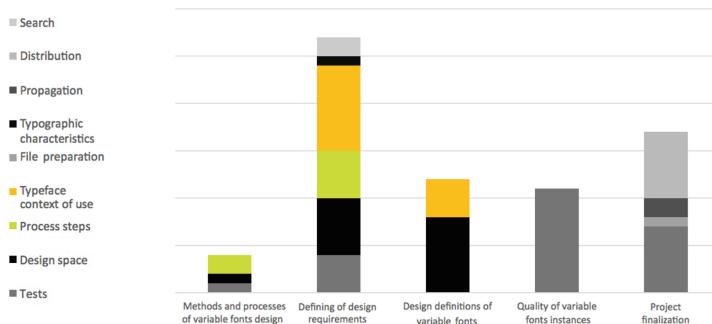


Fig. 11. Recurrence of the context of use and process steps of variable fonts design

The third most discussed topic in the questionnaires, which is also identified in two of the four themes covered in the survey, is the influence of the font **context of use** in the design process of variable fonts. This subject appears linked to the definitions of the project requirements and the definitions related to the variable fonts. Regarding the **process steps**, it is possible to note that the approach of stages, phases and moments of projects mentioned by the consulted professionals can also be noted in the bibliography, emphasizing the importance of stages and sequencing in a type design project, especially in the development from variable fonts.

Regarding the results discussed so far, this prospective research with type designers allowed identifying the main elements of variable fonts design process according to

their degree of recurrence. Therefore, the tests, the design space and font context of use are identified as the main elements of the variable font design process. As secondary elements, there are the process steps and distribution, and, in turn, the tertiary elements involve researches, typographic characteristics, preparation of the file and distribution, as shown in Fig. 12.



Fig. 12. Elements of the variable font design process

Therefore, tests refer to the constant revisions necessary during the design process of variable fonts, such as digital media tests and the context of use defined for the font. This context refers to the medias and projects that the typeface is designed to serve. Design space refers to the axes, extremes, and instances of the variable font and the definitions relating to these issues. The process steps reinforce the need to organize the variable font development flow. In turn, the distribution demonstrates how the typeface will be exposed and delivered to the end-user. File preparation involves defining the variable font information and metadata. Searches reflect investigations for historical references and typographic inspirations. On the other hand, the typography characteristics deal with the formal and conceptual definitions of the letters. It is understood that the elements complement each other and that the process takes place in a sequential but non-linear way due to the reviews and significant influence of the tests to guarantee the final product's quality.

5 Final Considerations

This study conducted prospective research from the practice of type designers aiming to understand and identify specifics and elements of the variable fonts design process. The data extracted with the questionnaire made it possible to identify elements that make up the process mentioned earlier and their relevance to it.

Regarding the data collection method used in this research – qualitative questionnaire – it presented as positive aspects the ease and practicality of being sent to the participants since it did not need to be answered at a specific time and place. By contrast, as negative aspects, there is a risk of misinterpretation of the questions and the inability to generate new inquiries for further discussion.

It is also important to emphasize the relevance of using the Atlas.ti software to analyze qualitative data. The program assisted in optimizing the management of a large amount of data and the possibility of viewing such data from the relationship between the codes, network diagrams and co-occurrence tables. Moreover, it is essential to emphasize the possibility of quantifying codes that allowed recognizing the relevance of recurrences in the participants' responses.

Finally, it is stressed that the results are conditioned to the particular universe of this research, considering the experiences and practices of the consulted participants concerning variable font design. Also, the small sample size limitation related to low adherence to participation in the research (50% of the invited professionals) stands out. As an indication of future research, the enlargement of professionals consulted is pointed out, as well as of different nationalities and levels of experience.

References

1. Kochhann, R., Dapper, S.T.H.: Design em transformação: uma análise do pensamento e da prática. In: Anais do 13º Congresso Pesquisa e Desenvolvimento em Design. Blucher, São Paulo (2019)
2. Farias, P.: Tipografia digital: o impacto das novas tecnologias. 4. ed. 2AB, Teresópolis (2013)
3. Scaglione, J.: Processos e métodos. In: Henestrosa, C., Meseguer, L., Scaglione, J. Como criar tipos: do esboço à tela. Estereográfica, Brasília (2014)
4. Cheng, K.: Designing Type. Yale University Press, New Haven (2020)
5. Hammerschmidt, C., Fontoura, A.M.: Notas para uma metodologia do design de tipos. In: Anais do 5º Congresso Internacional de Design da Informação (2011)
6. Henestrosa, C., Meseguer, L., Scaglione, J.: Como criar tipos: do esboço à tela. Estereográfica, Brasília (2014)
7. Pamental, J.: Responsive Typography: Using Type Well on the Web. O'Reilly Media, Sebastopol (2014)
8. Pamental, J.: Fontes variáveis: O futuro da tipografia. User Exp. Mag. **18**(4) (2018)
9. Louis-Rémi: Versatile type design for the web. In: Prototype Blog (2016)
10. Smeijers, F.: Contrapunção: fabricando tipos no século dezesseis, projetando tipos hoje. Estereográfica, Brasília (2015)
11. Victionary. On the road to variable: the flexible future of typography. Two Points, Hong Kong (2019)
12. Berning, B.: Designing written communication for reading on screens (201-?)
13. Mena, M.P.: The ideation Process in Typographic Creation: The Conceptualization of the Letter through the Stroke. In: Ilustrafic. 2º Congreso Internacional de Ilustración, Arte y Cultura Visual (2015)
14. Henestrosa, C.: Desenvolvimento conceitual. In: Henestrosa, C., Meseguer, L., Scaglione, J. Como criar tipos: do esboço à tela. Estereográfica, Brasília (2014)
15. Meseguer, L.: Escrita, caligrafia, desenho de letras e design de tipos. In: Henestrosa, C., Meseguer, L., Scaglione, J. (eds.) Como criar tipos: do esboço à tela. Estereográfica, Brasília (2014)
16. Freire, P.S.: Aumente a qualidade e a quantidade de suas publicações científicas. Manual para a elaboração de projetos e artigos científicos. CRV, Curitiba (2013)
17. Flick, U.: Introdução a pesquisa qualitativa. Artmed, Porto Alegre (2009)
18. Bardin, L.: Análise de conteúdo. Edições 70, São Paulo (2016)



Fluid Collaborations. Digital Platforms to Support Creative Communities

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Abstract. Collaboration and relations systems have contributed to the diffusion of new places of the project by involving multidisciplinary creative teams, and local and global stakeholders’ networks.

Nowadays, digital transformation and participatory design have spread the value of new relationships and synergies between disciplines making essential the use of tools that facilitate the collaboration to share communication codes and to create virtual places for interaction. The research identifies features and functionalities through the analysis of collaborative approaches and physical and digital tools used in the design process. The aim is to define a digital tool able to facilitate communication and collaboration in multidisciplinary teams and guide the different phases of the creative process.

Keywords: Collaborative design · Digital platform · Visual languages

1 Introduction

Collaborative design practices have always generated relations to find ways to involve communities in the phases of idea generation and strategies and development of strategies and actions *bottom-up*.

Looking back to the Scandinavian movement of Participatory Design (PD) and User-Centered Design (UCD) approach, the dynamics of interaction inside the creative groups have changed, democratizing the design processes and involving the user as an active part in the development of solutions [1]. The design paradigm has changed, involving all the research fields from healthcare to environment, from local to global actions through co-design practices, creative workshop, events and digital open-source interactions.

Throughout history, enabling technologies have constantly contributed to influence all aspect of society. In the context of “distributed systems” [2] have helped the experimentation of more sustainable ways of living, new forms of social interchange and mutual aid, alternative systems of personal mobility and in general the implementation of sharing and participative strategies, as the result of a complex process in which technological components cannot be separated from social ones.

The spread of digital platforms has led, in many cases, to the diffusion of an innovation model, not only socio-technical but also environmental and cultural. It encourages openness to cooperative behaviors and culture [3] in which open innovation

spaces, as innovation labs and hubs, are created to meet social needs and solve *wicked-problem* through the definition of new digital and public services in which stakeholders, community and users are connected in all the design process.

Referring to maker-space, fab labs networks and open-source collaboration tools, the way of interacting, creating and producing objects or services, and sharing know-how and tools has changed; as Manzini claims, these phenomena help to create “voluntary, light, open communities without which exists only the loneliness of connected individuality” [4].

Today we live in the era of participation, or “participatory culture” [5], in which people are able to contribute in new ways by sharing interests, needs and ideas.

However, the types and forms of collective creativity and the exploration of co-design practices have strengthened the possibility of the design discipline to design in synergy with the community and other disciplines through a system of ‘fluid interactions’ to fulfil all the requirements of innovation with effective and shared actions.

In this scenario, social evolutions, the diffusion of collaborative practices and digitalization have contributed to change the meeting and working place, which became an active part of the design process, an operational space for the exchange of information, skills and know-how.

The collaboration models are being completely rethought. Workspaces become plurals, as virtual spaces for ideas and visions comparison in which institutions, companies and communities share strategies and co-produce knowledge.

The result is the spread of a critical and collaborative ability that helps creative communities from voluntary and fluid to become specialized communities operating in digital platforms. This enables the design discipline to establish transdisciplinary connections to produce digital democracy [6].

2 Connectivity and Digital Transformation

Digital transformation with the introduction of database, open-source and platforms has facilitated the diffusion of an economy based on collaborative and collective processes, as a system able to communicate between network nodes.

This new digitally-based economy, defined as “digital platform economy”, “sharing economy”, or “economy of collaboration or participation”, is the manifestation of a social phenomenon originated by people interaction and simplified access to information.

Digitalization, now widely spread, has highlighted the necessity to create a network of relations that through the comparison and the idea generation for problem solving is able to create new values by anticipating visions and behaviour and contributing to social innovation [7].

These strategic actions, over the years, have been translated with the creation of spontaneous experiences and new forms of social interchange such as mutual help, time banks, carpooling, co-housing [8] up to the development of collaborative networks, peer-to-peer organizations, widespread knowledge and skills, open access to databases and information that impact on daily life, living, sociality and working.

If before, platforms were mostly used as means to access a service, now they are part of daily life, becoming active participants by facilitating the transfer, management

and access to information through communications flow and visual representations. Digital system such as *WikiHouse* [9] or platforms of cultural movements such as *Stand up for democracy* [10], *Google Arts&Culture* [11] act as spokespeople of actions and strategies to reduce economic and environmental costs, to create shared services and exchange networks to inform and involve larger groups.

Services and platforms become a medium for consultation and participation in events, exhibitions and cultural discussion; horizontal models of social participation, rather than vertical, where citizen participation and involvement are promoted.

These tools aim to systemize various actors by including them in socio-economic, environmental and daily dynamics and promoting participation, collaborations and inclusive storytelling; are accessible in the public and private dimension, reducing role imbalances between institutions, experts and communities.

As claimed in the Ethical Design Manifesto, “Technology that respects human rights is decentralized, peer-to-peer, zero-knowledge, end-to-end encrypted, free and open source, interoperable, accessible, and sustainable. It respects and protects your civil liberties, reduces inequality, and benefits democracy” [12].

In this complex system of interdependences, connections and flows between various social and design fields, disciplines become “a network that connects points and intersects with its own skein” [13] participating synergistically in the creative process. It helps to create knowledge networks and relational spaces where competencies use *cyberspace* as an extension of the human brain to collaborate. The design process changes in a dynamic and evolutive way with a continuous flow of information.

The diffusion of design practices, characterized by open, agile and flexible interactions and fluid and diffuse knowledge, is being extended from physical space as a place of meeting, actions and work to a lightness of space composed by network flows and relations as a shift “from atoms to bits” [14] through the use of digital tools.

Therefore, interactions originated by the use of user-friendly digital technologies help to build a more fluid, liquid and hybrid sociality that allows a constant evolution and adaption of environment, space and objects which generate a contents’ densification.

Moreover, the necessity to support teams through physical tools and guide creative processes in new sharing spaces becomes visible. For example, the MIT Media Lab integrate disciplines such as design, art, science and technology to create an open-research system and a connected society in order to make innovation more ‘popular’ by interpreting dynamically problems in a new “antidisciplinary space” [15].

3 Collaborative Dialogues Through Physical and Digital Tools

Digital and virtual spaces become the ‘place’ in which multidisciplinary and creative groups interact visually, dynamically and interactively. This represents a new spatio-temporal dimension of breakdown and recomposition of relations in which the design process, tools and work-space are modified. From meeting places, turn into operative tools where to connect and discuss in an open and connected network.

In the *post-digital era* [16], virtual spaces are used as tools to share knowledge and information and work in groups. Tools from “things-to-think-with” [17] become software in which to collaborate.

Over the years, the most common tools used to support the creative process and activities are represented by toolkits, defined as a collection of tools that “are used in combination to serve a specific purpose. They can be sorted, categorized, prioritized, used to make a collage, tell a story and/or used to spark conversations” [18]. Toolkits are composed of physical objects that become the physical medium to communicate and express ideas in a play context, facilitating collaboration. The aim is to explore various design possibilities, inspire creativity, involve users and facilitate relationships in workshops and laboratories between stakeholders, manage the fluidity of the design situation and mediate the logical processes of the team.

All individuals involved have the possibility to collaborate by translating the design process in new visions and creating transversal languages and relational skills.

In co-design workshop and participatory design activities toolkits as Philips Co-CREATE Toolkit are frequently used to enable people to think with hands by visualizing the meta-project phase. The twelve thematic drawers contain abstract objects, magnetic and 3D symbols and exercise cards, used to simulate a physical language and to communicate. With similar features to digital platforms, physical objects are dynamic, capture the interest through visual representation and sharing a common ground by reducing hierarchic group dynamics [19].

“Through seeing, moving, pointing, building, and rearranging the physical tools, actors use their bodily senses and interactions to communicate with others, expressing themselves in a visual dimension” [20].

Similarly, through the use of visual artefacts, virtual spaces allow to work in a collaborative and multidisciplinary way, democratizing the design process and simplifying the connectivity; Latour [21] describes it as ‘atmospheres of democracy’, where there is the possibility that hybrid space, physical and virtual, composed by networks, platforms and digital media, as a whole, create a wide variety of arenas for public debate in which to focus on issues of common interest, transforming people into more active participants by involving them in the decision-making process.

The digitalization of virtual workspaces focuses on the possibility to support the design activities of creative communities, composed of stakeholders, users and multiple disciplines and to involve new actors by managing activities, timetable and tasks and making the whole design process an information flow elaborate by the collaboration of different competencies.

However, analyzing some collaborative digital platforms is possible to distinguish three main categories of functionality: *project management* tools as Slack and Monday, in which teams can communicate and collaborate in a virtual space working remotely, managing and organizing activities by timeline; *digital workspaces* as Miro (Fig. 1) or Milanote (Fig. 2) in which is possible to share the workspace visually to design asynchronous or real-time and personalize the creative process with templates; *collaborative whiteboards*, for example, Mural (Fig. 3) and Figma, in which visual collaboration allows teams to design together by translating the design process into a real project through sketches and animated prototypes.

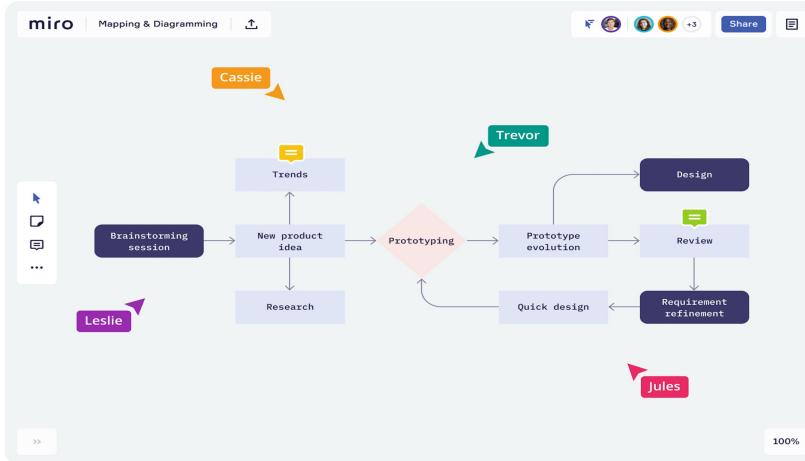


Fig. 1. Miro, online whiteboard to remotely collaborate through the use of templates. www.miro.com/

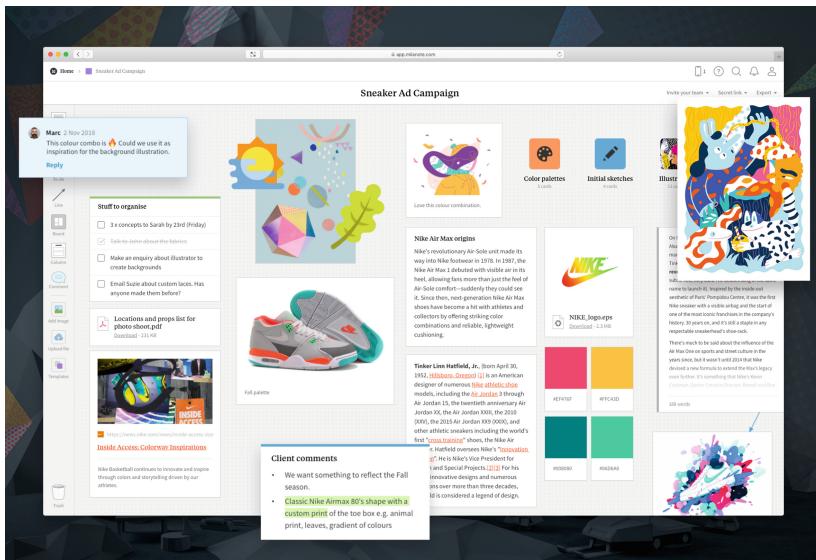


Fig. 2. Milanote, digital tool for creative projects useful to organize ideas into visual boards. www.milanote.com

These digital tools have some common features such as dashboard and whiteboard, that become the virtual space for working and sharing; template, for example, sticky notes, lists and flowcharts, through which organize diagrams and sketches; project management tools such as timeline and workflow to personalize design process, track and manage flows, activities and deadlines; chat or channel, areas dedicated to team member conversation and immediate file sharing.

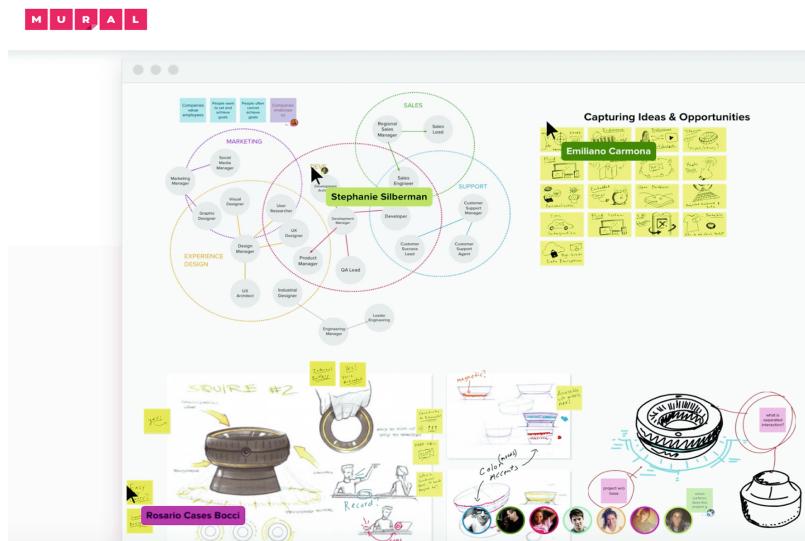


Fig. 3. Mural, workspace for visual collaboration by using template or drawing. www.mural.co/

Although technology can support collaboration and participatory design practices, a paradigm shift is required to the design. This change can be simplified by the use of digital narrations where multidisciplinary dialogues and creative activities are facilitated by visualizing data, information and building a common vision of the problem through collaborative whiteboards. The design process starts to be modified in real-time, in a personalized way from distributed stakeholders worldwide, without the need for key actors.

Platforms become useful tools to develop projects, actions and strategies by managing ideas, knowledge and methods to provide teams with the opportunity to collaborate in new ways by sharing information, changes in real-time and allowing multiple stakeholders to work simultaneously on the same project even remotely.

Therefore, we are witnessing a change from a dialogic design approach to a visual approach composed of images, datasets and multimedia contents that represent private places in which think or shared spaces to collaborate.

4 Conclusions

Knowledge-based economy, digitalization and collaborative platforms have contributed to creating new forms of engagement that go beyond the traditional idea of participation by involving different actors and stakeholders in the design process. Digital platforms assume the role of synergistic catalysts to creating new scenarios in which flows of data and know-how dialogue, visually rethinking languages.

All inputs are translated into a network dimension through the construction of visual space in which people can collaborate and contribute, modifying behavior, habits and

social relations. Therefore, the digital interfaces require new features and codes to simplify the interaction, creating networks of interdependence between the actors involved, in which is possible to explore data and information dynamically and share knowledge.

In this transition from atoms to bits, workspace is dematerialized and databases with images, information and know-how are visually synthesized through charts, maps and graphs; consequently, platforms have the power to simplify complexity through the experimentation of new codes and visual languages.

The digital space is intended as a ‘place’ in which is possible to design visually by actively participating inside the community and developing new shared actions and strategies. Contents are humanized and simplified to be accessible, personalized and open.

The research will converge in the definition of a digital, visual and interactive tool that simplifies the team-building, enhancing skills of various disciplines involved in the project and supporting all the phases of the creative process. The tool aims to support the management of activities, identifying conflicts and opportunities arising from relations established inside the team and visualizing ideas for the meta-project phases. To support the realization of leading by design projects and to facilitate the process of sharing and the interaction, languages and workflow, the collaborative digital tool will promote a visual collaboration to share goals, languages and ideas by placing all the disciplines and actors on the same level and ensuring a continuous flow of information between stakeholders.

Platforms through which stakeholders collaborate to the project are interconnected, and the design networks are based on digital languages that reduce the boundary between hardware and software, analogic and digital into an exchange of narrations and content. In this scenario, the language is densified as the synthesis of multiple actors and competencies and digital becomes a medium of creative and collaborative practices for the community.

References

1. Sanders, E., Stappers, P.J.: Co-creation and the new landscapes of design. *Codesign Int. J. CoCreation Des. Arts* **4**(1), 5–18 (2008)
2. Manzini, E.: Design, When Everybody Designs. An Introduction to Design for Social Innovation. The MIT Press, Cambridge e Londra (2015)
3. Meroni, A., Selloni, D.: Design for social innovators. In: Stuart, W., Tom, C., Martyn, E., Amy, T.H., Jeyon, J. *Design Roots: Culturally Significant Designs, Products and Practices*, pp. 305–318. Bloomsbury Academic, London (2018)
4. Manzini, E.: Politiche del quotidiano, Edizioni di Comunità, p. 15, Milano (2018)
5. Smith, R.C., Bossen, C., Kanstrup, A.M.: Participatory design in an era of participation. *Co-design* **13**(2), 65–69 (2017)
6. Simon, J., Bass, T., Boelman, V., Mulgan, G.: Digital democracy: the tools transforming political engagement. Nesta, Londra (2017)
7. Murray, R., Grice, J.C., Mulgan, G.: The Open Book of Social Innovation. The Young Foundation Nesta, London (2010)
8. Meroni, A.: Creative Communities. People inventing sustainable ways of living. Edizioni Poli.Design, Milano (2007)
9. WikiHouse platform. <https://www.wikihouse.cc/>. Accessed 28 May 2021

10. Manzini, E., Margolin, V.: Open Letter “Stand Up for Democracy”. <https://www.desisnetwork.org/2017/04/11/open-letter/>. Accessed 28 May 2021
11. Arts&Culture Google. <https://artsandculture.google.com/>. Accessed 28 May 2021
12. Ethical Design Manifesto (2017). <https://ind.ie/ethical-design/>. Accessed 25 May 2021
13. Foucault, M.: Of Other Spaces: Utopias and Heterotopias (1986). Translated by Miskowiec, J.: Des Espace Autres. In Architecture/Mouvement/Continuité October (1984)
14. Negroponte, N.: Being Digital. Alfred A. Knopf, New York (1995)
15. Ito, J.: Design and science. *J. Des. Sci.* (2016). <https://doi.org/10.21428/f4c68887>. Accessed 12 Oct 2021
16. Cramer, F.: What Is ‘Post-digital’? In: Berry, D.M., Dieter, M. (eds.) Postdigital Aesthetics, pp. 12–26. Palgrave Macmillan, London (2015)
17. Brandt, E.: Participation through exploratory design games. In: Lauge, B.R. (ed.) Facilitating Change: Using Interactive Methods in Organisations, Communities and Networks, pp. 213–256. Polyteknisk Boghandel og Forlag, Denmark (2011)
18. Sanders, E.B., Brandt, E., Binder, T.: A framework for organizing the tools and techniques of participatory design. In: ACM International Conference Proceeding Series, Denmark, p. 2 (2010)
19. LVWP Studio: Philips Co-Create Toolkit (2017). <https://lvwp.nl/PHILIPS-Cocreate-Toolkit>. Accessed 28 May 2021
20. Kleinsmann, M., Valkenburg, R., Buijs, J.: Why do(n’t) actors in collaborative design understand each other? An empirical study towards a better understanding of collaborative design. *CoDesign – Int. J. CoCreation Des. Arts* 3(1), 59–73 (2007)
21. Latour, B.: Making Things Public: Atmospheres of Democracy. MIT Press, Cambridge (2005)



Color Sensitivity in Digital Interfaces Designed for Elderly People

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Abstract. As ageing brings harmful effects to human vision, this study's goal was to verify, in seniors, what kind of problems could occur with humans' visual perception of color and with their ability to distinguish between visual elements that are differentiated by color. Because in digital artifacts designed for seniors, color can be used as a means of distinction between interaction resources (for example items of a navigation menu), it is vital to be able to correctly identify and distinguish between the used colors. Therefore, a literature review of reference research in the field of digital interface design for seniors was conducted, where it was mapped what is already described about these problems in seniors. Then, starting from an iconography set that had been designed for the menu of a digital application, and that used color as an element of segmentation of the contents it displayed, a sample of seniors was recruited for testing it. Their perception and sensitivity to the colors used in the icons was tested, in order to understand if they could identify them and if they could distinguish them from each other, when displayed together. Given results that diverged from the reviewed literature, a second phase of testing was conducted that allowed to deepen the results of this study and confirm some hypotheses that had raised with the testing's first phase. The final results confirmed partial divergences with the literature reviewed and also provided some insights that are presented and discussed in this paper.

Keywords: Color sensitivity · Digital interface design · Ageing · Seniors · User interface

1 Introduction

In a world where the growth of the senior population is accelerating and where, according to the World Health Organization, in 2030 and 2050 this population will increase from the 1 billion already recorded in 2019 to 1.4 billion and 2.1 billion, respectively (WHO, n.d.), it becomes increasingly relevant to study the effects of ageing on human beings in order to adapt the interfaces of any digital product to the specific needs and limitations of seniors. According to Martins et al. (2022) not doing so can create barriers to the adoption of technological products by senior users, which in turn might result in non-inclusive and unusable products. Knowing that vision and, consequently, color

sensitivity are affected with age it is also imperative to study these impacts in order to take them into account in the design of any interface that is especially aimed at a senior audience. Because in a visual and digital interface, color is often used as a visual feature that helps segmenting and identifying either, for example, thematic typologies of content, or the structural areas where these contents are found and displayed within the structure of a digital product's system. Therefore, in this context, the use of color can go beyond its strict aesthetic and symbolic functions, becoming very important the ability to effectively recognize and identify colors. Thus, the study presented in this paper aimed to understand how elderly people perceive color. So, first of all, a literature review was conducted in specialized works and reference research works in the Design of digital interfaces for seniors' research field, to try to map what is already mentioned about color perception in seniors. Secondly, chromatic sensitivity tests were applied to a sample of the senior Portuguese population, where a set of iconography items from the interactive menu of a digital application for seniors (which used color as a tool for chromatic identification and segmentation of the application's areas and contents) was tested for chromatic sensitivity. A second phase of testing was also conducted to verify hypotheses and suspicions raised from the results obtained in the first phase of testing. It was also the intention of this study to see if its results converged or diverged from what is already described in the literature and if it could, somehow, bring new insights to the use of color in interfaces designed for seniors. Therefore, in this paper, structurally it is first presented the conducted literature review. Secondly the recruited sample of senior participants is classified and characterized. Thirdly, the conducted tests are described by identifying and describing: a) the data collection methodologies applied; and b) the data collected with the tests. Lastly, the reached conclusions with this study are presented.

2 Literature Review

The detrimental effects of ageing on a senior's ability to identify color and to effectively distinguish colors from each other have already been identified in specialized literature about interface design for seniors. According to the literature reviewed, the causes for these adverse effects are closely linked to the degeneration of the sensory apparatus of vision. And (...) "vision problems brought by ageing can be strong constraints and barriers to the adoption of digital applications that have visual interfaces, if these are not designed taking into account these characteristics of seniors" (Pereira et al. 2021: p. 5).

Although vision is not a sensory capacity exclusively affected by age, nor does it affect everyone in the same way, according to Fisk et al. (2004), the onset of vision problems increases with the increasing of age. It is therefore natural that problems associated with color discrimination also increase with age. This vision decline problem is essentially due to two factors. Firstly, it results from a reduction in the eye's ability to focus on near objects. Secondly, it results from a reduction in the amount of light that is transmitted to the retina, light that is filtered out by its yellowing (Hawthorn 2006). This retinal yellowing is related, according to Johnson and Finn (2017), to the constant exposure of humans to ultraviolet light. And one of the most frequent consequences of this change in the retina is the large and also frequent reduction in color discrimination sensitivity (Hawthorn 2006; Fisk et al. 2004) that these individuals suffer when this

happens. This yellowing affects not only how humans see color, but also the ability to distinguish between different colors (Johnson and Finn 2017). According to Houde (2007) the incidence of the reduction of this ability affects half of the elderly when they reach the age of 80. Which in itself shows how much this limitation cannot be ignored in this type of audience or user.

Regarding this reduction in color sensitivity, the authors referred in this review, despite not disagreeing, present different but complementary considerations. According to Hawthorn (2006) this reduction in sensitivity to color discrimination is concentrated mainly in the green and blue colors. Houde (2007) agrees with this short list of colors mentioned by Hawthorn (2006), although he also adds shades of purple. However, he supports this statement with the fact that with ageing, the eye lens decreases in transparency, resulting in a non-uniform passage of light to the retina, which can negatively impact the ability to discriminate color (Houde 2007).

McLaughlin and Pak (2020) also mention this issue of decreased lens transparency as a factor interfering with the ability to discriminate color in seniors. Although they add that the lens changes from transparent to slightly yellowish, which makes it absorb preferentially blue light. This in turn makes colors appear less blue and more yellowish. As a consequence, it becomes more difficult for senior individuals to distinguish shades of blue that have small differences, and in more severe cases it becomes more difficult to discern between shades of red and purple. In this regard, Johnson and Finn (2017) also make considerations. They state that, as color perception in seniors tends towards some yellowing, certain color combinations such as greens, blues, and violets become more difficult to distinguish.

A second negative effect of ageing on vision, and one that can also impact color discrimination, is the reduction in the eye's pupil ability to close and open to regulate light's entry. According to McLaughlin and Pak (2020) in a senior eye the pupil not only takes longer to open or close than in a young eye, but has greater difficulty not only opening or closing, but dilating to its maximum opening. Therefore, older eyes receive much less light than young eyes, to such a degree that, as noted by McLaughlin and Pak (2020) the retina of someone 60 years old may receive up to a third less light than the retina of someone 20 years old (idem). Although these last authors do not make any recommendations about this problem of reduced light sensitivity in seniors, Johnson and Finn (2017), for exactly the same reasons, state that these individuals have a harder time distinguishing between dark colors such as dark blue and black, or red and purple. It can, therefore, be inferred that it is advisable to avoid dark colors or colors with low brightness, as colors that are already too dark may not be distinguishable from one another.

Another vision-related problem that arises with ageing is a reduction in contrast sensitivity (Hawthorn 2006). According to Johnson and Finn (2017), beginning at age 50, many individuals begin to experience a reduction in their ability to detect small chromatic contrasts. Whether it is between small differences in shades of gray or between shades of any color, this reduction continues to worsen as one ages. This suggests that low contrast ratios between visual elements and their background not only make elements difficult to distinguish from their background but, as stated by Johnson and Finn (2017), make it difficult to perceive their exact color when the colors are similar. This, in turn, suggests

avoiding the simultaneous use of colors that are similar, especially in elements of an interface that must necessarily be distinguished, such as the iconography of a navigation menu.

3 Characterization of the Tests' Recruited Senior Sample

Typology wise, this sample was a convenience sample (Carmo and Ferreira 2008). This was due to the fact that participation was voluntary and that the participants were direct relatives of one of the authors of this study. To protect the participants' privacy, they are identified in this document with numerical terminology, from P1 to P8 (for example: P1 = Participant 1). As for the sample's size, it was composed of four couples, which makes it a statistically unrepresentative sample. However, according to Jacob Nielsen, testing with 5 participants will let you find almost as many issues or problems than the ones that you would find if you were to test with a bigger number of participants (Nielsen 2012). Therefore, it is considered that this lack of statistical representability, does not compromise this study's results.

Age wise, four of the eight participants were aged between 61 and 65 years old, two were between 66 and 70 years old, and the remaining two were between 71 and 75 years old. All of the participant couples resided in their own homes. In professional terms six of the participants were retired, one was still employed and the remaining participant was unemployed.

As far as vision characteristics are concerned, it was found that most of the sample already had some vision-related problems, as shown in the data described below. First, seven out of eight of the participants declared they used glasses. Second, as far as Visual Acuity (VA) levels were concerned, the data presented in Fig. 1 was collected, where the black bar represents the VA level of the right eye and the gray bar represents the left eye. These VA levels were measured with a *Snellen scale* and following the protocol recommended by Sue Stevens, advisor of the *Community Eye Health Journal, International Center for Eye Health, London School of Hygiene and Tropical Medicine* (Stevens 2007).

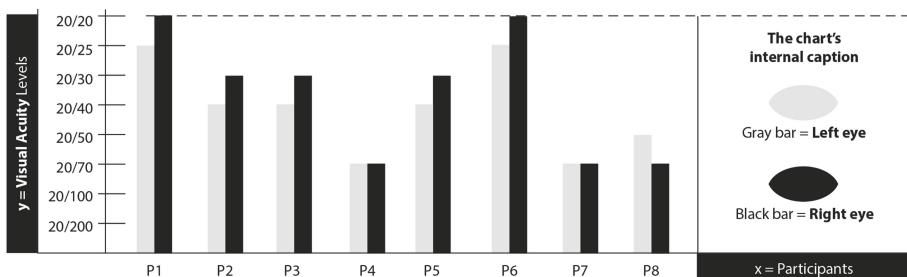


Fig. 1. Participants' Visual Acuity measured per eye

It turns out, that only two of the participants had an VA level of 20/20 and in only one of their eyes (the left one). The remaining participants had a VA level below the

level considered normal. Three were characterized by a VA between 20/30 and 20/40, meaning that they could only see clearly at 20 feet what a normal person could see at a distance between 30 and 40 feet. The remaining three had an VA of 20/70, meaning that they could only see clearly at 20 feet what a normal individual could see at a distance of 70 feet, although one of these participants, in his left eye, had a measured VA of 20/50. Therefore, most of the participants had a VA below that considered normal, meaning that, their vision was already characterized by difficulties that, if in some cases were slight (Fig. 1 - P1 and P6) in other cases were already significant (Fig. 1 - P4, P7 and P8).

4 Tests: Methodologies Employed and Data Collected

4.1 First Assessment of the Individual Color Identification Ability

These first tests used the iconography set developed for the menu of an interactive TV application. Each icon displayed a different color (see Fig. 2). The goal was to test, firstly, if the participants could easily identify and distinguish each of the colors used in each icon, or if there would be problematic colors not to use, because they tend to be difficult for seniors to identify. Secondly, it was intended to test whether there would be any kind of relationship between the size of the icon display on the TV set and the degree of color identification, since the iconography was displayed in two different sizes on the interface. Finally, it was also intended to test whether the colors could be effectively distinguished from each other when displayed together.

4.1.1 Assessment and Data Collection Methods Employed

In a first phase of this assessment, participants were shown two sequential series of seven differently colored icons, one by one, on a television set. In the first series the larger sized version and then the smaller sized version. The sizes respected the resolution in which they were used in the application, that is, 30×30 pixels and 50×50 pixels. Finally, each participant was individually asked what color each icon displayed was. Then participants were shown a page with seven different colored icons (see Fig. 2) side by side, and were asked the question "*Do you think these symbols all have colors that are well distinguishable from each other, or are there some with colors that you think are similar?*".

4.1.2 Collected Data Analysis

As for the ability to identify each of the colors of the tested iconography, no major problems were detected. Consider the following chart where the color identification results are compared between the larger version (left) and the smaller version (right). The black bars represent the number of wrong answers while the colored bars represent the right ones.

From the analysis of Fig. 2 it is visible that only two of the colors - orange and brown - in both the large and small versions, are less identifiable by the participants. Six out of eight did not identify the colors as orange and brown. Interestingly they even

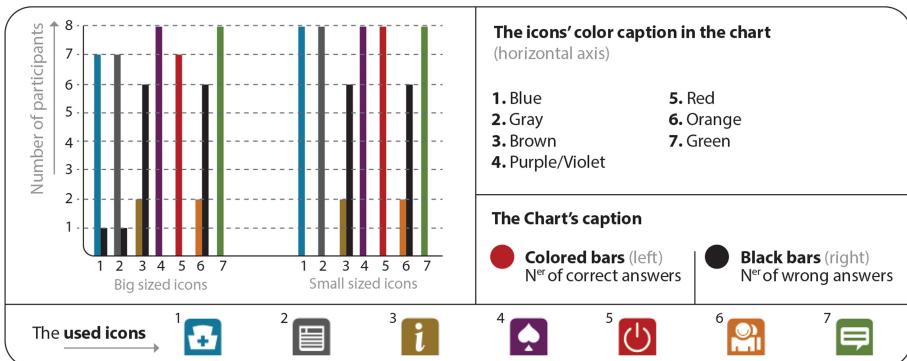


Fig. 2. The participants' chromatic sensitivity assessment results using the iconography set

confused them by sometimes answering brown when it was orange, and orange when it was brown. These results suggest that the use of colors such as brown and orange may raise problems of chromatic identification, and it is not recommended to use them, at least together, because the results of this test suggest that they tend to be confused with each other.

Another finding that stems from the comparison between the results of this test and what is advocated by some of the reviewed literature, is that the problems of chromatic sensitivity described by Hawthorn (2006), who argues that the problems are concentrated (...) in the colors green and blue, did not occur. These colors were identified in this first test by seven of this study's eight participants. Nor did occur the problems with purples/violets described by Johnson and Finn (2017), Houde (2007) and McLaughlin and Pak (2020). Also this color, used in icon 4 of Fig. 2, was easily identified by all of the eight participants. At the time it was hypothesized that this lack of confluence might be related to the fact that the color of these icons was tested against a black background. And so the question was raised whether these results would be maintained if evaluations of the color sensitivity of seniors were also done with a white background and whether there would not, therefore, be some confluence with what was advocated by the authors mentioned before. Therefore, in order to: i) deepen this study on color; ii) test the hypothesis on blue, green and purple/violet mentioned before; iii) and to identify more problems with a wider chromatic spectrum; it was decided to conduct a second chromatic sensitivity assessment with this study's participants.

With regard to the intention of verifying if there is any type of relationship between the icon display size and the increase in chromatic sensitivity, the analysis of Fig. 2 also reveals that the results are relatively transversal. The difference between the results of the larger and smaller versions of the iconography does not allow us to say that there is any advantage in using larger iconography to attenuate the reduction of chromatic sensitivity.

Finally, regarding the question - “*Do you think these symbols all have colors that are well distinguishable from each other or are there some with colors that you think are similar?*” - the answers suggest that the colors used are different enough to be distinguishable among these participants. Six answered that the colors were distinguishable,

while two answered that some were not. But even though the majority answered that the colors are distinguishable, five participants also mentioned that the only problem was the proximity between orange and brown, because the difference was small. If this problem doesn't determine that these colors should not be used, it certainly determines, in line with the assessment of color identification, that they should not be used at the same time, at least, per example, in elements of an interface in which one of the forms of distinction between these elements is precisely their differentiation by color.

4.2 Second Assessment of the Individual Color Identification Ability

In this second assessment it was intended to: a) verify the hypothesis that were previously raised about the sensitivity to blue, green, and violet/purple (whether these colors became less identifiable on white backgrounds); and b) identify other problems associated with a wider color spectrum than that used in the first test.

4.2.1 Assessment and Data Collection Methods Employed

Sixty-six different colored squares, in three tone variations of eleven colors, were displayed one by one to the participants on a TV set. That is, a lighter version, another version in its normal shade, and a last one darker, as shown in Fig. 3. All were displayed both on a black and on a white background. Next the participants were asked which color they saw in the displayed square.



Fig. 3. Colors used in the second assessment of the participants' individual color identification ability

4.2.2 Collected Data Analysis

The following figure displays quantitatively the wrong and right answers given by the participants about the tested colors. The left-hand side shows the results of the test against a black background. The right-hand side shows the results of the test with a white background.

The overall results suggest that only lemon yellow, orange and brown, in the version over a black background, performed negatively. The remaining colors, at least in their

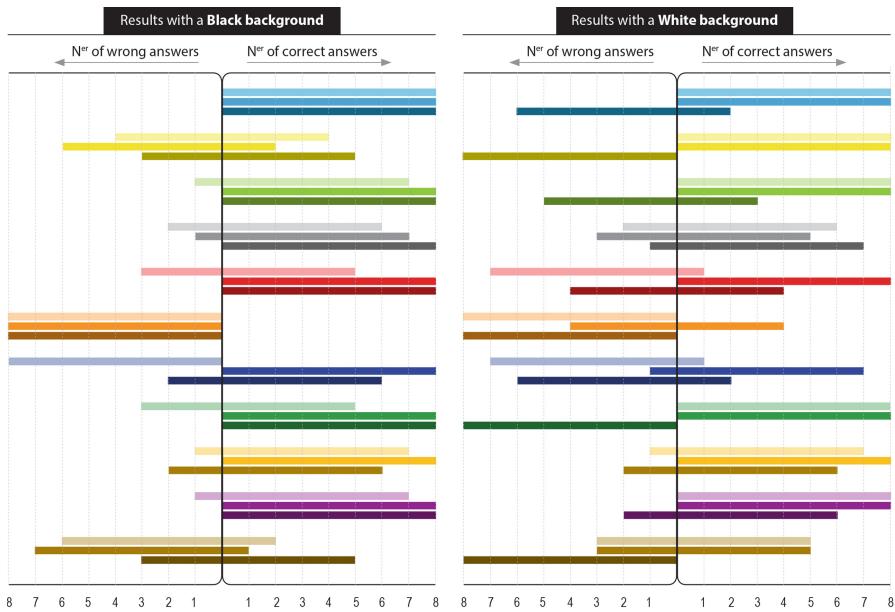


Fig. 4. Chromatic sensitivity assessment over black background (left) and over white background (right)

normal version, had a positive performance. However, the results of the test over white also suggest that lemon yellow, orange and brown are slightly more effective when used in this chromatic environment. On the other hand, these results also suggest that colors in darker versions are more effective over black backgrounds than over white backgrounds. Over black backgrounds ten out of eleven performed positively. While over white backgrounds only four out of eleven performed well. This suggests that over black backgrounds (with the exception of a dark navy blue) the darker colors seem to be more effective than the lighter toned colors.

As for the lighter color versions (pastel), there were no significant differences between the performance of these over the two different backgrounds. Seven of the black versions had a positive performance. Over white there were eight with a positive performance. However, while over white background there were eight pastel colors that had a positive performance, on dark colors there were only four. This suggests that on white backgrounds pastels are more effective than dark colors. This apparent difference in effectiveness between light and darker shades of colors is important because it suggests, through the use of color, differentiated strategies to create distinctions between states (active and inactive states) of interactive items. If the background is black it seems to be more effective that, deactivated, the interactive items display darker colors. If the background is white it seems to be more effective that deactivated interactive items display pastel colors.

With regard to the colors that were identified in the first test as problematic - orange and brown - the results of the second test confirm them. With a black background

none of the participants were able to identify orange as orange in any of the three tone variations tested. With a white background the orange performance improves a little - four participants identified it as orange - but only in the shade previously called normal. In the remaining shades the performance remained completely negative with none of the participants identifying this color as orange. Analyzing the answers given by the participants, there is a very significant tendency to identify this color in its three shades, as a yellowish color (in the normal and light shades) and a brownish color (in the darker shade), both in the version over a black and white background.

As for brown, these results suggest that the performance of its three shades depends on the background. Over a black background, with the exception of the darker shade that had a positive performance (five participants correctly identified the color), the color performance is very negative (seven got the normal shade wrong and six got the lighter shade wrong). But over a white background the color performance is positive, (five got the light one right and five got the normal one right), although the darker shade is no longer identifiable (all got it wrong). This suggests that brown is more identifiable as brown in its lighter and normal shades, over a white background; and more identifiable in its darker shade over a dark background. When the wrong answers given for brown, both over a black and over a white background, are analyzed, it becomes obvious that there is also a very significant tendency to perceive a yellowish color. This, to some extent, seems to be confluent with what McLaughlin and Pak (2020) describe about the consequences of the transparency of the lens of the eye becoming slightly yellowish. This causes it to preferentially absorb blue light, and thus colors appear less blue and more yellowish. However, these authors do not mention the difficulty for seniors to identify oranges and browns. They only mention that it can be difficult for them to discern, for severe cases, between red and purple hues.

With regard to the colors that have been identified in the literature as being problematic - blue, green, and violets/purples - the results of the second assessment partially diverge from what is advocated in the literature. Regarding the blue and green colors which were, in this assessment, tested in two versions each (three tonal variations of a cyan blue and of a navy blue; and three tonal variations of a lime green and of an emerald green), in the case of the black background, again, there are no major difficulties in color identification. Only the light-shaded version of navy blue performs negatively, both on black and on white background. With the other versions of blue and green no major issues were detected. However, when the background is white, the performance of these colors decreases a lot in the dark shaded version. In the normal version the participants were, on the whole, able to identify them correctly. This suggests that what Hawthorn (2006) describes about green and blue being problematic colors may be more applicable to situations where these colors are used with light or white backgrounds and only with dark shaded versions. Regarding violets/purples it turns out that the performance of the three shades of this color was, again, quite positive. The normal tone version was identified by all participants, both over a black and white background. The lighter version was also mostly identified by the participants, both over a white and black background. As for the darker version, over a black background it was curiously identified by all participants. On the other hand, on a white background, only two of the eight participants got it wrong. So there is a clear divergence here between these results and what is advocated

in the literature, namely by Johnson and Finn (2017), Houde (2007) and McLaughlin and Pak (2020) about this color. Regarding reds, the results of this study indicate that they perform worse, in the lightest and darkest versions, when used over white backgrounds. When used over black, the performance of all shades of red is positive. This suggests that, at least for white backgrounds, very dark and light variations of reds should be avoided. But since normal red performed very well on both backgrounds, this suggests that, for seniors, normal red can be freely used.

To conclude, a new insight worth highlighting is related with the performance of the two versions of yellow tested over a black background. If one compares, in Fig. 4, their performances, one can see that the honey yellow, especially in the light and normal shades, has a significantly higher efficiency than the lemon yellow. In fact, lemon yellow has a negative performance in the normal shade and a medium performance in the light shade (half of the sample was wrong). This suggests that, if yellow is used on a black background, one should opt for a slightly toasted yellow like the honey one used in this test. It should be noted, however, that on a white background the same does not seem to apply (with the exception of the darker version of lemon yellow which also clearly had a negative performance and where there is also a greater ability to identify the color if a more toasted version of it is used).

5 Conclusions

The results of this study seem to offer some insights into the use of color in interfaces of digital artifacts designed for seniors. On the other hand, they seem to suggest that color sensitivity problems in seniors are somewhat contextual and depend on the relationship between the luminance of the background and the color of the element overlaid over it. More. They seem to suggest that they also depend on the degree of luminance of the color of the element and the background's luminance. In the conducted tests there were colors and tonal versions (darker and lighter shades) that behaved better on dark backgrounds and others that behaved better on light backgrounds. Finally, it should also be mentioned that this study's global results suggests some partial divergence from the data collected from the conducted literature review, fact that highlights some need for further study of this problem.

Regarding new insights that this study's results seem to bring, it should be noted that the collected data suggests more sensitivity and chromatic discrimination problems in colors such as oranges, browns, and yellows, than in other colors mentioned in the reviewed literature. Oranges and browns were easily confused by the participants. Therefore, their use is not recommended, at least simultaneously, especially in situations where elements of an interface need to be clearly distinguished by color, such as iconography or even interactive items. As for yellows this study's results suggest that if yellow is used on a black background, one should opt for a honey like yellow and not lemon like yellows. Note, however, that honey yellows in the three tonal versions that were tested in this study over a black background, do not perform negatively. But if a more toasted and honey like yellow is used, this seems to greatly amplify the ability of the seniors to identify it as yellow. If the background is white, however, this does not apply, and both the lemon and honey yellows seem to be globally identifiable by seniors. So it seems

like its desirable to add a little “heat” to the yellows used when they are used on a black background.

As far as the partial divergences are concerned, first of all the results of this study did not arise exactly the same chromatic sensitivity problems as the ones described by Hawthorn (2006), who argues that in seniors these are concentrated (...) in the colors green and blue. What was observed suggests that these problems only occur if these colors are used over white backgrounds and only in darker tonal variations or darker shades of these colors. In lighter tonal variations and in the normal tones of these colors, with the exception of navy blue in the lighter version, there were no chromatic sensitivity problems or issues.

Secondly, the problems with purples/violets described by Johnson and Finn (2017), Houde (2007) and McLaughlin and Pak (2020) were not observed or confirmed in this study. In both of the conducted assessments these colors were globally identified by the participants, whether these were over a dark or white background.

Thirdly, one would expect from what is advocated in the reviewed literature, that it would be advisable to avoid low chromatic contrast ratios, due to the reduction in contrast sensitivity that humans typically suffer from with ageing. Yet the results of this study, interestingly, suggest somewhat the opposite. Because, as described before, in the second conducted assessment the tested darker color variations behaved much better on black backgrounds than on white backgrounds.

Nevertheless, this set of divergences does not refute, either what is advocated in the literature nor the results of this study. Rather, they only highlight the need for further study and research of this issue.

References

- Carmo, H., Ferreira, M.M.: Metodologia de Investigação — Guia para Auto-aprendizagem, 2nd edn. Universidade Aberta, Lisboa (2008)
- Fisk, A., Rogers, W., Charness, N., Czaja, S., Sharit, J.: Designing for Older Adults. Principles and Creative Human Factors Approaches, 1st edn. CRC Press LLC, Boca Raton, Florida (2004)
- Hawthorn, D.: Designing effective interfaces for older users. Doctoral dissertation. The University of Waikato, Hamilton, New Zealand (2006). <https://hdl.handle.net/10289/2538>
- Houde, S.: Vision Loss in Older Adults. Nursing Assessment and Care Management, 1st edn. Springer Publishing Company LCC, New York (2007). <https://www.springerpub.com/vision-loss-in-older-adults-9780826102188.html#yotpo.reviews.tab>
- Johnson, J., Finn, K.: Designing User Interfaces for an Aging Population. Towards Universal Design, 1st edn. Morgan Kaufmann Publishers, Elsevier, Cambridge (2017)
- Martins, N., Ralha, S., Simoes, R.: ICT4Silver: design guidelines for the development of digital interfaces for elderly users. In: Machado, J., Soares, F., Trojanowska, J., Yildirim, S. (eds.) *icieng 2021. LNME*, pp. 178–188. Springer, Cham (2022). https://doi.org/10.1007/978-3-030-79168-1_17
- McLaughlin, A., Pak, R.: Designing Displays for Older Adults. Human Factors & Aging Series, 2nd edn, CRC Press, Taylor & Francis Group, LCC, Boca Raton, Florida & Abingdon, Oxon, USA (2020)
- Nielsen, J.: How many test users in a Usability Study. Nielsen Norman Group, 03 June 2012. <https://www.nngroup.com/articles/how-many-test-users/>

Pereira, L., Brandão, D., Martins, N.: Ageing related human factors to be addressed in the design of visual interfaces of digital applications developed for seniors: a literature review. In: Martins, N., Brandão, D., Moreira da Silva, F. (eds.) Perspectives on Design and Digital Communication II. SSDI, vol. 14, pp. 65–80. Springer, Cham. (2021). https://doi.org/10.1007/978-3-030-75867-7_5

Stevens, S.: HOW TO... Test distance vision using a Snellen chart. Community Eye Health J. **20**(63) (2007). https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2040251/pdf/jceh_20_63_052.1.pdf
World Health Organization. https://www.who.int/health-topics/ageing#tab=tab_1. Accessed 28 Dec 2020



Enhancing Human-Centered Design Methods Through Jobs To Be Done: An Exploratory Study to Enhance UX

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Abstract. Often, the creation of digital products tends to prioritize the Design of the interface instead of focusing on how to solve the user's problems. In order to undertake deeper user research and build better products, the Jobs To Be Done (JTBD) methodology might be a feasible addition to the general UX toolbox. Despite that the JTBD framework has been around for a while now, it has gained popularity among UX Designers just recently. Nevertheless, at the moment of this research, there is not enough research or information available about how to combine these methodologies; but a comparative study could provide a valuable stepping stone to decide the course of action to perform further research. If successful, this study can lead to insights that would be beneficial to the Design Community, as well as the companies and institutions investing in software and app development, and most importantly, for the end user.

Keywords: Jobs To Be Done · Human-Centered Design · UX · Design methodology

1 Introduction

With the continuous growth of digital products worldwide, designers face the challenge of understanding the increasingly complex technical constraints of technologies to create better products and interfaces. These products need to fit the user's lifestyle, but also help them achieve whatever task they have at hand without getting in their way. Because of the constantly changing nature of technology, there is no general methodology that designers can follow to create novel products that completely satisfy those requirements and anticipate any potential problems. Over the last decades, Human-Centered Design (HCD) has established itself as the dominating approach for digital product design. HCD defends that the focus of design should be the user's needs (Norman 2013; Johnson 1998). Therefore, designers need to acquire first-hand knowledge about their users, their environments, motivations for using products, among other relevant information. Additionally, after being designed, the product needs to be tested by the people who are

going to use it, to obtain as much feedback as possible about potential issues that might arise and that were not taken into account during the development phase. In theory, HCD should guarantee a high degree of success for product design, nonetheless, this approach is not entirely flawless.

For its part, the Jobs To Be Done (JTBD) framework has been gaining popularity recently among product developers and UX practitioners. Unlike HCD, which focuses on improving the users' *existing* circumstances through design, JTBD focuses on innovation; it attempts to forecast *future* needs and thus potential opportunities for product design. Both HCD and JTBD put the user's needs at the center of the process but JTBD might actually have some advantages during the ideation phase of the design process.

However, JTBD is not yet widely used, mainly due to a lack of structure and detailed information about how to incorporate it during the design process. This paper is part of an ongoing MA research project and contends that JTBD can bring great benefits into the Design practice by expanding the method in which the user and their needs are being studied to design products. The first section will outline a very brief background of HCD and JTBD and carry out a comparative analysis of their main aspects. Section two explains the basic concepts and principles behind these frameworks. The last section discusses how the JTBD framework could be incorporated during the ideation phase of the design process. This article does not intend to give a solution or final "formula", nor to argue that HCD should be abandoned, but rather to expand its scope and strengthen its panoply. Ultimately, the goal of this paper is contributing to the conversation about design methods and their future.

2 The Emergence of JTBD

Although design as a profession only emerged in the early nineteenth century, the concept of Design can be traced back to the fourteenth and fifteenth centuries in Europe (Cooley 1999). The role of the designer is unthinkable without the separation between making (conceptualizing) and producing that the introduction of new forms of automation during the Industrial Revolution brought. Design, as a field, discipline and profession is fundamentally modern. The history of design theory and practice has evolved following the realization that designing is ultimately about (practically) researching the possibilities of making (Redström 2020), moving through different schools of thought, and developing along with technology. Yet, there is not a blueprint that everyone can follow when designing new products, instead a shared understanding of procedures (research, prototype, design, test, repeat.) that function like a guide that can be adapted to different situations.

When designing digital products, nowadays the method of choice is usually some variation of Human-Centered Design (HCD), which puts the user as the most important element of the process. Arguably, however, there is still a limitation at the core of this methodology, as some authors claim that the human aspect is often neglected in methodological approaches of design (Badke-Schaub et al. 2005). In a sense, HCD does not fulfill the totality of the user's needs, mainly because it only focuses on a present problem and does not take into consideration the evolving nature of the user. Additionally, it has become increasingly evident "that the use of technology critically

depends on complex, meaningful, social, and dynamic contexts in which it takes place” (Kaptelinin 2014). On the other hand, the wealth of projects and publications that are created and sustained through an HCD approach seems to argue differently. Hence, a new approach needs to be taken in order to satisfy the requirements of the ever more demanding customer.

Parallel to design practice, the Customer Job Theory (later Jobs To Be Done) was born from the quality management movement with the intention of bringing into play the Voice of the Customer (VOC) (Klement 2018a). Voice of Customer (VOC) is a term that emerged in a paper by Griffin and Hauser in 1993, in which they defined the VOC as “a complete set of customer wants and needs; expressed in the customer’s own language; organized the way the customer thinks about, uses and interacts with the product and service; and prioritized by the customer in terms of both importance and performance” (Griffin and Hauser 1993). Moreover, the JTBD framework was developed to create new products and services, as it focused on the progress the customer desires to achieve, instead of the product itself. Although this theory was born in another area of study, the possibilities of using it in the design practice can close that broken link and help build better products overall.

3 Theoretical Context

Human-Centered Design (HCD) was born as a response to technology-centered systems design; as a way to put human interests in the field of Human-Computer Interaction (Boy 2012). HCD is a holistic approach for addressing and preventing problems that users might experience while interacting with technologies. Even though there may be different ways to name them, depending on the author and her approach, projects that follow HCD are normally broken down into five main stages of development: Scope, Analysis, Design, Validation, Delivery (Wallach and Scholz 2012). This framework is iterative, which means that designers have to continuously test the product with the users, incorporate their feedback to improve the design, and test again. Ideally, the process should continue until every issue has been addressed. Consequently, HCD can be regarded as a cyclic model, where improvements on the product can be carried out infinitely—at least in theory because the users’ needs change over time (Hartson and Pyla 2012).

A simple search in Google Ngram Viewer (Google 2019) reveals the term “Jobs to Be Done” has been around for a long time. Nonetheless, it only became associated as a framework for innovation in business in the mid-2000s, as a popularisation of a process called Outcome Driven Innovation, patented in the early 1990s (Ulwick 2017). Consequently, although this process has been around for three decades, it started gaining popularity among the UX Community just recently (Fig. 1).

According to Klement (2018b) there are two JTBD main interpretations: (1) the “Jobs-As-Activities” model, which indicates that users acquire products because they want to “do work” with them, so products are seen as tools; and (2) the “Jobs-As-Progress” model, which implies that users are looking to create progress or a positive change in their life. In the latter case, the attention should be put on such progress, and not just on the product and its functionality.

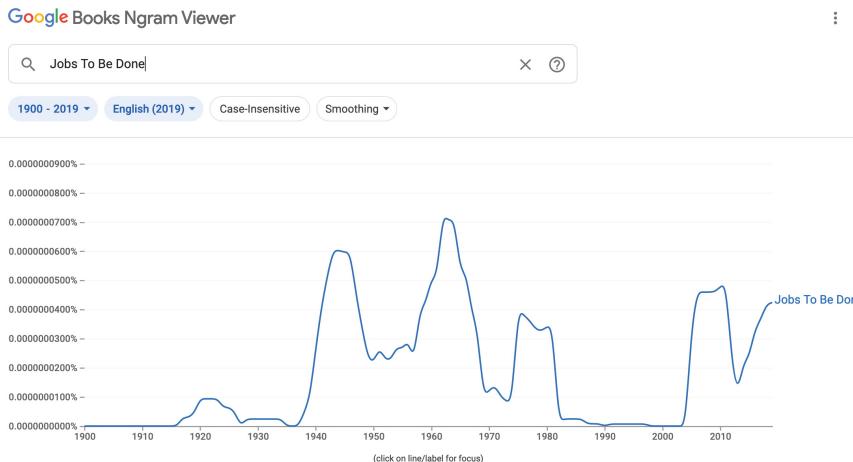


Fig. 1. Search results for “Jobs To Be Done” on Google Books Ngram Viewer 2019.

In Klement’s words (2018a) “A Job to be Done is the process a consumer goes through whenever she aims to transform her existing life-situation into a preferred one, but cannot because there are constraints that stop her.” In other words, the consumer or user has aspirations, they want to become a better version of themselves, but in order to do that, they need a product or service to assist them. When these aspirations are taken into consideration when designing new products and services, user’s needs can be fulfilled in a finer way leading to better products and happier customers.

Both variants of the JTBD framework resemble other theories that are well known among designers. For example, “Activity Theory”, a research framework originating in Soviet psychology in the 1920s (Nardi 1996), establishes the “activity” as the basic unit of analysis, providing a way to study both the subject and the object involved in the activity, and therefore avoid having any of them being studied separately, and without a context (Kaptelinin et al. 2006). Activity Theory, just as the JTBD framework emphasizes the study of the subject along with her environment and the conditions, as well as her motivations and goals.

In Herbert Simon’s “Science of Design” (1988), a scientific approach was intended to transform design from arts and crafts to a rational problem solving methodology that relied on conceptual schemes embodied in research practices. Most importantly, it defined design as a logical search of courses of action aimed at changing existing situations into preferred ones (Huppertz 2015). Arguably, this idea was a reformulation of John Dewey’s pragmatist understanding of “Inquiry”, which he defined as a “controlled or directed transformation of an indeterminate situation into one that is so determinate in its constituent distinctions and relations as to convert the elements of the original situation into a unified whole” (Dewey 1964, as cited in Buchanan 2009). Ultimately, Simon’s proposal didn’t come to fruition mainly because it left aside the human element, but that new definition of design is now found in the “Jobs-As-Progress” model of the JTBD framework, as the focus goes to that positive change that the user is trying to

achieve. The main difference is that JTBD takes into account all the emotional segments that Simon left out.

In 1988, Foucault introduced the term of Technologies of the self (Hernández-Ramírez 2017), and although it is an unfinished work, it keeps appearing as a reference in today's research. Technologies of the self are specific techniques found in tangible practices that shape people's lives. This way, individuals help transform themselves in order to obtain a preferred state (Abbas et al. 2009). This concept of transformation into a preferred state is one of the leading ideas in the "Jobs-As-Progress" model of the JTBD framework.

4 Going Beyond Design Theory

This paper studies the possibility of integrating the Jobs-To-Be-Done framework with Human Centered Design practices in order to have a better understanding of the user's needs and design better products for them. Through an integrative literature review, we "aim to assess, critique, and synthesize the literature (...) in a way that enables new theoretical frameworks and perspectives to emerge" (Snyder 2019). In view of the fact that JTBD is not part of the design methodology, our research went beyond the limits of the design practice, trying to incorporate other disciplines in the hopes of enriching the contemporary HCD practice.

After learning about JTBD and the potential uses in design, we performed a quick research to understand how other designers are incorporating this framework into their work, but we quickly realized that a large quantity of them have not been able to do it successfully because of a lack of structure in the research methodology of JTBD. In addition, we found similarities with other theories, like the ones proposed by Simon, Dewey and Foucault, and attempted to perceive if these theories are applied in today's design practices. With this research we do not claim to have found a definitive solution to integrate JTBD and HCD, but we seek to spark a conversation that can lead to a successful study and further application in the Design field.

5 Discussion

5.1 Current State

HCD is arguably the leading approach for designing digital products nowadays. Although it can be used for the creation of any kind of product or service, people usually think about web or mobile applications when they hear about this framework. As the name implies, the focus of this framework should be the user, specifically, addressing her needs by shaping technologies so as to make them as usable, useful (and even) delightful as possible. The problem, however, is that in reality this focus on the user's experience is often limited to the User Interface (UI) design. And although to a certain degree the product *is* the interface, as Gould and Lewis (1985) presciently noted, the visual language should be the result of the input obtained through user research.

With this misunderstanding, some products lack a proper methodology when built, or are built based on insufficient user data. For example, one of the complaints in the

Design Community is that User Personas, used as a characterization of the ideal user for a specific product, are created mainly with demographic data, when in reality the focus should be in the psychographics gathered during research (McKeen 2019). In addition, there has been criticism regarding the fictional nature of the persona; because of the fictitious elements, it can be difficult to conceive a relationship between real users and a made-up profile. Moreover, this fabrication of information denies the User Persona the possibility to be considered scientific information, as the objectivistic scientific paradigm states that “science consists of statements that can be verified” (Nielsen 2014). While some may argue that the Design process does not have to adhere to scientific standards, rooting a product’s development on fictional information will not produce the best results to improve the user’s life.

Research is, or at least it should be, an essential part of the Design process. Many research methods and styles are used in current Design practice, and with that, some problems have arisen, as there is not a single model that works for every problem. As Ann Blandford notes in a conversation with Ditte Hvas Mortensen (Ditte 2020), some of the issues that designers encounter include being overwhelmed by data and thus unable to know where and how to start analyzing the information they obtained during the research phase.

Another problem that researchers come into, is confirmation bias. When you have an hypothesis or an idea about the outcome of your research, and some data seems to prove the validity of that hypothesis, it is usual to draw a sweeping conclusion from that fragment of information and overlook the rest of the data. (Ditte 2020) Clearly, a new approach to research or a complementary method is necessary if we intend the Design practice to evolve and become more rigorous.

Additionally, there are other concerns about research for innovation in general. For example, as Ulwick and Osterwalder (2016) explains, the Ideas-First Approach encourages companies to come up with as many ideas as possible as a method to innovate. During this process, after many proposals are generated, the ones that are likely to fail are filtered out and only the promising ones will continue along the process. With this largely accepted method, employees are encouraged to fail fast and cheap, in order to save money for the company. While this method is widely used, it may not be the best way to fulfill the user’s needs, as they are contemplated only after the ideas are generated.

As noted earlier, within HCD, an important notion is Activity Theory, which defines activities as “generative forces that transform both subjects and objects” (Kaptelinin 2014). To a certain extent, this approach considers the human side of the user and her relationship to a context, but it still regards subject-object interaction without fully considering the dynamic nature of the “ecosystems” surrounding her. The focus on single interactions in specific contexts and times might leave out important information about the user’s needs. In addition, it addresses the perceived problems of the user, without considering what she aspires to *be* in the future. That is, without taking into account that a user might undergo certain transformations through her interaction with technologies.

5.2 The Study of the Ecosystem Instead of the Tool

Within the JTBD framework there are two methods that help study and identify the different components of the user’s ecosystem. The first one, a diagram titled “The Timeline”,

illustrates the path that users follow before deciding to buy any new product or service. The timeline starts with the first thought, and progresses through (a) passive looking, (b) active looking, (c) decision, (d) consuming and, finally, (e) satisfaction. According to the JTBD principles, every purchase made by the consumer goes through these stages, meaning that no new acquisitions are made without having thought about it first. While this diagram looks very similar to the customer journey, the main difference is that JTBD focuses primarily on the emotions (i.e. the experience) that the user is undergoing while going through these phases, instead of just the mere actions (Fig. 2).

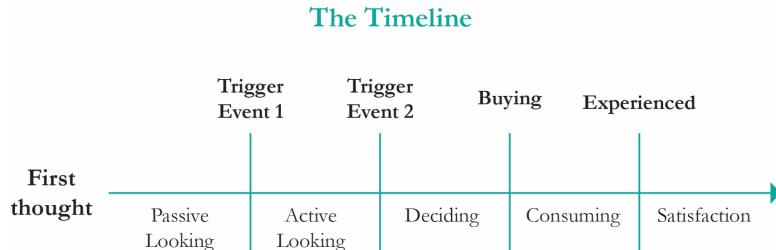


Fig. 2. The timeline diagram based on Klement's work (2018a).

The second diagram is called “The Forces of Progress”, and it brings to the fore the fact that there are forces that cause and regulate customers’ demand for a given product. At the center of the diagram you find the user, which is influenced by forces of “Demand Generation” and “Demand Reduction”. The forces that generate demand are divided in two: Push forces (that can be either internal or external to the person, generally propelled by an event that changes the customary life of the user) and Pull forces (which are an idea of a better life and an existent preference to a certain solution). The forces that reduce the demand are inertia and anxiety. JTBD claims to be a “Technology Independent Solution” (Klement 2018a) as both of these diagrams can be of use when designing any type of product or service (Fig. 3).

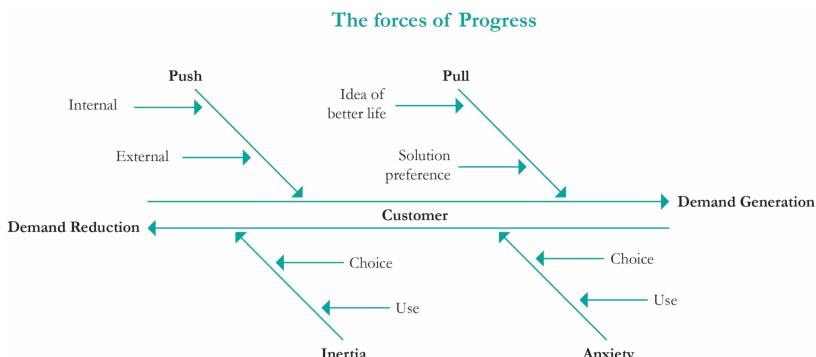


Fig. 3. The forces of Progress diagram proposed by Klement (2018a).

Nevertheless, JTBD is not the first one that proposes to change the focus from the tool or product to the user. Foucault et al. (1988) stated that humans have used tools or technologies in the process of enhancing themselves, and these tools have evolved and changed over time. A common mistake is to focus on the tool itself, and try to design new tools and products as isolated objects. Instead, the effort should be into creating progress for the customer through new systems (Klement 2018a). In other words, the effort should reside in understanding the progress that the user is trying to achieve, and have the tools and products as an outcome of that desire to change, and not the other way around.

Now more than ever it is important to study the entire ecosystem and the user's interactions, since the distinction between online and offline environments is getting blurred, as our physical reality merges with the abstract world of cyberspace (Hernández-Ramírez 2017). The user is no longer utilizing mobile apps and digital solutions as independent tools, but as part of an ecosystem of online and offline products that work together to solve everyday problems.

5.3 The Possibilities with JTBD and HCD

Hypothetically, JTBD and HCD should complement each other and could be used together in the process of creating new products. However, there is not enough information available on how to combine these two frameworks, or studies that analyze the results obtained from using them. The few researchers that have embarked in the journey of trying to incorporate the JTBD framework into the Design field have not been successful. Some authors, like Settelen et al. (2020), believe that the JTBD framework hasn't been very successful because previous knowledge and experience is required to apply it correctly. The problem might reside in the lack of a proper system that can be replicated and applied.

If enough research leads to a robust JTBD methodology, the possible applications within the User Centered Design framework, go beyond the user research phase. For instance Livio (2018) explains that JTBD may be applicable during the design of the User Interface. Klement (2018b) claims that the methodology should be used to determine competition in the mind of the user, and more importantly, to discover innovation opportunities within the product or in additional ones. Perhaps the solution is to merge the JTBD framework into the different stages of the HCD, instead of using them as separate solutions that can be used one without the other.

Some research has undertaken the task to create a step-by-step process. For example, Lucassen et al. (2018) proposed a 5 stage process (Interview, Analysis, Survey, Prioritization and Project Definition). After testing they realized that the method was not as effective as they expected, and concluded that they lacked guidance and validation for their proposals. Now it's the job of Designers, Scholars and Researchers alike to work together and find the best framework to design new products and services that serve the hyperconnected humans of today.

6 Implications

The merge of the JTBD methodology into the HCD practice could lead the way to a more holistic approach to Design in which we take into consideration not only the subject-object relationship, as it has been done during the past couple decades, but also the ecosystem in which the subject inhabits (both offline and online) and the constant aspirations that are part of human nature. However, the difficulty occurs when we attempt to fit a very subjective and quantitative model into an actionable procedure that anyone can follow and replicate.

We believe that one way to make sense of this combination of methods, is through case studies, testing the current JTBD theoretic framework during the HCD process, noting the similarities and differences, and reporting back so others can learn about it and hopefully continue the research work. During the next months we will undertake a research study in which we will execute User Research, with a standard HCD method, and with an experimental method that incorporates the JTBD framework, with the hopes of observing the compatibility of these frameworks.

7 Conclusion

Considering that we are surrounded by more digital products each day, Designers must study the user's ecosystem as well as the interactions with products. In addition, since reinventing oneself constantly is part of being human, the study of this aspiration for something better should be included in the design process. The latter can be achieved by incorporating the JTBD framework into the HCD practice.

However, before anybody can successfully incorporate the JTBD framework into HCD, we need to make sure: a) that we have a proper methodology that explains what are the specific steps to execute; and b) that there are clear guidelines that allow anybody to evaluate and validate their process. Until both of these requirements are not met, people will fail to implement this process. Future Designers and researchers have the task of converting qualitative and subjective research into a proven methodology that can be replicated by anyone.

As noted earlier, this paper is part of an ongoing MA research, the results here presented are preliminary and function as a foundation for further investigation. After the literature review, we will proceed to gather, analyze and organize what others have done regarding user interviews within the JTBD framework, to create an interview script that can be replicated in the future by other researchers. We will then perform the JTBD interview to half of the participants and a more conventional user interview following the HCD practice. Finally, we will review the results and determine what the differences in results are, if any, and report our findings to encourage further research and incorporation of these two frameworks.

Acknowledgements. This study was supported by UNIDCOM under a Grant by the Fundação para a Ciência e Tecnologia (FCT) no. UIDB/DES/00711/2020 attributed to UNIDCOM/IADE – Universidade Europeia, Lisbon, Portugal.

References

- Abbas, Y., Dervin, F. (eds.): Digital Technologies of the Self. Cambridge Scholars Publishing, USA (2009)
- Badke-Schaub, P., Lloyd, P., van der Lugt, R., Roozenburg, N., Badke, P.: Human-centered design methodology. In: Proceedings from Design Research in the Netherlands 2005, pp. 23–32 (2005)
- Boy, G.: Orchestrating Human-Centered Design. Springer, London (2012). <https://doi.org/10.1007/978-1-4471-4339-0>
- Buchanan, R.: Thinking about design: an historical perspective. In: Meijers, A. (ed.) Philosophy of Technology and Engineering Sciences, pp. 409–453. Elsevier North Holland, Amsterdam, London, Boston (2009)
- Cooley, M.: Human-centered design. In: Information Design, pp. 59–81 (1999)
- Dewey, J.: Logic: The Theory of Inquiry. Holt, Rinehart and Winston, New York (1964)
- Ditte, M.: How to Do a Thematic Analysis of User Interviews (2020). <https://www.interaction-design.org/literature/article/how-to-do-a-thematic-analysis-of-user-interviews>
- Foucault, M.: Technologies of the self. In: Martin, L.H., Gutman, H., Hutton, P.H. (eds.) Technologies of the Self: A Seminar with Michel Foucault, pp. 16–49. The University of Massachusetts Press, Amherst (1988)
- Google. Google Books Ngram Viewer: Jobs To Be Done (2019). https://books.google.com/ngrams/graph?content=Jobs+To+Be+Done&year_start=1800&year_end=2019&corpus=26&smoothing=3&direct_url=t1%3B%2CJobs%20To%20Be%20Done%3B%2Cc0#t1%3B%2CJobs%20To%20Be%20Done%3B%2Cc1. Accessed 04 Sep 2021
- Gould, J.D., Lewis, C.: Designing for usability: key principles and what designers think. Commun. ACM **28**(3), 300–311 (1985). <https://doi.org/10.1145/3166.3170>
- Griffin, A., Hauser, J.R.: The voice of the customer. Market. Sci. **12**(1), 1–27 (1993). <https://doi.org/10.1287/mksc.12.1.1>
- Hartson, R., Pyla, P.S.: The UX Book: Process and Guidelines for Ensuring a Quality User Experience. Elsevier Amsterdam (2012)
- Hernández-Ramírez, R.: Technology and self-modification: understanding technologies of the self after Foucault. J. Sci. Technol. Arts **9**(3), 45–57 (2017). <https://doi.org/10.7559/citarj.v9i3.423>
- Huppertz, D.J.: Revisiting Herbert Simon’s “science of design.” Des. Issues **31**(2), 29–40 (2015). https://doi.org/10.1162/desi_a_00320
- Johnson, R.R.: User-Centered Technology: A Rhetorical Theory for Computers and Other Mundane Artifacts. SUNY Press, USA (1998)
- Kaptelinin, V., Nardi, B.A., Foot, K.A.: Acting with Technology: Activity Theory and Interaction Design (2006)
- Kaptelinin, V.: The Encyclopedia of Human-Computer Interaction, 2nd edn. Chapter 16: Activity Theory (2014). <https://www.interaction-design.org/literature/book/the-encyclopedia-of-human-computer-interaction-2nd-ed/activity-theory>
- Klement, A.: When Coffee and Kale Compete: Become great at making products people will buy (2nd ed.). Create Space Independent Publishing Platform (2018a)
- Klement, A.: Know the Two — Very — Different Interpretations of Jobs to be Done. Medium, 15 January 2018b. <https://jtbd.info/know-the-two-very-different-interpretations-of-jobs-to-be-done-5a18b748bd89>
- Livio, V.: Applying Jobs-to-Be-Done theory to designing a Business-to-Business software product, 21 August 2018. <http://urn.fi/URN:NBN:fi:aalto-201809034862>
- Lucassen, G., van de Keuken, M., Dalpiaz, F., Brinkkemper, S., Sloof, G.W., Schlingmann, J.: Jobs-to-be-done oriented requirements engineering: a method for defining job stories. In: Kamsties, E., Horkoff, J., Dalpiaz, F. (eds.) REFSQ 2018. LNCS, vol. 10753, pp. 227–243. Springer, Cham (2018). https://doi.org/10.1007/978-3-319-77243-1_14

- McKeen, H.: The Pitfalls of Personas and Advantages of Jobs to Be Done. UXmatters, 18 February 2019. <https://www.uxmatters.com/mt/archives/2019/02/the-pitfalls-of-personas-and-advantages-of-jobs-to-be-done.php>
- Nardi, B.A.: Context and Consciousness: Activity Theory and Human-Computer Interaction. MIT Press, Cambridge (1996)
- Nielsen, L.: The Encyclopedia of Human-Computer Interaction, 2nd edn. Chapter 30: Personas (2014). <https://www.interaction-design.org/literature/book/the-encyclopedia-of-human-computer-interaction-2nd-ed/personas>
- Norman, D.A.: The Design of Everyday Things (Revised and Expanded Edition). Basic Books, New York (2013). (Original work published 1990)
- Redström, J.: Certain uncertainties and the design of design education. *She Ji J. Des. Econ. Innov.* **6**(1), 83–100 (2020). <https://doi.org/10.1016/j.sheji.2020.02.001>
- Settelen, C., Seyff, N., Hess, A.: Is the “job map” the next-generation “story map”? Investigating the application of jobs-to-be-done for requirements engineering in agile projects. In: 2020 Fourth International Workshop on Learning from Other Disciplines for Requirements Engineering (D4RE), 2 (2020). <https://doi.org/10.1109/d4re51199.2020.00006>
- Simon, H.A.: The science of design: creating the artificial. *Des. Issues* **4**, 67–82 (1988)
- Snyder, H.: Literature review as a research methodology: an overview and guidelines. *J. Bus. Res.* **104**, 333–339 (2019)
- Ulwick, A.W., Osterwalder, A.: Jobs To Be Done: Theory to Practice. IDEA BITE PRESS, USA (2016)
- Ulwick, A.W.: Outcome-Driven Innovation®(ODI): Jobs-to-be-Done Theory in Practice. Strat-egyn, LLC Whitepaper (2017)
- Wallach, D., Scholz, S.C.: User-centered design: why and how to put users first in software development. In: Maedche, A., Botzenhardt, A., Neer, L. (eds.) Software for People. MANAGPROF, pp. 11–38. Springer, Heidelberg (2012). https://doi.org/10.1007/978-3-642-31371-4_2



A Case Study of Emotional Interaction Response with Cutlery: EEG and Semantic Tools

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Abstract. Emotions accompany our daily life, influence our interaction with products, and are essential to understanding human behavior through non-verbal communication. It becomes evident for designers the need to understand how products establish meaningful and emotional experiences, as well as work with tools that allow evaluating emotional responses.

This article aims to evaluate the interaction of individuals with a cutlery object, through a case study. In this study, we applied Electroencephalography (EEG) – for the evaluation of qualitative and quantitative data, which allows us to obtain the physiological responses of individuals. The experiment consisted of three blocks of tasks: observing pictures of the product, observing the real product, and touching/handling the real product, based on a homogeneous sample of 11 participants. In the end, the participants answer a questionnaire.

The results demonstrate that the questionnaires are an important assessment tool when correlated with other tools. It provided relevant information for the validation of the emotional response, being perceptible the typologies that evoked positive and negative effects, as well as the characteristics of the product that influenced this feeling. Regarding the EEG, the results show that there are cognitive differences between the frequency bands and the positioning of the electrodes, for the different types of product. In the statistical analysis, it was not possible to identify significant differences in the study variables, possibly derived from the protocol changes throughout the study.

Keywords: Design neuroscience · Emotional design · Product design · Electroencephalography (EEG) · PANAS

1 Introduction

Understanding the emotional response of user interaction with objects is essential for successful new product development [1]. In product evaluation, emotional rating scales are applied that assess users' feelings and preferences. Recent studies apply brain processing assessment scales, to observe whether one can improve the assessment of emotions in users.

The emotional design emerged in the early twentieth century, aiming to study user interaction with objects from sensory and cognitive experiences, particularly in the perception of stimuli. Norman [2] believes that emotions and other affective states originate in different parts of the brain, with emotional processing occurring under three systems - visceral, behavioral, and reflexive. Damasio [3] on the other hand, recognizes that emotions are a program of actions played out by the mind, something physical that happens in the body, whereas, feelings are the mental experience of changes in our body, that is, a mental reaction to actions. Emotions and feelings are involved in cognitive processes, such as perception, learning, and purchase decision [3]. Through the somatic marker hypothesis, Damasio further defines a mechanism through which emotional processes can guide decision-making.

Based on the theoretical assumptions in the literature, the research questioned the relationship between the brain processing assessment technique - EEG, in neuroscience, and emotions, and gaps were identified in the literature on design and emotion. Thus, the study focused on the application of EEG in the design process as a support tool in the evaluation of new product development. The research methodology followed the following steps: literature review, fieldwork, experiment design, data collection, and data processing and analysis.

The EEG - brain processing assessment scale, allows obtaining the involuntary responses through brain activity, which has allowed direct measurement of the physiological and emotional response of individuals. Songsamoe et al. [4] legitimize this information by stating that the data obtained through questionnaires are subject to not match reality because they are obtained from reported thoughts or through questionnaire responses. Thus, these tools can contribute to the validation or corroboration of the information obtained through questionnaires or interviews. The authors [4] also address the relationship between brain waves and human emotions, mentioning that the EEG signal in its waveform and in the different brain regions, can be analyzed and translate the activity into emotional states. The literature review allowed to study the experimental protocols applied in studies [4–8] that served as a basis for the protocol designed in this research.

This is a study of exploratory character, where the objective is to study a method of evaluating brain processing through the “*Emotiv insight*” equipment. Thus, at the methodological level, it was considered more appropriate to develop a case study. This research method allows a qualitative and quantitative data collection - mixed approach [9].

This study is the result of a partnership with the Portuguese company HERDMAR, intending to study issues associated with the semantic evaluation of cutlery, and other information can be consulted in [10]. The study was developed between the year 2019–2020, the period of the covid-19 pandemic, which implied changes throughout the research.

Research Objectives:

To study and evaluate whether through evoked potentials it is possible to do brain mapping and identify, in an exploratory and primary way, which brain areas have the most and least activity. Also, to study if the changes in brain activity when the individual is

exposed to different stimuli can contribute to the identification of emotions, and thus, translate the data into emotional states.

1. To understand if it is possible to identify changes in brain activity in different types of product;
2. Brain activation to stimuli allows for the identification of emotional states;
3. EEG can be used as a complementary assessment tool to other emotional state assessment tools.
4. To evaluate whether the triangulation between the scales of affection, semantic analysis, and Norman's perspective [2] can contribute to the emotional analysis of products.

The research question defined:

“Can we through EEG identify the user’s emotional responses towards a cutlery product?”

2 Methodologies

2.1 Participants

The study gathered a homogeneous sample composed of 11 participants, selected by convenience method. The individuals considered are potential buyers of this type of product and were available at the time of data collection. They were aged between 18–50 years, 5 men and 6 women. The number of participants for the study considered in the design of the research protocol was 20–30 individuals because it was a pilot case. Due to the limitations in the course (SARS-CoV-2 virus pandemic), the sample number was restricted to a total of 11 participants.

2.2 Object Study – Stimuli

The company HERDMAR is currently one of the largest producers of table cutlery in the world, which aims to present cutlery as a fashion element at the table [11]. In this sense, we chose to select the three product categories most used in everyday life in various cultures - fork, knife, and spoon. For the cutlery selection, in a meeting with the brand, some requirements were defined such as - shape, color, and texture, as well as the cutlery models present in the market that the brand was interested in evaluating. With this, twelve sets of flatware were selected – Fig. 1, with the following variables - six of shape and six of finish. In the finished variable, the model is the same in all six types, so that the emotional response of the user is focused only on the type of finish that varies according to color or production method.



Fig. 1. HERDMAR Cutlery - study typologies, Herdmar. (<https://www.herdmar.com/pt/pt/talheres>)

2.3 Experiment Design – EEG

The design of the experiment was defined considering previous research that applies EEG as a tool to assess emotions, if possible, in the area of design and the objective of the study. This was done by considering the resources needed for the research – human, materials, and space, which due to the limitations mentioned at the beginning, had to be adapted. The experiment brings together two sensory components reported previously [10] – visual and tactile and is composed of three blocks: 1. Observation of product photographs; 2. Observation of the real object; 3. Touching/handling the real object. In each of the blocks, the participant is exposed to the product (stimuli) with two variables – finishing cutlery and shaping cutlery. In pre-task, participants are informed about the study and familiarized with the equipment. Subsequently, the equipment is placed on the participant's scalp and the data recording software is started for a period of stabilization of brain activity before the session begins.

After the participant is prepared and the equipment is connected, the experiment involves six separate tasks for data collection. In its sequence the experiment follows the following order: (1) presentation of a video of the shape cutlery; (2) presentation of a video of the finish cutlery; (3) presentation of the shape cutlery – evaluate the visual component; (4) presentation of the finish cutlery – evaluate the visual component; (5) presentation of the shape cutlery – evaluate the tactile component; (6) presentation of the finish cutlery – evaluate the tactile component.

In the video presentation – shape and finish, each set of cutlery is shown to the participant for 10 s and the images are interspersed with a grey image for 5 s. The grey image has the function, to stabilize the brainwave signal. In the physical product – visual variable, the participant observes each of the shapes and finish sets for 15 s. In the physical product – tactile variable, the participant has no set period, they can handle the flatware as long as they wish. The sequence by which the cutlery is exposed to the participants both in the image and real object has a distinct order between them to ensure randomness and simultaneously not provide reading biases. The grey image incorporated in the videos and the time between the change of cutlery in the last two variables has the function of a silent rest that allows the stabilization of the brainwaves signal in a neutral emotional state between stimuli.

2.4 Equipment – EEG

Brain activity was recorded with a portable system - “*Emotiv insight*” composed of 5 electrodes – Fig. 2. The electrodes are arranged according to the standard 10–10 I.S. configuration. The equipment is composed of five sensors - AF3, AF4, T7, T8, Pz, which are positioned on the individual’s scalp. In the study, the electrodes and frequency bands were considered: Theta (4–8 Hz), Alpha (8–12 Hz), Low Beta (12–16 Hz), Hight Beta (16–25 Hz), and Gamma (25–45 Hz). Brain waves were recorded in terms of power at 128 samples per second in each channel. The data was recorded in the software from “*Emotiv - EmotivPRO*”, which allows you to record, view in real-time data and export it later.

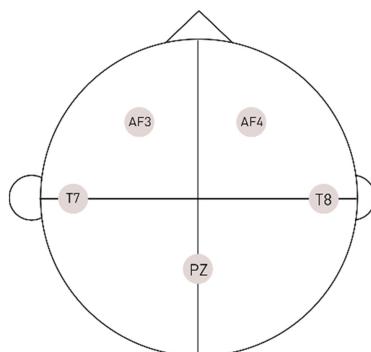


Fig. 2. Positioning of the 5 electrodes - author's scheme (2021)

In addition to the objects of investigation explained, specific objectives were defined for the EEG equipment to clarify what is intended to be studied with this tool:

1. To understand whether the data obtained allow us to identify differences between the participants about the stimuli experienced.
2. To understand which frequency bands and electrodes have greater activation in the emotional response.
3. Understand, even if only in a primary way, what the EEG data tells us.
4. Understand if there is any relationship between the positioning of the electrodes on the scalp and emotional responses.

2.5 Subjective Evaluation

Subjective evaluation was developed based on Norman’s perspective, in a similar way as in other studies [12]. The design of the questionnaire was essentially divided into three parts - A: evaluation of the cutlery typologies of the shape variable using two scales. To assess the individual’s affections with the product - PANAS self-report scale, was applied on a Likert scale between 1 and 5, like [13]. The PANAS scale applied to the study consists of twenty words associated with affection, ten positive and ten negative,

which was validated for Portuguese [14]. Participants rated their experience for each of the emotions on a five-point scale - 1 (not at all or very slightly) to 5 (extremely).

The same scale of values was applied to evaluate nine characteristics of the product that were defined considering the characteristics that are normally associated with this category of products. B: evaluation of the cutlery typologies of the finishing variable. In this case, the evaluation was only semantic, asking the participants to define characteristics and comments for each of the typologies, since what changed in each one was only the type of finish. Thus, it would be possible to identify the associated feelings and/or preferences. C: Finally, evaluation of the cutlery typologies of both variables - shape, and finish. This last section of the questionnaire aimed to compare the answers obtained in parts A and B through open and closed questions, thus allowing to certify the responses of the participants. The questions were previously defined based on the three levels of Norman (2004), to obtain information about the cutlery at the visceral, behavioral, and reflective level.

3 Data Collection

Initially, it was planned to use the EEG equipment for laboratory, Psychological Neuroscience Laboratory – University of Minho use, but due to limitations imposed by the pandemic, we had to use the “*Emotiv insight*” equipment, with all the limitations inherent to the reduction from 64 to 5 electrodes, calibration, and data acquisition, as well as the way these are provided by the software. Regardless of the use of this new equipment, the previously designed protocol was used, as well as the tools and data analysis.

The experiment was performed in a home - office environment, where an environment with characteristics close to those of data collection (in a laboratory) was created. The space incorporated only the necessary materials - desk, computer for recording the data and computer for presenting the videos, chair, support table with the products and the “*Emotiv insight*” equipment.

At the beginning of the experiment, the participant sat comfortably on a chair - with the monitor in front of him - and the objective of the study, as well as the role to be played in each of the tasks, was briefly explained. Next, the equipment - previously disinfected, is placed on the participant’s head. The first step is to connect the equipment to the software, which to begin effective data collection, the equipment must achieve 100% connectivity. After this connection, the software starts recording the brain activity in the electrode areas, so that data analysis can be done later - Fig. 3. The experiment is started, and recording is done during the time the participants perform the tasks of the study – Fig. 3, described in the experiment design section. During the experiment, the human resource placed the products to the participant while the researcher recorded the times of the participant’s viewing/interaction to make the analysis step more practical because, in this equipment, there is no synchronization between the software and the experiment – trigger.

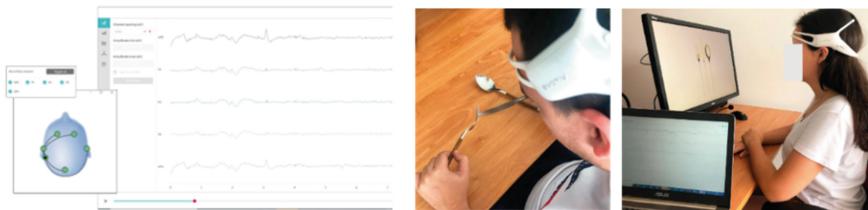


Fig. 3. Screenshot capture of the EEG collections software and photos of the physical task (Silva, R., 2020).

3.1 Data Processing

EEG

In the method for evaluating brain processing - EEG, six different tasks were performed per participant, three in the shape component and three in the finish component, and each component is composed of 6 types of cutlery - 12 in total. In this way, the data recorded in the software “EmotivPRO”, were exported in the movement component, performance metrics, and frequency bands in CSV format - compatible with Excel format. The exported data refers to the power values for the frequency bands recorded by the equipment - Theta, Alpha, Beta Low, Beta High, Gamma. For the data analysis, it was necessary to treat the data manually since the data provided by the “EmotivePRO” software did not allow the automatic analysis in the MATLAB software. For this, an average was obtained for each task in each type of cutlery, in each frequency band, and electrode.

Subjective Evaluation

In part A. the answers were organized by each type of cutlery and the ratings of all participants were obtained for each of the adjectives of the PANAS scale. The same process was applied on the scale of product characteristics. Lizz typology - Fig. 4, shows the way the results were presented. In the evaluation of the cutlery of the finishing variable - part B., the characteristics were grouped by product typology and theme, so that afterward through word clouds, the semantic analysis - Fig. 5 (Oslo Gold typology) was carried out. Finally, the treatment of the questions in part C. for comparison with parts A. and B. In addition, throughout the experience, it was possible to observe the



Fig. 4. PANAS scale results and product characteristics (Silva, R., 2020)

individual's behavior, in facial expression and body posture. One of the tasks - touching the real object, was most evident by the time the participant devoted to the object and by the way he handled it.



Fig. 5. Word cloud of ‘Oslo Gold’ set (Silva, R., 2020)

3.2 Data Analysis and Results

EEG

The data obtained through the treatment of the data in each of the tasks were put into the SPSS program (advanced statistical analysis software). We considered the analysis of variance (ANOVA) which aims to check if there is a significant difference between the means and if the factors exert influence on any dependent variable.

A series of repeated measures ANOVAs with the intra-participant factors Cutlery - shape ('Lizz', 'Cairo', 'Nohc', 'Malmo', 'Oslo', 'SantaMarta'), Electrodes (AF3, AF4, T7, T8, PZ) and Task (view pictures of object - video, view real object, play real object) was used to evaluate the effects of task and shape as well as their interaction on the different electrodes studied for the powers of the theta (4–8 Hz), alpha (8–12 Hz), beta Low (12–16 Hz), beta High (16–25 Hz) and gamma (25–45 Hz) frequency bands separately.. The second series of repeated-measures ANOVAs changing the intra-participant factor Cutlery- form by the factor Finish ('Oslo Copper', 'Oslo Mat Gold', 'Oslo Gold', 'Oslo Gold CBT', 'Oslo Black', 'Oslo Rainbow') was performed to evaluate the effects of finish and its interaction with the task on powers in the same frequency bands as in the case of the previous series. For all ANOVAs performed in the present work, Greenhouse-Geisser correction was applied whenever the assumption of sphericity was violated, and Bonferroni adjustment was used to correct for multiple comparisons. Differences were considered significant at an alpha - 0.05 level and revealed that there was no significant effect. The outputs of the SPSS statistical program allowed the ANOVA results to be written, taken from the Intra-subject contrasts table. Only those of assumed sphericity (because no significant difference was considered in Mauchslv’s test) were considered for the variables under study - cutlery, task, and electrode for the form and finish level (Silva, R., 2020).

A limitation of the study was the sample size, which due to the great inter-individual variability in the EEG data and the low statistical power achieved, may have made it impossible to observe significant differences between conditions. Although the study is not statistically validated, the absolute values verify differences between the participants - Fig. 6. Thus, one of the objectives defined on the equipment is confirmed: to understand whether the data obtained allow to identify differences between the participants regarding the stimuli experienced.

ELÉTRODO/ BANDA DE FREQUÊNCIA	PARTICIPANTE	TIPOLOGIA DE TALHERES					
POW AF3 THETA		LIZZ	CAIRO	OSLO	NOHC	MALMO	SANTAMARTA
	1	77.60534583	45.00530427	53.74783679	37.09169776	85.79266732	71.9387077
	2	7.334527365	37.51821826	13.85957693	25.80612692	20.20016505	56.08574936
	3	101.3759539	143.6196824	135.8454394	115.1900629	134.5439207	153.7204853
	4	12.5051731	10.82733812	9.5092013	11.67310987	9.927672403	16.01548545
	5	17.6464536	18.51.07360	20.98433288	24.21091238	16.69682494	16.72591904
	6	2.876334375	13.51669588	5.47489925	2.410470879	2.297674625	27.13236443
	7	24.16254298	12.50337388	8.663942063	24.39107551	65.58341054	13.82742959
	8	36.65730183	6.611154375	23.836395	4.221053879	9.606184469	7.347631825
	9	58.2811338	34.86479463	22.90408871	9.632353129	18.0765603	18.11286129
	10	6.247799079	5.367086216	3.890211495	7.333728706	10.94238113	5.126808063
	11	33.17560693	23.20448964	11.21952627	7.22610255	20.76932363	18.90288725
<hr/>							
POW AF3 ALPHA							
	1	18.92457172	11.28053059	10.68373813	8.411482083	12.66129727	11.98149061
	2	4.236813269	9.208750099	5.927799826	5.676538938	6.228875302	8.208913056
	3	16.04689562	24.92589517	23.48901041	21.77623111	21.42503933	22.31740072
	4	2.634389118	3.16689875	3.772790575	3.108613942	3.282467354	2.987318818
	5	8.14944945	6.877101388	6.708191969	6.912511154	7.899600616	5.913685948
	6	0.792329375	2.39536825	5.142873125	1.592925375	2.179773	16.91053403
	7	6.629692009	4.584193217	3.632872678	6.847142221	5.30641321	5.208838486
	8	13.93007944	15.35705429	16.00959172	4.892485719	9.391638219	5.5026748
	9	15.60993544	9.95650666	6.180688458	4.0155462	8.24819995	4.945138589
	10	2.19462301	2.007394101	2.496698458	3.479578349	2.964591034	2.000770056
	11	5.058029018	4.332977613	4.628184766	3.611894925	5.044492913	2.8955406

Fig. 6. Software results after data processing - author's scheme (Silva, R., 2020)

Subjective Evaluation

The case study made it possible to arrive at some important considerations in the analysis of these objects through questionnaires and observation during the execution of the tasks. Of all the types of cutlery, texture and color (finish) proved to be the most interesting variables for study, although the participants' preferred types belong to the shape variable. For example, the 'Nohc' typology, in general, aroused immediate reactions when exposed to the stimulus due to the material used in the cutlery handles - cork. The participants made an immediate connection to the material, awakening in them - the surprise, the novelty, the interest. These emotional reactions that started to trigger reactions through visual appearance, disappeared at the moment of touching when handling the object. Here, the reflective level is awakened because the tactile sensation does not correspond to the memory we have of the material - ceasing to be a rough natural material, for a material that brings the feeling of 'false'. The response at this level influenced the response at the behavioral level because in addition to the participants considering that the design fails due to the material of the handles, this material and the thickness of the cutlery influence the use of it. 'Cairo' also stands out negatively for its texture in the tactile but also visual sense. It was an immediate reaction to the stimulus, the texture creates disgust, contempt at the visceral level, which ends up influencing the behavioral and reflective level. The finishing cutlery were the ones that raised the most and

demanded reflections on the part of the participants. The response of the participants to this variable is because the participants do not fit these colors in this type of product due to the context in which they are used, resulting in the majority in rejection. Despite this, two of the participants show surprise and positive emotions, privileging the difference.

4 Data Collection

Factors such as motivation, memory, decision making, and user behavior are important considerations in the study of user experience. The brain processing evaluation scales reveal to be an opportunity in the study of these factors, even if still in a primary way in the design area since it allows to directly provide the brain activity of the individual to a given stimulus. In this sense, a study was developed that applies EEG as an evaluation tool, to analyze the emotional responses of individuals to the stimulus - cutlery. This research is supported by the study of the cutlery of the brand HERDMAR, in the dimensions of emotional design with the use of brain functioning scales (EEG).

Regarding the research question “Can we through EEG understand the emotions that user has with a cutlery product?”, it was not possible to obtain a conclusive answer. The EEG results did not allow significant differences to be observed through statistical analysis of the variables under study. However, it was possible to observe differences between the electrodes and frequency bands in the different typologies that may indicate relevant information in the evaluation of the different typologies of the product. Besides the variability of the data compromising the statistical analysis, some considerations may have influenced the results obtained: software algorithm, we assumed the output provided (greater control over data processing may increase the quality of the information obtained); the number of participants: due to the limitations entered during the research period, the sample number had to be changed from 20/30 to 11; equipment: we changed from an equipment used in the laboratory with 64 electrodes to 5 electrode. This information may be relevant to take into consideration in the development of studies with EEG.

On the other hand, the data collected through the questionnaire and the observation of the participant during the execution of the tasks, allowed us to obtain interesting results. Between the two variables - shape and finish, the typologies of the shape variable aroused a greater interest on the part of users.

In the future, further concentrate the detailed analysis on frequency bands, electrodes, and activated brain areas to understand the changes in brain activity and understand the correlation with emotions. Through this study - by changing the variables, or by developing a new protocol.

5 Future Research

The way individuals respond emotionally to stimuli is an area under research, which demonstrates an important contribution to the development of new products that meet the user's needs, based on emotional satisfaction, and, consequently, contribute to well-being. On the other hand, studies have revealed that the brain is the organ with the least scientific information. In this way, this area of knowledge, allows us to anticipate beyond

the application in design, in the existence of a vast area of multidisciplinary research on brain functioning. In the case of this research, it was possible to explore the relationship between Design and Psychology, as well as the potential of the correlation between both in the development of new methodologies to support design.

Soon, it is intended to analyze how the “*Emotiv*” collects and evaluates EEG data, as well as what interpretation or algorithm is used in interpreting the stimuli. On the other hand, redefining the variables of the study that allow the data to be analyzed independently. In continuing this exercise, it is also intended to consider and explore other assessment methods such as, face recognition equipment and eye-tracking that may provide additional data to interpret/validate the EEG data.

Acknowledgments. This work was financed by the Project Lab2PT - Landscapes, Heritage and Territory laboratory - UIDB/04509/2020 through FCT - Fundação para a Ciência e a Tecnologia.

References

1. Desmet: Designing emotions. Delft University of Technology, Delft (2002)
2. Norman, D.: Why We Love (or Hate) Everyday Things. Perseus Books Group, New York (2004)
3. Damasio, A.R., Santos, L.O.: A estranha ordem das coisas: A vida, os sentimentos e as culturas humanas. Temas e Debates, Lisboa (2017)
4. Songsamoe, S., Saengwong-ngam, R., Koomhin, P., Matan, N.: Understanding Consumer physiological and emotional responses to food products using electroencephalography (EGG). Trends Food Sci. Technol. **93**, 167–173 (2019)
5. Moon, S.-E., Kim, J.-H., Kim, S.-W., Lee, J.-S.: Assessing product design using photos and real products. In: Proceedings of the 2017 CHI Conference Extended Abstracts on Human Factors in Computing Systems, vol. 17, pp. 1100–1107 (2017)
6. Ramirez, R., Vamvakousis, Z.: Detecting emotion from EEG signals using the emotive epoch device. In: Zanzotto, F.M., Tsumoto, S., Taatgen, N., Yao, Y. (eds.) BI 2012. LNCS (LNAI), vol. 7670, pp. 175–184. Springer, Heidelberg (2012). https://doi.org/10.1007/978-3-642-35139-6_17
7. Simon, M., Hu, M.: Mind the Perception and Emotional Response to Design: Emerging Methodology, pp. 507–514 (2019)
8. Neale, C., et al.: The aging urban brain: analyzing outdoor physical activity using the emotiv affectiv suite in older people. J. Urban Health 1–12 (2017). <https://doi.org/10.1007/s11524-017-0191-9>
9. Yin, R.K.: Estudo de caso: Planejamento e métodos. Bookman, Porto Alegre (2001)
10. Silva, R.: O EEG – Eletrocefalografia como ferramenta de apoio na componente emocional de desenvolvimento de projetos de design. Dissertação de Mestrado, Universidade do Minho (2020)
11. HERDMAR. (n.d.). Consultado em, 5 March 2021. <https://www.herdmar.com/pt/pt/talheres>
12. Providência, B., Brandão, R., Albuquerque, P.B.: Designing for emotions: evaluation of the drooler, a toy for preschoolers. In: Reverse Design, pp. 389–397. CRC Press (2018)

13. Ribeiro, M.: Mapeamento da hedonomia e das experiências emocionais: A percepção do aluno no ensino superior sob a perspectiva do design emocional. Recife: Universidade Federal de Pernambuco (2020). 472p.
14. Galinha, I.C., Pais-Ribeiro, J.L.: Contribuição para o estudo da versão portuguesa da Positive and Negative Affect Schedule (PANAS): II-Estudo psicométrico [Contribution to the study of the Portuguese version of the Positive and Negative Affect Schedule (PANAS): II-Psychometric study]. *Análise Psicológica* **23**(2), 219–227 (2005)



Mobile Application of Communitarian Participation Oriented to the Prevention of Forest Fires in Portugal

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Abstract. Forest fires have caused devastating social and economic damage in the forest-dependent regions of Portugal. This phenomenon can accentuate in the following years due to many factors that can aggravate conditions like extreme drought, lousy forest management, or interior depopulation. On digital platforms, forest fires are a target of investigation and analysis. The results point to few varieties of applications, most of them focused on the combat phase. The ones about prevention are limited and with little interaction. This work summarizes the Portuguese situation respecting forest fires and presents a study of the country's existing apps and prevention campaigns. Based on the analysis of interviews conducted by the orientation team, a mobile application oriented to the active participation of the community in the prevention of forest fires was conceptualized, prototyped, and tested. This app lets users add Alerts or Public Actions on a map and give them space for discussion and useful information.

Keywords: Forest fires · Prevention · Community · Mobile application

1 Introduction

Forest fires are a natural phenomenon that frequently hits the Portuguese forest due to its special characteristics. The structural profile of the Portuguese forest is mainly composed of fragmented private lands [1]. The interior depopulation is also problematic since a big part of the forest area is in those regions. Also, the negligent management of the private land and the general behavior of the population towards the forest and its resources are important factors that should be considered. Moreover, the aggravating climate conditions can cause significant occurrences and endanger the people living in the so-called wildland-urban interface (WUI).

Given these circumstances, short and long-term prevention of forest fires in the Portuguese context gains relevance to protect the affected communities and these region's social and economic well-being. Therefore, it is important to identify the actual prevention measures and understand their impact and how the community can actively protect the WUI they live in.

The other domain of this investigation is the digital platforms, specifically the mobile applications, and how they can be helpful in the context of forest fires prevention. Nowadays, these platforms are the main medium of communication and are already a tool in emergency response support, namely the social networks [2]. However, most forest fires oriented mobile applications are focused on the combat phase, and some of its characteristics are not useful for the most affected by this phenomenon.

The cross between these two domains - forest fires and their prevention through mobile applications - is the primary motivation of this investigation, and the question that guides the work is: "Which functionalities must be present in a community forest fire prevention-oriented mobile application?". These functionalities must be the result of research that considers the context, the needs of potential users, and much other information regarding this field of study. The investigation aims to conceptualize and prototype a mobile application where the population can actively participate in the prevention process and the protection of their houses or lands and the supervising and cooperation of the local authorities. After that stage, the goal is to develop the prototyped application to be used locally and with a system that can be scalable to the national territory. The purpose of the application is to close all the intervenients of each region, increasing their participation in forest prevention and conservation actions, therefore contributing to their protection and well-being.

This paper's goal is to present the methodology used to conceptualize the mobile application based on the Portuguese context and its specific characteristics and reflect on the impact of knowing the environment when prototyping such platforms and how they can be helpful to the most affected.

2 Methodology

The methodological proceeding is based on a development research with a mixed-methods approach. To accomplish the final objective of the investigation - conceptualize, prototype, and develop a mobile application focused on the participation of the community in the prevention of forest fires - the workflow was divided into different stages (Fig. 1). Initially, it was made a systematic review of the literature. Then, a study of the existing forest fires mobile applications and a research about the Portuguese prevention campaigns across different communication media was made. After these examinations, the first version of the application is conceptualized.

In the next stage, the results of semi-structured interviews with the citizens and stakeholders of the communities of São Pedro do Sul and Pedrogão Grande – highly affected regions by the forest fire occurrences of 2017 – were analyzed. Those interviews are part of a Ph.D. study [3] conducted within the research group this work is included. With this intel, the second version of the functional requirements is created.

The following step consisted of prototyping the last conceptualized version of the application, considering the identified user's profile and the application's environment. Testing the prototype makes it possible to understand whether the functionalities are useful or not and check if they are well implemented in terms of design.

The last step, still in process, is the implementation of the mobile application. Firstly, the technical requirements and the system architecture were defined. Then the backbone

of the database was constructed. With an order of priority, the functionalities start being implemented, and the database is being updated and complemented.

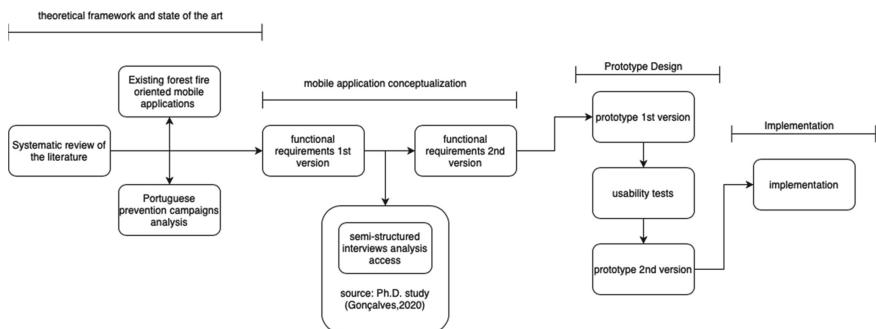


Fig. 1. Investigation stages

3 Results

In this section, the results of the different stages of the investigation are presented.

3.1 Systematic Review of the Literature

This systematic review of the literature aims to get a general snapshot of the state of art. Each query results presents research about prevention on digital platforms and studies that focus on the response phase and measures to reduce those situations consequences’.

The literature review identified a common type of system, which can be useful given the goal of this investigation: Volunteered Geographic Information (VGI) systems, where a user can share relevant data with an associated geographic context. Klonner’s study [4] affirms that VGI systems can perform a role in forest prevention and mostly on community protection, providing valuable information about safe infrastructures or places of highest fire propensity. This kind of contextualized information can be essential in decision-making processes and be helpful in communication between members of a community.

Another frequently referred concept on this systematic review is the data retrieved by users or volunteers, with associated geographic context, used in investigations or studies by the scientific community on forest-related knowledge. The generalized use of mobile devices provides opportunities to implement VGI systems in communities, allowing users to share information about situations they consider relevant. Ferster [5] reiterates this potentiality, referring that community participation can increase the number of volunteers and, on the other hand, provide strategies and knowledge that can be determinant on forest fire prevention and protection. Once again, mobile devices can be the tool that speeds up this process of data retrieval and communication between the different forest fire management and prevention contributors. This concept was implemented by a mobile application conceptualized by Bioco and Fazendeiro [6], consisting

of a system based on VGI, composed of two parts: a mobile application where every user can collect information about fire occurrences or other relevant information in fire-prone areas, sharing them through the app, always with user location associated; the other part consists in a Web application in which only experts and authorities can access and analyze the data collected by volunteers, to make best decisions.

3.2 Existing Forest Fires Mobile Applications

A relevant statistic concerning this discussion is the percentage use of smartphones and the internet penetration rate in the Portuguese context. 93% of people between 16 and 64 have a smartphone, and around 83% have internet access, covering most of the Portuguese population [7].

This mobile application analysis aims to understand the existing functionalities and perceive if they are useful and relevant to the users. This search enables typology predominance analysis respecting forest fires and contributes to listing potential features for the expected application.

In total, 21 mobile applications listed on *Google Play* and *Apple Store* were studied. From this total, 11 had an international scope; 5 were focused on the Portuguese context, and 4 had regional relevance. Each app was categorized within a typology after its characteristics examination.

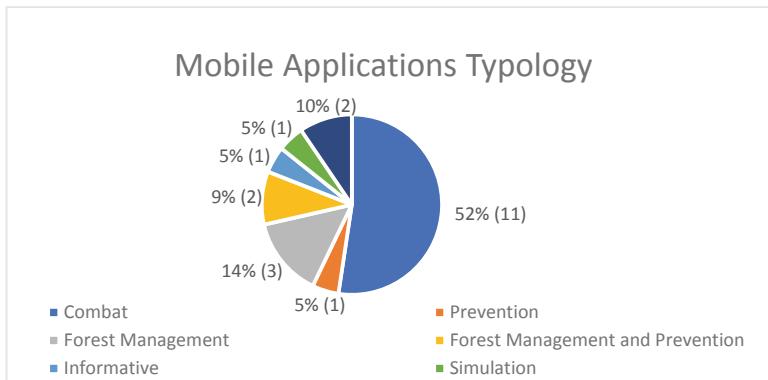


Fig. 2. Existing mobile applications typology

The results represented in Fig. 2 demonstrate the predominance of combat phase mobile applications, with fire occurrences listing or georeferencing functionalities, the number of response units, and fire occurrences notifications, as shown in Fig. 3. All the combat phase applications analyzed have georeferencing functionalities. Notifications appear in most applications in different formats, like Alerts by occurrence status or predefined user areas. Another common characteristic is fire risk Alerts.

Only 5 of 21 applications were considered appropriate in the prevention typology, sometimes combined with other typologies. Only 1 of those 5 applications fits the prevention typology exclusively. Aggregated with the prevention component are the informative

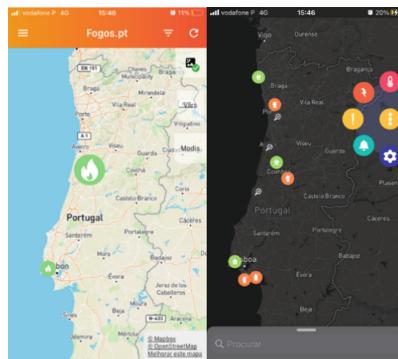


Fig. 3. Occurrences Georeference on *Fogos.pt* and *Fogos em Portugal* mobile applications

typology and the forest management since both can be considered preventive acts in the short and long term. The most frequently observed characteristics are risk behaviors and good practices dissemination in textual or audiovisual formats with little interaction. Only regionally contextualized apps provide useful links and relevant contacts to the local communities.

Forest management mobile applications retrieved were centered on systems that allow the user to register land areas of their interest to assist in managing those spaces. The other typologies, Simulation, and Informative, aggregate 4 applications. 2 of them are informative ones categorized in the prevention typology, but with news and data appropriate to the communities they reach (*Pro civ Madeira* and *Pro civ Azores*).

In sum, it is appropriate to affirm that combat phase mobile applications are the predominant type of system. Despite being helpful from the informative perspective, these functionalities might not be essential and even beneficial for the directly affected communities during the occurrences, as observed by the Fort McMurray wildfires study [8]. It was also verified the existence of a limited number of forest fire prevention-oriented platforms. Those focus on textual or visual information and had little interactivity between the users.

3.3 Portuguese Prevention Campaigns Analysis

This section summarized the most recent prevention campaigns implemented in Portugal, emphasizing the informative focus, media diffusion, and methods.

The research made to the responsible institution for the Portuguese forest conservation (ICNF) allowed identifying 3 sensitization plans designed to prevent rural fires between 2017 and 2019 (Fig. 4). These sensitization plans aim to “bring the citizens and society closer to the forest, increasing the knowledge on its working mechanisms and its fragilities incrementing the participation and involvement on its management, maintenance and protection” [9].

In each sensitization plan, there is always different content and different diffusion methods for each target audience. Concerning the campaigns, it was possible to retrieve some of the flyers integrated into the sensitization program for each year. It was more

challenging to collect digital content since it might be updated or not online anymore. Except for tv or radio advertising spots, the emphasis on digital platforms or social networks is low. It is possible to find content on some institution's websites, but with unappealing approaches and without a previously defined campaign.



Fig. 4. Rural areas constraints flyer from 2017

In 2017 there was also a parallel campaign called Movimento ECO with the popular slogan - “Portugal sem fogos, depende de todos” (Portugal without forest fires depend on all of us). Different entities contributed to this campaign to disseminate short videos with the participation of public figures using the previous slogan. These videos were broadcasted on tv, radio, and some social networks.

The 2018 national sensibilization plan was also on ICNF's hands, as well as its concretization. By analyzing the plan, there is a slight increase regarding the dissemination on digital platforms. However, it was not possible to find any online content from that year. Also, there were no organized online campaigns, only the renewal of flyers, tv, and radio advertising spots.

In 2019, there were some structural changes in the sensibilization plan. With a new agency responsible for its implementation, it was possible to observe a more robust adoption of digital platforms for the campaign dissemination – “Portugal Chama” (Portugal calls/Portugal flame) – mainly through web platforms or social networks. The tv and radio spots were renewed, and, in physical formats, there was also a graphic renewal on the flyers.

Regarding the 2020 year, it was not possible to obtain the national sensibilization plan. However, from a digital perspective, the website portugalchama.pt is still available and is one of the leading portals to get online information on the “Portugal Chama” campaign.

3.4 Functional Requirements and Prototyping

The next step is the functional requirement stage, based on previous research on existing mobile applications, Portuguese forest fire prevention campaigns, and the systematic literature review. Here, the goal is to list the specific characteristics of the mobile application. Furthermore, this functional requirements definition integrates some results from a doctoral research conducted within the author's research group [3]. This investigation targets the communicational model development of a forest fire prevention digital platform. The research focuses on Pedrogão Grande and São Pedro do Sul as case studies,

regions with highly affected communities by the 2017 forest fires. It contributed to this work with the point of view of the local communities and local stakeholders, who were interviewed about their needs and perspectives regarding using a digital platform to communicate and prevent forest fires. The results of this research will be published shortly. Both investigations converge on the importance of local populations and institutions' participation and their activeness on forest fire prevention.

With the final goal in mind, the priority was to define the target audience and understand their role regarding forest fire prevention and their most frequent difficulties and complaints. Another important aspect was the way these different participants would communicate with each other. The semi-structured interviews conducted by the doctoral investigation allowed listing possible users within the local community and the multiple stakeholders. Those interviews converge with this work objectives since they were made in a regional context that coincides with the geographical scope idealized for this final mobile application. They also sought to identify the infocomunicacional needs and the demographic profile of each respondent. Therefore, with the help of these interviews and background research, it was possible to identify the correct profiles and define their main features.

For the general features and to encourage Public Action, there were defined two main actions that users can execute: Alerts and Public Actions. The backbone and process of execution are similar for both features: the users are backed up with a map where they can see listed Alerts or Public Actions created by other users or by themselves. Alerts can have different typologies and correspond to critical forest problems like burned areas or bad combustible management, which the authorities and municipalities do not consider. Every user can confirm a listed Alert to verify and reinforce the response to the Alert itself. The Public Actions feature arises from the need to create a platform for the population to interact and actively protect their lands or houses or even respond to the identified Alerts. Users can add their participation to an already created Public Action or create one themselves. A Public Action can also have different typologies, for instance, combustible management, cleaning, plantations, among others. It is then composed by other users that add their participation. A date has to be defined and also the necessary materials.

Another important idealized feature is a forum with different sections of forest fire prevention and protection. This forum promotes communication within the communities giving all possible participants a space to share their concerns or ideas. Each section is filtered by region and topic so discussions can be more efficient and less noisy. Every user can add a new post with an associated tag or write comments in other posts.

The remaining characteristics of the application are informative spaces with relevant data concerning good practices or examples of risky behaviors and important contacts. Finally, the users can create their interest areas to receive Alerts and Public Actions notifications that intersect those areas. The following Table 1 represents a model of the general features of the application.

Additionally, there is a section oriented to the occurrence response phase, where users can search for safe spots near their location and mark the spots as safe so other users can have that feedback.

Table 1. Functional requirements of the mobile application

Alerts	Public actions	Forum	Information
With GPS location	With GPS location	Subsections	Contacts
Alert description	Public Action description	Posts and commentaries	Good practices
Typology		Filter by:	Risk behaviors
Verification (users)	Typology	- Tags (prevention-related)	Service providers
Certification(authorities)	Date	- Regions	
Alert photos	Materials		
	Participants		
	Public Action photos		

The following Table 2 represents the identified user roles for the mobile application and their possible actions and profile characteristics.

Table 2. Profile typologies; possible actions; user profile page content

Landowner	Inhabitant	Service provider	Authorities/municipalities
Add Alert Add Public Actions	Add Alert Add Public Actions	List available services Add Alerts Add Public Actions	Change Alert status Change Public Action status Create notifications List services and contacts
<i>Profile page</i>			
Alert history Public Action history Interest areas contacts	Alert history Public Action history Interest areas contacts	Contacts Service types Intervention area	Contacts Intervention area

Prototyping. The prototype was created using the InVision Studio Platform and was designed to be tested on a device with specific dimensions, namely the Samsung S8 smartphone.

It was considered the target audience, the application's usefulness, and the kind of environment it would use. Group icons were meant to be easily perceptible and always with textual aid. The color scheme should also converge with the application concept, using colors that resemble the forest and its natural environment. Different font families and weights were defined for title, subtitle, button texts, and descriptive texts. Finally, another essential aim was to design all the functional requirements with the minor clicks possible to simplify the user experience when adding content to the application.

Moreover, there was also the concern in giving the users more than a one-way navigation flow to achieve a designated task.

There were created screens for every main functional requirement listed on the previous tables and interactions that allowed the user to navigate between screens. Some noted difficulties in designing the prototype were creating important interactions within screens, limited by the InVision platform possibilities. The following figure shows some of the constructed screens on the prototype.

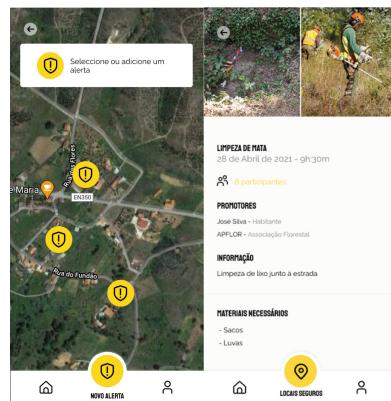


Fig. 5. Prototype first version screens example

In Fig. 5 left image, there is a screen with 3 georeferenced markers displaying Alerts added by users. The users can tap on an existing Alert to check the details or add one themselves by tapping on the central button at the bottom navigation bar, triggering the addition process. This button is present in almost every screen of the application, allowing the users to execute the most important task of the corresponding section. The screen on the right presents, in a concise way, detailed Public Action information: date and schedule, participants, and other essential data to the users' participation.

Addition and visualization tasks were similarly designed for the Alerts and Public Actions features, simplifying the complexity of the application regarding the execution of these tasks and improving the user experience. Other prototype sections used the same color scheme, group icons, and usability guidelines previously identified as important.

The prototype's first version, which implemented all the previously listed functional requirements, was then used to perform usability tests, corresponding to the subsequent investigation stage. After the first test round, the most pointed out problems were noted and reflected on the next version's changes. However, the corrections that needed the most attention will be reflected in the actual application implementation.

Testing. There were performed 10 usability tests on the designed prototype in presential meetings. Although a convenience sample was used, the participant profiles were evenly distributed, and part corresponded to the potential target audience. The profile scope of the participants varied between 25 and 63 years old, from students to industry and public workers and landowners as well as inhabitants from a forest fires-affected region.

The tests were conducted using the Samsung S8 smartphone as expected due to the prototyping platform restrictions.

The usability test structure was composed of 6 tasks proposed to the participants that traversed the essential application usage flows:

- User registration and login;
- Create a new interest area on the user profile;
- Create a new Alert;
- Add participation on an existing Public Action;
- Create a new Public Action from an existing Alert;
- Check for contact t information and search for a post filtered by tags

The test results demonstrated some utilization aspects that needed reflection and minor navigation problems evidenced by most of the participants and pointed out by some of them.

One of the most observed difficulties was finding the button to add an Alert or Public Action because it had an incorrect icon that was not being perceived as it should, as represented in Fig. 6. Another common witnessed mistake by the participants was automatically creating a Public Action right after making an Alert. This happened because there was a button on the Alert details screen to create a Public Action in the bottom, next to the bottom navigation bar, misleading the users. Lastly, another difficulty observed was returning to the home screen after creating an Alert or a Public Action. This might have been caused by a lack of feedback after the Alert or Public Action was created.

The testing document allowed participants to share their recommendations or observations. Some of the responses suggested, as previously noticed, adding temporary feedback after creating an Alert or a Public Action. Another common suggestion was to present Alerts and Public Actions in a list format, so users do not need to tap on markers on the map to see their details. Finally, there was a suggestion to add a notifications page and complement the home page buttons with images corresponding to the button content.



Fig. 6. Screen differences example before and after the usability tests

On a general note, the main core of the prototype received positive assessments by the participants, that were pleased by the screens' simplicity and ease of use. The following image reveals the 'add Alert' button difference before and after the usability testing.

3.5 Implementation

This stage is still in development. Therefore, this section explains what is already implemented and the future perspectives. For this stage, the adequate data model was initially defined, and the database backbone was constructed right after that. In this initial period, all the services needed to complete the full streamline of the system were defined. After documentation readings and considering the technological knowledge from the researchers and time constraints concerning the project deadline, the decision was to proceed using the following available amazon web services:

- DynamoDB (database)
- AWS Amplify (provide tools to develop and deploy a full-stack mobile application)
- AWS AppSync (graphQL API)
- S3 (Image Storage)
- Cognito (User Authentication)

For the front-end environment, the application was built with react native, allowing Android and IOS Systems development. However, at the moment, the current implementation is structured to work only on Android-supported smartphones.

Currently, several of the requirements listed previously are already functional but not fully implemented. Main characteristics like adding an Alert or Public Action are already possible, and also, the Forum section is now available. However, until most of the requirements are entirely implemented and robust enough to deploy the application,



Fig. 7. Screens example from the mobile application development stage

the system will continue in the development phase. The Fig. 7 presents two screens of already functional characteristics.

4 Conclusions

The analysis and systematization of mobile applications dedicated to forest fires and the campaigns to disseminate information on rural fire prevention allow the general conclusion that using digital platforms to communicate forest fires prevention content is not yet a common practice in Portugal. On the other hand, the contributions collected through state of art make it possible to understand the usefulness of digital communication systems that promote the interest and participation of citizens around scenarios such as forest fires. In this sense, and understanding the relevance that digital media have in Portugal, it seems logical to converge on the use of digital platforms to promote interaction and participation practices from the most affected by forest fires.

With the development phase still in progress, this research contributes insightful improvement to the ongoing investigations in this area. Using highly evolved smartphone technologies to conceptualize and develop an application can help the most affected communities by forest fires protecting their living areas. This is a surprisingly unusual scenery, given the already vast economic but mainly social damage caused by this phenomenon. In the near future, the aim is to finish the mobile application development with the most robust possible result. Future usability and UX design testing can also be executed to improve the user experience since it is crucial to mobile applications.

Acknowledgments. This research was supported by the Portuguese Foundation for Science and Technology (FCT) through the FCT fellowship [SFRH/BD/140247/2018] attributed to the author Liliana Gonçalves.

References

1. ICNF: Perfil Florestal - Portugal (2018). <http://www2.icnf.pt/portal/florestas/pfp/estatisticas-oficiais/resource/doc/ICNF-Perfil-Florestal-v08nov2018.pdf>. Accessed 21 Nov 2020
2. Brengarth, L.B., Mujkic, E.: WEB 2.0: How social media applications leverage nonprofit responses during a wildfire crisis. *Comput. Hum. Behav.* **54**, 589–596 (2016)
3. Gonçalves, L.: Partilhar Conhecimento através de Plataformas Digitais: O Caso Dos Incêndios Florestais [Ph.D. under progress]. University of Aveiro (2021)
4. Klonner, C., Marx, S., Usón, T., De Albuquerque, J.P., Höfle, B.: Volunteered geographic information in natural hazard analysis: a systematic literature review of current approaches with a focus on preparedness and mitigation. *ISPRS Int. J. Geo-Information* **5**(7), 103 (2016)
5. Ferster, C.J., Coops, N.C., Harshaw, H.W., Kozak, R.A., Meitner, M.J.: An exploratory assessment of a smartphone application for public participation in forest fuels measurement in the wildland-urban interface. *Forest* **4**, 1199–1219 (2013)
6. Bioco, J., Fazendeiro, P.: Towards forest fire prevention and combat through citizen science. In: Rocha, Á., Adeli, H., Reis, L.P., Costanzo, S. (eds.) WorldCIST'19 2019. AISC, vol. 930, pp. 904–915. Springer, Cham (2019). https://doi.org/10.1007/978-3-030-16181-1_85
7. We Are Social and Hootsuite. Digital 2020 July Global Statshot Report, p. 247 (2020)

8. Nayebi, M., Quapp, R., Ruhe, G., Marbouti, M., Maurer, F.: Crowdsourced exploration of mobile app features: a case study of the fort McMurray wildfire. In: Proceedings - 2017 IEEE/ACM 39th International Conference on Software Engineering: Software Engineering in Society Track, ICSE-SEIS 2017, pp. 57–66 (2017)
9. DPFVAP and DGAPPF: Plano Nacional de Sensibilização DFCI | 2017 (2017). <http://www2.icnf.pt/portal/florestas/dfci/planos/resource/doc/pns/Sensibilizacao-ICNF-2017.pdf>. Accessed 10 Jan 2021



Systematic Mapping of Methods Used to Evaluate the Usability and UX of Learning Management Systems

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Abstract. LMS (Learning Management System) platforms have become relevant in the last two decades and their adoption by educational institutions around the world increased considerably, which shows the importance of developing systems with proper usability and user experience (UX). In the context of the current pandemic, in which long distance education is no longer a matter of choice, but a necessity, having LMS that meet usability standards becomes even more important. These platforms should contribute to an efficient and effective learning process. Identifying the main usability problems found in existing LMS is a key step towards improving the experience they provide to their users. This paper presents a Systematic Mapping (SM) of the existing literature on the subject, which identifies the most common approaches followed over the last decade (2010–2020) to evaluate the usability and UX in LMS. Close to 80 publications were analyzed, and our preliminary results show that the vast majority of them follow approaches that are either based exclusively on Jakob Nielsen's heuristics or use them in combination with other methods. While there are reasons to believe Nielsen's heuristics provide a robust approach for usability, their overwhelming use raises the question of whether there are alternative methods (including the ones that resort to automation) to guarantee that LMS and other digital products meet usability standards.

Keywords: Usability evaluation · User experience evaluation · Learning management systems · Systematic mapping study

1 Introduction

E-Learning involves activities to assist the teaching-learning process using Information and Communication Technologies (**ICT**). There are different ways to implement e-learning strategies. The most recent ones are based on online courses (distance learning) and courses following some kind of “mixed” modality (a.k.a. Blended Learning).

In the first type, students only use digital platforms and do not physically attend their campus. In the second kind, a certain number of classes occur in a digital environment whereas the rest are presential [1]. The e-Learning process can be synchronous or asynchronous. The synchronous model involves a learning modality in which both instructors and students are online and communicate directly with each other in real-time. In the asynchronous model, instructors and students interact intermittently, and not necessarily in real-time time, through discussion groups, e-mail, chats and other communication solutions integrated within a given OLE (On-line Learning Environment). E-learning normally relies on Learning Management Systems (LMS). An LMS is a type of software that offers administration, documentation, delivery, and compliance with activities established during the teaching-learning process, allowing teachers and students to communicate and interact efficiently and effectively [2]. Some examples of LMS are: *Moodle*, *Sakai*, *dotLRN*, *ROLE*, *ATutor*, *Claroline*, *Dokeos*, *Subtopic*, *OpenACS*, *ILIAS*, *OpenUSS*, *Doubtfire*, *Totara*, *open class*, among others.

LMS are not exclusive to educational environments such as universities and schools, but have also been adopted by companies, hospitals, government agencies, and other institutions. Given their relevance, evaluating these platforms to improve their quality and performance in terms of usability, UX, and success in supporting the educational process is of the utmost importance. The evaluation of LMS can improve the way teachers and students interact and ideally overcome difficulties that get in the way of successful learning, since usability and UX are perhaps the most important factors in that regard.

Usability concerns the pragmatic aspects of task execution by users, specifically, the interactions between two types of users, students and teachers, through an interface. UX is related to the subjective, phenomenological quality of the interaction with and through a digital system, i.e., aspects related to emotions and aesthetic value experienced by users [3].

When the teaching-learning process occurs through an LMS, students need to set aside time to learn how to use the system, *while simultaneously attending their classes*. Therefore, if an LMS does not offer good usability, students will not only spend time overcoming the learning curve of the system but also battling issues caused by its faulty design. Although, in many cases, students and teachers do overcome these obstacles and continue using the platform, albeit ending up with a negative experience. It follows that a more pleasant and satisfying LMS environment (i.e., one that provides a better UX) tends to be more stimulating for students [2, 4].

Nonetheless, there are still significant difficulties when it comes to evaluating the usability and UX of LMS and, ultimately, proposing alternatives to improve their interfaces [2]. Although some approaches have sought to integrate existing heuristics and pedagogical principles to improve the quality of LMS interfaces [5–7], software development culture is still reluctant to consider usability, user experience, and pedagogical principles when developing systems. Consequently, evaluation methods for LMS need to be improved and perhaps need to incorporate more sophisticated empirical procedures, for example, automated analysis, technological resources, or even artificial intelligence (AI) [2, 4, 7, 8].

This paper describes a Systematic Mapping (henceforth SM) of the main approaches used over the last decade (2010–2020) to evaluate the usability and UX of LMS. The

article is organized as follows: part one presents a brief introduction on LMS; part two presents some studies about LMS; part three presents the methodology adopted to carry out the SM; part four presents a discussion about results and a triangulation with a reference study; finally, part five offers some concluding remarks.

2 Related Work

Over the last years, some studies have attempted to systematize the methodological approaches used to evaluate the quality of the interaction in LMS [4, 9–11]. For example, a Literature Review (LR) carried out by [10] addressed the relationship between ergonomics and usability in e-learning contexts. One of the most important conclusions of this study is that instead of using evaluation methods adapted for educational systems, most studies are conducted using generic software evaluation metrics.

The authors note the constant use of consolidated methods to assess the usability of learning systems, such as interviews and questionnaires, or a combination of methodological approaches related to User Centered Design (UCD), Cognitive Walkthrough (CW), among others. On the other hand, in 2012 these authors identified the start of a paradigm shift for LMS evaluation, observing that several researchers began to analyze ergonomic principles of usability focusing on e-learning [10].

For their part, [9] developed a systematic mapping (SM) to find publications related to the usability of mobile e-learning. The study highlights the absence of appropriate frameworks or guidelines to assess usability and educational factors in m-Learning systems (Mobile e-Learning). The authors proposed a model of m-learning applications during the system development phases, considering factors such as educational goals, usability, and student experience. Subsequently, the survey conducted by [11] proposed an update to Cota's SM [9]. The authors mention that although it has been possible to perceive an advancement in the techniques and evaluation approaches for m-Learning environments, there were still not enough framework or guidelines to improve aspects related to UX, usability or the pedagogical context. As a result, the authors proposed a framework to evaluate mobile learning environments.

The systematic mapping carried out by [4] focused on publications that evaluated LMS from the perspective of usability and UX of desktop and mobile applications [4]. The SM analyzed 62 publications retrieving information such as origin, type, method of execution of the study, existence of learning factors, technical application restriction and resource availability. The authors concluded that there was still no sufficient evidence to indicate a more appropriate method for evaluating learning environments. The SM reveals the need for further research to find better techniques to evaluate the complexity of OLE environments.

The above studies, however, were not included in the sample analyzed by this paper, precisely because they are systematic literature reviews, but they were nonetheless used as a reference for the development of our own SM.

3 Research Method

In general terms, a systematic mapping is a rigorous and well-defined research method used to identify, evaluate, and interpret the largest possible number of relevant publications about a given topic. A SM allows finding results that are less influenced by the researchers' biases. It also allows to capture more information about a variety of methods applied within a certain area of research [12]. Our SM expands the approach followed by Nakamura's [4] “*Usability and User Experience Evaluation of Learning Management Systems*”. In addition to identifying LMS evaluation methods, our SM included the following criteria and metrics used over the last decade:

Objective of the Systematic Mapping: To obtain evidence and “gaps” about research techniques used to evaluate LMS in the context of usability and UX over the last 10 years. Secondary objectives include determining which criteria have been used to assess the quality of the LMS interfaces and the interaction between students and teachers.

Working Protocol: The process consisted of two steps: definition of scientific knowledge bases to be consulted; definition of data recovery criteria, such as language, document types, date of publication, and large clusters of keywords.

Knowledge Bases: B-ON - Online Knowledge Library was used to recovery the publications. The library indexes the following databases: *Academic Search Complete*, *American Chemical Society*, *American Institute of Physics*, *Annual Reviews*, *Association for Computing Machinery*, *Business Source Complete*, *Coimbra University Press*, *Current Contents (ISI)*, *Elsevier*, *Essential Science Indicators (ISI)*, *Eric*, *IEEE*, *Institute of Physics*, *ISI Proceedings*, *Journal Citation Reports (ISI)*, *LISTA*.

Research Criteria: Knowledge area, publication date, document type (PDF, DOC, etc.), language.

Data Retrieval Goal: The SM used *Basili's GQM (Goal-Question-Metric) Paradigm* [13] as a Reference, as shown in Table 1.

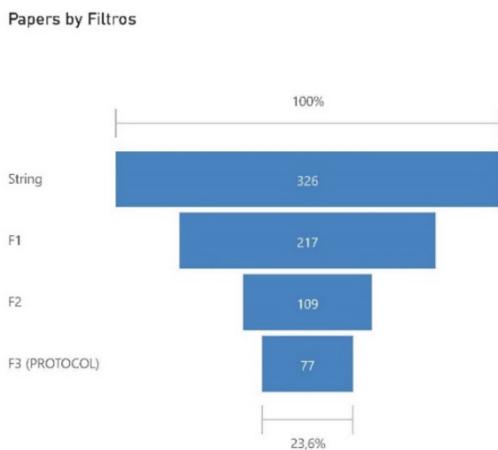
Table 1. Research objectives according to *Basili's GQM (Goal-Question-Metric)*.

Scope	Scientific publications
Purpose	Characterization of the situation
Relation	Usability and UX Assessment Techniques
Point of View	Researcher
Context	LMS

Search Method: 17 guidelines were defined to perform the Data Recovery (DR) according to Table 2.

Table 2. Data recovery questions.

No.	Question
1	What is the origin of the LMS evaluation technique? If it is new, what is the difference in relation to other techniques?
2	What type of technique was used?
3	Mode of evaluation: manual, semiautomatic or completely automatic?
4	Which specific factors related to LMS were taken into account during the evaluation?
5	Considers: usability, UX or Pedagogical criteria or a combination of them?
6	Does the evaluator get any feedback during the evaluation?
7	Were there empirical procedures in the evaluation process? Which ones?
8	Are there any restrictions/conditioning factors?
9	Does the evaluation consider specific learning factors?
10	Does the evaluation consider specific technological factors?
11	Is the approach available for consultation or download?
12	What was the type of LMS evaluated? Is it strictly educational?
13	Is there any comparison between the chosen technique and others?
14	Type of institution: educational, business, others
15	Type of e-learning: Online, Blended, Mixed
16	Methodological-Scientific approach? Heuristics, User Tests, etc
17	Are Nielsen heuristics used to evaluate the interface?

**Fig. 1.** Papers by filters.

Retrieval Research Languages: Portuguese and English languages.

Database Research Terms: The procedures described by [14] were used to define the research terms. Both studies suggest defining the following parameters: population, intervention, comparison, result and context. Based on that, the following set of parameters was defined: Population—LMS; intervention—techniques, tools, processes; comparison—does not apply since the objective is to characterize the techniques; Results—Assessment of usability, UX or pedagogical criteria for systems definition learning management; Context—it does not apply because there is no comparison to determine the context. The terms of the research were divided into LMS—concerns different ways of writing the research terms and the different synonyms for the terms themselves and Usability + UX—relates to the different types of research approaches for the two terms. There was still a subdivision considering the defined languages. The terms were identified using authors referenced within HCI. An exploratory study (EE) carried out previously helped in this process [2]. This phase used a semantic analysis tool¹ to identify terms related to the keywords found in the previous Exploratory Study: UX Analysis, Usability Analysis, LMS, Pedagogical Criteria. The search string passed through several tests until we found one that resulted in a reference that was semantically close to the terms of interest. During refinement, we noticed that the search term “pedagogical criteria” and its variants returned a considerable number of results outside the Systematic Mapping definition scope. Therefore, we decided to remove it from the Data Recovery phase, without affecting the application of the protocol.

Application of the work protocol: The application of the search protocol in scientific databases, resulted in 326 publications.

Papers Selection: At this stage our goal was to ensure the recovery of papers exclusively related to usability, UX and LMS. The process was conducted in 3 stages, using three sequential filters: Filter 1 (F1) - applied to the following paper elements - title, summary and keywords recovered from the execution of the search string. After this first step, 217 publications remained. Filter 2 (F2) - this filter corresponds to the complete reading of all remaining items from F1. After applying F2, 109 publications were left. Filter 3 (F3) - corresponds to the Data Treatment (DT) and happened during the extraction of information from the papers (Data Extraction - DE) trying to identify the answers to the Systematic Mapping Questions. After applying Filter 3 (F3), 77 publications remained. Figure 1 shows the recovered funnel of publications and their respective phases.

Inclusion and Exclusion Criteria: Throughout every stage, the inclusion criteria (IC) and exclusion criteria (EC) were applied as indicated in Table 3 and Table 4. Four “inclusion criteria” and nine “exclusion criteria” were defined. The exclusion and inclusion criteria were adapted from our reference study, albeit with some changes [4].

Considerations About the Inclusion/Exclusion Criteria: Regarding the Criterion Exclusion 2 (CE-2), the systems denominated as MOOC (Massive Open Online

¹ <https://lsigraph.com/>.

Table 3. Criteria used to include papers after string application.

Code	Inclusion criteria
CI-1	Describes the application of UX techniques and/or criteria to evaluate the LMS interfaces
CI-2	Describes the application of techniques and/or usability criteria to evaluate the LMS interfaces
CI-3	Describes the application techniques and/or criteria of UX or usability to evaluate LMS
CI-4	Describes the application techniques and/or criteria of UX and usability to evaluate LMS

Table 4. Criteria used to exclude papers after string application.

Code	Inclusion criteria
CE-1	Not related to the application of UX/Usability techniques and/or criteria to evaluate the LMS interfaces
CE-2	Describing the application of UX/Usability techniques and/or criteria to evaluate MOOC interfaces
CE-3	Describing the application of techniques and/or criteria of UX and/or usability to evaluate the LMS interfaces in languages other than English and Portuguese
CE-4	It describes the application of techniques and/or criteria related to UX and/or usability to evaluate LMS interfaces that are inaccessible or behind paywalls
CE-5	It describes the application of UX techniques and /or criteria and/or usability to evaluate the LMS interfaces, but which are considered duplicated
CE-6	Strictly related to “augmented reality” studies or those in which the application of UX techniques and/or criteria and/or usability to evaluate the LMS interfaces are not the main objective
CE-7	Strictly related to “accessibility” studies or those in which the application of UX techniques and/or criteria and/or usability to evaluate the LMS interfaces are not the main objective
CE-8	Strictly related to the application studies of techniques and/or criteria of UX and/or usability to evaluate the LMS interfaces of Closed Source Platforms
CE-9	Publications with insufficient information to be analyzed

Course)—open and massive online course are considered learning platforms focused on mass and unrestricted access of students [15]. MOOC main representatives are Coursera, Udacity, Udemy, Open University. There are obvious difficulties to access the administrative environment of these platforms, which are mostly closed-source (Criterion Exclusion 8 (CE-8). Additionally, it is not possible to identify whether a course is not inserted into a MOOC because it is of no interest for the teacher/instructor or due to usability and UX

issues [4]. In the exploratory study (EE) it was possible to verify the categorization of the LMS in the context of the On-line Learning Environments [2]. OLEs can be categorized in two groups: LMS and MOOC. LMS can be subdivided into: Open Sources (OS) - Moodle, Sakai, Dotlrn, Role; Closed Sources (CS) - Blackboard, Ping Pong, LMS Canvas, McGrawhill Education, Blackbaud. Based on this, the Criterion Exclusion (CE-8) was defined considering the specifics of the closed sources applications.

Data Extraction: After selecting publications following Filter 2 (F2), the data extraction from papers was based on the complete reading of each publication. The extraction was processed based on a set of pre-defined questions according to the work of [16] and [4]. Besides that, new questions were added to this study. The purpose of this phase was to ensure that the same extraction criteria were equally applied to each one of the publications.

Data Treatment: The data obtained were processed through Microsoft Power BI and Excel. First, trying to find the frequency of publications related to the evaluation of usability/UX in LMS context between 2010 and 2020. This study was carried out in September 2020. Therefore, the data for this year may be incomplete, which may explain the low rate of publications belonging to that period. 2012 and 2019 have the lowest indexes of publications. The Library *b-on - Biblioteca de Conhecimento Online* available at <https://www.b-on.pt> was used and it has a considerable set of scientific indexers. However, that papers analyzed was restricted to this database. The data of this phase can be found at: <https://jc7.co/dgc21>.

The following Table 5 is an overview of the questions used in the Protocol Application.

Table 5. SM application protocol questions.

Questions	Possible answers
QE01 - Technique Origin (TO)	QE01A - New
	QE01B - Existing
QE02 - Type of Technique (TT)	QE02-1 - Primary Technique Type (PTT)
	QE02-2 - Secondary Technique Type (STT)
	QE02-3 - Tertiary Technique Type (TTT)
QE03 - Execution Mode (EM)	QE03A - Manual
	QE03B - Semiautomatic
	QE03C - Automatic
QE04 - Pedagogical Aspects (PA)	QE04A - PA + UX + Usability (YES)
	QE04B - Only UX + usability (NO)

(continued)

Table 5. (*continued*)

Questions	Possible answers
QE05 - Evaluation Objectives (AO)	QE05A - Usability
	QE05B - UX
	QE05C - UX + Usability
QE06 - Opportunities Suggestions (OS)	QE06A - Suggests improvements (YES)
	QE06B - Only identifies the problems (NO)
QE07 - Research Category (RC)	QE07-1 - Primary Research Category (PRC)
	QE07-2 - Secondary Research Category (SRC)
	QE07-3 - Tertiary Research Category (TRC)
QE08 - Application Restrictions (AR)	QE08A - There are AR (YES)
	QE08B - There are not AR (NO)
QE09 - Resources Availability (RA)	QE09A - There is RA (yes)
	QE09B - There is not RA (NO)
QE10 - Device Type (DT)	QE10A - Desktop
	QE10B - Mobile
	QE10C - Desktop + Mobile
QE11 - Type of application (TA)	QE11A - Web
	QE11B - Desktop
	QE11C - Web + Desktop
QE12 - Techniques Triangulation (TT)	QE12A - There is TT (yes)
	QE12B - There is not TT (NO)
QE13 - E-Learning System (ES)	What is the system tested?
QE14 - E-Learning Institution (EI)	Type of institution where the LMS is in use?
QE15 - E-learning Type (ET)	QE15A - Online
	QE15B - Blended
	QE15C - Not identified
QE16 - Evaluation Approach (EA)	What is the evaluation approach?
QE17 - Nielsen Base (NB)	QE17A - Yes (use Nielsen's heuristics)
	QE17B - No (do not use Nielsen's heuristics)

The model used was adapted from [4]. At the beginning of the Data Extraction (DE) - corresponding to F2, there were 109 publications. During the refinement process, 32 articles were excluded according to the established exclusion criteria. The reasons for exclusion are mostly related to Criteria of Exclusion 1 and 9 (CE-1 and CE-9). Some articles were excluded because they were literature reviews themselves. Some articles were also excluded because they analyzed different LMS environments according to CE-1. In some cases, it was not possible to obtain enough information about the process applied in the study. In other situations, some studies were in an initial stage, making their process difficult to analyze. Some articles used more than one evaluation technique. In these scenarios, unlike the reference study, we chose to identify the other techniques applied. Because of this approach, the QE02 (Question 2) was subdivided into three parts: QE02-1 - Primary Technique Type (PTT), QE02-2 - Secondary Technique Type (STT) and QE02-3 - Tertiary Technique Type (TTT). In this context, 116 techniques were identified across 77 publications, with repetitions. In this study, we also decided to verify the research categorization of papers. It was defined in QE07 (Question 7) - Category of Research (CR) which was subdivided in QE07-1 - Primary Research Category (PRC), QE07-2 - Secondary Research Category (SRC) and QE07-3 - Tertiary Research Category (TRC).

4 Preliminaries Results

Through our Systematic Mapping we obtained 77 publications extracted after Filter 3 (F3) was applied. Geographically speaking, there was a higher concentration of scientific work from Asia (30) followed by Europe (23) and South America (9). There was a greater concentration of scientific work from Brazil (9), Indonesia (7) and Malaysia (6). For other countries, we found a ratio of one to four studies throughout the decade. The year 2015 had a peak of 14 publications, the highest in the sample, followed by years 2010, 2011 and 2016, which corroborates the results found in [4].

The Systematic Mapping can gather studies with different methodological approaches to investigate the quality of LMS from the perspective of usability and UX. The approaches based on Heuristic Evaluation (HE), are still largely or entirely based on Nielsen's heuristics. They are frequently used alone or in combination with other methods, such as User Testing, Inspection by Evaluators, Questionnaires and other qualitative techniques. On the other hand, some initiatives were more related to the Pedagogical Field. It was also possible to verify a certain overlapping of the scientific production. Many studies make repeated use of standards and methods that are already consolidated. In some way this can contribute to validate the approaches, but it can also become an obstacle innovation.

Moreover, the use of new approaches and techniques is still restricted. The analysis and criteria are still limited to qualitative and already consolidated approaches and quantitative studies are less frequent. The use of automated evaluation processes, based on computational strategies potentially leading to automated—or at least, semi-automated—analysis is still scarce. The criteria used in each study to evaluate the LMS interface were numbered and from this result was possible to identify the authors most frequently adopted by the analyses. Preliminary results point to the frequent use of the

criteria established by Nielsen's studies, followed by the metrics established by the ISO 9242–11. It is possible to verify a more frequent use of Nielsen's heuristics until the mid of the decade, with a higher concentration in the first half of this period, as shown in Table 6. The same is true for the ISO 9241–11 criteria. Interestingly, our data shows that the year 2017 marks a reduction in the presence of these references.

Table 6. Frequency of author by year (2010–2020). Data processed and extracted with Power BI.

Primary Author(s) - PA01	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	Total
Nielsen (1993)	11	30		10		43	14	10	10			128
Nielsen (1994)	7	30				9		10				56
Reeves (2002)	5	15						13				33
ISO 9241-11 (1998)	6		2	3	1		3	17				32
Laugwitz et al. (2008)						6		10		3	6	25
Vasconcelos et. al (2019)										25		25
Mehlenbacher et al. (2005)												23
Gay et. Al (2009)								21				21
Alsumait (2010)							20					20
Squires andPreece (1999)	9	9										18
Wixom and Todd (2005)						17						17
Methakunnawut (1997)							16					16
Shneiderman et al. (2018)			8						8			16
Dringus and Cohen (2005)	13											13
Barker's and King's (1993)	12											12
Constantine and Larry (2011)								12				12
Davis et al. (1989)				2		4		2	3			11
Villiers (2004)												11
Squires (1999)	2	8										10
Total	76	123	4	13	11	89	54	74	13	36	6	499

5 Conclusion

The preliminary results of this Systematic Mapping confirm the significant use of Nielsen's heuristics to evaluate Learning Management Systems (LMS). This situation is especially relevant regarding the early years of the decade (2010–2020). Towards the end of the decade, it is possible to see a specific paradigm change in the research field with the emergence of new authors whose theories were considered as a basis for evaluating LMS interfaces. The study presented here is still under development. However, we expect that it will contribute to finding the most used methodological approaches during the last ten years to evaluate LMS. A systematization of the criteria used by the studies to evaluate LMS is underway and can be a good point for advancing research to improve the quality of interaction in OLE such as LMS. The data used in this research is available at: <https://jc7.co/dgc21>.

Acknowledgments. This study was supported by UNIDCOM under a Grant by the Fundação para a Ciência e Tecnologia (FCT) No. UIDB/DES/00711/2020 attributed to UNIDCOM/IADE – Unidade de Investigação em Design e Comunicação, Lisbon, Portugal.

References

1. Zaharias, P., Koutsabasis, P.: Heuristic evaluation of e-learning courses: a comparative analysis of two e-learning heuristic sets. *Campus-Wide Inf. Syst.* **29**(1), 45–60 (2011). <https://doi.org/10.1108/10650741211192046>
2. Author. Details withheld to preserve blind review (2019)
3. Hassenzahl, M., Law, E., Ebba, H.: User Experience – Towards a unified view. In: UX WS NordiCHI'06: COST294-MAUSE, p. 161 (2006)
4. Takashi Nakamura, W., Harada Teixeira de Oliveira, E., Conte, T.: Usability and user experience evaluation of learning management systems—a systematic mapping study. In: Proceedings of the 19th International Conference on Enterprise Information Systems, pp. 97–108 (2017). <https://doi.org/10.5220/0006363100970108>
5. Hosie, P., Schibeci, R., Backhaus, A.: A framework and checklists for evaluating online learning in higher education. *Assess. Eval. High. Educ.* **30**(5), 539–553 (2005). <https://doi.org/10.1080/02602930500187097>
6. Oztekin, A., Kong, Z.J., Uysal, O.: UseLearn: a novel checklist and usability evaluation method for eLearning systems by criticality metric analysis. *Int. J. Ind. Ergon.* **40**(4), 455–469 (2010). <https://doi.org/10.1016/j.ergon.2010.04.001>
7. Mtebe, J.S., Kissaka, M.M.: Heuristics for evaluating usability of Learning Management Systems in Africa. In: 2015 IST-Africa Conference, pp. 1–13 (2015). <https://doi.org/10.1109/ISTAFRICA.2015.7190521>
8. Cantabella, M., López, B., Caballero, A., Muñoz, A.: Analysis and evaluation of lecturers' activity in Learning Management Systems: subjective and objective perceptions. *Interact. Learn. Environ.* **26**(7), 911–923 (2018). <https://doi.org/10.1080/10494820.2017.1421561>
9. Cota, C.X.N., Díaz, A.I.M., Duque, M.Á.R.: Evaluation framework for m-learning systems: Current situation and proposal. In: Proceedings of the XV International Conference on Human Computer Interaction - Interacción '14, pp. 1–3 (2014). <https://doi.org/10.1145/2662253.2662265>
10. Freire, L.L., Arezes, P.M., Campos, J.C.: A literature review about usability evaluation methods for e-learning platforms. *Work* **41**, 1038–1044 (2012). <https://doi.org/10.3233/WOR-2012-0281-1038>
11. Navarro, C.X., Molina, A.I., Redondo, M.A., Juarez-Ramirez, R.: Framework to evaluate m-learning systems: a technological and pedagogical approach. *IEEE Revista Iberoamericana de Tecnologías Del Aprendizaje* **11**(1), 33–40 (2016). <https://doi.org/10.1109/RITA.2016.2518459>
12. Kitchenham, B., Charters, S.: Guidelines for performing Systematic Literature Reviews in Software Engineering, p. 65. University of Durham (2007)
13. Basili, V.R., Rombach, H.D.: The TAME project: towards improvement-oriented software environments. *IEEE Trans. Softw. Eng.* **14**(6), 758–773 (1988). <https://doi.org/10.1109/32.6156>
14. Kitchenham, B., Pearl Brereton, O., Budgen, D., Turner, M., Bailey, J., Linkman, S.: Systematic literature reviews in software engineering – a systematic literature review. *Inf. Softw. Technol.* **51**(1), 7–15 (2009). <https://doi.org/10.1016/j.infsof.2008.09.009>
15. Pireva, K., Imran, A.S., Dalipi, F.: User behaviour analysis on LMS and MOOC. In: 2015 IEEE Conference on E-Learning, e-Management and e-Services (IC3e), pp. 21–26 (2015). <https://doi.org/10.1109/IC3e.2015.7403480>
16. Fernandez, A., Insfran, E., Abrahão, S.: Usability evaluation methods for the web: a systematic mapping study. *Inf. Softw. Technol.* **53**(8), 789–817 (2011). <https://doi.org/10.1016/j.infsof.2011.02.007>



A Checklist Proposal to Evaluate the Quality of University Websites

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Abstract. Currently, internet is the most wanted medium of communication and most used by people or entities. Unquestionably, it has transformed significantly consumer behaviour, namely in the access to information or in the way a product or service is purchased.

In this context, the evaluation of the effectiveness of websites has increased over time, following the evolution of the concepts of Human Machine Interface, Usability and User Experience Design.

In the context of the methods and processes of usability evaluation, different proposals have been developed, from direct observation, to interviews and questionnaires, among other techniques and tools.

Thus, this article is based on a case study of descriptive type, based on the literature review concerning the models of evaluation of the quality of websites.

The results of the article consist in the definition of a set of parameters to analyse the quality of the interface of websites and in the proposal of a checklist concerning content, aesthetics and navigation.

Keywords: Website interface · University websites · Usability · Website evaluation Checklist

1 Study Framework

From the 1990s onwards there was a progressive increase in the number of personal computers, hardware, use of the internet and the expansion of websites [1]. Consequently, the progressive increase and the daily use of websites have created the need to define criteria to evaluate their quality in order to ensure its usefulness, financial return and good user experience [2].

In this context, an organisation whose website is difficult to use, or which is aesthetically inadequate leaves a negative impact among its audience, compromising its market positioning [3]. Therefore, the website design has quality requirements [4].

Among the website quality requirements there is the content adequacy to the audience profile, for example, in financial websites users value the updating, accuracy and sources of information [4].

When we refer to content, we include texts, images, visuals, tables and videos, but also the aesthetic options considered in their conception, design development on the website.

With regard to navigation and user experience, particular consideration is given to the ease of access to information and the interface effectiveness to promote enjoyment and satisfaction while performing user's tasks, to which contribute content, aesthetic factors, information levels (and number of clicks) as the information architecture (from page layout to the hyperlinks map) [5].

Given the need to evaluate websites, during their design, development and after their implementation, several models have been proposed, many of those presenting similarities, but their cross-referencing and comparative study is still lacking [6].

In the context of the pandemic caused by COVID-19, during 2020 and 2021, the digitalisation of businesses associated with the provision of services at a distance has accelerated, giving new emphasis to websites and social networks.

Thus, this study seeks to answer the following research question:

How to create a robust checklist to evaluate the quality of a website with users or empirically by the designer or developer?

And for reasons of objectivity and rigour, we defined the following objectives:

- To analyse and compare the main existing models, conceived to evaluate websites usability;
- To define a set of criteria and indicators, using those more relevant and indicative about the quality and effectiveness of the usability of education websites.

In order to answer the research question the following hypothesis was presented:

The study and comparison of existing models of websites usability evaluation allows the identification of common denominators and the most relevant criteria and indicators, supports the creation of a robust checklist which allows the evaluation of the quality of a website with users or empirically by the designer or developer.

To test our hypothesis, we selected a descriptive case study methodology, based on the literature review specific to the research topic.

2 Descriptive Case Study Based on Literature Review

We tried to be exhaustive in the selection of the models of quality evaluation of websites, following a chronological order from the literature review.

Considered as a pioneer model in the evaluation of software quality, as product or as service [5], the proposal by McCall & B. Boehm, mid 1970s, passed the ISO (Inter-national Organisation for Standardization) standard No. 9126–1 in 1991, revised in 2001. The quality evaluation criteria of this ISO 9126 standard are: functionality, usability, efficiency, reliability, maintainability and portability.

The ServQual model, proposed by Zeithaml et al. [7] evaluates service quality from the user's perspective, comparing their expectations with the system's performance and services through 5 dimensions: tangibility, reliability, responsiveness, assurance and empathy. From the perspective of this model, website users are consumers of information, products or services, and it is essential to understand their expectations and satisfaction during access [8].

Nielsen [9] argues the need for usability tests in the quality evaluation of websites, stating that the evaluation cannot be done only with technical knowledge, but the user must be included in the design and development process to prevent incorrect or unexpected interpretations that compromise the use. According to Nielsen [9] usability is not just an evaluation concept, it can be identified through a set of criteria which it has designated as Usability Heuristics: dialogic communication, speaking the user's language, recall, consistency and standards, feed-back, clear marking of output (ease of cancelling a task or undoing an action), shortcuts, good error messages and error prevention, help and supporting documentation).

The WebQual model of Loiacono et al. [10] proposed to evaluate the quality of websites for online commerce, rejecting subjective or social factors and focusing on user perception and the number of return visits to the website. They recommend defining the specific parameters that impact on the perceived ease of use and perceived usefulness, deepening the Technology Acceptance Model (TAM). In this way, the WebQual proposal is organised into 4 constructs: ease of use, usefulness, entertainment and the complementary relationship; proceeding to the evaluation through a questionnaire based on the 4 constructs and on 12 dimensions of the method.

In the same sense, the SiteQual proposal also focused on evaluating the quality of online commerce websites, measuring 4 dimensions: ease of use, processing speed, aesthetic design and interactive responsiveness [11].

In the case of Zhang & Dran [8], these defined a theoretical evaluation framework based on user satisfaction by applying the Kano Model which, unlike the ServQual model, stated that consumer expectations change over time and with the continuity of use of the product or service. From this study resulted the checklist composed of 74 items to be adapted and adjusted to each website.

Olsina & Rossi [12], created the Website Quality Evaluation Methodology called WebQEM (Website Quality Evaluation Methodology), evaluates the quality of systems through the individual evaluation of each website, to later establish a comparison between them. Olsina & Rossi [13], have defined a quality requirements artefact with more than 100 characteristics, which should be adapted according to the website domain, providing a descriptive structure to specify the quality characteristics. The definition and

specification of the quality requirements is based on the ISO 9126 standard. WebQEM distinguishes 3 types of users: the visitor, the developer and the manager. The characteristics have associated weights and their aggregation should be determined according to the type of user.

Generally speaking, the proposals to evaluate the quality of websites are organised into those that define universal criteria and those that should be adapted according to each case: public administration, cultural websites, commercial websites, medical information websites, educational websites. Despite the differences, they share many characteristics, parameters and criteria [6] and there is greater consensus in valuing the possibility of adapting the criteria to the type of website, establishing a relationship nature of the content-interface-user profile [4]. In summary, for the user, the same features have different levels of importance depending on the theme and type of website [8].

With regard to content, it is associated with the reliability and legitimacy of the information [14, 15] and its credibility, so it must be correct, insofar as it impacts directly on the reputation [2]. The quality of the information conditions the perception of the website also through the information architecture [4] and as such should always be up to date, indicating dates and sources, avoiding pages under construction [4, 16]. In addition, the language should be adapted [7] and language [1] to the type of user and there should be no spelling mistakes [10].

In a few words, the content should be evaluated autonomously according to: the quality of updating, quality of content, adequacy of the website content to the type of user and for its credibility and indication of sources.

At the aesthetic level, the information is observed from the design perspective and should be defined according to the user, in terms of usefulness, accessibility and fruition, and a display should be chosen which does not raise doubts or frustrations, as it is essential that the experience is positive [16].

The Design Dimension refers to the interface, visual appearance and aesthetic options of the website that impact on user satisfaction and enjoyment, facilitating use and encouraging return [17, 18]. The design should help the user in terms of navigation, establishing a visual (layout, typography, colours, graphics, etc.) and semantic relationship between pages and ensuring good orientation at all times [19].

The visual language should be adequate to the website nature, to the entity that owns it and to the user profile, valuing clarity and objectivity, legibility and readability [20], although there are context-dependent exceptions. In general, the interface should make use of affordances and have a friendly display capable of generating empathy, satisfaction or emotional attachment [10, 21].

The layout should be simple, structured, oriented and responsive [2], avoiding mistakes, delays and frustration of the user in performing tasks [18, 22, 23].

In terms of navigation, the characteristics that support the enjoyment and intuitive access to the different areas and levels of information are assessed in the shortest possible time and fewest possible steps [19, 24, 25]. Navigation correlates aspects of information architecture with the interface, namely the aesthetic options where the contents are included, associating with usability, that is, the ease of use and understanding to operate and navigate the website [3].

Equally to all the criteria already mentioned, usability is focused on facilitating the use of the website, that is, it is intended that the user has a positive experience proposing him/her the emotional satisfaction of performing the intended tasks [1, 16, 26, 27]. Usability is an essential factor to ensure the user's permanence on the website, being one of the demotivating factors [15].

3 Proposed Criteria for a Checklist for Evaluating University Websites

Thus, considering the principles, criteria and indicators of the models studied, it was sought to define a checklist with the common denominators suitable for the evaluation of university websites.

Thus, in order to be able to compare the studied models and point out the source of the indicators in our checklist, the previous proposals were coded as follows:

- Heuristics of Nielsen [1] – M1;
- WebQEM [12] – M2;
- Zhang & Dran, [8] – M3;
- SiteQUAL [11] – M4;
- WebQUAL [10] – M5.
- Signore [2] – M6.
- Hasan & Abuelrub [28] – M7.
- Islam [4] – M8 (Table 1).

Table 1. Proposed checklist for evaluating the usability of university websites

Indicators of the content criterion		
Indicators	Checklist	Evaluation Models
Update	1. <i>Updated website</i>	M1 M2 M5 M7 M8
	2. <i>Website frequently updated</i>	M7
	3. <i>Date of last update</i>	M3 M4 M7
Accuracy	4. <i>The information meets the user's needs</i>	M3 M5 M8
	5. <i>Precise and objective information</i>	M3 M5
	6. <i>Logically organised content</i>	M2 M3 M6 M7 M8
	7. <i>Easy access to information</i>	M7
	8. <i>User-friendly language</i>	M1 M3 M6 M8
	9. <i>No spelling/grammar mistakes</i>	M6 M7
	10. <i>Appropriateness of the content to the values of the organisation</i>	M3 M5 M6 M7

(continued)

Table 1. (continued)

Indicators of the content criterion		
Indicators	Checklist	Evaluation Models
Credibility	11. <i>Identification of the entity</i>	<i>M2 M3</i>
	12. <i>Physical address</i>	<i>M2 M3 M7</i>
	13. <i>Contact details (telephone, email)</i>	<i>M2 M5 M7</i>
	14. <i>Webmaster contact</i>	<i>M3 M5 M6 M8</i>
	15. <i>Privacy and Cookies Policy</i>	
	16. <i>Source-identified information</i>	<i>M3 M6 M7</i>
	17. <i>Reputation of the website entity</i>	<i>M3 M5 M7</i>
	18. <i>Security of personal and financial information</i>	<i>M2 M4 M5 M6</i>
19. Design criteria indicators		
Indicators	Checklist	Evaluation Models
Suitability	20. <i>Brand mark legibility</i>	<i>M3 M7</i>
	21. <i>Design according to the domain type</i>	<i>M2 M3 M7 M8</i>
	22. <i>Proper image for the organisation</i>	<i>M3 M5 M7</i>
Layout	23. <i>Attractive and innovative design</i>	<i>M5 M6 M7 M8</i>
	24. <i>Design simplicity</i>	<i>M1 M5 M6</i>
	25. <i>Emotional appeal</i>	<i>M3 M5 M7</i>
	26. <i>Blank/empty space</i>	<i>M7</i>
	27. <i>Visual hierarchy is defined</i>	<i>M1 M2 M6 M7</i>
	28. <i>Consistency/visual correlation</i>	<i>M2 M5 M6 M7 M8</i>
Colors	29. <i>Clear background colour</i>	<i>M2 M5 M7</i>
	30. <i>Readable text colour</i>	<i>M6 M7</i>
	31. <i>Moderate use of colour</i>	<i>M6 M7 M8</i>
	32. <i>Contrast in graphics/images</i>	<i>M4 M6</i>
Texts	33. <i>Architecture of information</i>	<i>M6 M7</i>
	34. <i>Readable and detachable titles</i>	<i>M3 M5 M6 M7</i>
	35. <i>Space between lines</i>	<i>M6</i>
	36. <i>Maximum three types of sources</i>	<i>M5 M6</i>
	37. <i>Type of font readable/legibility</i>	<i>M2 M6 M7 M8</i>
	38. <i>Font size</i>	<i>M6 M7</i>

(continued)

Table 1. (continued)

Indicators of the content criterion		
Indicators	Checklist	Evaluation Models
Multimedia	39. Number of elements per page	M2 M3 M5 M6 M7
	40. Elements labelled by text	M3 M4 M6
	41. Suitable size/quality	M6 M7
	42. Different media (video, image, text)	M6 M7
<i>Indicators for the navigation criterion</i>		
Indicators	Checklist	Evaluation Models
Links	43. Error-free links	M2 M3 M6 M8
	44. Shortcuts (back, previous, top)	M1 M2 M3 M6 M7 M8
	45. Useful links	M1 M2 M6 M7 M8
	46. Highlighted in visited links	M2 M7 M8
	47. Matching links to content	M2
	48. Memorable links	M2 M6 M8
Mapping	49. Site map/Index page	M2 M3 M6 M7
	50. Constant access to homepage	M1 M2 M6
	51. Current page indication	M2 M6 M7 M8
	52. Link Path at the top of the page	.2
Usability	53. Ease of use, understanding, performance, finding	M1 M3 M4 M5 M6 M7
	54. Main menu on every page	M2 M6
	55. URL appropriate and easy to remember	M1 M7
	56. Rapid response capability	M1 M4 M5 M7
	57. Works in all browsers	M2 M3
	58. Indication of system charging time/response time	M1 M3 M5 M7
	59. Responsive/Adjustable	M6
	60. Website is always available (efficient)	M3 M8
	61. Clear help message in case of error	M1 M8
	62. Help function (support texts)	M1 M8
	63. No Advertisements	M8

(continued)

Table 1. (continued)

Indicators of the content criterion		
Indicators	Checklist	Evaluation Models
Interactivity	64. <i>Intuitive navigation</i>	M1 M2 M6 M7 M8
	65. <i>Search customisation</i>	M2 M3 M4 M5 M7
	66. <i>Efficient internal search tool</i>	M3 M5 M7
	67. <i>Frequently asked questions (FAQ's)</i>	M2 M5 M7
	68. <i>Information/help contact</i>	M2 M5 M7
	69. <i>Contact form</i>	M2 M7
	70. <i>Online Chat</i>	M5 M7
	71. <i>Links to social networks</i>	M5
	72. <i>Newsletter</i>	M2
	73. <i>Downloadability</i>	M2
	74. <i>Information Sharing</i>	M2
	75. <i>Special needs</i>	M2 M5
	76. <i>Online transactions</i>	M2 M4 M5 M7 M8
<i>Indicators of the educational criterion</i>		
Indicators	Checklist	Evaluation Models
Institutional information	77. <i>Institutional identification</i>	
	78. <i>Institutional History</i>	
	79. <i>Mission/objectives</i>	
	80. <i>Photographs</i>	
	81. <i>Organisation chart</i>	
Key Information	82. <i>Entry Requirement</i>	M2
	83. <i>Fee information</i>	M2
	84. <i>Online enrolment</i>	M8 M2
	85. <i>Training offer</i>	M8 M2
	86. <i>Course syllabuses</i>	M8 M2
	87. <i>Scheduling/Booking a visit</i>	M2

(continued)

Table 1. (continued)

Indicators of the content criterion		
Indicators	Checklist	Evaluation Models
	88. <i>Staff information</i>	<i>M8 M2</i>
	89. <i>Student work</i>	<i>M2</i>
	90. <i>Testimonials from students and former students</i>	<i>M2</i>
	91. <i>Contacts</i>	<i>M2</i>
	92. <i>Employability/Entrepreneurship</i>	
	93. <i>Internationalisation</i>	
	94. <i>Research</i>	
Support for students	95. <i>Health services</i>	<i>M2</i>
	96. <i>Scholarship</i>	<i>M2</i>
	97. <i>Housing</i>	<i>M2</i>
	98. <i>Culture/sport</i>	<i>M2</i>
	99. <i>Academic Association</i>	<i>M2</i>
Conditions and Infrastructure	100. <i>Photos of the conditions and infrastructure</i>	<i>M2</i>
	101. <i>Library</i>	<i>M2</i>
	102. <i>Computer rooms</i>	<i>M2</i>
	103. <i>Laboratories</i>	<i>M2</i>
Multilingual/Multicultural	104. <i>Bilingual</i>	<i>M2</i>
	105. <i>Multicultural</i>	<i>M2</i>
	106. <i>Impartial information</i>	<i>M2</i>
	107. <i>Absence of prejudice and gender or ethnic stereotypes</i>	<i>M2</i>
	108. <i>Internationalisation</i>	
Other Information	109. <i>News</i>	<i>M2</i>
	110. <i>Events</i>	<i>M2</i>

An empirical analysis of the websites was carried out from the designer/developer's perspective [29, 30], allowing the effectiveness of the checklist to assess the following dimensions: content quality, design quality, navigation quality and educational quality.

The criteria and the checklist were tested using a convenience sample of four websites of Portuguese universities (two) and polytechnics (two), one US university website and another from the UK, considering their common characteristics, making it possible to identify other quality indicators that did not exist in the proposals studied.

4 Conclusions

The investigative process allowed the study of the main models of quality assessment of websites. The literature review allowed the study and detailed description of each proposal and allowed the data analysis and comparison.

The literature review permitted the study of the selected models, resulting in a deepening of knowledge, which the limits of this article do not allow us to detail.

Finding the common denominators, as a result of the comparison between models of website quality evaluation, it was possible to define a set of criteria and indicators that constitute a checklist proposal for the evaluation of university websites.

We chose to delimit the checklist to university websites in order to adjust the criteria and indicators to the nature of the contents, scope of interfaces and profile of the target user. So far, the data indicates that the checklist allows diagnosing the absence and quality of written data and information, the reliability of data, the information architecture, the fruition of the interface at the level of layout and Affordances, the different content typology and quality, the complexity of graphics as well as the alignment with the visual identity.

The study and comparison of existing models allows us to identify common denominators and extrapolate them, namely from the literature review and direct observation. However, we acknowledge that the limits of the validation of our checklist lie in the fact that it was not used in a user survey, which we intend to carry out in future studies. In this sense, we consider that our hypothesis was partially validated.

On the other hand, the size of our sample prevents the results from being generalisable, pointing to the need for more data at the validation level.

References

1. Nielsen, J.: Usability Engineering. Academic Press, New York (1993)
2. Signore, O.: A comprehensive model for web sites quality. In: Proceedings of the Seventh IEEE International Symposium on Web Site Evolution (WSE'05) (2005)
3. Barnes, S., Vidgen, R.: An integrative approach to the assessment of e-commerce quality. *J. Electr. Commerce Res.* **3**(3), 114–127 (2002)
4. Islam, A.: Evaluation of usage of university websites in Bangladesh. *DESIDOC J. Libr. Inf. Technol.* **31**(6), 469–479 (2011)
5. Anusha, R.: A study on website quality models. *Int. J. Sci. Res. Publ.* **4**(12), 1–5 (2014)
6. Biscoglio I.: Quality models for websites: theories and criteria of evaluation (2005)
7. Parasuraman, A., Zeithaml, V.A., Berry, L.L.: SERVQUAL: a multiple-item scale for measuring consumer perceptions of service quality. *J. Retail.* **64**(1), 12 (1988)

8. Zhang, P., Dran, G.: Expectations and ranking of website quality features: results of two studies on user perceptions. In: Proceedings of the 34th Hawaii International Conference on System Sciences (2001)
9. Nielsen, J.: User interface directions for the web. *Commun. ACM* **42**(1), 65–72 (1999)
10. Loiacono, E., Watson, R., Goodhue, D.: Webqual: a measure of site quality. *Am. Mark. Assoc.* **13**, 432–438 (2002)
11. Yoo, B., Donthu, N.: Developing a scale to measure the perceived quality of an internet shopping site (SITEQUAL). *Q. J. Electron. Commer.* **2**(1), 31–47 (2001)
12. Olsina, L., Rossi, G.: Toward web-site quantitative evaluation: defining quality characteristics and attributes. In: Presented at the WebNet World Conference on the WWW and Internet (WEBNET), Honolulu, Hawaii (1999)
13. Olsina, L., Rossi, G.: Measuring web application quality with WebQEM. *IEEE Multimedia* **9**, 20–29 (2002)
14. Bantjes, L., Cronje, J.C.: An analysis of criteria for the evaluation of educational web sites. *South Afr. J. High. Educ.* **14**(1), 21–129 (2000)
15. Kent, M., Taylor, M.: Building dialogic relationships through the world wide web. *Public Relat. Rev.* **24**(3), 321–334 (1998)
16. Banati, H., Bedi, P., Grover, P.: Evaluating web usability from the user perspective. *J. Comput. Sci.* **2**(4), 314–317 (2006)
17. Hasan, L., Abuelrub, E.: Criteria for evaluating quality of websites. *Manag. Inf. Dig. Econ. Issues Solut.* **233** (2006)
18. Sutcliffe, A.: Visual design principles for usable interfaces everything is designed: why we should think before doing. In: Jacko, J.A. (ed.) *The Human-Computer Interaction Handbook: Fundamentals, Evolving Technologies, and Emerging Applications*, 3rd edn., pp. 387–403. CRC Press (2012)
19. Hasan, L.: Evaluating the usability of educational websites based on students' preferences of design characteristics. *Int. Arab J. e-Technol.* **3**(3), 179–193 (2014)
20. Symonds, J., Procter, C.: Designing for web site usability. *AJIS* **9**(1), 92–101 (2001)
21. Liu, C., Arnett, K.: Exploring the factors associated with web site success in the context of electronic commerce. *Inf. Manag.* **38**, 23–33 (2000)
22. Lautenbach, M., Schegget, I., Schoute, A., Witteman L.: Evaluating the usability of web pages: a case study. *Artif. Intell. Preprint Ser.* **11** (1999)
23. Marques, T.: Portugal gestual: a importância do utilizador na criação da interface. In: *Convergências - Revista de Investigação e Ensino das Artes*, vol. VIII, no. 15 (2015). <http://convergencias.esart.ipcb.pt>
24. Martins, N., Pires, F., Brandão, D.: The graphic interface design of the ALU13 online store. In: Martins, N., Brandão, D., Raposo, D. (eds.) *Perspectives on Design and Digital Communication: Research, Innovations and Best Practices*, pp. 49–64. Springer International Publishing, Cham (2021). https://doi.org/10.1007/978-3-030-49647-0_4
25. Costa, M., Amaral, I.: Communication design and space narratives. In: Raposo, D., Neves, J., Silva, J. (eds.) *Perspective on Design: Research, Education and Practice*, pp. 103–113. Springer International Publishing, Cham (2020). https://doi.org/10.1007/978-3-030-32415-5_8
26. Martins, N., Brandão, D., Alvelos, H., Silva, S.: E-Marketplace as a tool for the revitalization of Portuguese Craft Industry: the design process in the development of an online platform. *Fut. Internet* **12**(11), 195 (2020). <https://doi.org/10.3390/fi12110195>
27. Kirakowski, J.: *Questionnaire in Usability Engineering: A List of Frequently Asked Questions*, 3rd edn. Human Factors Research Group, Ireland (2000)
28. Hasan, L., Abuelrub, E.: Assessing the quality of web sites. *Appl. Comput. Inf.* **9**, 11–29 (2010)

29. Brandão, D., Martins, N., Alvelos, H.: The museum of all: institutional communication practices in a participatory networked world. *Des. J.* **15**(2), 203–217 (2012). ISSN: 1460–6925, <https://doi.org/10.2752/175630612X13258652805130>
30. Rijo, C., Sanches, M.C., Franceschi, R.: Integrating the syntactic and semantic dimensions in packaging design projects. In: Rebelo, F. (ed.) AHFE 2021. LNNS, vol. 261, pp. 932–939. Springer, Cham (2021). https://doi.org/10.1007/978-3-030-79760-7_111



Non-linear Storytelling Applied to Data-Driven Web Design

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Abstract. The growing climate problem has been exacerbating the importance of appropriate sustainable solutions, as well as the need for information and the sharing of scientific knowledge with the public, so as to develop a shared ecological conscience. Design is, therefore, a relevant tool in the creation of spaces and visual identities suitable for the sharing and promotion of sustainable messages, products or services.

The exercise at hand aims at the exploration of reactive storytelling in the context of education in the field of eco-efficient architecture. Our work is to be applied to the website of Lugar-Zero, a company that focuses on this exact area of study. Therefore, a visual representation of the company's core values through these same techniques of storytelling is also a relevant aspect to this paper.

Keywords: Data-driven web design · Non-linear storytelling · Identity · Sustainability

1 Introduction

In recent years, the internet has swiftly become one of the main public spaces for the communication of brand identities, allowing proximity between its services or products and its target audience, through social media, client reviews, or even the classic company website (Biloslavo and Trnavhević 2009: 1165; Paun 2020; Wheeler 2017: 152).

For example, in 2019, it was estimated that, at each minute, around 3.8 million Google searches lead to results related to local businesses, highlighting the overwhelming connection between a digital presence and a brand's public recognition (Paun 2020). This same idea is congruent with the model introduced by Ha and Perks (2005: 444), stressing the positive reinforcement loop established between the web brand experience, and its client familiarity, satisfaction, and trust. However, it is relevant to understand that the web, in its origins, was not developed as a commercial space but, instead, with the aim of establishing connections and relationships between people and contents. An exaggerated and overt corporate presence may, in fact, have the opposite effect to the one desired, trivializing the brand's services and creating an intrusive, negative perception of the company (Fournier and Avery 2010: 2). Through this same line of thinking, going back to the ideas of community and correlation introduced, we can also understand

how the initially crafted experience of the web can fit as an effective conductor for Schank and Abelson's (1995: 1) view of storytelling as shared human knowledge, capable of representing the evolution of human communication, always interconnected with technological development (Jorgenson 2016; Peters 2018). This paper aims at exploring this exact intersection between the inherit adaptable and storytelling-friendly potential of the web, along with a mindful use of this same space as a ground for brand promotion and recognition.

The presented work is a website¹ for the company Lugar-Zero, whose projects are centered around the themes of sustainable and eco-efficient architecture. With a focus on technological development and with strong ties to scientific investigation, the company's action underlines a critical respect for the pre-existence of the natural and historical context of each area, as well as an awareness for the different needs of a house throughout the many hours of the day and seasons of the year.

With this in mind, the proposed design solution makes use of the user's location and hour of visit to the website, in order to develop reactive illustrations, capable of accompanying the complex themes and concepts that are used as the foundations for the work of the company. In this way, it is possible to present not only the core values of an idea through an understated reactive interface storytelling, but to also use the web in a way that is compatible with its root intent, to share knowledge.

In the following sections, there will be a focus on the related work that served as a basis for this paper, as well as on the process of development, with a description of the multiple steps for the implementation and validation of the website.

2 Related Work

The work at hand centers itself around the topic of reactive storytelling. This gathers two main fields of study, web design, along with its methods of interaction and evaluation, and data-driven digital storytelling, that takes from both the world of multimedia and classic narratives.

2.1 Accessibility in Corporate Web Design

Research like Wheeler's (2017:152) and Krug's (2006:17) has been made regarding the needs of a user during the process of interaction with a website interface, putting a spotlight on the need to eliminate potential questions and facilitate effective visual communication in these spaces.

An accessible structure aids, not only with predicting user difficulties, but it smoothens the process of content learning, on their part, allowing for information to be found without detailed analysis of the website's elements (Flavián et al. 2009: 20; Krug 2006: 22–24). There is also something to be said regarding the quality of this information, design and interactivity, within a framework of e-commerce and corporate web (Liu and Arnett 2000: 29), as other commercial alternatives become more promising when the content that is looked for is inaccessible on one specific platform, taking into

¹ The website can currently be accessed through the link: <https://lugar-zero.dei.uc.pt/inicio>.

account the growing multiplicity of options out there for a service or product (Nielsen 2012).

Nielsen's work on usability also becomes relevant, focusing on the attributes capable of identifying methods for implementation and evaluation of the main characteristics of interaction within an interface. These methods range from efficiency to error detection and prevention, providing important tools at the designer's disposal.

2.2 Data-Driven Storytelling

Storytelling proves to be an effective way to pass information along and to connect different facts, in a way that feels memorable and easy to understand (Gershon and Page 2001:31; Kosara and Mackinlay 2013:44–45). When placed in an online setting (digital storytelling) these narratives may take on different media as a way to propagate knowledge, ranging from images to audio, video, text, or information visualization. The former is typically used to inform and illustrate scientific or more complex data (Gershon and Page 2001:33). Still, they are characterized by a structure of beginning, middle and end, be it within a linear, non-linear or a mixed anatomy (Robin 2006: 709; Seyser and Zeiller 2018: 401; Kosara and Mackinlay 2013:44; Segel and Heer 2010: 1139–1140).

The concepts of multimedia and memorability may be presented as going hand in hand. As studies show, the usage of different media in the context of learning may allow for a better cognitive parsing of information and comprehension of complex data (Kosara and Mackinlay 2013:44–45; Robin 2006: 711; Seyser and Zeiller 2018: 401). Journalism, for example, makes use of these exact benefits to tell interactive data-driven and long-form stories, capable of regularly challenging the traditional aesthetics of information in publications like the New York Times (Segel and Heer 2010: 1139; Setlur and Mackinlay 2014: 401; Seyser and Zeiller 2018: 401; Lupi 2012:1).

In the context of our work a slideshow metaphor, as described by Kosara and Mackinlay (2013:47), was used. This approach is meant to guide the reader through multiple concepts, while creating an idea of stability and consistency within the visual representations used. This structure also aligns with Segel and Heel's focus on animation transitions and framing as tools to constantly direct and sustain the focus of the user, without disorientation. Additionally, these transitions are controlled by scrolling. Following an illustration centric approach with the aid of text blocks, this method creates a distancing of our approach from the recurring text-centered scrollytelling, identified by Setlur and Mackinlay (2014:401). Elements like a progress bar, for example, that allow for the user to determine the pace of the website, also helped structuring the visual narrative (Segel and Heer 2010: 1140–1141).

Last, but not least, unlike with classic web design, where there are standard methodologies to validate the quality of a website, there are no clear ways to evaluate the effectiveness of online storytelling. In this case, it is not only relevant to study the accuracy and efficiency of the web design that imprints it with context, but it is also important to understand the semantic and emotional connections established by the audience as it engages with the story, remembers highlights and gathers information for potential decision making (Kosara and Mackinlay 2013:48–49).

3 Concept

As a company, Lugar-Zero focuses on developing sustainable and eco-efficient structures and solutions within the world of architecture. The issue is that the concepts surrounding this field of study tend to get fairly complex and inaccessible to the average person, making the company itself feel distant from its target audience. In this case, it becomes relevant to highlight the value of sharing knowledge and information clearly with a client. This would allow for more confidence and power to be instilled in them in the decision-making process. In the context of Lugar-Zero, such power would be facilitated by the company's strong ties to investigation in its field. With all this in mind, we defined that the proposal for the company's website should incorporate not only some institutional characteristics, but also allow for this clarification of key concepts related to Lugar-Zero's foundational principles and activities, which was made possible through the use of storytelling.

One aspect that stood out, while consulting with the company, was the importance given to a construction's ability to adapt, be it through the seasons or the position of the sun. Both of these elements became, then, the driving forces behind the concept for the brand's image. It is clear that a dynamic and reactive approach to the development of the website would not only make it stand out from what could be perceived as conventional, but also visually highlight the company's values and practices as they are being deconstructed through storytelling.

That said, the proposed illustration-centered website aims at showcasing this adaptability and the resilience of eco-efficient constructions through the use of color. The rationale behind this idea is the following: the color scheme is swapped as the seasons change, remaining static only the parts that illustrate the interior of the houses implying its feeling of stability. Additionally, the time of day impacts the shading of the objects represented in the illustrations. It is important to note that the seasons represented throughout the project are limited to the four-season model, despite there being many other perceptions and experiences of seasons around the globe (something that is highlighted on the website's initial welcoming message).

4 Storytelling and GUI

The process to develop the website centered storytelling within the frameworks of interaction design. This choice led to multiple iterations of the story itself, including the addition of a non-linear structure and the proper mechanisms to aid through its navigation.

The React.js library was used in order to facilitate this particular construction of the story. The React.js is a library written in JavaScript that allows construction of graphical user interfaces based on the concept of module, where each component (e.g., button, text area) is treated independently. This allowed us to associate each chapter of the non-linear narrative to a React module, each of them called upon a button click. Along with this library, skrollr.js and Bootstrap, were also used for the visual structuring of the different website's elements and animations. This section details our approach for construction of non-linear narrative, beginning with script analysis to the particularities of navigation.

4.1 Storytelling Breakdown

The storytelling breakdown corresponds to a moment of analysis of the script for the website. The script is submitted by the company and provides a way to a series of iterations around prototypes for the website's layout. It also provides descriptions of the illustrations that should go along with each paragraph of the text. Finally, the script allows an initial exploration regarding the reactive behaviors of these same illustrations, which, again, change with seasons and time. Also, it is important to mention that breaking down the script allowed us to derive the concept for the grid that is used as a basis for illustrations, and series of icons, which are going to be detailed in Sect. 5.

While analyzing the script, it became clear that a fully reactive narrative would not be possible. This is justified by the complexity of changes within a sustainable house, throughout time. A dense visual representation of these houses' abilities to adapt to the weather and sun exposure would detract from the main goal of highlighting the stability they provided. However, from this analysis, there surfaced an understanding that different users would have different needs for complexity within the story and, as consequence, showcase special interest in different chapters. The script developed to acknowledge this by creating separate narratives for different types of users.

4.2 Non-linear Construction

The story at hand was divided into four different chapters: Introdução, Vantagens, Mitos and Condições, which can be translated to English as “Introduction”, “Advantages”, “Myths”, and “Conditions”, respectively. The first, an introduction to the story, the second and third, the debunking of some advantages and misconceptions associated with the construction of eco-efficient buildings, and the last one aimed at users with a higher level of expertise on the matter.

With the knowledge that the website's target audience can range from casual sustainability enthusiasts to builders and architects working in the field, it was important for its structure to accommodate these different needs. This way, the user may choose not only the chapters they are interested in, but also the order in which they want to access them, allowing for each person to craft their own path through the story and avoid information that isn't of interest to them.

4.3 Navigation

While the website in question contains different institutional pages aimed at introducing the company and its portfolio, the storytelling aspect of it, upon which this paper revolves around, is presented in one single page divided in sections, corresponding to each chapter of the story. In this way, the user explores the “Introdução” section of the website by scrolling vertically and, at the end of this chapter, they are presented with three different buttons each offering the possibility to open up a new section of the text.

As the user clicks on their preferred portions of the story, and taking the order of the clicks into account, a vertical side menu is updated showcasing the clicked-on chapters. This navigation menu also functions as an indicator of the scroll progress within the currently selected section. Besides indicating the open chapters and their

state, these buttons also allow for the user to travel between sections of the website, avoiding unnecessary scrolling. Last, but not least, the grid upon which the illustrations and typography were created is also used to accent this vertical side menu, in a visually folder-like system, as presented in Fig. 1.

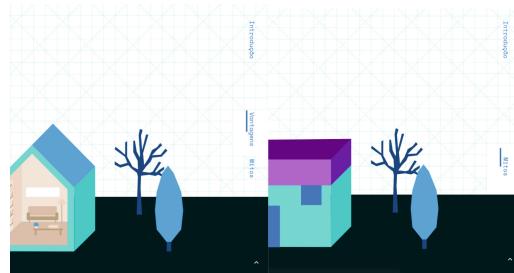


Fig. 1. Two different vertical side menu settings depending on the opened chapter

5 Reactive Illustrations

With an image-centered website in mind, there was a large focus on developing illustrations capable of holding both the technological associations of Lugar-Zero and the need for an eco-efficient house to react to the changing seasons and sunlight. For this to be possible, a set of SVGs were developed in Illustrator, based on a static grid. Afterwards, these were integrated into the website, with the help of the d3.js library. This section details conceptual, as well as technical, aspects of this process.

5.1 Grid System

Having an idea in mind concerning what elements were needed for the website's storytelling, the first task centered around developing a grid system capable of accommodating both the illustrations and typeface for the brand.

With a previously stated interest in the International Typographic Style, from Lugar-Zero's part, and a focus on the relevance of technological structure for the company's activity, a square isometric grid was developed to be used on the website. This served as a basis for the brand's typography and an initial set of icons, as shown in Fig. 2. This grid is also crucial for the website's layout as it is used to indicate the page and section of the text the user is in (Fig. 3).



Fig. 2. Grid applied to the typography developed for the website and brand identity

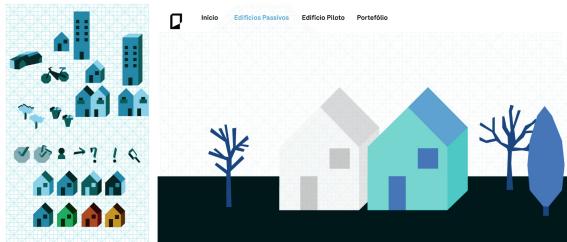


Fig. 3. Grid applied to an initial set of icons, on the left, and on the website layout, on the right

5.2 Color Scheme

The color scheme of the illustrations for this work was of particular importance as it was the only element, besides the changing leaves of the trees, to showcase the variables the website was reactive to, which again are the season and the time of day.

Through multiple iterations revolving around a clear differentiation between the colors of Autumn and Summer, which tend to both lean towards warmer tones, there was a focus on selecting a semantically resonant set of colors for each season, so as to improve their recognition and recall (Lin et al. 2013:401). These iterations are shown in Fig. 4. Four color palettes were then created in order to represent each season, each one with six colors with approximate hues. While four were chosen to be applied to the eco-efficient houses, one to the tree trunks and another to the ground, other icons within the illustration also showcased these colors, creating a general environment corresponding to the season.



Fig. 4. Color Scheme iterations for each season

Meanwhile, buildings not related to sustainable construction and, consequently, to Lugar-Zero's activity, were represented in a grey scale, of five tones. These were also applied to roads and cars. With a more subdued representation, they became consistent secondary elements, giving space for a redirection of the user's focus from them.

In this way, the chosen color schemes ended up presenting an effective solution as they provided a clear association of stability between sustainable houses and their environment. However, they also created a visual highlight for the story's positive icons, as these became outliers in color, contrasting with the grey. This visual effect meant these icons attracted more attention to themselves and contributed more effectively to the visual narrative of the website, as referred to by Segel and Heer (2010:1140).

As for the inside of an eco-efficient house, initially there was an attempt to represent how the seasons had an impact on how the temperature of the house presented itself,

appearing cooler during Summer and warmer during Winter. However, this representation, visible in Fig. 5, distracted from the fact that the inside of a passive house aims to remain constant. Therefore, a more neutral color palette was chosen for the inside of sustainable houses, while normal constructions were represented by a saturated purple, dissonant from the color palette of every season, and also used to represent negative elements like loud noises, cost rates and mold, shown in Fig. 6.



Fig. 5. Initial scrapped variation of the inside of an eco-efficient house, shifting with the seasons



Fig. 6. Final static color scheme for the inside of the houses, with a dissonant color for normal construction and a neutral palette for eco efficient houses.

5.3 Semantic Enrichment

After the illustrations were created, they were divided into layers depending on the colors shared by each element of the image. The most recurring ones were titled “frente”, “lado”, “cima”, “janela”, “arvore” and “chao”, which are translated as “front”, “side”, “top”, “window”, “tree”, and “floor”, respectively, in order of lightest to darkest. These titles corresponded to the colors of the illustrated house in the morning, imagining the position of a hypothetical sun facing its facade. Furthermore, they were also then applied to elements like cars, trees, and bikes, as long as they shared the same color.

These images were then exported into SVGs, where the data of each layer was stored to be used on the website, with the aid of Javascript and the d3.js library.

5.4 Data Mapping

The variables upon which the reactive storytelling depends are: Latitude, Month and Hour, all of them retrieved through the browser via Javascript. The first two variables indicate the location of the user, and are gathered through the method Geolocation.getCurrentPosition(), followed by position.coords.latitude. Along with the method getMonth(), used to retrieve the month the user is accessing the website, these values allow for the calculation of the season the user is experiencing (“Inverno”, “Primavera”, “Verão”, “Outono”, translated as “Winter”, “Spring”, “Summer” and “Fall”).

If the user is accessing the website from the northern hemisphere, in January, for example, the detected season will correspond to Winter, while a user from the southern hemisphere will have the website detecting Summer. Upon this detection, the array used

to fill out the colors of each SVG is updated with the six colors corresponding to the season. This update was implemented by loading the XML data of the exported SVGs from Illustrator, with the d3.js library, altering its stroke and fill values. Figure 7 presents an example of this application on one of the sections of the website.



Fig. 7. Variation of colors and in the illustrations of trees, through the seasons

There are also changes to the annual plants that are shown in the story, changing from bare trees in the Winter, to trees with a full set of leaves in the Summer, with a middle term in both Spring and Autumn. This allows for a more organic feeling of the storytelling, taking into account that the illustrations themselves are quite minimalistic and structured. In regard to its implementation, all three versions of the trees (Winter, Summer and Spring/Autumn) were loaded in one SVG as different layers, that are then updated in visibility, depending on the detected season, with the same d3.js method previously described.

The other variable, Hour, gathered with the method getHours(), is used to detect the time of day, which can be equal to “Manhã”, “Tarde”, “Fim da Tarde” and “Noite”, translated as “Morning”, “Afternoon”, “Evening”, and “Night”. Once again, to create a more realistic perception of the illustrations, this data is also dependent on the season detected, considering the daylight savings time (Table 1).

Table 1. Time of day variables depending on the season

Time	Season	Hours
“Manhã”	“Primavera”/“Verão”	7 h–13 h
	“Outono”/“Inverno”	5 h–11 h
“Tarde”	“Primavera”/“Verão”	14 h–18 h
	“Outono”/“Inverno”	12 h–16 h
“Fim da Tarde”	“Primavera”/“Verão”	19 h–21 h
	“Outono”/“Inverno”	17 h–19 h
“Noite”	“Primavera”/“Verão”	22 h–6 h
	“Outono”/“Inverno”	20 h–4 h

In this case, the practical changes regarding the variable “Hour” center around the alteration to the order of colors in the color array, creating a consequent but corresponding change in the colors of each layer of the illustration, as seen in Fig. 8. While elements like the ground, the inside walls of the buildings and the tree trunks remain the same, for purposes of stability within the images, the walls and ceiling of the houses, along

with the cars and other occasional tridimensional elements change depending on the sun's position. The background of the illustrations also shifts to black at night, though maintaining a grid with a stroke of the season's lightest color through the day.



Fig. 8. Variation of colors through the day

6 Validation and Analysis

In order to evaluate the quality of the storytelling aspect of the website, a series of user tests was performed. This evaluation was done with a group of eight people between the ages of 19 and 24, 5 of which identified as female and 3 as male, in the same setting. 75% stated they had no knowledge of eco-efficient architecture, even though all of the participants showed some level of interest around themes of sustainability. Furthermore, the interest shown in regard to architecture as a general field revealed to range from slightly disinterested to very interested. Even though this represents a very small sample of users, both in number and age, it is noteworthy that a typical client for Lugar-Zero, who would benefit from these processes of storytelling, would fit into this exact description of high interest in ecology, but a small amount of knowledge around its applicability to architecture.

The main goals of this process of validation were centered around the illustrations and their ability to create a clear understanding of the text, and an intelligible introduction to the non-linear story, through the identification of chapter buttons. There was also some interest in evaluating the association between the illustrations and the brand values, and in analyzing if the changing aesthetics of the seasons and time of day were reflected in people's perception of the website.

In regard to usability, the user's capacity to learn and remember the interface, and the website's efficiency and efficacy in the transmission of information were of crucial importance, while the user experience analysis was centered around evaluating the motivation and appeal the website imprinted on the user.

The tests were made up of five parts. The first is a phase of pre-test questions, aimed at defining the profile of the user. The second consisted of a series of tasks to complete on the website. Consequently, there were four Likert and three Semantic scale post-test questions. Finally, four open-ended questions.

In the end, there was an overwhelming consensus that the illustrations revealed themselves to be helpful, guiding the user through the text, and sustaining their interest.

It was also clear that the users felt an incentive to learn further about these specific concepts of sustainability. This was made evident by the fact that those who identified themselves as being less interested in architecture stated an equal interest engaging with the website in comparison to other users (Fig. 9).

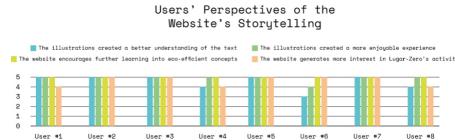


Fig. 9. Users' perspectives of the storytelling applied to the website

As for the variation of colors along with the seasons and time of day, while all seasons were tested in a night time look, and all times of day were tested in the context of the website's winter aesthetic, so there could be a constant variable, the amount of tests developed were not fruitful in showcasing big differences in the perceptions of the interface, meaning that, while the user is capable of identifying them, these differences did not generate any distinct negative or positive reactions towards the website.

In regard to the identification of the company's values when faced with the website, all users identified sustainability or ecology as a core value, while two users emphasized themes of efficiency and progress.

Finally, the main issues brought to light during the process of testing were mostly focused around the text and interface (some screenshots of which can be seen in Fig. 10). Some users pointed out the unnecessary complexity of certain language and a disinterest when faced with longer blocks of text, especially after the introduction chapter. This means that, while the illustrations can be helpful, they can only do so much for the current script, which needs to be further evaluated and refined in order to become fully accessible. Meanwhile, the interface needs to be finetuned so as to highlight the selected chapters and the vertical section menu. Certain aspects not yet implemented in the context of these tests, such as the grid, indicating the section the user is seeing, would allow for the non-linear structure to become easier to identify and used to its full potential, but also for the task duration to become closer to the expected one, since this proved to be the biggest discrepancy out of all the tasks, with a difference of approximately 10 s.

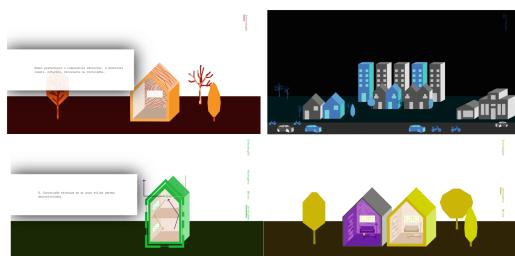


Fig. 10. Four screenshots of the prototypes used for user tests

7 Conclusion

With this website, there was a focus in portraying the knowledge held by Lugar-Zero in an accessible and visual way, using the website not just as a platform for the brand's promotion, but as a way of encouraging users to understand the basics of eco-efficient architecture enough to make a conscious and informed decision when choosing to use the company's services. There was also an effort to create a cohesive brand image, showcasing the company's area of work and its core values through reactive storytelling at the center of the look of its website.

In the context of this particular work, the setting and the type of information represented in the script used to develop the website meant that its reactive variations had to be slightly muted, in order to not overload the user with noise. However, in a more experimental setting, reactive storytelling could be used to a more expansive degree, by the development of storylines and narratives that are themselves adaptable to different detected user variables, instead of just being reactive through a visual nature.

Still, based on the results of the developed user tests it was possible to understand how these reactive images were helpful in the process of immersing the reader and introducing them to complex concepts that they could otherwise lose interest in more easily. It also became evident how the interface's structure and text used need to feel clear for the illustrations to be able to have full impact on the user, as any potential and unwanted errors and distractions can detract from the storytelling's message and pull focus into other elements.

In the future, it would also be of interest to develop further studies with a wider group of participants so as to confirm if the reactive changes do not in fact have an impact on the user and the way they perceive the information handed to them on the website.

Finally, adding inclusivity to the project through the varying representation of seasons around the world would be an interesting and important challenge, as the four-season model is not capable of accurately accommodating all cultures and experiences of weather in different regions.

Acknowledgments. We would like to thank Penousal Machado and Sérgio M. Rebelo for valuable suggestions and reviews.

References

- Biloslavov, R., Trnávčeviň, A.: Web sites as tools of communication of a “green” company. *Manag. Decis.* **47**(7), 1158–1173 (2009). <https://doi.org/10.1108/00251740910978359>
- Flavián, C., Gurrea, R., Orús, C.: A heuristic evaluation of websites design for achieving the web success. *Int. J. Serv. Stand.* **5**(1), 17–41 (2009). <https://doi.org/10.1504/IJSS.2009.021664>
- Fournier, S., Avery, J.: The Uninvited Brand (2010). <http://ssrn.com/abstract=1963056>
- Gershon, N., Page, W.: What storytelling can do for information visualization. *Commun. ACM* **44**(8), 31–37 (2001). <https://doi.org/10.1145/381641.381653>
- Ha, H.-Y., Perks, H.: Effects of consumer perceptions of brand experience on the web: brand familiarity, satisfaction and brand trust. *J. Consum. Behav.* **4**(6), 438–452 (2005). <https://doi.org/10.1002/cb.29>

- Jorgenson, E.: The ancient origins of storytelling and how you can apply them in your life. Medium (2016). Accessed 5 Jan 2021, <https://medium.com/evergreen-business-weekly/the-ancient-origins-of-storytelling-and-how-you-can-apply-them-in-your-life-4bad396652f1>
- Kosara, R., Mackinlay, J.: Storytelling: the next step for visualization. Computer **46**(5), 44–50 (2013). <https://doi.org/10.1109/MC.2013.36>
- Krug, S.: Don't Make Me Think! : A Common Sense Approach to Web Usability, 2nd edn. New Riders Pub, Indianapolis (2006)
- Lin, S., Fortuna, J., Kulkarni, C., Stone, M., Heer, J.: Selecting semantically-resonant colors for data visualization. Comput. Graph. Forum **32**(3pt4), 401–410 (2013). <https://doi.org/10.1111/cgf.12127>
- Liu, C., Arnett, K.P.: Exploring the factors associated with Web site success in the context of electronic commerce. Inf. Manag. **38**(1), 23–33 (2000). [https://doi.org/10.1016/S0378-7206\(00\)00049-5](https://doi.org/10.1016/S0378-7206(00)00049-5)
- Lupi, G., Aesch, M.: Non-linear storytelling journalism through “info-spatial” compositions. Parsons J. Inf. Mapp. **IV** (2012)
- Nielsen, J.: Usability 101: Introduction to Usability. Nielsen Norman Group (2012). 5 Jan 2021, <https://www.nngroup.com/articles/usability-101-introduction-to-usability/>
- Paun, G.: Council post: building a brand: why a strong digital presence matters. In: Forbes (2020). 5 Jan 2021, <https://www.forbes.com/sites/forbesagencycouncil/2020/07/02/building-a-brand-why-a-strong-digital-presence-matters/?sh=4bcaacb549f2>
- Peters, M.: The history of storytelling in 10 minutes. In: Cortex (2018). Accessed 5 Jan 2021, <https://www.meetcortex.com/blog/the-history-of-storytelling-in-10-minutes>
- Robin, B.R.: The educational uses of digital storytelling. In: Proceedings of Society for Information Technology & Teacher Education International Conference, pp. 709–716 (2006). <http://www.coe.uh.edu/digitalstorytelling/>
- Schank, R., Abelson, R.: Knowledge and memory: the real story. In: Robert S. Wyer, Jr (ed.) Knowledge and Memory: The Real Story, pp. 1–85. Psychology Press, New York (1995)
- Segel, E., Heer, J.: Narrative visualization: telling stories with data. IEEE Trans. Vis. Comput. Graph. **16**(6), 1139–1148 (2010). <https://doi.org/10.1109/TVCG.2010.179>
- Setlur, V., Mackinlay, J.D.: Automatic generation of semantic icon encodings for visualizations. In: Conference on Human Factors in Computing Systems - Proceedings, pp. 541–550 (2014). <https://doi.org/10.1145/2556288.2557408>
- Seyser, D., Zeiller, M.: Scrollytelling - an analysis of visual storytelling in online journalism. In: 2018 22nd International Conference Information Visualisation (IV), pp. 401–406 (2018). <https://doi.org/10.1109/iV.2018.00075>
- Wheeler, A.: Designing Brand Identity: An Essential Guide for the Whole Branding Team, 5th edn. John Wiley & Sons Inc, Hoboken (2017)



The Relevance of UI/UX Design in Human-Computer Interaction of Educational Games and Therapeutic Practices

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Abstract. In an era rooted in technological means, nowadays used as vehicles for subsistence, the world of games and gamification is one of the examples of how this evolution has been rapid and fruitful. Thus, human-computer interaction (HCI) is proving to be a preponderant theme in the scientific and business universe, considering that interactive digital systems, intended for various purposes, are globally accessible and have a considerable impact on people's daily lives. Nowadays, there are countless challenges to be faced in terms of user interface (UI) and user experience (UX), so that the needs, demands and satisfaction of the user continue to be granted, including in the universe of digital games. In this context, there has been the evolution of several technologies, such as Virtual Reality (VR), which expanded to several areas besides entertainment, including medicine. In this sense, in this paper we made a literature review on the nature of various paradigms of HCI, UI and UX used in educational practices and/or as therapeutic supplements, and we highlight the strategies that contribute to satisfactory results in motor, cognitive and emotional development of the respective users.

Keywords: Human-computer interaction · User interface · User experience · Educational games · Therapeutic games

1 Introduction

In recent decades, the accelerated technological evolution had to be quickly accompanied by the development and adaptation of methods and principles at the level of the construction of interfaces for the various types of machines (computers, mobile devices, consoles, etc.) that were effective in fitting the needs and demands of their users. Particularly, with the introduction of personal computers into the market in the mid-1980s, complex design issues evolved from 'what the computer was capable of doing' to 'how the computer was capable of doing it'. To answer to these questions, researchers started to focus on Human-Computer Interaction (HCI), which involves implementation, evaluation, and design of interactive computer systems, to help understanding how the user manipulates it, how he interacts with it and with the elements that surround it (Carol 2003; Miraz Ali and Excell 2021; Murphy 2019). In other words, HCI presents itself as

a relevant field of research since it contributes to understand how the user manipulates the devices and systems (Caroll 2003). Based on HCI, it becomes possible to analyze and delineate user interfaces (User Interface - UI) composed of physical components (hardware) and virtual components (software), which constitute a vehicle for the creation and development of environments that facilitate the construction of interfaces at the graphical level (Caroll 2003; Karray et al. 2008; Stone et al. 2005). The analysis and construction of interfaces must also consider their main objective: user satisfaction which, in turn, derives from the interaction with all the elements that make up the final product. This aspect refers to the user experience (UX).

All the previously mentioned areas, in short, study human behavior and needs, and can be categorized into three dimensions: physical, cognitive, and affective (Karray et al. 2008). Regarding the physical dimension, the studies focus on the interaction mechanisms, namely vision, hearing, and touch; regarding the cognitive dimension, they focus on means, methods, and strategies to create perceptible systems for the user; finally, the affective dimension focuses on the direct influence and change of the user's attitudes and emotions, motivating him/her to repeatedly explore the interaction experience (Karray et al. 2008; Rosa 2010). With reference to these dimensions, HCIs can be classified as intelligent, when they start from the study of human physical activity, or adaptive, when they focus on cognitive and affective studies. In the former, the system focuses on the user's ability to perceive, i.e., regarding motor movement, the direction of the gaze, resulting in a response according to the human reaction. The adaptive HCI system is based on the user's recognition memory, which maintains a search and suggestion activity according to the user's data, or to the tasks the user has already performed in the past (Karray et al. 2008).

As far as UI is concerned, the physical components that constitute the mentioned hardware are identified by devices and can be divided into two groups: communication devices and storage devices. Both are subdivided into two types of communication channels, namely input and output. Input devices receive information from the outside, whether from a human user, mechanical object, chemical or biological process, or even from another computer. Output devices send information to the outside in formats perceivable to a human, physical process, or another computer. Each singular communication channel (input or output) is identified as a modality and a UI may communicate through one (unimodal) or several modalities (multimodal) (Big and Shaw 2003; Karray et al. 2008).

Regarding software, this is the sum of the resources for processing certain information and its graphical presentation. The goal is to be an effective formula for presenting and working with information of various natures (written, artistic, mechanical, etc.) through fast and dynamic actions (Galitz 2002). Software development is divided into several phases that overlap and provide information to each other. During design there may be problems related to requirements and during programming there will be design problems, etc.

"There is the development team, which includes users, development team leaders, marketing people, software engineers and designers, programmers, graphic designers, systems analysts, HCI specialists, and other development and research staff. (...) each one works from his or her own perspective. A software engineer,

for example, may provide input on better system architecture configurations and software performance. A graphic designer will focus on the visual aspect of the UI and will want to establish what kind of graphics are appropriate for all areas of the application or whether there are potential problems in selecting iconic representations for certain situations. Marketers want to sell products on time and as price-effectively as possible, and they want the right image for the application. Users need to feel that the computerized system will provide the right facilities to ensure that their work is performed effectively” (Stone et al. 2005, p. 18).

Thus, the software development process does not start from a simple linear model but involves a sequence of repetitions of tasks in the different phases of the process (Sommerville cited in Stone et al. 2005). For Stone et al. (2005), since the interface is effective for the users, they must be present during the various phases of development. At the outset, when listing the requirements, previous studies may be necessary, or carried out for that purpose, with the contribution of users, where first-person opinions and experience about a certain type of software are detailed. In the pre-release season, the team may run several versions of the software and solicit feedback from users for final adjustments, and even after the release, they may collect suggestions for a next version of the software.

Properly programmed, the software reduces the requirement for recoding and reorganization of perceptual and mental information and reduces the memory load. It also contributes to the rapid transfer of information between computers and people, allowing more visual comparisons of values, trends, or work relationships; more compact representation of information; and simplifying the perception of structure. Graphism can also make the interface attractive and appealing (Galitz 2002), and allow greater customization to create a graphic style adapted to the context.

The UX is a relevant area in terms of information architecture, interaction design and usability testing as it contributes to assertive decision-making about the product's functionality, but not only. Peter Morville is one of the most relevant names in the field of UX, with the presentation of his “honeycomb”, in which he highlights the most important facets of UX in relation to the product itself: useful, usable, desirable, accessible, reliable, findable and valuable (Hsu and Chen 2018; Wesolko, 2018).

To ensure a pleasurable user experience, UI and UX designers together must consider all aspects surrounding the user of the computerized mechanism. In the case of users with motor, cognitive and/or visual health problems, the challenge is greater, but technology and science are also advancing in this direction, as there are already interfaces with specific properties to use in therapies that aim to recover one or more disabilities of various natures, at the same time (Karray et al. 2008). Among these interfaces, the Virtual Reality (VR) systems stand out. VR are systems defined as a three-dimensional computational experience that enables interaction with an unlimited number of objects, contexts, and creative environments, allowing their users to more easily engage in repetitive practices that will enable them to achieve the desired behaviors (Chen et al. 2007).

In this sense, this paper will focus on HCI, UI and UX in order to understand their impact on the development and adaptation of digital aids in education and therapeutic practices, particularly in gamification environments.

2 User Interface (UI) Development

Stone et al. (2005) determine an initial step, subdivided into four phases, advised to those who are beginning the development of an interface, specifically the development of the conceptual design. The latter consists of a diagram with all the navigation windows where the main (requires system responsibility) and concrete (requires simple correspondences representing the actions taken by the user) use cases, objects, attributes, and main and secondary actions are identified; and arrows between the windows, to get a clear notion of the navigation that is intended.

It will be necessary to define whether the UI will be unimodal or multimodal, as already mentioned. There is a distinction between the various types of modalities: visual, auditory, and sensory.

A unimodal UI based on visual capture covers the research fields of facial expression analysis, for recognition of emotions expressed via the face; body gestures, which are largely used to record movements, although they can be used for different purposes; and, finally, the direction of the gaze, captured for various interactive purposes, such as the direction and movement of the arrow on the screen, as well as the blink of an eye that replaces the mouse click (these are usually interfaces created for disabled people). These are not the only UIs in this field, but Karray et al. (2008) highlight them as the ones that have received the most attention in the scientific community.

Unimodal UIs in the audio capture field include those that individually have the ability to recognize speech, in which functions are activated according to the enunciation of certain words; voice recognition, through timbre, tone, etc.; the ability to identify emotion through voice, which consist of studies within non-verbal communication research, such as paralinguistics, which contribute to a more intelligent processing by computers; and also UIs for musical interaction (Hermsen 2000; Karray et al. 2008).

The sensory aspect, in a capture context, implies at least one intermediate sensor between the machine and the human being. Digital pens, used in cell phones, tablets and cintiqs, mouse, keyboards, joysticks, sensors for motion capture, tactile and pressure sensors, used mainly in robotics and virtual reality for various purposes, and also sensors for taste and smell are part of this type of UI (Karray et al. 2008).

Multimodal UIs combine two or more modalities. Some examples refer to videoconferencing, smart homes or offices, car driver monitoring, smart games, online commerce, helping disabled people, interactive maps, emotion recognition, human-machine interaction interfaces, and multimodal applications in medicine (Karray et al. 2008). In multimodal UIs there are then “combinations of speech, gestures, gazes, facial expressions and other non-conventional modes of input” (Karray et al. 2008, p. 146), which have an additional functionality of a mutual aid, i.e., for example, lip movement recognition (visual modality) helps speech recognition (auditory modality) and the latter can help in capturing gestures (visual modality) (Karray et al. 2008).

As already mentioned, this type of interfaces helps disabled people, whose motor deficit is centered on the use of arms and hands, with speech and head movements recognition. From this perspective, the use of this type of interface as an additional support to therapy has been deepened in studies such as the one by Zoccolilo et al. (2015), given its potential to not only contribute to improving the physical and motor development, but also to influence the user’s motivation and confidence (Chen et al. 2017).

Regarding emotion recognition, more satisfactory results are achieved when two modalities are mixed in the capture. Karray et al. (2008) identify two projects where face and body information were captured simultaneously with good results. Using audio capture, they achieved 70.9% effectiveness in emotional recognition, versus 85% via visual capture of the facial expression. By capturing with both modalities, they reached a total of 89.1% effectiveness. Regarding interactive maps and human-machine interaction, they indicate that it is beneficial for the user to use various modalities, such as speech and gestures. In medicine, multimodal UIs have come to bridge the human limits in accuracy and sensitivity to the naked eye in order to exponentially add success cases in surgical interventions (Karray et al. 2008).

In short, a UI is defined based on what it can do, that is, how its functions (functionality) can help in achieving its purpose (usability) (Karray et al. 2008).

“The functionality of a system is defined by the set of actions or services it provides to its users [although its value] (...) is visible only when efficient use becomes possible. (...) The usability of a system with a certain functionality is the range and degree over which the system can be efficiently and appropriately used to achieve certain purposes for certain users” (Karray et al. 2008, p. 138).

In other words, the functionality of a UI determines the actions or services that users can take advantage of, and usability consists of the limitation of the scope of intervention. The efficiency of a UI is determined by the balance between functionality and usability.

3 HCI, UI and UX Paradigms at Console and Gamification Level

In terms of HCI, the gaming and gamification industry has been betting on the way the user interacts with the consoles and their level of immersion in the games.

In 2006, Nintendo launched the Wii console based on a revolutionary Wiimote, a controller whose movements were captured by the sensor bar and translated into actions in games (Gogoni 2020). This type of interaction was taken advantage of by the company Microsoft, which sought to implement a similar system in the console XBOX 360 and XBOX one, with the acquisition of a motion sensor, called Kinect, launched in 2010, which allowed users to interact with games without a joystick or controller (Hsu 2011). The great advantage is that users can move freely in the physical space, which was a significant and revolutionary contribution to HCI. This sensor was also purchased together with a wide range camera, an RCB camera and a 3-D microphone (Friess 2011). A year before Kinect was released, SONY also introduced the PS Move, whose controls system was closer to the Wiimote (Gogoni 2020).

It should be noted that, at the UI level, issues had to be solved regarding the creation of menus that would work with the new concept of controls, ensuring an intuitive interaction and a perceptible interface by the user. Also, considering the familiar user interaction with the in-game menu navigation that is usually “point and click”, these commands had to be replaced by the user’s hands. One of the most popular gestures in Kinect is the “swipe” as it allows navigation along menus and screens with just the movement of the whole arm. The introduction of this possibility raised several issues in terms of design since configuring the system to understand all arm movements would have been quite

expensive, so the solution was to teach the user which movements he could make (Friess 2011).

Although these products have now been discontinued, they contributed to a technological revolution in gamification, culminating in 2016 with a rise in VR systems, as a variety of head-mounted displays (HMDs) were introduced that promised a highly immersive VR experience. Notable among these systems were the Oculus Rift (launched by the Facebook company), the PlayStation VR (from SONY), and the HCT (from the Vive company) (Fröjdman 2016). However, the concept of VR has been developed since the 1930s, with Stanley G. Weinbaum presenting, in a fictional context, a story in which through a pair of glasses it would be possible to experience the world in a holographic way with the creation of three-dimensional images. In the mid-1950s, the filmmaker Morton Heilig developed one of the first immersive, multimodal systems, Sensorama, where the user watching one of the films, directed by Heilig himself, could feel the wind or the smells corresponding to what he was watching in the film (BCC Research Editorial 2018; Craig and Sherman 2002). Later, Heilig also developed the first VR system, Heilig's Telesphere Mask, consisting of a head-mounted display with extended vision and stereo sound (BCC Research Editorial 2018; Craig and Sherman 2002). Despite numerous changes throughout the development of the VR concept, its designation was not used until 1987 by Jaron Lanier, founder of the Visual Programming Lab (VPL) (BCC Research Editorial 2018; Craig and Sherman 2002). In the 1990s, VR devices became commercialized, despite being a very expensive technology. In 1993, SEGA announced some VR glasses for the SEGA Genesis, however, due to technical difficulties, it did not make it past the prototype stage, although four games were developed for that purpose (BCC Research Editorial 2018; Craig and Sherman 2002). Over the next two decades, VR, in parallel with augmented reality, have significantly increased their inclusion in the market at the gamification level.

Parallel to the acquisition of Oculus by the Facebook company, Google developed solutions such as Cardboard and Google Daydream, which could be used with smartphones. Samsung has taken this concept even further with products such as the Galaxy Gear, which contains smart features such as motor control (BCC Research Editorial, 2018; Craig and Sherman 2002).

According to Sherman and Craig (2003) the VR experience focuses on four fundamental elements, namely: the virtual reality world, sensory feedback as a response to user input, interactivity, and immersion. In particular, regarding sensory feedback, it is important that the VR system creates an authentic environment for its user, such that it is interactive and responsive to the actions of its users. Another key component of a VR system, physical immersion, realizes the very concept of VR, in that it presents the virtual world with reference to the user's location and orientation by providing an accordingly stimulus (Sherman and Craig 2003).

However, the development of HMD systems involves several issues at the UI level, particularly at the 3D interaction level. HCI focuses on how eye control can be used as input into command systems.

Even at this level, the designations of the technologies involved vary by manufacturer. Oculus Rift refers to the VR system as HDM, but Google CardBoard or Samsung Gear VR designates them as VR glasses and headsets (Fröjdman 2016). However, in 2016,

the Virtual Reality Society assigned the designation of VR glasses and headsets as being synonymous with HDM systems.

The different VR systems identified earlier make use of different technologies. The Oculus Rift uses a computer as a processor, whereas the SONY PlayStation VR the PlayStation, Samsung Gear VR, Google CardBoard and Google DayDream use smartphones (Fröjdman 2016).

Regarding the physical characteristics of HDM systems, Google Cardboard, Google DayDream or the Samsung Gear VR resorts only to the smartphone's screen split in two, which contributes to a split in resolution. In this sense, the physical characteristics of the systems used, such as the geometry of the screen, the transfer mechanism, the refresh rate of the system, as well as its ergonomics, are factors that distinguish the different VR systems and that will contribute to a more or less satisfactory experience. The disadvantages usually associated with the use of HDM systems are related to the latency period of the system itself and the discomfort in ergonomic terms, which leads, in most cases, to headaches, nausea and dizziness (Fröjdman 2016).

Recently, Nintendo released the Nintendo Switch, which allows a transition between TV mode and portable game mode. This transition raised specific problems at the console interface level since a single device could be used fixed or portable with a huge diversity of inputs and outputs. Nintendo solved the problem by slightly increasing the scale of the entire UI in order to cater to all screen types (Deets 2019).

Aligned with the immersive demands of its users, in 2019 Nintendo introduced Nintendo Labo for the Nintendo Switch - a VR kit where users can create their VR glasses from cardboard designs, similar to CardBoard and Google Daydream systems, but with the ability to be tailored to each game (Nintendo 2019). This kit was launched, and first outlined, for the creation of six projects aimed at children aged 7 + in a constructive and collaborative learning perspective with other children and/or family members.

In particular, with the introduction of the Oculus Rift VR system, a paradigm shift was observed not only in gamification but also in other areas, such as medicine, education, and simulator-based skills training (Fröjdman 2016), and one of the reasons is that the system is affordable compared to other competitors.

4 The Importance of VR Systems as Educational and Therapeutic Aids

There is an alignment of the evolution of gamification with the teaching standards that current education seeks to promote: the use of games in learning. If we take into account Howard Gardner's Theory of Multiple Intelligences, the use of technology as a promoter of more meaningful learning and closer to the student's reality, the use of games is part of a widespread type of kinesthetic intelligence identified as preferable for students, particularly those with disabilities (Hsu 2011).

Regarding the use of technologies as an educational aid, it dates back to the early 1950s, and the use of VR emerged as a natural evolution of computer-assisted instruction (CAI) or computer-based training (CBT) (Pantelidis 2009). In the 1990s, Youngblut (1998) conducted extensive research to answer questions about the use and effectiveness of VR in preschool through high school from a constructivist learning perspective. Most

teachers in the study would consider using VR in their practice if it were accessible and available to both students and teachers (Youngblut 1997).

In 1993, Winn identified a conceptual basis for educational applications of VR that relied on: (1) VR provides non-symbolic experiences specifically designed to help students learn the material; (2) VR enables experiences that could not otherwise be obtained in regular education; (3) while the school would try to promote symbolic experiences, VR contribute to closer proximity to the student's everyday life; (4) educational applications of VR be based on constructivism; (5) VR technology contribute to learning being driven based on the manipulation of objects in virtual worlds and the reification of abstract ideas (Winn 1993).

The use of game-based therapy enhances neurorehabilitation by enabling functional tasks to be performed repeatedly, contributes to stimulation through sensory enrichment (visual, auditory, and tactile), as well as providing cognitive feedback (scores). In addition, the interaction between participants, contributes to intensified training of not only motor and cognitive skills, but also socialization. Several studies focus on research on the relationship between games and the basic needs that therapists consider fundamental to be worked on, namely: amplitude of movement and articulation of the upper limbs; visual-motor coordination; sensory and proprioceptive feedback; and the management of multiple and simultaneous stimuli according to a cognitive approach for the development of appropriate motor strategies (Winn 1993). It should be noted that other video game consoles, besides those mentioned above, could be used in therapies more focused on balance training, such as Nintendo's Wii-Fit Balance Board. But being the XBOX 360 Kinect a motion capture tool, studies, such as the one by Zoccolillo et al. (2015), projected that in the future it would be possible to monitor offline, from home, the video game-based therapy, to correct the children's performance and to progressively adapt the therapy, for example, by increasing the degree of difficulty of the proposed games.

In addition to these attributes, VR can effectively contribute to improve motor development, as well as influence the child's personal aspects associated with motivation and confidence. The main goal of a VR intervention is to support the child in increasing his/her participation in the real environment by allowing him/her to gradually overcome and adapt possible environmental barriers by interacting with the virtual environment and transferring the skills learned to the real world (Chen et al. 2017).

The evolution of the concept of VR has been made parallel to the evolution of the concept of Interface Design taking into consideration that there are numerous design elements necessary for the construction of immersive VR worlds. A very important feature of VR, and that the designer will have to consider, is its immersiveness, because the user may lose the perception of external stimuli to the game, namely the level of reaction to it: users may wave their arms and sometimes hit objects and people that are around them. As time goes by, the level of immersion will tend to be even higher, with the use of bodysuits, tactile and smell reproduction devices. A final design feature of VR environments is the mapping capability, that is, the way controls are mapped to user input (Ogusko 2018).

Considering the positive impact that the Nintendo Wii is shown to have on the level of intervention in children and young people with disabilities, in particular with cerebral palsy, studies have been conducted involving another console, the XBOX 360

- Kinect (Luna-Oliva et al. 2013). In studies such as that of Yamaguchi et al. (2012), some advantages of this console over the Nintendo Wii have been identified, namely the possibility for the user to control and interact with the VR environment without needing a remote control which, for example, allows children with hemiparesis to develop the affected hand (Fonseca and Lima 2004). VR glasses allow the creation of a totally immersive environment offering an interface with greater potentiality, more detailed visual graphics and a wide variety of available games that can be adapted to be a support system (Tori et al. 2006).

It should be noted that the VR environment can be an enabler of cognitive stimuli, insofar as its manipulation involves attention, memory, concentration, and planning on the part of its user. The fact that the environment changes in real time according to the commands made by the user should also be highlighted, which enhances the user's motivation and involvement in the game (Lee 2012). In addition, the intervention can be performed in the different contexts in which the user is included (Afonso 2012; Monteiro 2011).

The limitations in the activities and participation of the disabled user, resulting from deficits in body functions, can be overcome, along with other strategies, by adapting the environment using assistive products. VR systems may become a key tool in promoting participation and rehabilitation of children and youth with disabilities.

However, the use of these systems by users with disabilities is only feasible if the design is present as a bridge between the goal of the game and its functionality. Inclusive design does not suggest that it is always possible that digital and product design can meet the needs of the entire population, but rather that it is able to tailor the design to meet particular users (Holmes 2018).

5 Conclusion

Nowadays, there are beginning to exist interesting digital interactive solutions for education and specific therapies. New ideas and projects are revealing positive results regarding to both environments.

There is a specific technology that stands out due to its versatility and immersiveness capabilities, as well as its progressive accessibility to a large majority of users, which caused a paradigm shift in terms of HCI: The VR systems. It is a technology that becomes the main interaction vehicle that mediates the game and the way it will take place. The inherent potential to its immersiveness and to the possibility of the inputs being done without the need for controls or other peripherals, but only with the mobility of the body itself, translates into numerous advantages that mostly go beyond the goal of the game itself.

However, we have noticed the need for more games to be developed, particularly those used in VR systems. UI and UX may play an important role regarding to these contexts, but we found that it is on its embryonic state. More research and gaming solutions are needed with contemporaneous UIs and UXs to extract the best from this kind of experience, and so that they can be used by a greater diversity of users, with different degrees of motor disabilities and educational difficulties.

References

- Afonso, Â.M. T.D.S.: O ensino e a paralisia cerebral. (Mestre em Educação Especial), Escola Superior de Educação Almeida Garret, Lisboa (2012)
- Bcc research editorial. The history and evolution of virtual reality technology (2018). <https://blog.bccresearch.com/the-history-and-evolution-of-virtual-reality-technology>
- Big, L., Shaw, A.: Operating Systems Principles. Prentice-Hall, New Jersey (2003)
- Carroll, J.M.: HCI Models, Theories, and Frameworks: Toward a Multidisciplinary Science (Interactive Technologies), 1st ed. Morgan Kaufmann, Burlington (2003)
- Chen, Y.-P., et al.: Use of virtual reality to improve upper-extremity control in children with cerebral palsy: a single-subject design. *Phys. Ther.* **87**, 16 (2007). <https://doi.org/10.2522/ptj.20060062>
- Chen, Y., Fanchiang, H.D., Howard, A.: Effectiveness of virtual reality in children with cerebral palsy: a systematic review and meta-analysis of randomized controlled trials. *Phys. Therapy* **98**(1), 63–77 (2017). <https://doi.org/10.1093/ptj/pzx107>
- Deets, C.: Thoughts on the Nintendo Switch User Interface - Charlie Deets. Medium (2019). <https://medium.com/@charliedeets/thoughts-on-the-nintendo-switch-user-interface-b441129f063d>
- Fonseca, L.F., Lima, C.L.F.D.A.: Paralisia cerebral: neurologia, ortopedia, reabilitação (G. Koogan Ed. 1 ed.). Rio de Janeiro (2004)
- Fröjdman, S.: User experience guidelines for design of virtual reality graphical user interfaces controlled by head orientation input (Master's Thesis) (2016). <https://www.diva-portal.org/smash/get/diva2:939381/FULLTEXT01.pdf>
- Galitz, W.O.: The Essential Guide to User Interface Design, 2nd edn. John Wiley & Sons, Hoboken (2002)
- GmbH, C.: Kinect: Revolution for User Interfaces? – Part 1 • Centigrade GmbH (2020). <https://www.centigrade.de/en/blog/kinect-revolution-for-user-interfaces-part1/>
- Gogoni, R.: O que deu errado com o Kinect? 10 anos do sensor de movimentos do Xbox. Meio Bit (2020). <https://tecnoblog.net/meiobit/419661/o-que-deu-errado-com-o-kinect-10-anos-do-sensor-de-movimentos-do-xbox/>
- Hermsen, P.M.: Speech Recognition vs. Speaker Recognition (2000). [Em linha]. <http://www.govtech.com/magazines/gt/Speech-Recognition-vs-Speaker-Recognition-.html?page=1>. [Consultado em 31/05/2021].
- Holmes, K.: The No. 1 thing you're getting wrong about inclusive design (2018). Retirado de <https://www.fastcompany.com/90243282/the-no-1-thing-youre-getting-wrong-about-inclusive-design>
- Hsu, H.M.J.: The potential of kinect in education. *Int. J. Inf. Educ. Technol.* **1**, 365–370 (2011). <https://doi.org/10.7763/ijiet.2011.v1.59>
- Hsu, C., Chen, M.: How does gamification improve user experience? an empirical investigation on the antecedences and consequences of user experience and its mediating role. *Technol. Forecast. Soc. Chang.* **132**, 118–129 (2018)
- Karray, F., Alemzadeh, M., Saleh, J.A., Arab, M.N.: Human-computer interaction: overview on state of the art. *Int. J. Smart Sens. Intell. Syst.* **1**, 137–159 (2008)
- Lee, S.-L.: The effects of gesture-based learning with virtual reality on counting ability for children with cerebral palsy. *J. Educ. Technol. Dev. Exchange* **5**(1), 10 (2012)
- Luna-Oliva, L., Ortiz-Gutiérrez, R., Cuerda, R. C.-D.L., Piédrola, R.M., Alguacil-Diego, I.M., Sánchez-Camarero, C.: Evaluation on the use of a virtual reality video-game system as a supplement for rehabilitation of children with cerebral palsy. In: Converging Clinical and Engineering Research on Neurorehabilitation, pp. 873–877. Springer, Heidelberg (2013)
- Monteiro, C.B.D.M.: Realidade virtual na paralisia cerebral (Plêiade Ed.). São Paulo (2011)

- Miraz, M., Ali, M., Excell, P.: Adaptive user interfaces and universal usability through plasticity of user interface design. *Comput. Sci. Rev.* **40**, 100363 (2021)
- Murphy, A.: 7 reasons to study human-computer interaction. KEYSTONE (2019). <https://www.academiccourses.com/article/seven-reasons-to-study-human-computer-interaction/>
- Ogusko, T.: Princípios de design aplicados à realidade virtual (2018). <https://ogusko.medium.com/princ%C3%ADpios-de-design-aplicados-%C3%A0-realidade-virtual-d79fbf7ef17e>
- Pantelidis, V.: Reasons to use virtual reality in education and training courses and a model to determine when to use virtual reality (2009)
- Sherman, W.R., Craig, A.B.: Understanding Virtual Reality: Interface, Application, and Design: The Morgan Kaufmann Series in Computer Graphics, 1st edn. Morgan Kaufmann, Burlington (2002)
- Rosa, S.: Ergonomia e Interação Humano-Computador. [Em linha] (2010). https://www.maxwell.vrac.puc-rio.br/8379/8379_3.pdf, Consultado em 31 May 2021
- Sherman, W., Craig, A.: The Virtual Reality Experience. In: The Morgan Kaufmann Series in Computer Graphics, Understanding Virtual Reality, pp. 381–411 (2003)
- Stone, D., Jarrett, C., Woodroffe, M., Minosha, S.: User Interface Design and Evaluation. Elsevier, AmsterdamK (2005)
- Tori, R., Kirner, C., Siscoutto, R.: Fundamentos e tecnologia de realidade virtual e aumentada. Porto Alegre: Editora SBC (2006)
- Virtual Reality - Latest Virtual Reality News Headset Reviews. Virtual Reality Society (2017). <https://www.vrs.org.uk>
- Wesolkو, D.: Peter Morville's User Experience Honeycomb - Dane Wesolkо. Medium (2018). <https://medium.com/@danewesolkо/peter-morvilles-user-experience-honeycomb-904c383b6886>
- Youngblut, C.: Educational uses of virtual reality technology (1998)
- Winn, W.: A conceptual basis for educational applications of virtual reality (1993)
- Zoccolillo, L., et al.: Video-game based therapy performed by children with cerebral palsy: a cross-over randomized controlled trial and a cross-sectional quantitative measure of physical activity. *Eur. J. Phys. Rehabil. Med.* **5**, 669–676 (2015)



The Design Thinking Process in the Development of an Intelligent Microscopic Equipment

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Abstract. This article aims to demonstrate how the application of user-focused methodologies, namely through the concept of Design Thinking, within a multidisciplinary work team, were important tools for the development of the “μSmartScope” project in the field of intelligent microscopy. In particular, this article focuses on the description of the design process, techniques and tools used to obtain information, and how it was reflected in the designed solution. Carrying out this work, according to the Design Thinking methodology, had the obligation to be adapted to the pandemic context, namely through the use of digital means such as interviews and online meetings, without losing the true essence of this methodology. The results obtained were the sum of all detected needs, which are the means to justify conceptual and technical choices for the project, and thus validate the involvement of a methodology based on Human-Centred Design (HCD). This analysis served as a justification for introducing these types of concepts in learning opportunities, in order to develop projects more focused on users in a real context and their involvement within the project itself, resulting in the design of a product capable of promoting a safer, more efficient, and comfortable relationship with the target audience.

Keywords: Product design · Design thinking · Human-centred design · Intelligent microscopy · μSmartScope

1 Introduction

This article intends to emphasize the role of Design and methodologies related to the HCD, in the development of diagnostic equipment in the healthcare area, particularly an alternative to conventional microscopes, more accessible and automated, framed by a project called “μSmartScope” [1]. This project addresses current issues related to the need to enhance the quality and availability of this type of equipment in different contexts, adapted to provide effective support for diagnosis based on microscopy and in geographic areas with limited access to health services. The project has been developed since 2013 [2] at the Research Center for Assistive Information and Communication

Solutions – AICOS, managed by Fraunhofer Portugal, a private non-profit association founded by Fraunhofer-Gesellschaft, being considered “(...) *the world's leading applied research organization.*” [3].

Although there was a professionally diverse team of seven people, it was necessary to introduce a designer¹ into the project “μSmartScope”, due to the need to redesign the previous version of the prototype (Fig. 1) developed by Fraunhofer Portugal – AICOS, fully 3D printed. Its concept is based on intelligent microscopy, through a fully automated microscope and supported by the smart and optical features of the smartphone, enabling a quick and assertive diagnosis of different pathologies. This prototype allows the autonomous acquisition of a pre-defined number of sample images, through a motorized and automatic process, generated through the programming of the smartphone software, without the need for manual focus. The μSmartScope also aims to reduce dependence on experts in microscopy diagnosis available on-site, by allowing straightforward integration with Artificial Intelligence, to support the diagnosis of target pathologies such as cervical cancer, which is currently one of the main focuses of this project. Nevertheless, the first version of the prototype was designed to support the diagnosis of malaria [4, 5], specifically for “(...) *acquiring microscopic images with 1000x magnification of malaria smears. Due to the success of the proof of concept, μSmartScope goal is to deepen the infection library. As such, the Malaria Scope was adapted for the acquisition of samples of cytological, in a liquid environment, of cervical cancer with magnification up to 400x.*” [6]. However, the adaptation of this version of the prototype for cervical cytology revealed some handling flaws, which were confirmed through usability tests [7]. Those results highlighted the need to improve the tangible part of the device, namely the way the microscopic slide is inserted in the prototype, as well as the smartphone fit and respective alignment with the internal optical system.



Fig. 1. μSmartScope prototype produced by Fraunhofer Portugal – AICOS [1].

¹ Carlos Pereira, first author of this article, has a degree in Product Design from the Polytechnic Institute of Viana do Castelo and is a student of the Master's in Integrated Design at the same institution.

This article is structured to demonstrate all the steps performed during the applied research process through the Design Thinking methodology [8] and its respective objectives and achieved results. It is important to note that the subject addressed in this article only concerns the methodology applied in the design process, and not the product resulting from this same project.

The article is also focused on the systematic analysis of professional experience that included the application of methodologies related to Design and Human-centred Design, in a multidisciplinary context, with the intention of being an asset to technological projects, increasing efficiency of its development and the relationship between product and user, respectively. In this way, it is thought possible to leave a testimony about the good results achieved and contribute to the scientific discussion in this area. Design becomes a means for a symbiosis between the various disciplines necessary for the implementation of a project with the typology of intelligent microscopy, such as mechanical engineering, electronics, informatics, and biomedical engineering.

The purpose of investigating in Design must have a practical consequence, to contribute to the exercise of its activity, but also to theory, because the “*(...) design practice may involve investigation, but design practice itself is not investigation. Without investigation, we are left to our intuition, based on existing knowledge.*”² [9].

2 Materials and Methods

The µSmartScope project benefited from the multidisciplinary nature of the work team responsible for developing the project, becoming relevant, as in this way it was possible to obtain greater responsiveness and a development of solutions and concepts, through the discussion of ideas between its members, thus introducing different ways of thinking and different areas to Design, such as mechanical engineering, physics, programming, and electronics.

The project also benefited from the workspaces provided by Fraunhofer Portugal – AICOS, as well as from the work tools, materials, and technologies for rapid prototyping, namely the application of 3D printing. In short, the involvement with the context offered by this organization made the project more efficient due to the interdisciplinary availability offered by the various professionals and researchers, often in non-face-to-face work. This involvement clearly contributed to the development of a more complete product, not only to respond to the key problem that the solution aims to address, but also to prepare it for future series production.

The initial stages of the project started in a more traditional way, linked to the Design and Development of Products [10] seen with the sense of adopting paths, previously studied, to make the design process more efficient. Therefore, it started from premises well structured: opportunity identification, product planning, identification of user needs, product specification, concept generation, concept selection, proof of concept, and prototype construction. After the designer entered the project, the choices essentially departed

² Translated quotation: “*(...) prática do design pode envolver investigação, mas em si, a prática do design não é investigação. Sem investigação, somos deixados à nossa intuição, baseada no conhecimento existente.*”

from the implicit knowledge necessary to the context and constraints of the project, that is, through information obtained by the scientific method and therefore proven.

Empirical knowledge, obtained through one's own experience and personal knowledge, contributed to support project directions, as well as the discussion of ideas among the team. This approach allowed to reach solutions justified by theoretical knowledge and simultaneously by the interpersonal and contextual character, i.e., more connected to the exercise of the activity.

Thus, it was anticipated that the contributions of a designer specialized in Integrated Design might bring significant improvements to the development of the μ .SmartScope prototype, particularly in terms of industrial design and design components for manufacturing. The most immediate consequence of the designer's work was to review the product's architecture to increase the quality of aspects related to handling, usability, reliability, construction, durability and the economy of materials, manufacturing, and assembly processes.

Since the design project is a typology of work with an experimental character, it must adopt methodologies capable of providing knowledge during the formulation of the problem and hypotheses. Due to the operational scope of its techniques, Design Thinking [8] was used as the main approach to develop an analysis capable of sustaining the results, and consequently generating theoretical and practical knowledge that is useful for the research area.

In the theoretical part, a non-interventionist methodology was used to collect the most reliable data possible, without interfering in the studied reality. In the practical part, a solution capable of formulating hypotheses that explore the use of interventionist methodologies was designed, given its practical and experimental format, and consequently the use of methodologies with the same character.

The methodologies adopted were essentially qualitative, since the project needs an analytical component capable of substantiating choices, using qualitative data provided by users, and thus developing solutions with proven and more coherent arguments. For the design process to make sense, it was necessary to draw a plan divided into parts, in order to create an organized and outlined method. This plan had in mind the main objective of developing a design solution, because, in this research context, the application of “*(...) a solution-focused strategy is clearly preferable to a problem-focused one: it will always be possible to go on analysing ‘the problem’, but the designer’s task is to produce ‘the solution’.*” [11].

According to Cross [11], the application of design is based on the solution of ideas, to solve ill-defined problems or needs. Although there is a huge number of methodologies and ideologies in Design, the essence always starts with the conception of these same solutions. As the current world and society are constantly adapting, due to changes in context (whether these are political, social, cultural or economic), it is crucial to use user-focused thinking, so that it is possible to develop solutions capable of integrating into an environment so complex, because individuality does not only come from individual physical and cognitive characteristics, but also from “*(...) connections that the individual establishes with the environment, with the objects he produces and manipulates, and*

*with other individuals, reflecting in their various domains of social performance, work, affectivity and intellectuality*³ [12].

The Design Thinking process is essentially based on the idealization of a solution focused on the user through an integrative and non-linear approach, in order to make the process fundamentally exploratory, in other words, “*(...) the process of problem solving is considered together with its framework conditions. The problem analysis and solution development are considered systematically and holistically in the form of process.*” [13]. Despite the need to apply a rigorous methodological process at work, it is important to remember that the entire design project was developed according to advances and setbacks, becoming a cyclical path, this means that “*(...) methodological processes applied to an innovative design cannot be understood as a linear and sequential path without room for questions and constraints.*”⁴ [14]. Thus, in continuation of the project started in 2013 by Fraunhofer Portugal – AICOS, the Design Thinking methodology was used through the five steps proposed for this method: *Emphatise, Define, Ideate, Prototype and Test*.

The *Emphatise* stage essentially served to collect data that could be beneficial to develop a broad knowledge of the problem, through intensive research obtained mainly by research close to the user’s vision, in order to obtain content related to the historical, social and cultural context and also the perception of the problem through a closer look, as these types of studies “*(...) often confirm the personal comments about practice made by designers themselves but try also to add another layer of explanation of the nature of designing.*” [11].

This data collection, in order to be in accordance with the Design Thinking methodology, must be carried out through an investigation in direct contact with users, so that the designer can effectively understand the problem through contact with all the intervening parties. Unfortunately, this proximity work was made impossible due to the restrictions of the Pandemic, which forced the search for information through other resources: bibliographic research, environments of use photographically registered, interviews carried out and also primary results of the investigation provided by Fraunhofer Portugal – AICOS, namely through the study of the context of action, as well as the needs of the environment and users (Fig. 2). In this way, it was possible to understand the state of the art regarding the project, namely in matters related to the historical context, ergonomic and anthropometric criteria, similar products, etc., as well as the needs of the real contexts obtained by direct contact with possible users of the product.

The second stage of the project, named *Define*, was related to the analysis of the information obtained in the previous stage, with the objective of internalizing the definition of the problem, solution hypotheses and its limitations. As explained by Dam & Siang [16], the *Define* stage involves gathering the information obtained in the previous stage and analysing all observations, from a critical point of view, to define the central

³ Translated quotation: “*(...) conexões que o próprio individuo estabelece para com o meio, para com os objetos que produz e manipula e para com os outros indivíduos, refletindo-se nos seus vários domínios de atuação social, de trabalho, de afetividade e de intelectualidade.*”

⁴ Translated quotation: “*(...) processos metodológicos aplicados a um design inovador não podem ser compreendidos como um percurso linear e sequencial sem espaço para interrogações e constrangimentos.*”

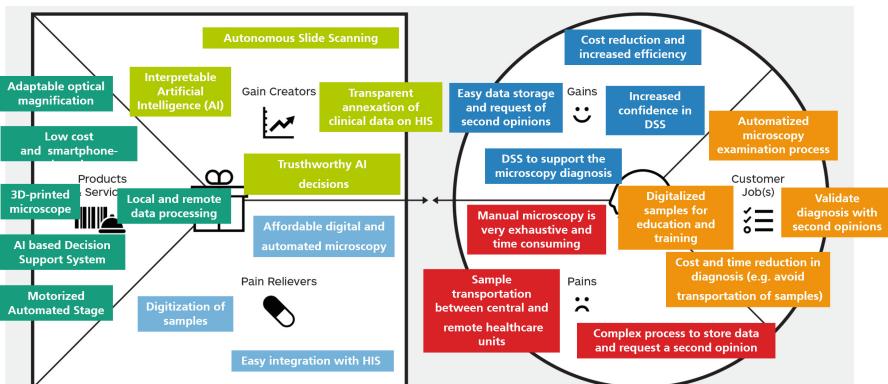


Fig. 2. Value Proposition of μSmartScope solution (for Healthcare Professionals) – made by Fraunhofer Portugal – AICOS in 2018 [13].

problems and needs of the project. In short, this step allowed us to define the needs of end-users, assess Fraunhofer Portugal – AICOS premises, and defining directions and objectives through the target audience, always based on the restrictions imposed.

The third phase of the project focused on *Ideate*, i.e., the creation of solutions capable of solving the problem through the development of a design concept, based on the results obtained in the previous phase. At this stage, it was necessary to use the brainstorming technique (Fig. 3), which allowed to demystify the analysis of the previous phase and create new perceptions through sharing and discussion among team members. As stated by Brown [8], the idealization stage must channel a divergent thought, to reach as many ideas as possible, and thus create choices for the project. The techniques used in this stage were essentially quantitative and materialized through the development of brainstorming, analysis of moodboards and sketches. In short, the ideate phase allowed to “(...) aggregate, edit and condense what we learned, as the synthesis helps to establish a new perspective and identify opportunities for innovation.”⁵ [17].

The fourth stage, *Prototype*, aimed to contribute to making important decisions regarding the solutions presented in the previous stage. In this step, it was also necessary to find the best strategies to place the models and prototypes made in the context of use, in order to analyse and conclude which solutions achieved the best results. The techniques used were the discussion and testing of 3D modelled solutions made on this stage among the team, and also conducting usability tests with external participants, to obtain impartial critical opinions and a critical reflection on the results obtained, aware that these solutions must be “(...) investigated and either accepted, improved and re-examined, or rejected on the basis of users’ experiences.” [16].

These 3D models were important for testing the ideas, and that is why two intermediate usability tests were performed, in which the object of study was the slide holder

⁵ Translated quotation: “(...) agregar, editar e condensar o que nós aprendemos, pois, a síntese ajuda a estabelecer uma nova perspetiva e a identificar oportunidades para a inovação.”

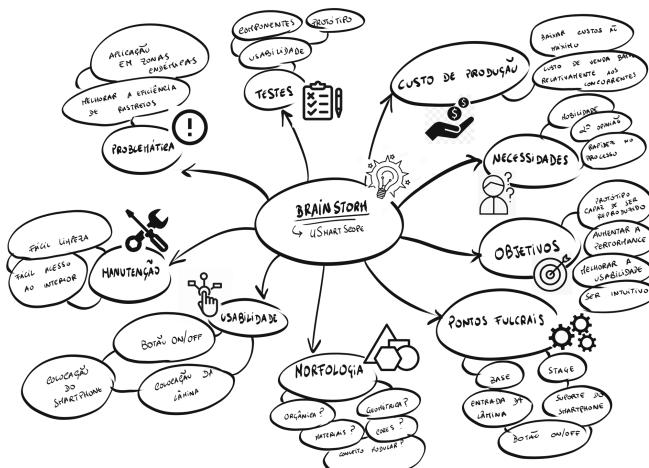


Fig. 3. Brainstorming mindmap session used for the project. Source: author image obtained in 2021/03/04.

and the on/off button. The first test (slide holder) had the support of ten generic participants, since the need at this stage of the project was to understand whether the solutions presented (Fig. 4) had potential in terms of comfort, efficiency, and intuition.

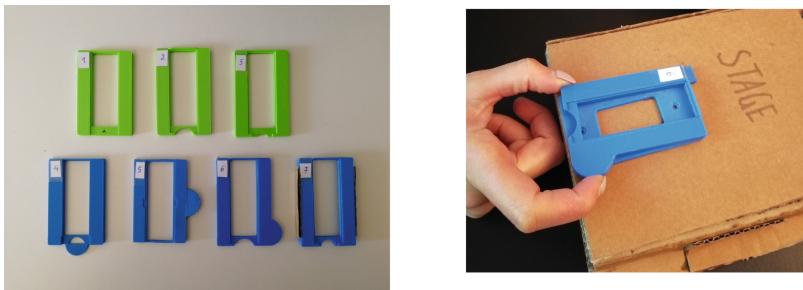


Fig. 4. From left to right: image of 3D printed models used in the usability test for the slide holders. Image of the slide holder in use during the usability test. Source: author image obtained in 2021/03/20.

Concerning the second test, the objective was to understand the best position for the on/off button, as well as its shape and diameter. For this, two models were built (Fig. 5), where one only served to understand the positioning of the buttons (model 1) and another to understand the morphology of each button (model 2). In particular, this test was divided into two parts, with eight participants in each, since after the test carried out by the first eight participants, it was noticeable that there was a need to place an extra button on top of the model 1, and thus test this theory. After analysing the conclusions obtained from the intermediate usability tests, it was possible to detail and

review the tested solutions, as well as other critical components for the construction of the equipment interface.

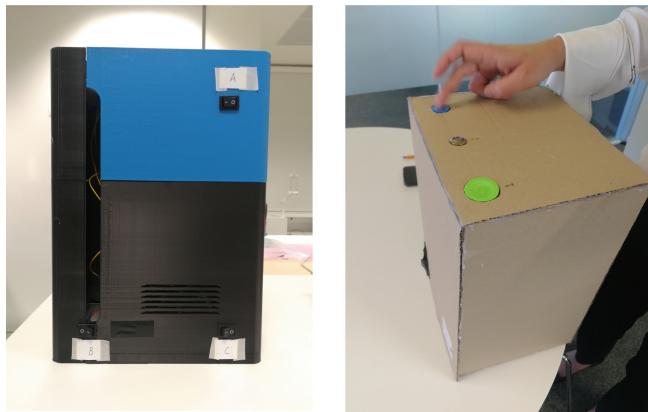


Fig. 5. From left to right: image of the model 1 (positions) used in the usability test for the ON/OFF buttons. Image of the model 2 (morphology/aesthetics) used in the usability test for the ON/OFF buttons. Source: author image obtained in 2021/04/06.

The last part of the project, the *Test* stage, becomes the most important of the entire process since it allowed to justify and conclude all the decisions taken, and consequently validate the investigation. The application of a final usability test became the means of consolidation to make the entire project valid, as this technique aims to test the final prototype (Fig. 6) through the collaboration of possible end-users of this device, allowing for a critical opening, which will be important for the future continuation of the project. Thus, a final usability test was carried out using six specialists in the health area and with different years of experience. The involvement of these participants was



Fig. 6. From left to right: image of prototype used in the final usability test. Image of the slide holder in use. Source: author image obtained in 2021/08/16.

based on the need to introduce possible end-users into the design process before being industrially produced in series, avoiding loss of time and significant financial expenses. The objective of this test was to analyse all the tangible functions of the equipment developed so far, namely: the process of turning on/off; connecting and attaching the smartphone to the equipment; handling the slide holder through the placement of a slide, and its respective introduction on the stage; analysis of transport and design aesthetic factors, to understand usability factors such as comfort, efficiency, and intuition.

Although the design process is phased according to the steps mentioned above, it is necessary to understand that every method in Design is made according to a succession of choices. To avoid potential errors and deviations, it is sometimes necessary to put this process on hold and create moments of criticism and reflection, both regarding the methodologies being used and the respective achieved results. In this way, it was possible to generate more sensible solutions, with a view to more positive and satisfactory results. In addition to this point, it is also necessary to realize that during the Design process there are several external factors that can affect project progress, such as the commitment of partner entities, altered production times, unforeseen events of various kinds, financial factors, and social conditions.

3 Results

The application of Design Thinking methodology in this project has become an important tool in the development of a product with a complex typology, such as intelligent microscopy. Its application was due to the scope of this method and the effectiveness that translates into developed and innovative solutions, where problems are solved together by a multi and interdisciplinary team, and also with the target audience itself. The introduction of this concept, using qualitative techniques, was essential to develop a solution capable of becoming comfortable, efficient, and intuitive. Its evolution was carried out jointly with the end-users, making them the object of study, and at the same time participating in the project itself.

The qualitative approach of this methodology allowed us to obtain knowledge about the subject studied through the opinionated criterion of the participants. The results obtained showed the solution's current needs, highlighted both by the analysis of the context of use and the users' opinion. These data allowed the justification of choices for the project, dividing it in two ways: justification of the conceptual choice and justification of the technical choice.

Regarding the justification of the conceptual choice, the needs are linked to the following conclusions:

- Absence of significant changes in the design of microscopes over the time;
- Explore the efficiency gains that Artificial Intelligence systems can potentially bring to laboratory and clinical contexts;
- Need to enhance the individual contribution regarding certain procedures only performed by a limited number of professionals;

Regarding the justification of the technical choice, it was possible to analyse the following aspects:

- Need for equipment capable of being mobile and easily transportable;
- Resistance to external factors (e.g., vibrations);
- Sanitation and maintenance;
- Need for complementary accessories to improve sample placement process.

The intermediate usability tests carried out were used to test some solutions, such as the slide holder and the on/off button, based on the concepts and information regarding the needs of the required users above. Seven different slide holder solutions were presented, and the results obtained allowed to discover which solution has the greatest potential. Additionally, these results also pointed to which aspects should be improved in future works, such as: the application of an ambidextrous handle with a textured surface; the use of an efficient lock system between the slide holder and the stage; and an opening for insertion/removal of the slide during its insertion in the slide holder.

Regarding the on/off button test, the results also showed that the implementation of a button to turn the equipment on at the top would be the most intuitive way to carry out this process (proving the theory mentioned), as well as the application of concave buttons and click switch and push systems.

The final usability test allowed to put into practice the detailing and review of previously tested solutions, as well as other tangible functions of the equipment, such as the placement of the smartphone and its alignment with the optical tube, or the transport of the prototype. The results obtained were quite promising, showing, through statistical analysis, a very high level of acceptance by the end-users. The critical opinion also allowed us to understand which points needed to be improved in each of the presented objects of study, such as the improvement of the slide slip through the slide holder, the stage lock-up system and the physical reinforcement of the handle. It was also possible to measure the time of each task, and therefore compare it with the result obtained in the usability test of the previous version of the prototype. The test performed in this investigation had an average time of 53.3 s (1 technical assistance) compared to 84.6 s (16 technical assistances) in the test performed with the previous version of the prototype [7]. In order to complement these results, each participant was asked to answer a SUS test (System Usability Scale) so that a value (on a scale from 0 to 100) of the usability experienced by the participant could be assigned. The calculation of answers allowed the attribution of a value of 96.25, corresponding to the highest score on the scale (A – between 90 and 100).

4 Discussion

The application of the Design Thinking methodology in the project was extremely important, as it amplified the solutions found, quantitatively and qualitatively, in order to develop equipment capable of asserting itself both in form and function, promoting a greater connection between the product and the user. The real challenge of this project was to be able to integrate this type of methodologies in a pandemic context, as the

techniques used involve a direct proximity to the surrounding people, both the team and end-users. Thus, an adaptation was necessary, namely through the online medium, and so turn problems into opportunities for the project.

The experience gained by the design process allowed us to verify that the disciplinary diversity within the work team makes the project more dynamic, thus helping to develop more efficient and innovative concepts and solutions. The areas involved in this project are divided essentially into scientific disciplines, which makes Design a link capable of materializing this same knowledge through product development, improving interaction with the user. This way, it was possible to develop new perceptions about how the contribution of Design can be a privileged means of materializing the various concepts developed at the theoretical level, in applied research processes.

The relevance of the link between Design and other disciplines was verified in the application of knowledge of team members and end-users from various technical fields, namely mechanical engineering, electronics, informatics, biomedical engineering, medical sciences, and human-computer interaction, united by design through participative methods. In this way, it was possible to create a means of reflection for new Design application models, integrating users as an object of study and project participants, as well as the sharing of useful knowledge, through multidisciplinarity for the creation of projects capable of promoting a better human interaction with the product. Given this, it is possible to understand that “*(...) strengthening the relationship that users establish with their products is one of the factors that can contribute to prolonging the time the products are in use, and thus postponing their replacement.*”⁶ [18].

The significance of the above-mentioned results allows showing the importance of the applied research process in product development, namely the typology of intelligent microscopy. These results are essentially critical, as they were provided directly from the participants, and allow us to reveal the technical needs for the project, such as the improvement of tangible processes for the fitting of the slide, placement of the smartphone, introduction of a transport system and application of a simple design for fast and efficient maintenance. Regarding conceptual factors, these are linked to social needs, such as the deficit of microscopy-based diagnosis in peripheral areas, both in terms of equipment and experts available on-site. It then becomes possible to justify technical and conceptual choices in applying the project. The application of approaches focused on human centred design, such as usability tests and their comparison between previous tests, were essential to develop, detail and validate ideas and solutions, and thus create a more complex interaction between product and user. This way, it was possible to justify the solutions developed, as well as validate the conceptual and technical choices of the project itself, which allowed us to accomplish the main objectives of the investigation: the redesign and optimization of the entire tangible interface of the equipment based on the previous version of the prototype.

⁶ Translated quotation: “*(...) fortalecimento da relação que os utilizadores estabelecem com os seus produtos é um dos fatores que podem contribuir para prolongar o tempo em que os produtos estão em uso, e assim adiar a sua substituição.*”

5 Conclusion

This multidisciplinary integration, coming from a mixed work team in their areas of origin, and the use of the Design Thinking methodology was important to create personal reflections on new ways of designing in a real context, as until then the design experience had only been academic. This article shows through the description of the appliance of methodological workflow in Design, how this type of methodologies and the integration in a multidisciplinary team can be important to create products with complex typologies. The phased process describe by Design Thinking, was crucial to determining the success of this project, as the introduction of end-users into the process itself allowed for the implementation of more effective ideas, capable of expanding the relationship between product and user. This improvement in interaction was only possible in this investigation due to the user-centred approach, combined with the multidisciplinarity of the surrounding work team, placing Design as a means for a symbiosis between the various disciplines necessary for the implementation of a project with the typology of intelligent microscopy.

In conclusion, it becomes possible to demystify traditional work methods, where the project flow is done individually, without resorting to information obtained directly from the target audience and from the experience of other areas of work, focusing on the real needs of end-users and companies.

Acknowledgments. I leave a huge thanks to my advisors Prof. Luís Mota and Prof. João Martins, and the Polytechnic Institute of Viana do Castelo, for believing in me and my potential, and for providing me with all the methodological tools to develop an effective and coherent design process. I would also like to say a big thank you to Eng. Paulo T. Silva and the entire team at Fraunhofer Portugal – AICOS for their trust, support and for all the necessary instruments for the development of the project and product conception.

The project “TAMI - Transparent Artificial Medical Intelligence” (NORTE-01-0247-FEDER-045905) leading to this work is co-financed by ERDF - European Regional Fund through the Operational Program for Competitiveness and Internationalisation - COMPETE 2020, the North Portugal Regional Operational Program - NORTE 2020 and by the Portuguese Foundation for Science and Technology - FCT under the CMU - Portugal International Partnership.

References

1. Rosado, L., et al.: µSmartScope: towards a fully automated 3D-printed smartphone microscope with motorized stage. In: Peixoto, N., Silveira, M., Ali, H.H., Maciel, C., van den Broek, E.L. (eds.) Biomedical Engineering Systems and Technologies, pp. 19–44. Springer International Publishing, Cham (2018). https://doi.org/10.1007/978-3-319-94806-5_2
2. Fraunhofer - AICOS: Micron – Affordable and automated mobile-based microscopy. https://www.aicos.fraunhofer.pt/en/our_work/portfolio/micron.html. Accessed 19 Nov 2021
3. Fraunhofer-Gesellschaft: Profile/Structure - Research Dedicated to the Future. <https://www.fraunhofer.de/en/about-fraunhofer/profile-structure.html>. Accessed 19 Jun 2021
4. Rosado, L., Costa, J., Elias, D., Cardoso, J.: Automated detection of malaria parasites on thick blood smears via mobile devices. Procedia Comput. Sci. **90**, 138–144 (2016)

5. Rosado, L., da Costa, J., Elias, D., Cardoso, J.: Mobile-based analysis of malaria-infected thin blood smears: automated species and life cycle stage determination. *Sensors* **17**(10), 2167 (2017). <https://doi.org/10.3390/s17102167>
6. Brandão, P.: μ SmartScope - development and optimization of a low-cost automated multi-axis microscope stage for the accurate diagnosis of cervical cancer. Faculdade de Engenharia da Universidade do Porto (2020)
7. Fraunhofer - AICOS: Malaria Scope Usability: Test Plan and Results. Porto (2018)
8. Brown, T.: Change by Design. Harper Business, New York (2009)
9. Silva, F.: Investigar em design versus investigar pela prática do design - um novo desafio científico. INGEPRO - Inovação, Ed. vol. 02, no. 04, pp. 82–91 (2010).
10. Ulrich, K., Eppinger, S.: Product Design and Development, 5th edn. McGraw-Hill, New York (2012)
11. Cross, N.: Designerly Ways of Knowing. Springer, London (2006). <https://doi.org/10.1007/1-84628-301-9>
12. Mota, L.: Design como fator de humanização no desenvolvimento de produtos: Posto de trabalho para ambiente cowork. Faculdade de Belas Artes, Universidade do Porto (2015)
13. Müller-Roterberg, C.: Handbook of Design Thinking - Tips & Tools for How to Design Thinking. Kindle Direct Publishing, Seattle (2018)
14. Soares, L.: O Designer como Intérprete de Cenários de Equipamentos. Departamento de Comunicação e Arte, Universidade de Aveiro (2012)
15. Rosado, L.: Pitch and Value Proposition. Porto (2018)
16. Dam, R., Siang, T.: 5 Stages in the Design Thinking Process. <https://www.interaction-design.org/literature/article/5-stages-in-the-design-thinking-process>. Accessed 20 Apr 2021
17. IDEO.: Human Centred Design - Kit de Ferramentas. 2nd edn. (J. Colucci, I. Melo, & T. Pinheiro, Trans.). IDEO, California (2011)
18. Martins, J.: A durabilidade dos Clássicos do Design como instrumento de apoio ao processo de conceção de produto: 10 princípios para o projeto. Departamento de Comunicação e Arte, Universidade de Aveiro (2015)



Character Design: The Case of Characters in a Hybrid Serious Game Called *FlavourGame*

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Abstract. *FlavourGame* is a hybrid board game, from the serious games category, which aims to promote among children, discussion and awareness for taking correct choices in their nutrition. As part of this project, the design of the characters that make up the game's narrative is being developed. This process, which is still undergoing, so far involved, in a first stage, a small literature review on the process of Character Design, in order to identify the existence of some kind of transversal methodology to follow. In a second stage, the main psychological and emotional characteristics of the characters were determined, so that, in a third stage, the visual design of these characters was studied. Finally, and in a fourth stage, different components of the Design of the characters were evaluated with three samples of the target audience. Thus, this article presents the theoretical framework connected to character design, describes the so far undergone creative and design process of *FlavourGame*'s characters and presents three small stages of the characters' design assessment with children between the ages of 10 to 12. Throughout the article, we also identify and describe the iterations and changes that were made to the character design according to both the opinions expressed by the children regarding their preferences and the collaboration of a graphic designer in the character design process.

Keywords: Character design · Graphic design · Concept art · Tabletop games · Serious games

1 Introduction

FlavourGame (FG) is a new hybrid game developed for children between 10 and 12 years old. This game aims, among this target audience, to promote discussion and raise awareness for healthy choices around nutrition and daily eating, since childhood overweight and obesity in Portugal have already reached alarming levels. In consequence, it becomes urgent to implement prevention and monitoring strategies and programs to prevent a growth in the number of children and adolescents at risk [1]. As a game, FG is based on a hybrid approach using both physical media (such as the typical game board, cards, dice, cubes, among others) and digital elements displayed on a screen. So, all media must

assume a visual representation that must, on one hand, serve and integrate the game narrative, the game experience and the game goals, and on the other hand, contribute to the game's sense of graphic unity and visual identity.

One of the most important visual components of a game are the characters. In this particular game, some characters will be used as physical pieces that integrate the game and move dynamically on a physical board, depending on the children's different game moves. Therefore, it was necessary to design the characters and give them a striking visual design that would remain in the children's memory. This process was based on a methodology that, on one hand, is close to the one described by Tavares & Teixeira [2] being free from a design method (not method), resembling more the work of an artist. In that sense, it obeyed to the individual and creative freedom of both the author and the Graphic designer who drew the characters, while at the same time they tried to come up with solutions that addressed the needs of the game. As stated by Morin [3] this type of method is important because it gives to whoever employs it the ability to control, in his own way, the development of the artistic creation, thus improving his own method.

On the other hand, the development process of FG's characters also included a previous stage of characterization of the characters, as it was found to be advocated by various authors consulted in the theoretical framework that is presented in the next section. As a result, this paper presents and describes the entire theoretical and practical process underlying the design of the FG's characters.

2 Character Design Theoretical Framework

A character's Design does not seem to obey a specific and transversally applied methodology. In fact, this process can be relatively free, as described by Tavares & Teixeira [2], who state that its rules and methodologies can be self-imposed, similarly to what happens with an artist. However, this does not seem to involve only the act of conceiving the visual design of the characters. In the case of a game, this becomes particularly true, since the characters themselves have to be created based on the story, goal and theme of the game. Like humans, the characters need to have differentiating features and traits that give them individuality and distinguish them from the other elements of a narrative. This is because, as Solarski [4] states, although referring himself to human gestures and not to characters, this is an immense source of information and clues to a person's personality and current emotional state. So, the same will apply to Character Design. And therefore, this process, while not having to follow a single methodology, involves more than just designing the appearance of characters, as will be discussed below.

For Blair [5], author of the book *Cartoon Animation*, the design of a character is not just an illustration exercise. Each character has a specific shape, personality, characteristics and even mannerisms and this should be addressed in its design. This is because, according to Blair, there are several personality types, such as the Goofy like, the Cute like and the Screwball like personalities. Thus, the author recommends that you first think about the type of character you want to create, and only then move on to the design. But Blair is not alone in this conception. For Heussner [6] designing and creating a character involves knowing what his past was like, what he likes, his concerns, where and how he lived. Maestri [7] adds that this process involves knowing the character's

personality and then making decisions that communicate that same personality visually. Oppositely, Tillman [8], takes this stage of prior characterization to the extreme by stating that the more information one has, the easier it will be to create the character. The author also says one should make a list of characteristics subdivided by categories, ranging from the most basic (e.g. hair color, weight, name, race, etc.) to emotional and spiritual characteristics (e.g. motivation, beliefs, etc.). Shell [9], despite also proposing a process based on prior knowledge of the character, puts at the base of the process, not the definition of a list of characteristics, but a listing of the functions they will have in the narrative. Only after this stage Shell proposes the definition of Character Traits, where a list of characteristics is then established. However, unlike Tillman [8], Shell [9] argues that a list of essential characteristics is enough to define traits. Silver [10] is an author who, unlike the ones previously mentioned, does not seem to place the previous stage of characterization of characters as necessarily the most important. In fact, he even seems to praise the visual design of the character by devoting almost 4 of the 5 stages of his design to it. Although he places visual design as a stage of the process that is also subsequent to an initial characterization stage, as advocated by the authors mentioned before. Thus, Silver [10] advocates for Character Design a process that is divided into 5 stages. The first stage, dedicated to the Story, is where one should learn as much as possible about the character, including what motivates him and what effect he is intended to have on the story. The second stage (Gestures), the third (Design), the fourth (Shape), and the fifth (Details) are stages of the process that Silver argues are more dedicated to exploring, through drawing, not only the visual characteristics of the character (the Design, Shape, and Details stages), but also the behavioral characteristics of the character (the Gestures' stage).

A slightly different opinion, although not totally divergent from those mentioned before, is that of Lee Sheldon [11]. Even though he does not refer directly to character design, but to concept art, he criticizes the fact that, often in the games industry, first the design is thought of and only afterwards the story is thought of, and then someone is hired to write a story that fits the design created. He also implies that characterization and concept art work well because they are developed at the same time and collaboratively. Therefore, Sheldon [11] understands that the development of any kind of art in a game, including the characters, should involve, in parallel and not in distinct stages, the process of characterization and visual design, in a dialogue between these two dimensions that feed each other in the design's process.

From the opinions discussed before, one realizes that a character design's process is, at least in a first stage, closely linked to the study and conception of the character's characteristics and function within the narrative and it seems that this is an essential stage in the process, although with many methodological variations that vary from author to author. Therefore, after this literature review, it was decided to value and integrate into the methodological process this stage of previous characterization, which seems to be as important as drawing.

3 Creative Development Process of FlavourGame's Characters

In this Character Design process, the visual design of the FG's characters was developed. However, this process did not immediately start with drawing. Based on what is

advocated by most of the aforementioned authors, before drawing any characters, they were first characterized so a good connection between them and the game's narrative was created in order to make the players understand it and engage with it. Thus, the following describes the characterization process and the later design, testing, and iteration stages of the characters' visual design.

4 First Stage: The Initial Characters' Characterization

Several characters were created for the game. However, this article focuses only on some of them (the ones considered to be the most important in the narrative), since the rest followed exactly the same design procedures. Thus, three heroic and two villainous characters are presented. On the hero side are Diana, Gabriel and Viktoria, all children of Celtic gods. These, despite having different personalities and personal goals, have a common goal in the narrative, namely, to defeat the Apalad tribe and restore their territory's biodiversity. The villains are Magnus and Darius, whose main goal is to invade the territory of neighboring tribes to devour everything they can.

In order to define the characters, we created, in a first stage, a table with the psychological and social characteristics of these characters. Thus, it was possible to come up with a general characterization of each character that is presented next:

Gabriel is adventurous, lonely and courageous. He has a tremendous fear of failure and craves for his mother's recognition. The pressure of others' opinions is one of his biggest problems, since his brother Magnus has run away to join the Apalad tribe. Thus, his main goal is to be the hero and get his brother back from the hostile tribe;

Diana is calm, kind and intelligent. She is the sorceress and healer of her tribe, and is revered for her mystical potions. Her greatest fear is the suffering that the people around her may experience, so tranquility both within herself and in others is her greatest desire and goal. Despite her serene appearance, Diana has insecurities in moments of greatest tension, which is a problem she permanently struggles with;

Viktoria is strong, extroverted, cheerful and impulsive. She's also very social and aims to make friends. Therefore, her greatest fear is loneliness. Despite having a charismatic personality she is sometimes seen as insensitive and unkind;

Darius is one of the strongest elements of the Apalad, being a grotesque and aggressive wizard. His desire is to make the other tribes his slaves. He despises nature, to which he recognizes no value and smothers all the beauty and diversity he finds. His only fear is Magnus, which he worships;

Magnus is the most powerful and ruthless character of the hostile tribe. He has an ambiguous personality, being both seductive and vengeful. He wants to annihilate Mother Nature, his brother Gabriel (one of the heroes) and to be the supreme leader of Chocó. That is why he's fearless and isn't afraid of using any means to achieve his ends.

5 First Stage of the Character's Drawings

The first sketches were created based on the characterization previously mentioned and on several visual references collected through the analysis of how large companies worked the characters of games, movies, series and animations aimed at children between

10 and 12 years old. The goal of this survey was purely qualitative, as we wanted to assess what elements could be used to define a visual identity. From this survey we selected inspiration elements that are part of the tribal visual imagery. Namely masks, clothing, weapons and face marks. After the visual research, the graphic experimentation began (Fig. 1). At this stage, besides the tribal elements, accessories related to their psychological and emotional characteristics were added to the characters, accentuating both their physical features and their poses as, according to Gard [12], the exaggeration of the pose will make the character gain meaning.

Regarding Diana's accessory, a staff (stick) was selected to symbolize magic and her sorceress side. Gabriel was given a bow and arrows to represent his dexterity. As for Viktoria, a sickle was added, associated to her strength (Fig. 1).

In the case of the villains, as they belonged to the hostile Apalad tribe that in the narrative used weapons and magic to fight and conquer the territories of the other tribes, they were also drawn with weapons (Fig. 2).

In accentuating the physical features, we chose to highlight the elements of the characters' faces since it is in these elements that the facial expressions and their emotions will be displayed. In the case of the heroes, for which three versions of each were drawn, the eyes and the eyebrows were highlighted. Tribal markings were also added to their faces, symbolizing the tribe that each character protects. In the case of the villains, masks were added to all of them with the aim of making the player think that behind them are hidden deformations that come from careless eating. Thus, it was decided to apply masks in which the eyes are always quite dark to accentuate their terrifying appearance. As for the villains' mouths, these were drawn in a position that is always open or hidden. In the villains who have the mouth open with the teeth exposed, we tried to deteriorate the teeth, since this is one of the consequences of a bad diet (Fig. 2). As Fairrington [13] states, beautiful and straight teeth convey that the character is honest and upright, while crooked teeth or the absence of them can give the impression that the character is poor or rude.



Fig. 1. First visual design studies of the heroes (three graphic versions of each).

As far as poses are concerned, it was decided to give the heroes poses that convey safety and friendship. In the case of the villains, they were given combative and exaggeratedly defiant poses. So the good characters get clearly distinguished from the bad ones. This is because, according to Rogers [14] a strong and clear silhouette is important as it quickly translates the character's personality, distinguishing it from others, i.e., it distinguishes the good characters from the bad ones and helps to make them stand out in the game world or environment.

6 First Stage of Testing and Results

After the sketches were created, it was decided to conduct a brief, informal exploratory test of children's preferences with a small sample of 3 participants aged 10. The goal was to adjust the visual design to the target age group of the game (from 10 to 12 years old). However, as previously mentioned, only the heroes were tested, for which three versions were designed, with different levels of graphic detail. Therefore, after showing the participants the three versions, they were asked which their favorite was and the reasons for this preference. This was because it was intended to understand which of the versions could work best at the empathic level with children of that age group. In terms of results, the opinion expressed by the children was unanimous. The preferred versions were the ones positioned in the middle (Fig. 1). The justifications for this choice were related to the size of their eyes and the fact that they appear to be short. It was also found that the version chosen is the one with the most simplified graphic visual language. Thus, this was considered the way to go for the visual language of all the characters in the game. Accordingly, it was chosen to simplify, also, the design of all the characters in the game.

7 Second Stage of the Character's Drawings

Shortly after the test described above, the FG research and development team integrated a new element, a graphic designer who would be responsible for the development of the graphic and visual design of the game's elements. Since the visual design of the characters would have to be consistent with the graphic design that would be developed for the other elements of the game, he was also called to intervene in the visual design of the characters. And, given his background in Communication Design, and the need to bring together the future graphic design of the remaining game elements with the characters' visual design, this new element immediately identified some issues that he considered problematic. In his opinion, there was a noticeable lack of consistency in the visual language between the characters' drawings. On the one hand, the heroes had a more childish visual language, which in itself he suspected could be unsuitable for 10 to 12 year olds. On the other hand, the villains seemed to have a visual language and stroke, which although calligraphic, was more fun and less childlike than that of the heroes (Fig. 2).

This kind of visual inconsistency in the characters' design is undesirable and should not exist as a whole and within the visual identity of a game because, as Budelmann et al. [15] point out, effective graphic identity systems require reasonable consistency to be



Fig. 2. Visual design studies of the heroes (bottom) and villains (top).

identified as such (p. 70). Regarding the heroes, the Graphic Designer also suspected that there was too much color, which could later raise problems in creating the visual identity and a sense of unity in the chromatic treatment of the other visual elements of the game. In fact, this was not desirable in the overall context of the game design, since it would also have to obey a graphic identity. Typically, this kind of visual identity is reinforced when you limit the chromatic palette and not the other way around, as Samara [16] points out, limiting the color palette creates a more focused and memorable chromatic experience. Limiting the palette to two or three colors will create a stronger impression (p. 26). However, the question arose as to whether or not characters with a reduced color palette would appeal to children of this age group. It was therefore decided to conduct a test to find out more about this issue, as described further on in this document.

Taking the described problems into account, it was decided that the visual design of the characters would also have to meet the following requirements: i) have a consistent graphic language that could be transposed into the design of the graphics of the remaining elements of the game (board, cards, etc.); ii) have a fun visual language more appropriate for the age group of the target audience; iii) have a more simplified drawing stroke and visual language.

Given these requirements, the heroes were redesigned to have a visual language more consistent with that of the game's villains, particularly in terms of expressiveness and exaggerated posture and also in terms of the type of stroke line. The graphic designer and the author who drew the characters decided to retain the calligraphic side and the expressiveness of the difference in thickness of the stroke's line, as shown in Fig. 3, which shows a villain and a hero vectorized in Illustrator, as such, in their opinion would give a more “fun like” feel to the character’s visuals.

As can be seen in Fig. 3, the transposition of the properties of the monsters' line stroke (more simplified and more calligraphic) to the heroes, helped to harmonize their visual language. The vectorization itself supported this process of uniformity which is also beneficial for the visual design of the game overall, as it can be transposed to the design of other game elements, such as the game board elements (Fig. 4).



Fig. 3. Stroke line study of a monster (left) and a hero (right).

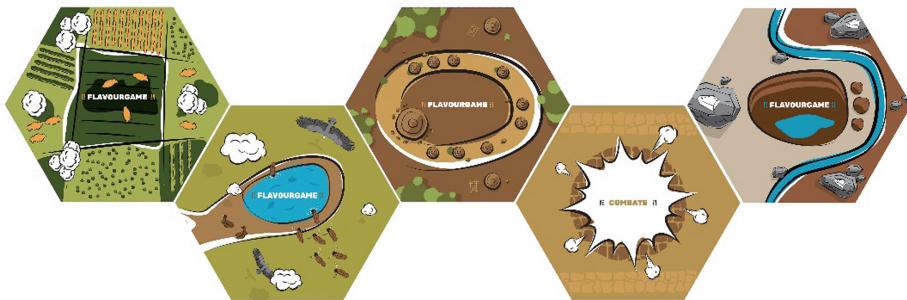


Fig. 4. Design of the hexagons that make up the FG game board.

8 Second Stage of Testing and Results

After bringing closer together the visual design of the heroes to that of the other characters, two new tests were conducted with two samples of the target audience on different aspects of the characters' design.

8.1 First Test and Data Collection Method

The first test of this second stage was conducted through a semi-structured interview with 3 children aged between 11 and 12 years old, with the goal of globally probing their opinion about the clothing, weapons and facial expressions of these characters. Methodologically, the interview lasted about 20 min and the interviewer used informal speech to make the children feel at ease while answering the questions. Additionally, cards with representations and descriptions of all the characters in the game were also created so that the children could read about their characteristics and observe the drawings created to represent them. After playing the game and after using different characters, the interviewer read the participants a brief synopsis of the basic narrative of the game and the

individual narrative of each character, information which was also summarized on the cards.

Results About the Characters' Clothing

After the procedure described above, the children were asked what they thought of the characters' clothes. The intention was to verify if they had difficulties understanding what the characters were wearing and whether or not they suggested any changes. In terms of answers, the results were mixed. While one of the children totally agreed with what was drawn, it was noticeable that the other two had a hard time interpreting what one of the characters - Magnus - was wearing. Therefore, they suggested that an armor should be added to it. Regarding the heroines Diana and Viktoria one of the children mentioned that they could also wear pants, since in a fight it would be impractical to wear a dress. Regarding the level I monsters, one of the children emphasized the need for them to have more damaged and old clothes or even wear an armor, since their skills were physical attacks. Regarding level II monsters one of the children associated clothing with abilities and proposed that a cloak should be added to them, given their magical abilities.

Results About the Characters' Weapons

The children were also asked what they thought of the weapons assigned to each character. The goal was to understand if they liked the options designed and if they suggested, or not, any kind of change. Regarding the level I monsters' weapons, only one child suggested a change. This was to make the weapons of these characters look more like rusty iron weapons. About the level II monsters' weapons, the children didn't make any remark. As for the heroes, one of the children suggested that Diana should have a stick with a more common shape and with vegetation around it. Regarding Viktoria, two of the children questioned the usefulness of the sickle since, for them, it doesn't convey the strength that characterizes the character, even symbolizing death. Thus, they suggested that the sickle should be replaced by a hammer.

Results About Characters' Facial Expression Designs

In order to understand what could be improved in the facial expressions of the heroic characters, the children were also shown several facial expressions for each character, in order to verify if the children made interpretations of these expressions that were, or were not, coincident with the emotions it was expected them to associate with each facial expression. In this case the facial expressions of level I and II monsters weren't tested, since they had masks covering their faces. In addition, the children were also given the freedom to suggest whatever they wanted about the shown expressions. Therefore, they were shown four facial expressions of each heroic character (Fig. 5).

In Viktoria's case, the interpretations were unanimous and almost all correct considering the initially intended interpretation. For expression A (Angry) they all answered that the character seemed to them to be "angry". For expression B (Happiness) all responded that the character seemed to be "happy". For expressions C (Fear) and D (Surprise) one child couldn't decipher the emotion that the expression conveyed. However, the other two children got it right.

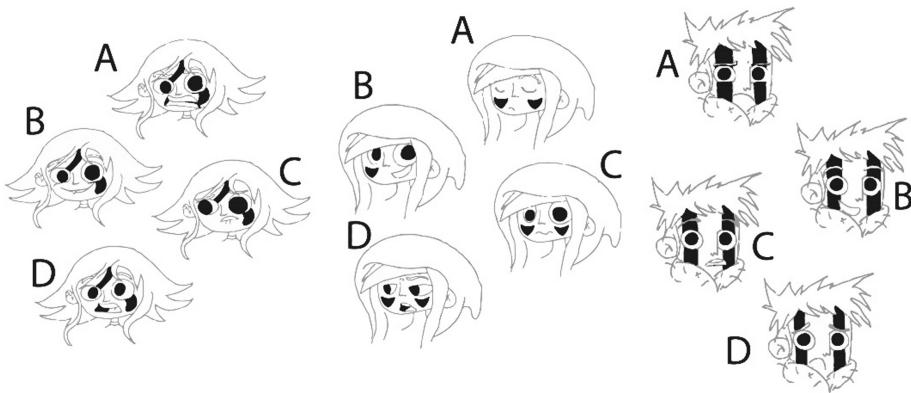


Fig. 5. Facial expressions studies of the tested heroic characters.

Regarding Diana, the only expression in which the associated emotion was correct and common to all was expression B (Happiness). As for expression A (Carefree), they were all wrong. The children's interpretations were: "convinced", "is crying" and "does not agree with what is being said". In the case of facial expression C (distressed/worried), the interpretations were not exactly the ones intended but they were not totally incorrect as two of the children interpreted this expression as "crying", which is a behavior that can be associated with worry and distress. However, the remaining child mentioned that the character looked sick. The last facial expression, D (Distrust), also raised doubts, although one of the children correctly identified the emotion. However, the remaining two ones were wrong, mentioning interpretations such as "unconcern" and "vomiting".

Finally, about the expressions drawn for Gabriel, the children made, in some cases, interpretations that coincided with those initially intended, and in other cases not. In the case of expressions C (Happiness) and D (Sadness) the interpretations made were all correct. For facial expression A (Angry) there was only one incorrect interpretation (Sadness). For facial expression B (Surprise), only one child got it right. However, a second one did not associate the facial expression with any emotion and the third interpreted the expression as "concern".

8.2 Second Test and Data Collection Method

The second test was applied to 7 children aged between 10 and 12, with the goal of verifying whether or not limiting the chromatic palette of the characters would be a chromatic solution that they liked compared to a less limited palette. Methodologically, the interview lasted about 3 min and the children were shown, on several A4 paper sheets, 3 different color schemes of two characters (Fig. 6): a monochromatic version (one color combined with a darker tone and uncolored hair and skin tones); a two color version (two colors combined with darker tones and uncolored hair and skin tones); and a version with more than two colors (two colors combined with darker tones but colored hair and skin tones).



Fig. 6. The three versions of coloring schemes tested on two of the game's characters.

Next, the children were asked to rank, by their order of preference, the shown colored versions and to justify their preferences.

Results About the Characters' Tested Color Schemes

In terms of results regarding color schemes, most children preferred the monochromatic one. Four of the seven children in the sample preferred the monochromatic version, one preferred the two color version and two preferred the version with more than two colors. When analyzing the justifications given for the preference for a more simplified color scheme, it becomes evident that the motivation is aesthetic and that it gives them more impact. Two of these children even suggested that having colored and non-colored details together helps to make the characters visually cleaner and more eye catching. These results seem to be confluent with what Samara [16] states about the use of color when he says that limiting the color palette creates a more focused and memorable chromatic experience. Therefore, these results suggest that both these and the other characters should have an equivalent monochromatic treatment to the monochromatic version used in this test, including having some details uncolored.

9 Conclusions

Throughout the creative and design development, we verified that, as described in the reviewed literature, the Design process of a character may not obey a specific methodology. There were several moments in which this process was governed by a more artistic and free approach than by a standardized method with properly segmented and chronologically ordered stages, due to different needs of the FG project, as well as different inputs from the project's elements (from the vision of the author of the character design and the graphic designer, to the opinions of the other team members). Nonetheless, the taken approach was not entirely free and was complemented with research methods that probed into the children's acceptance degree of the created characters and their visual features. Notwithstanding this methodological digression, the various approaches reviewed in the literature also provided some guidelines that were important for the FG's characters design process, particularly the characterization stage. This characterization proved to be very important in helping to define visual and postural properties that are identity marks and that allowed to differentiate some characters from others and visually link them to their function in the game's basic narrative. On the other hand, the tests with children also allowed for data collection that will further aid in improving the design of the characters in future design iterations, in terms of weapons, clothing and

facial expressions. They also allowed to understand what kind of graphical and chromatic approach to pursue in order to adapt their visual appearance to the expectations and tastes of a player within the age group of FG's target player. Regarding clothing and weapons, the suggestions mentioned by the children show that it is important that the choice of these elements and their visual configuration is based on the function of the character in the story and the connotations that may be associated with it. As for the facial expressions, there is still room for improvement as some of them weren't correctly identified by the children and still need some changes to make it easier to identify the emotion conveyed by the designed expression. In terms of graphic and chromatic approach, the results suggest a more simplified visual language (a stylized one) and the adoption of a monochromatic color scheme, since the children tended to prefer it. Their own justifications suggest that this gives them a greater aesthetic impact and it appears less confusing to them. Further on we still have to study the specific colors to be used in each character as, we have only tested what kind of color scheme the children preferred and not the specific colors themselves used in the chosen color scheme. That remains, so far, to be addressed and tested.

Acknowledgments. The authors would like to acknowledge POCI-FEDER and FCT for funding this Project, under the Grant Agreement No. POCI-01-0145-FEDER-031024.

References

1. Viveiro, C., Brito, S., Moleiro, P.: Pediatric overweight and obesity: the Portuguese reality. *Revista Portuguesa de Saúde Pública* **34**(1), 30–37 (2016)
2. Tavares, P., Teixeira, P.M.: Drawing and project: tradition and innovation. In: Proceedings of Conferência Designa 2011. Universidade da Beira Interior (2011)
3. Morin, E.: O método III - O conhecimento do conhecimento/1. Publicações Europa-América, Lisboa (1986)
4. Solarski, C.: Interactive Stories and Video Game Art: A Storytelling Framework for Game Design, 1st edn. Taylor & Francis, A K Peters/CRC Press, BR, FL (2017)
5. Blair, P.: Cartoon Animation, 1st edn. Walter Foster Publishing, USA (1996)
6. Heussner, T.: The Advanced Game Narrative Toolbox, 1st edn. CRC Press, BR, FL (2019)
7. Maestri, G.: Digital Character Animation 3, 1st edn. Pearson Education, USA (2006)
8. Tillman, B.: Creative Character Design, 1st edn. Focal Press (2011)
9. Schell, J.: The Art of Game Design: A Book of Lenses. 1st edn. Morgan Kauffman, Burlington, MA (2008)
10. Silver, S.: The Silver Way: Techniques, Tips, and Tutorials for Effective Character Design, 1st edn. Design Studio Press (2017)
11. Sheldon, L.: Character Development and Storytelling for Games, 1st edn. Thomson Course Technology PTR, BS, MA (2004)
12. Gard, T.: Building character. *Gamasutra*, 12 (2000). http://www.gamasutra.com/features/20000720/gard_01.htm. Accessed 30 Dec 2020
13. Fairrington, B.: Drawing Cartoons and Comics for Dummies, 1st edn. Wiley, Inddy, IN (2009)
14. Rogers, S.: Level Up!: The Guide to Great Video Game Design, 1st edn. Wiley (2010)
15. Budelmann, K., Kim, Y., Wozniak, C.: Brand Identity Essentials. 100 Principles for Designing Logos and Building Brands, 1st edn. Rockport Publishers Inc., Beverly, MA (2010)
16. Samara, T.: Graphic Designer's Essential Reference. Visual Elements, Techniques, and Layout Strategies for Busy Designers, 1st edn. Rockport Publishers, Beverly, MA (2011)



Creating Cultural Experiences in a Cemetery: A Storyboard for a VR User Interaction

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Abstract. There is an increasing need to promote and disseminate cultural heritage. Tourism explores cultural heritage in many different contexts. However, in cemetery tourism, the approaches are scarce. Thus, a cemetery needs to be seen and also accepted as art, culture, and knowledge. This paper aims to present a pilot study to develop a VR-based experience, mainly considering the storytelling and storyboards as core factors for increasing user experience in cemetery tourism. Also, it aims to promote cemetery tourism as an important role in showing the history of a nation. For that, the Mausoleum of the Palmela's Dukes, the biggest private mausoleum in Europe, in Prazeres Cemetery, Lisbon, will be used as an intervention place. Combining cultural heritage and the Palmela's family history presented there with the creation of a virtual reality experience will give the users a unique cultural experience. Our research methodology comprises an analysis of guided visits to Prazeres Cemetery and the Mausoleum, a semi-structured interview, a qualitative analysis, and bibliographical research. All the information collected allowed us to develop a storytelling proposal that set the base for the storyboard, developed to be used for the VR experience.

Keywords: Virtual Reality · Interaction design · Cemetery tourism ·
Storytelling · Storyboard · Cultural heritage · User experience

1 Introduction

User experience (UX) is the “user’s perceptions and responses that results from the use and/or anticipated use of a system, product or service” and the “users’ perceptions and responses include the users’ emotions, beliefs, preferences, perceptions, comfort, behaviors, and accomplishments that occur before, during and after use” [1]. UX increases user satisfaction by improving usability and the interaction between human users and

computers. In addition to usability, UX also influences the emotional impact during interaction, usefulness, and the memory after interaction [2]. There are different processes in UX design, but there is one important process that is under study in this paper: storytelling.

To be a good storyteller in user experience, there are two important things: honesty and authenticity, along with simplicity or clarity of expression. Those are important because “a story is not just a collection of facts, but of information structured to appeal to an audience’s logic and emotion” [3]. And especially if the main objective is to catch their attention, moving people to thought and action.

Storytelling is possible the main way people understand the world as it allows humans to create an identity. “I have a trust, a faith in story that sustains me in my relationships with self and others. It is through story that we may come to know, through the story of the others” [4]. It can take many forms like oral, textual, or visual.

For the design area, storytelling can be fundamental in the projection of new and different experiences, enhancing the engagement and sense of presence, directly affecting how people feel and be into these experiences, learning and/or enjoying them in a different and sticking way.

There are five parts in the UX design process where storytelling can be most helpful: when you are collecting input, exploring user research and other information, stimulate or experiment with design ideas, testing your designs or when you need to share (or sell) your ideas [3].

When a design is well thought and projected, the designer would like to believe that it will sell itself. But if a picture worth a thousand words, a story has the correct number of words to explain that picture. This is where the role of storyboards in UX design enter when making storytelling more accurate and more communicative through a sequence of panels. “Narratives paired with visuals are one of the most effective tools for communication” [5]. Thus, it is significant to highlight the importance that storyboards have in UX and usability tests.

Therefore, user experience supported by well-developed storytelling and storyboards connected with technology could make design projects so complete and different from one another to respond to the user’s needs and adapt to new opportunities in the market to make the difference.

The development of new information technology brought several new opportunities for communication in different areas from teaching to leisure. Joining something “older” with something “new” can make a huge change in the way we teach cultural heritage. And why cultural heritage? Because it is part of us, it makes our history more tangible. So, “older” refers to the cultural heritage and “new” the digital techniques. Together, both, can make a difference in experiencing even more what the cultural heritage in our world has to show and talk about us and our history.

Digital techniques also could impact the cultural heritage field through the audience’s effective engagement, contributing to promoting their awareness about preservation importance. Thus, combining storytelling with new digital media could be a powerful way for sustain cultural heritage [6].

In this context, Virtual Reality (VR) could emerge as a powerful tool to fulfill some requirements (e.g., sense of presence, interaction, engagement, pleasure, fun) for creating a high-impact user experience with cultural heritage, mainly when tourism objectives

are also considered. That can be achieved using VR, giving life to storytelling, taking people to another level, an immersive one, another world, being inside the story, and then making our own story of the experiences we lived there. So, storytelling and VR can have an important role in tourism for cultural heritage and how the users can have new experiences in different places, with different concepts.

Tourism has been growing day by day and faster than we think. The reason is that there is a constant “attempt to offer new experiences, create new travel motivators and reach new markets” [7]. Those were responses for the visitors and client’s needs because it is important to have new experiences, emotions, and “knowledge in search for weird, unusual and unique memories” [7].

Although there are different types of tourism, it is relevant to highlight one that has increasingly awakened interest in other different locations around the world called cemetery tourism.

This can be an interesting and enthusiastic concept to be worked on to create new tourism products in a place that is both a source of a peaceful and respectful experience and full architectural, cultural, and social history. With this in mind, it is of paramount importance to develop strategies that can make cemetery tourism a pleasurable experience, taking history, art and knowledge to everyone in a different and exciting way, and giving life to cemetery heritage and the history of a country, but, above all, respecting the memory of those who are resting in this place.

In this context, the main objective of this paper is to present a study focused on the narrative creation and storyboards development for a VR experience to promote cemetery tourism and cultural heritage. For this, the mausoleum of the Palmela’s Dukes was considered as a case study and focus of intervention for this tourism experience development.

The paper is divided into five main sections. First, the introduction, in which the general lines of this work were highlighted. Second, the theoretical background that supports the study’s development and focused on the historical aspects that inspired and delineated the narrative structure. The third section is about the creation of a cemetery tourism experience in VR, and in the fourth section are shown the results of this study. Finally, the fifth part are the conclusions which summarizes the study’s main outcomes.

2 Theoretical Background

2.1 The Cemetery Tourism Concept

It is interesting to notice that, in the 19th century, cemeteries were considered places to spend time with family, get together with other people, and to be seen as a society member. But they became “closed for public with the intention to create a place of silent mourning, respect and privacy exclusively for those who came to visit their buried relatives or owners of burial places” [7]. This happened due to “the importance given to the individual grave, as opposed to the mass grave. Highlighting, respectively, issues of hygienic order and of individuality of each person” [8]. Then, in the 20th century, many cemeteries opened to have visitors to visit their loved ones, and to know the history of the place, the people, the art, the symbolic details, and travel between different eras in a place with so many to tell. After all, the cemetery is like an open-air museum that reflects our cultural, artistic, and historical heritage and development of the cities, being

one of the most important and specific types of outdoor museum due to their sculptures, architecture, and headstones.

Considering this, a tourism that is increasingly being discovered is cemetery tourism. The concept of cemetery tourism is widespread abroad, especially in Europe, where historically visits to burial sites for leisure or research purposes are not considered alien to society [9]. “The existence of this type of tourism will not cause surprise to those who are interested in these themes. If we think about it, we conclude that generally the cemetery, the necropolis, the city of the dead, is the other face, the other side of the mirror of the city of the living” [10].

Cemeteries are a heritage because in academic terms, it is assumed that the cemetery environment brings together art, memory, and historical-social interpretation of the community in which it is established [11]. So, they were made to be visited, travel through different eras and get to know new monuments, art, and culture. In addition to this, people go there out of curiosity fed by myths or legends or to attend cultural events, the main being religious [12]. This type of tourism in a cemetery does not necessarily allude to death because visits to cemeteries can have cultural or educational objectives. Several interests can be related, such as faith, tomb art, iconography and the important people buried there representing a specific country [11].

Each person has their individual experience in a cemetery. They go there to feel, to know and to see different things. Experiential states are usually categorized into cognitive activities (rational activities), affective (emotional responses), and conative (behavioral intentions). On the other hand, individual experiences comprise sensations (aesthetic and sensory qualities), feelings (including mood and emotions), and thinking (convergent/analytical and divergent/imaginative thinking) [13].

Cemetery tourism has advantages: the alert and sensitization for the authorities that oversee the cemeteries for their conservation and restoration. These are places of memory, sources of knowledge for researchers as well as for tourists who want to learn more about the place they visit through the graves of great and important personalities, to appreciate works of art included in the tombs and to enjoy the peace and quiet place that cemeteries provide.

2.2 Case Studies

Nowadays, more and more countries are doing some activities to promote the cemetery space as something different, changing the view of the concept of cemetery only as something mortuary, but also as a space for leisure, hanging out together, learning, creating memories and to know more about the place and some stories that remain there.

From concerts, shows and activities in Guarulhos cemeteries, São Paulo, Brasil to celebrate the holiday symbolized by the Day of the Dead in 2018 [14] to cinema, music, yoga classes, night walks to explore the monuments and wine tasting in Congressional Cemetery, Washington, U.S.A. [15]. Strange for some people, an attraction, and a different experience to others there are more things done than we imagine promoting cemetery tourism, the cemeteries themselves, the heritage and culture that exists and the memory of the death. For example, the creation of a QR code and its placement on tombstones in Plano da Paz Cemetery, Fortaleza, Brasil in order to keep alive the stories and memories of loved ones by placing photos, videos, music, and documents that can be accessed by family, friends, and visitors via QR Code [16].

There is also a research that caught our attention and that served as one of the cases related to the idea presented in this paper. This is about a virtual visit to an historical cemetery, called The Salla World War II “located in an inaccessible border zone between Finland and Russia” [17] so the team created a virtual graveyard “accessed through a head mounted display, aimed to create an as accurate as possible simulation of the Salla graveyard, including its atmosphere” [17]. The users can interact with some elements, but the main goal is to make a virtual experience in that cemetery available, as it is not accessible to get there, so it needs to be publicized and appreciated.

In the present project we also aim to increase the knowledge of the heritage, namely the one related with the Mausoleum of the Palmela’s Dukes, through an immersive, educational and playful experience in VR.

2.3 The Case of Prazeres Cemetery, Lisbon

The word cemetery has several meanings; one of these is to be considered a second city for many people. It was through the existence of a reference model of the cemetery named Parisian Père-Lachaise (1804) that Lisbon’s public cemeteries of the 19th century began to be thought and designed, namely Prazeres Cemetery (1834) and the Alto de São João Cemetery (1834). Those were considered as the mirror of the evolution of thinking and feeling death, especially in Portugal [18].

“As scenographic spaces cemeteries have become the preferred stage of the new belief: that of the representation of the memory of life, to which a historical value is given” [19]. This historical value is portrayed through the various people buried there and their graves, telling a little of their history and how they wanted to be remembered. The time in which they lived, demonstrated in the design of the personal grave, often shows the taste and evolution of the decades at the architectural and decorative level.

“In Portugal, the decree of September 21, 1835, with the signature of the liberal minister Rodrigo da Fonseca Magalhães (1787–1858), established, in its 1st article, that in all villages public cemeteries were to be established so that the dead could be buried in them. Until then, the dead were buried in sacred or private ground” [19]. Until then and since the XIII century, burials were made inside buildings that belonged both to the church and Religious and Military Orders, and could also be made outside, around these buildings, or on land expressly designated for burials, and on private property.

“The Prazeres Cemetery (see Fig. 1) was built in 1833 to accommodate thousands of mortal victims of the “cholera morbus” epidemic that devastated Lisbon that year. For public health reasons, burials in religious spaces were at that time forbidden, as usual” [20]. It is in the western part of Lisbon city, named Campo de Ourique.

To visit this cemetery is like taking a trip over the Portugal’s history, art, and culture, through the richness of this place that takes us back to other times. It is considered a peaceful place, full of relics, experiences and nature that enriches the visitor’s whole experience who is marked by the place and soaked by wisdom. Walking through the Prazeres Cemetery is the same as entering a magical space, away from the hustle and bustle of city life, in an atmosphere of its own, surrounded by the largest cluster of cypress trees on the Iberian Peninsula, with the Tejo river as a backdrop.

In this space, or in this “Koimétérion” (from the Greek), a “place to sleep”, we are invited to interiority, silence and confrontation with the anguish and mysteries of death and life. The architecture of the tombs is magnificent, such as the mausoleum of the



Fig. 1. Prazeres cemetery, Lisbon

Palmela's Dukes, the figures, and the symbols they bear reflect the various sensibilities and the different beliefs in the face of this great and ultimate mystery named death [20].

This cemetery is a place rich in information and, sometimes, people don't take advantage of or do not know of its existence and the value it possesses especially heritage, historical, cultural, and artistic value. That for it deserves to be worked and explored to pass this "fortune" both to the Portuguese society and the world outside because it will be these people and the interest it triggers that will continue to make the Prazeres Cemetery one of the most important places in Lisbon.

There is still a lot of working on regarding the possible change and thinking about the word cemetery, not only in Portugal, but in some places in the world. Firstly, it is necessary to quickly change mentalities about the word cemetery as something only mortuary, and not, also, as a well of art, culture, and history, that transmits and reflects the identity of a nation and that is not valued enough to be properly a place of interest for the majority of people. In a second moment, there is a need to understand how information can reach people so that they become interested and soaked by the richness that exists in the place. One starting point is the union between the old and the new between the cemetery and the technology that can be associated with that same environment. Using virtual environments and immersion will help visitors to be taken on a journey through the history existing at the local and experiences striking enough for the word cemetery to have more meanings than just death.

To start this desire to look at a cemetery in another way is to go to the Prazeres Cemetery and get to know one of the biggest mausoleums in Europe, a Portuguese heritage impossible to remain indifferent because all the history, knowledge, art and meaning it has, called Mausoleum of the Palmela's Dukes.

2.4 Mausoleum of the Palmela's Dukes

Anyone who visits the Prazeres Cemetery, in Campo de Ourique, is not indifferent to a construction that stands out for its size and historical value named Mausoleum of the Palmela's Dukes (see Fig. 2), the largest private mausoleum in Europe with the capacity to keep 200 remains of relatives, friends and servants of the Palmela's family.

This building takes us on a journey through different eras, with magnificent symbology, art of great value, and family stories. It gives us knowledge that stays in our memory and enchants anyone who visits. To be and feel inside (see Fig. 3) this well of

knowledge is to be transported to another dimension. It is just not a mausoleum inside a cemetery; it is a building that tells a story.



Fig. 2. Mausoleum of the Palmela's Dukes, Prazeres cemetery, Lisbon (left)



Fig. 3. Interior and upper part of de Mausoleum (right)

A tomb is built according to each family's religious beliefs and social value judgment, so that those who demonstrated greater architectural value had a better chance of acquiring a more welcoming place and aspiring to the kingdom of God [21].

The monumentality and structure of this mausoleum are connected to the Palmela's family, whose patriarch figure, D. Pedro de Sousa Holstein (1781–1850), defended the values associated with security, stability, and family [21]. This mausoleum was projected by the architect named Giuseppe Cinatti and finished building in 1849. It must be seen as a unique case in the 19th century Portuguese tumular panorama because of the architectural and artistic value it contains [22].

Great artistic names are included in this project, such as Anatole Calmels, master, and professor of sculpture to the 3rd Duchess of Palmela, D. Maria Luísa de Sousa Holstein, the brothers Teixeira Lopes and António Canova. Therefore, the existence of exemplary repositories of sculpture, architecture, and masonic symbolism is noteworthy.

This private mausoleum is separated from the rest tombs by a railing and a gate, giving it greater prominence and privacy. It is remarkable the size of the plot that the 1st Duke of Palmela, together with the architect Giuseppe Cinatti, managed to acquire in the Prazeres Cemetery. It can be considered as a small private cemetery in the middle of a public cemetery space, occupying a rectangular area, all surrounded by a decorative railing, having at the opposite end to the top where the mausoleum was built a gate flanked by the family arms and the exterior of the enclosure of the mausoleum, and the interior an enormous symbolic and historical value that deserves the highlight and attention of those who visit.

In 1997 the mausoleum was donated by the 4th Count of Póvoa named Manuel de Sousa e Holstein Beck to the Lisbon city council to continue to be preserved, make known this Portuguese heritage that has so much value, and make its history meaning available.

Because it is one of the great attractions for visitors of the cemetery, it is increasingly important to give these visitors unique, different, and striking experiences that will make known both the wealth of symbols and history that the mausoleum has, as well as the

Palmela's family and this can be done through the union between storytelling and virtual reality, creating a unique virtual experience that allows visitors to interact with this iconic place in a pleasant and ludic way.

3 The Creation of a Cemetery Tourism Experience in VR

For the creation of this cemetery tourism experience, the first step was the development of storytelling. There was a subsequent process that was necessary to inspire and feed the storytelling narrative. For this experience, the context is the Prazeres Cemetery, precisely the Mausoleum of Palmela's Dukes. Despite its historical and architectural value, this was chosen because it is closed to the public, that are only allowed to visit the space by appointment.

This process started with a guided tour by a Historian responsible for the visits to the Prazeres Cemetery, between conversations, sharing stories and curiosities about the mausoleum and the Palmela's family. This information had a reliable source that helped in the development and creation of the storytelling and a semi-structured interview with one of the Palmela's family members that showed total willingness to answer any curiosity and questions about the mausoleum and family history. After collecting this information, a qualitative analysis of it and the bibliographical research done to complement all the information obtained made possible this creation process. It is important to understand that a story is not created by itself. It is created through a complete process that we need to learn, get involved in, and then make and tell our story.

Storytelling is an essential process for design to concretely demonstrate the experience you want to pass on to the user.

To start the creation and development of storytelling for VR is essential to explain the context of use, the equipment that will be used, the interaction time and the target that will be part of the experience.

The mausoleum is only accessible to the public by appointment because this is a building full of history, with a heritage that needs to be disclosed, valued, and cared for, and protected. The objective for this VR experience is to make possible visitors of the cemetery, even with no appointment, to travel in the mausoleum, joining knowledge and technology in a different, unique and striking way.

For the thoughtful VR experience to best demonstrate what is intended, there needs to be equipment that complements and is part of it. Thus, the equipment to be used for the development and testing purpose, and for the future VR experience interaction are an all-in-one head-mounted display (HMD), and the VR Oculus Quest 2 because it is affordable equipment with good graphic quality at the same time. To avoid problems with the commands of this equipment, the interactions of the experience with the virtual environments will be done mainly through the direction of the participant's gaze. It should be noted that the VR experience is being created and developed using the game creation software Unity.

Considering some requirements related to the VR experience, interaction time is an important aspect. For this project, the storytelling was developed to create an interactive experience with an estimated time of 10 to 15 min that was considered suitable for an experience in the context of a visit to the cemetery where the VR experience is only a part of that visit and can also promote the Prazeres Cemetery at the same time.

Another development requirement is related to the target. Although this VR experience is designed so that most people can use it, it is also necessary to establish the target group. These are the tourists from the Portugal's countryside and abroad who visit the Prazeres Cemetery, aged 16 and up, and curious about the existing cultural aspects.

It is important to note that the storytelling must create engagement in the participants in addition to the requirements. To do this, it must have challenges and reward systems that are appropriate for the target group.

3.1 Storytelling, Storyboard, and User Interaction Proposal

A narrative storyboard consists of “a sequence of images to tell a more complete story about people’s interaction” [23].

The following storyboard (see Fig. 4) was created to demonstrate, visually, a part of the storytelling thought for the VR experience in the Mausoleum of the Palmela’s Dukes, using photos taken of the mausoleum and drawn over them in the Adobe Illustrator program. Only eight scenes were created for this paper to demonstrate the whole process of creating both the narrative, the storyboard, and the moments of interaction. These eight scenes have all the necessary details for a good and complete demonstration of what is intended to do in the other scenes. We want to show how this process has a way to go to get to the final idea. It is not just the storyboard part that is important, but everything that makes it one of the most important parts of creating an experience that pleases the users and conveys what is intended by the creator.

It is relevant to emphasize the importance of planning a storyline for the storyboard before starting sketching scenes [23]. That storyline made a considerable difference in the creation of the storyboards. Each image represents a particular event of the storytelling communicating information about the location of the experience, the user interaction proposal with each one of the scenes, providing details about the name of the scene, what the player sees and listen, what information or challenge is transmitted to the player, what can the player do and what happens when the player interacts.

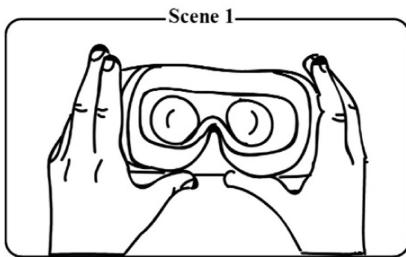
The color details in the storyboards were placed because they have the power to emphasize actions and motions “that otherwise difficult to show in a static image” [23].

Since this is a VR experience, the storyboards were drawn from the first-person perspective, with close-ups when necessary to show something with more detail. To explain how the interaction process is done, or what the participant can do in the experience, is repeated in almost all the scenes that the participant moves his head to position a cursor that is in the center of the screen over something that the participant will interact with for 3 s. During this period, he receives visual time feedback, feeling in the line of the circle. When the circle is completed, the participant goes to the next scene.

Before the participant can test the VR experience, there will be a training session for the user to understand how to interact with the proposed model and the system itself so that there is no obstacle to the use and good development of the experience. That is not described in the storyboard itself, but it is part of the whole process.

4 Results

The following images (see Fig. 4) represent a part of the narrative that is intended to be done.



Scene 1



Scene 2

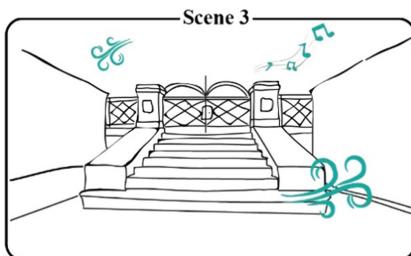
Name of the scene: You put on the VR glasses and the experience starts.

What the participant sees and listen? The participant is in a room to do the experience and sees the VR glasses on top of a table. The environment of this room is very calm, with no sounds around so as not to be a distraction to the experience.

What information or challenge is transmitted to the participant? Is told to the participant to put on the VR glasses so that the experience starts.

What can the participant do? The participant puts on the VR glasses.

What happens when the participant interacts? After putting the VR glasses, an information appears about how to interact with the VR experience: the participant must aim his gaze to interact with the information that will appear.



Scene 3

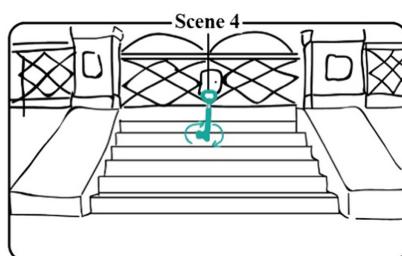
Name of the scene: A voice is heard introducing the experience.

What the participant sees and listen? The environment is dark with nothing around just a light in the end, like a gate to something, but the participant cannot understand what that is. It is also seen a path and the sound of the wind blowing softly in the distance.

What information or challenge is transmitted to the participant? An unfamiliar voice says: "The story takes place in one of the most beautiful mausoleums in Europe, named Mausoleum of the Palmela's Dukes one of the most important families in Portuguese history. You will be immersed beyond the real in an experience rich in stories and secrets, making this virtual visit a well of knowledge that will mark anyone who decides to enter this journey."

What can the participant do? The participant moves his head to position a cursor that is in the center of the screen, towards the gate, for 3 seconds. During this period, he receives visual time feedback (filling in the line of a circle).

What happens when the participant interacts? Teleport by looking will move the participant to the next scene, the gate that is seen in the end of the dark environment.



Scene 4

Name of the scene: The entrance of the mausoleum.

What the participant sees and listen? The participant is transported to the mausoleum entrance and sees a gate at the end of the stairs with 8 steps right in front, the gate that has seen in the past scene. Here, the environment seemed mysterious, the wind is blowing gently but with a strong sound, like thunder, the leaves of the trees beat with the sound of the wind and birds are tweeting. An environment that somehow reassures the participant, looking like a place of respect.

What information or challenge is transmitted to the participant? Is informed to the participant to approach the first step of the stairs.

What can the participant do? The participant moves his head to position a cursor that is in the center of the screen, in the gate's direction, for 3 seconds. During this period, he receives visual time feedback (filling in the line of a circle).

What happens when the participant interacts? Is transported to the front of the first step immediately.

Name of the scene: A turning key appears in one of the steps.

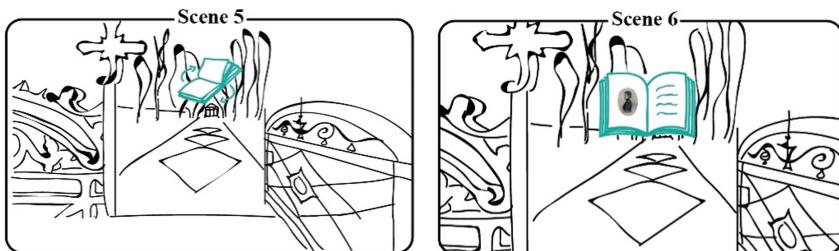
What the participant sees and listen? The participant sees a turning key above one of the steps and noticed that has moved closer to the entrance of the mausoleum enclosure. The sounds of the environment are the same as the other scene, maintaining the place of respect in which the participant finds himself.

What information or challenge is transmitted to the participant? The challenge is what to do with that key. The participant immediately realize that the key will allow to do something or enter somewhere. The instinct tells to look at that key to start this experience and to open the door that gives access to the enclosure of the mausoleum.

What can the participant do? The participant moves his head to position a cursor that is in the center of the screen, looking at the key, over for 3 seconds. During this period, he receives visual time feedback (filling in the line of a circle).

What happens when the participant interacts? The key disappears and the gate opens.

Fig. 4. Narrative storyboard example: the first eight scene.



Name of the scene: An open book floating in the air appears after the gate opens.

What the participant sees and listen? For the participant amazement, when the gate opens with that key, is found an open book floating in the air, as if it were an opening to a story that was about to begin.

What information or challenge is transmitted to the participant? The challenge in this scene is to approach the book so that the participant understands why is that book there and what meaning has.

What can the participant do? The participant will approach the book to see what is going to happen moving his head to position a cursor that is in the center of the screen, in the book's direction, for 3 seconds. During this period, he receives visual time feedback (filling in the line of a circle).

What happens when the participant interacts? The participant will have to approach the book to see why it is there floating in the air.

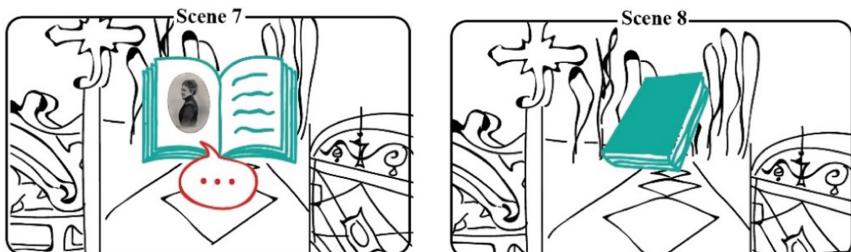
Name of the scene: A photograph is in a page of the book.

What the participant sees and listen? A book that is at a distance from the participant's eyes that allows effortless reading, making the participant curious, looking at a page of the book that has a photograph of an unknown lady, capturing his attention, but who seemed to be from a different era. Here the sound changes, there is a more mysterious atmosphere around, the trees stopped beating, the wind has become stronger, the birds have stopped chirping. Something was about to happen if the participant read what the book had to tell.

What information or challenge is transmitted to the player? The purpose is to discover who is that woman and why is that book there with that specific photograph.

What can the participant do? The participant moves his head to position a cursor that is in the center of the screen for 3 seconds. During this period, he receives visual time feedback (filling in the line of a circle). Pointing the look to that photograph will make a sound appear in the next scene.

What happens when the participant interacts? If the participant points his gaze to that image, the next scene will be about what that book and lady had to tell.



Name of the scene: A female voice is heard.

What the participant sees and listen? The participant approaches and look at the picture, hearing a female voice saying: "I see that you are ready to start the experience and to meet my family's Mausoleum. I'm Maria Luisa de Sousa Holstein, 3rd Duchess of Palmela. 16 squares you will have to follow for the door of the Mausoleum to open."

What information or challenge is transmitted to the participant? The voice heard gives the participant the challenge to follow 16 squares to open the door that gives access to the interior of the mausoleum. So, the participant will have to look for that squares to complete the task.

What can the participant do? The participant will hear an information given by that lady and has the opportunity to listen again or pass to the next scene. To pass to the next scene there is a need to point his head to position a cursor that is in the center of the screen for 3 seconds. During this period, he receives visual time feedback (filling in the line of a circle).

What happens when the participant interacts? If the participant wants to listen the information again, a play button will appear in the corner of the scene view that will be triggered by pointing the gaze to that button. If the participant wants to go to the next scene, the goal is to point the gaze to close the book.

Name of the scene: The photograph disappears and the book needs to be closed.

What the participant sees and listen? After the information is given, the image disappears, the book stopped floating in the air and the participant realizes that will have to close the book and go on. There is no sound around as if the sound is waiting for the participant to enter the enclosure of the mausoleum causing mystery and waiting.

What information or challenge is transmitted to the participant? The participant needs to close the book to make it disappear and pass to the next scene.

What can the participant do? To close the book the participant moves his head to position a cursor that is in the center of the screen for 3 seconds. During this period, he receives visual time feedback (filling in the line of a circle).

What happens when the participant interacts? The book disappears, suddenly and leaving a smoke in the air. The participant sees the path that gives access to the entrance to the interior of the mausoleum, remembering that first has a task to do given by the 3rd Duchess of Palmela.

Fig. 4. continued

5 Conclusions

The purpose of this VR experience for cemetery tourism is to make the Mausoleum of Palmela's Dukes available to the general audience through a pleasant and engaging experience, combining the power of strong storytelling with gamification strategies to enrich UX.

The challenge is to give visitors a more immersive experience, protect the heritage that exists and make a visit more fun with a knowledge gain that stays in memory. The intention is to take cemetery tourism to other spaces, namely virtual (VR) and together they will take the visitor's knowledge and involvement to another level.

For this, storytelling was developed to make known an architectural and cultural heritage and its symbology, but also a little of the history of the family that created it. The narrative was made to fulfill this objective. Still, simultaneously, it was adapted to telling the story using VR and some level of interaction, as the aim is to develop an intense experience that creates interest and curiosity to seek to know more about the historical heritage present in the Prazeres Cemetery, in Lisbon.

In this paper we highlighted the context of cemetery tourism, the Prazeres Cemetery, particularly the mausoleum of the Palmela's Duke. All the information collected allowed us to create a storytelling proposal and the development of a storyboard even if it does not show all the scenes of the narrative designed for the experience, these scenes demonstrate the entire process needed to get to the final narrative, to have a better understanding of what happens in each scene and to help in the process of developing and designing the VR experience. Storyboards are very useful to communicate the demonstration of creating something more visual and closer to the experience it is intended to have using virtual reality. Creating storytelling was demonstrated and explained in this paper, for it is a fundamental process in creating a VR narrative and experience that will be tested, evaluated, and made accessible to anyone who wants to try it.

As the area of virtual reality is very broad to the creation of new concepts and projects, this project was designed to be used in cemetery tourism, but can and should also be extended to tourism itself by the amount of challenges and techniques that it has, because it is an asset to the involvement of people with technology and the environment itself and can bring many benefits both for tourism itself, and for those who visit and participate in virtual experiences.

In a human centered design perspective, the next step will be evaluating the storyboard by a group of potential users. Using the storyboard, the narrative will be evaluated concerning comprehension, interpretation, and user's emotional reaction. This iteration will allow to correct aspects of the future VR interaction before the development in Unity. During the VR development in Unity other user evaluations will be performed, that permit to evaluate the emotional impact of the experience as well usability issues concerning the VR interaction. It is worth to mention that 360° photos of the mausoleum have already been obtained and are being tested in Unity to apply in the VR interaction.

The solutions for storytelling and its narratives can be diverse but given the limits in terms of time (10 to 15 min) that will be allowed to tourists, we will not be able to have a very long narrative as it would be desirable to be able to include all aspects of the rich heritage present in the mausoleum. In this sense, different proposals are being worked out that constitute other episodes that the cemetery's visitors can choose. At this

moment only the project of just one storytelling and the respective VR experience is being developed so that it can be evaluated and implemented. Other sensory modalities will also be included to the presented virtual reality experience, as it will need to go beyond the visual to create more impact and engagement. Olfactory stimuli will also be used in order to increase presence inside the VR environment. This challenge will be worked on closer to the end of the experiment in Unity and the creation and adaptation of olfactory stimuli to the scenes that are part of the experiment that is being developed in the ErgoUX lab [24].

Acknowledgments. Research funded by CIAUD Project UID/EAT/4008/2020 and ITI/LARSyS-FCT Plurianual fundings 2020–2023 (UIDB/50009/2020).

References

1. ISO/CDIS 9241-210: Ergonomics of human-system interaction - Part 210: Human-centred design for interactive systems (2019)
2. Orlova, M.: User Experience Design (UX Design) in a Website Development: Website redesign (December 2016). <http://www.theses.fi/handle/10024/120948>
3. Quesenberry, W., Brooks, K.: Storytelling for User Experience, p. 298 (2010)
4. Lewis, P.J.: Storytelling as research/research as storytelling. Qual. Inq. **17**(6), 505–510 (2011). <https://doi.org/10.1177/1077800411409883>
5. Salevati, S.: Visual Storytelling: a design method to capture and validate experience in the early stages of the design process (2010). <https://ecuad.arcabc.ca/islandora/object/ecuad%3A2716>
6. Podara, A., Giomelakis, D., Nicolaou, C., Matsiola, M., Kotsakis, R.: Digital storytelling in cultural heritage: audience engagement in the interactive documentary new life. Sustainability (Switzerland) **13**(3), 1–22 (2021). <https://doi.org/10.3390/su13031193>
7. Tomašević, A.: Cemeteries as tourist attraction. Turisticko Poslovanje **21**, 13–24 (2018)<https://doi.org/10.5937/turpos1821013t>
8. Cabaço, G.P.: Cemitérios municipais de lisboa, p. 23 (2009)
9. Nogueira, R.S.: Quando um cemitério é patrimônio cultural (2013)
10. Augusto, J., Marques, M.: Turismo cemiterial - o «porquê» e o «onde». Revista Turismo & Desenvolvimento **0**(29), 47–63 (2018)
11. Del Puerto, C.B., Baptista, M.L.C.: Espaço cemiterial e Turismo: campo de ambivalência da vida e morte. Revista Iberoamericana de Turismo **5**(1), 42–53 (2015)
12. Rosa Gomes Afonso, L.: Universidade Federal de Minas Gerais Instituto de Geociências Curso de Graduação em Turismo (2010)
13. Schmitt, B.: Experiential marketing. J. Market. Manage. **15**(1-3), 53–67 (1999)
14. Estadão Homepage. <https://emais.estadao.com.br/noticias/comportamento,cemiterio-realiza-musical-noturno-e-atividades-ludicas-neste-feriado-de-finados,70002578631>. Accessed 05 Aug 2021
15. Corrêa, A.: Cemitérios nos EUA viram opção de lazer com cinema, música e até degustação de vinho. BBC NEWS, Brasil (2016). <https://www.bbc.com/portuguese/internacional-36887697>. Accessed 05 Aug 2021
16. Duarte, J.: Aplicativo cearense disponibiliza histórias de entes queridos que já morreram. OPOVO online (2020). <https://www.opovo.com.br/noticias/ceara/2020/11/02/aplicativo-cearense-disponibiliza-historias-de-entes-queridos-que-ja-morreram.html>. Accessed 06 Aug 2021

17. Häkkilä, J., et al.: Visiting a virtual graveyard - designing virtual reality cultural heritage experiences. In: ACM International Conference Proceeding Series, January 2020 (2019). <https://doi.org/10.1145/3365610.3368425>
18. André, P.: Modos de pensar e construir os cemitérios públicos oitocentistas em Lisboa: o caso do Cemitério dos Prazeres, vol. 2, pp. 66–105 (2006)
19. Carriço, M.: 6 factos que deve conhecer sobre o Cemitério dos Prazeres. Observador (2017). <https://observador.pt/2017/01/10/6-factos-que-deve-conhecer-sobre-o-cemiterio-dos-prazeress/>. Accessed 15 May 2021
20. CLA Homepage. <https://clablog2016.wixsite.com/cla2015/cemiterio-dos-prazeress>. Accessed 20 May 2021
21. Regime, A.: Jazigo dos Duques de Palmela – Uma simbólica Maçónica, pp. 1–12 (2019)
22. Letras, F.D., Lisboa, U.D.: Cemitério dos Prazeres e o Jazigo dos Duques de Palmela (n.d.)
23. Greenberg, S., Carpendale, S., Marquardt, N., Buxton, B.: The narrative storyboard: telling a story about use and context over time. *Interactions* **19**(1), 64–69 (2012). <https://doi.org/10.1145/2065327.2065340>
24. Rebelo, F., Noriega, P., Vilar, E., Filgueiras, E.: Ergonomics and human factors research challenges: the ErgoUX lab case study. In: Rebelo, F. (ed.) AHFE 2021. LNNS, vol. 261, pp. 912–922. Springer, Cham (2021). https://doi.org/10.1007/978-3-030-79760-7_109



Supporting the Construction of Mobile Games Interfaces: The Gamers4Nature Mobile Game Guidelines Cards Set

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Abstract. Research indicates that engaging younger audiences in the creation of their own digital games for learning may increase the interest towards the addressed theme and a better understanding of the value of what is learned. Giving young creators the tools needed to develop good games emerges as a key point for the success of this kind of activity. Toolkits, due to its problem-solving features and support materials, are often seen as powerful learning and teaching tools, assisting in the production of interactive artefacts. Taking this into consideration, the Gamers4Nature project developed a Toolkit to support youngsters in the creation of mobile games. The Gamers4Nature Toolkit to Game Design includes resources developed to support younger audiences in the creation of digital games: a game construction cards set, a rapid game design document, a set of thematic cards addressing environmental awareness theme and a set of cards presenting guidelines to be followed when developing mobile games interfaces. This paper describes the Mobile Game Design Guidelines cards development and validation process. The cards were developed following a User-Centered Design approach and validated through Expert Evaluation, with industry and academic experts in game design and development ($N = 9$) invited to analyze and validate the Guidelines Cards. Although additional tests are still needed, namely with the target audience, preliminary results indicate that the guidelines presented in the cards can be a useful guide along the process of constructing a game while promoting the acquisition of knowledge related to the mobile interface design field.

Keywords: Mobile user interfaces guidelines · Digital games · Expert Evaluation

1 Introduction

Encouraging young students to create their own games addressing educational subjects may increase their interest in the addressed theme and a better understanding of the importance of what is learned. Challenging students to create digital games – and not only to play them – promoted collaboration and the exchange of views and ideas, enhanced the development of critical thinking skills [1, 2] and fostered the acquisition of scientific

concepts and developed technological and digital literacy [3]. Moreover, it increased the interest in the programming and design field [4] and enhanced their sense of achievement, self-confidence and self-efficacy, making students more engaged with the coding and implementation process [5].

Nevertheless this positive impact of engaging youngsters in the creation of digital games, research also points out some obstacles that may hinder the involvement of students in exploring educational contents through game design: low or undeveloped programming skills and low interest in the educational subject [4], a focus on storytelling and character development and a disregard to gameplay mechanics and content integration [6, 7].

Taking all these concerns into consideration, the Gamers4Nature project developed a toolkit to be used by younger audiences during mobile games development sessions. The initial version of Gamers4Nature (G4N) Toolkit to Game Design comprised several resources developed to support the development of mobile games about certain environment issues: a set of 12 cards addressing game design and game elements; a rapid game design document that proposes a path to explore the game design cards; and a set of thematic cards addressing a nature protection and biodiversity preservation. Along the game design sessions held with upper secondary and undergraduate students with and without experience in the digital game design field [8], it was possible to identify several constraints related to the design of mobile games user interfaces. Participants, most with no knowledge about mobile interface design, faced some difficulties when designing the game's interface. Constraints – not limited to the small size of the screen – included knowing where to place buttons and other interaction elements, how to guarantee text contrast and legibility, icons dimension, feedback and the adequate use of color, which justified the development of a new resource to be included in the G4N toolkit, focused on mobile interfaces design – the “Mobile Game Design Guidelines” cards set.

This paper describes the “Mobile Game Design Guidelines” Cards Set, from the conceptual process to the final physical cards’ validation by experts in the mobile interface and the design field.

Following a background section (Sect. 2) presenting a theoretical background about the development of interfaces for mobile games, Sect. 3 introduces the G4N Mobile Game Design Guidelines cards, with a highlight on its topics and contents. Section 4 provides an overview of the two cycles of Expert Evaluation and their main results. The paper ends with Sect. 5, where conclusions and potential directions for future work are presented.

2 User Interface (UI) Design for Mobile Games

Creating a user interface able to provide an engaging gaming experience is crucial when designing mobile games. The User Interface (UI) design affects the gameplay and the game experience, and thus games designers usually avoid features overload, complex interfaces or any other issues that may require an extensive learning phase and therefore impair the player’s experience [9].

UI emerges as a key feature when designing mobile games, as it provides the medium for players to interact and engage with the game [10–12]. While having a good UI does not

guarantee a great User eXperience (UX) per se [13], offering simple and familiar methods to control the game and adopting familiar navigation patterns may in fact impact the user experience, game flow and contribute to meaningful and engaging gaming experiences.

One of the main challenges of designing for mobile games arise from the nature of the physical device where they are played. Mobile phones' portability and ubiquity features make it a device that can be used any time and any place, and while expanding the opportunities for the game to be played, they also present small screens and small keyboards. In addition, there is the need for a stable gaze and hand coordination, namely when the game's main inputs are based on touch [14].

Usability heuristics usually applied to video games [15] can be a challenge when designing for small devices. Mobile applications are designed for small screens with limited input capability and therefore, while designing the game interface, mobile games UI designers must aim for the balance between the apps efficiency and on how to provide relevant information in a quick and clear way, and the need to design an experience able to provide a sense of progress, accomplishment and enjoyment [10].

Besides considering the way the device is used and its own specificities [16], mobile game UI designers need to concern about the UI's intuition to the player, if it will transmit the required information easily and quickly, and also make adequate use of colors, fonts and symbols [10]. Moreover, having a clear understanding of the "how and why" is crucial in the user interface design process, and it is also a skill that requires time to be learned [17].

Toolkits, mostly because of their problem-solving features, support materials and resources, can be seen as a powerful tool that allows faster prototyping, supports creative design, and assists in the production of interactive artefacts [18, 19]. Often presented in the physical form – e.g. a deck of cards, allowing users to think through design, playing and exploring the resources in a more free and unrestricted way [20] – toolkits are frequently used as tools to support and influence interactive systems' design and implementation [21], emerging as a useful resource to be used in implementation activities, either by game design experts [22–24] or by users with no relevant experience in the game design field [25–27].

3 The G4N Mobile Game Design Guidelines Cards

3.1 Background

Creating and developing a game is a demanding process, namely for developers with no specific expertise in the field of game narratives, game design and interface design. When the lack of background and skills in the construction of games and game narratives is seen as an obstacle to the game making process [4, 6, 28, 29], the G4N project developed a Toolkit to Game Design to support young users with and without game design experience in the creation of mobile games addressing nature and biodiversity preservation.

The G4N Toolkit includes several resources developed to support the process of creating mobile games: a set of cards addressing game design and game elements; a rapid game design document that proposes a path to explore the game design cards; and a set of thematic cards addressing a nature protection and biodiversity preservation theme

(e.g. microplastics, invasive species). The toolkit is available both in physical format – so it can be used independently of internet or computer access – and in digital format, available for download on the project’s website. All resources were developed following a User-Centered Design approach, with experts in the game design field, biology and education and potential users (i.e. undergraduate and upper-secondary students with and without experience in the game design field) being involved in the design and validation process [8, 30–32].

Throughout the validation process held with the students, several constraints related to the mobile interface design process were mentioned by participants and observed by the research team: participants mentioned to have difficulties when deciding where to place buttons or interaction elements in the mobile interface; were not familiar with images recommended format and size; were not aware or were not familiar with the guidelines and heuristics for mobile interfaces design; created games revealed some inconsistencies in what concerns font size, inappropriate use of color and contrast; there were issues of alignment and incorrect use of white space; and guidelines about icon and buttons size were not taken into consideration. Taking these constraints into consideration and acknowledging the importance of designing a clear and usable user interface in mobile applications and mobile games, a new set of cards introducing and exploring the main guidelines for designing mobile game interfaces was developed.

Developed through a User-Centered Design (UCD) approach that took into consideration the opinions and perspectives of the students that participated in the game design sessions, the development of the Mobile Game Design Guidelines cards set was guided by three concerns: (i) to summarize the main guidelines for designing mobile games presented in the literature and followed? by the game design market; (ii) to present the information in an understandable format to individuals with and without knowledge in the mobile games’ interface design field; and (iii) to present that information as “cards” – i.e. in the same format as the other toolkit’s resources – in order to include it in the G4N Toolkit to Game Design.

3.2 Defining Topics and Contents

The Mobile Game Design Guidelines cards summarize and aggregate essential guidelines regarding mobile game design, from interface design to game performance and monetization. Taking as starting point the constraints mentioned participants in the game design sessions faced during the mobile game design process, a comprehensive and broad search about game design rules and guidelines – either from academy or industry – was carried out, gathering a list of fundamental design principles (e.g. visual hierarchy and alignment), UI design concerns (e.g. usability and intuition), and specific game design elements (e.g. sliders and pop-ups) [33–40].

As result of the content analysis of the collected information, several dimensions emerged: how to design clear and intuitive interfaces; deciding on font’s readability; the importance of visual hierarchy (font size, color, contrast, alignment, repetition, proximity, white space); how to monetize games, advertisements and awards; when and how to use sliders for large amounts of information; when to present pop-ups with game information; presenting dialogues; and how to present an introduction video.

These dimensions were analyzed and revised, taking into consideration the Toolkit's target audience (upper-secondary and university students). Dimensions related with game monetization – as they delved into the very technical details of game design – were removed from the list of topics to be addressed, and gestures and device orientation, the “fat thumb” problem, feedback, interaction types (e.g. gestures, device orientation), and performance optimization (e.g. file sizes and formats) were added to the list.

From this revision, 24 guidelines for designing games interfaces for mobile devices emerged. The guidelines were grouped in four categories: 1) interface, presenting information on how to design the game interface, alluding to UI design principles (e.g. clarity and usability), color schemes, fonts' face, size and weight, contrast, white space, buttons and icons' size, visual metaphors to apply in sliders, most frequently used buttons, and particular specifications when designing pop-ups; 2) interaction, addressing key topics on feedback (visual, vibration and sound), interaction types and models, crucial information to create an introduction video, and opinion dialogues; 3) performance, addressing methods to optimize the game's performance through file's size and format, specifications when including tridimensional objects into the game, and the device's battery autonomy; and 4) promotion, introducing characteristics of promotional/purchasing dialogues, and briefly approaches the freemium model – an industry's standard.

4 Evaluation Approach: Expert Evaluation

Following the same methodology applied for all Toolkit's resources development and validation, the new set of cards was developed and validated through Expert Evaluation. Expert evaluations, which can be conducted at any stage of the design cycle, are settled on the expert's expertise and experience in their fields of work.

The cards' development and validation process went through two iterative evaluation cycles, with industry and academic experts being invited to analyze and validate the Mobile Game Design Guidelines Cards.

4.1 First Validation Cycle: Mobile Game Design Guidelines' Content Validation

The first stage of expert evaluation focused on discussing, in an individual interview format, the content of the guidelines list.

Participants. 5 experts were invited to participate in the first validation cycle. Three were from the academic field with expertise in design, UX, Human-Computer Interaction, accessibility, and mobile development, with over 10 years of experience; and two from the game industry specialized in mobile game software development and game art and design with experience of 4 and over 10 years respectively.

Settings. Due to the Covid-19 pandemic restrictions on social distancing, validation sessions were carried individually through video call conferences, between 28th October and 21st December 2020, and participants were asked permission to record the sessions for further analysis. Prior to the sessions, a document presenting the 24 guidelines distributed amongst the pre-defined four categories (i.e. interface, interaction, performance

and promotion) and guidelines' related content (i.e. guideline title, guideline description, representative image) was sent to the experts, to be read and analyzed. This allowed the experts to read, analyze and reflect upon the document's content at their own pace, so that the interview would focus on gathering perspectives and opinions rather than on reading the document.

Each session was divided into two moments. In the first part, the moderator shared his screen with the guidelines document previously shared with the participants, being the experts invited to discuss each guideline's content and analyze it from their expertise and experience in the field.

In the second part of the session, and after the analysis of each guideline was performed, a short interview was made to the experts. The questions were the following: 1) The mobile game design guidelines will be used in different contexts, such as game jams, classrooms, workshops. In what concerns the contents you have analyzed, do you consider 24 guidelines an appropriate amount?; 2) Concerning the categories to which the different guidelines were assigned (Interface, Interaction, Performance, Promotion), do you consider them relevant considering the contexts of use?; 3) Following the theme of the previous question, what is your opinion regarding the titles/designation of each category, do you think they correspond to their contents?; 4) In your opinion, are there any guidelines that should be revised?; and 5) Do you have any other suggestions or comments?.

Main Results. Four of five experts considered the 24 guidelines an adequate number. In what concerns the name of the categories and related contents, all experts ($n = 5$) considered it a suitable approach. Nevertheless, some experts referred that some topics could benefit from a more detailed description, namely the topic about multimedia contents which could approach tridimensional objects and could be subdivided in video, audio, and images. The topic about interaction types could also be subdivided, and information about accessibility should also be covered by the guidelines. As for the guidelines, the only observations were about the guideline addressing the device's sensors, included in "peripherals", and that – according to experts – should be "internal sensors", and about the category "promotion", that could be shorter since it is not an extremely relevant topic for beginners. In what concerns the guidelines' illustrations, experts considered that adopting a model that presented examples of the right and wrong use of each guideline would aid its understanding and help to "convey ideas" – as one of the experts said.

Overall, all the experts considered these guidelines a proper approach and an optimal synthesis of crucial topics regarding mobile game design, since these guidelines narrowed down subjects that are sometimes extensive and complex into something brief and clear.

As a result of the first validation cycle and received inputs, a new version of the mobile game design guidelines – with a total of 28 guidelines – was produced. Table 1 presents the Mobile Game Design Guidelines that were considered to be included in the G4N Toolkit to Game Design.

Table 1. Mobile game design guidelines.

Category: INTERFACE	
<i>Guideline title and specification</i>	
Usability and Clarity	Design an intuitive interface and apply specific language
Font face	Adjust the font to the context of the game
Font size and weight	Apply different sizes and weights to the font according to hierarchy
Color	Adapt the color scheme of the game
Contrast	Ensure readability of texts and any game elements
Alignment	Align the text according to the context of its reading
White space	Valuing the importance of empty space
Button/Icon sizes	Hierarchize the importance of buttons and icons
Sliders	Create visual clues that induce a navigation method
Frequently used buttons	Make the most used buttons accessible
Pop-ups	Present information in pop-ups without breaking the flow of the game
Category: INTERACTION	
<i>Guideline title and specification</i>	
Feedback: Game status and navigation	Informing the player of the current state of the game and its location in the navigation
Feedback: Sound and vibration	Adapting sound and vibration to different moments
Interaction types: Interaction gestures	Use mobile device interaction gestures
Interaction types: Drag items	Dragging game items without hiding them
Interaction types: Device's sensors	Using in-game mobile device sensors
Interaction models	Orienting the device to the game
Introduction video	Present a short and concrete video tutorial
Opinion Dialogues	Show request for feedback on the game without being hasty
Category: PERFORMANCE	
<i>Guideline title and specification</i>	
File size	Check maximum game size
Multimedia contents: Image formats	Adapt the image format to the context in which it will be applied
Multimedia contents: Video formats	Use the recommended formats for videos

(continued)

Table 1. (continued)

Category: PERFORMANCE	
<i>Guideline title and specification</i>	
Multimedia contents: Audio formats	Choose the most appropriate audio format
Multimedia contents: Tridimensional objects	Creating 3D objects optimally
Smartphone battery autonomy	Orienting the device to the game
Category: PROMOTION	
<i>Guideline title and specification</i>	
Promotional pop-ups	Display pop-up adverts
Awarded advertising	Freemium model Increasingly recurrent in the gaming industry

4.2 Second Validation Cycle: Mobile Game Design Guidelines' Visual Layer Validation

After validating the guidelines and defining the contents, a first version of the new set of cards (28 cards, one for each guideline) was developed. The Mobile Game Design Guidelines Cards layout follows the G4N identity manual [30] and color palette. To facilitate the understanding of the information contained in the cards and to exemplify the application of the guidelines, representative illustrations of each guideline were added to the cards (see Fig. 1).

To ease the interaction with the cards and to highlight and reinforce the structuring into four content categories, each content category is represented by a color. Blue, a well-accepted color by most people, was used for the “interface” category (12 cards). Pink was chosen for “interaction” category cards (8 cards); being considered as a positive and sensitive color, pink is suitable according to the meanings conveyed by this category – the interaction with the players must be sensitive to their feelings throughout the game flow [41]. Purple was used for the “performance” category cards (6 cards); purple is associated with the invisible [41] – in this case, a metaphor for what’s happening in the game’s background that reflects on its performance. Yellow, often related with optimism [41], was chosen for the “promotion” category cards (2 cards).

Colors were applied in a way that would create a connection between the front and the back of each card: in the front of the card, the color is used as background color; to establish the visual connection, the back of the cards is outlined with the same color. The category color is also applied in the category name and in background coloring integrated into the illustrations. Figure 1 represents a card model for each category (interface, interaction, performance, and promotion), both front and back faces (up and lower row, respectively).

Participants. The second validation cycle, also with expert evaluation, was focused on the visual aspects adopted in this card set. To validate the design of the cards, four experts with expertise in Communication Design, Product Design, Interaction



Fig. 1. First design approach to the Mobile Game Design Guidelines cards set (example of each category).

Design, Graphic Design were recruited. Three participants had expertise in evaluating educational resources, and a two had experience in the digital games' field.

Settings. As the restrictions due to the Covid-19 pandemic were still imposed, these evaluation sessions took place through video call conferences between 11th March and 8th April 2021, with participants being asked permission to record the sessions for further analysis.

Along the sessions, experts were invited to explore each card and analyze it from their experience and expertise in the design field, using the think aloud protocol. After the sessions, a questionnaire was applied. The questionnaire was divided into two main sections: 1) characterization questions, asking about the experts' profile (field of study and expertise, experience in developing and using education resources); and 2) questions centered on the analysis of the visual design of the "Mobile Interface Design Guidelines" cards.

Experts were asked to agree/disagree (by using a 5-point Likert scale) with the following statements: 1) The graphic solution is congruent with the concept; 2) The contrast employed emphasizes the relevant elements; 3) The design elements work together to create a seamless whole; 4) There is a cohesive use of the visual elements; 5) The color palette is appropriate; 6) The font face and size are appropriate; and 7) The amount of text is reasonable.

Experts were also asked to reflect about the visual hierarchy of the several elements presented in each card (i.e. title, color, QR-code, descriptive text and illustration) by sorting the visual elements by the order they visualized them, and invited to talk about the main strengths and weaknesses of the cards content and visual design approach.

Main Results. In what concerns visual hierarchy of the different visual elements presented in the cards, experts pointed out the color as the most striking element, followed by the title, the QR-code, descriptive text, and illustration.

All experts agreed that the graphic solution was congruent with the concept, three experts strongly agreed/agreed that “the contrast employed emphasizes the relevant elements, and four experts strongly agreed/agreed that the design elements worked together to create a seamless whole. Three experts strongly agreed/agreed that there was a cohesive use of the visual elements. In what concerns color, three experts strongly agreed that the color palette was appropriate. As for font usage all experts agreed/strongly agreed that the font face and size were appropriate. All experts strongly agreed/agreed that the amount of text was reasonable.

As for the main strengths and weaknesses of the adopted visual layout and format, the experts considered as strengths that the set of cards was well conceptualized and organized with a clear and clean layout, and accurate representative illustrations of the textual elements. As for weaknesses, they suggested that the space between the title and descriptive text should be levelled, that a chromatic variation in the purple cards should be applied; experts also suggested a more expression on the design of the illustrations (i.e. more thickness in the illustrations’ stroke), smoothing text breaks and revising any text widows, orphans and rivers, and polish alignments.

Lastly, in the expert’s opinion, these guidelines could be useful in guiding the construction of a game and promoting knowledge about different interface design fields, being adequate for in-class or recreational activities, and even appealing for young children. Asked to give their opinion about the potential of the cards, participants said that they could be used “*in Classroom or Home Learning activities. I think they are quite attractive and different from other games, so they can have a greater adherence from children*” [E1] and “*for the purpose intended, the guidance of the construction of games*” [E2]. Experts also mentioned that the cards have potential to “*motivate learning in different areas*” [E3] and “*to support the construction of a solution when creating the game and defining interaction strategies*” [E4].

Nevertheless, it was also mentioned that these cards could restrict creativity, and that a technical glossary should be provided in order to supply more specific information. It should also be emphasized that the cards represented not rules but guidelines, that could differ in each context. Experts also stated that the cards’ shape (irregular hexagon with rounded corners) might be difficult to replicate at home (e.g. if the users would like to print an additional set), namely because of the corner cut-outs.

Following the evaluation sessions, expert’s evaluations and opinions were analyzed and discussed, with the suggestion to provide a glossary – because of its complexity and because the cards aimed to provide guidelines and not a complete description about the development mobile visual interfaces – being discarded. As for the cards’ format, it was decided that the cards would follow the same shape/size as the already available Toolkit’s resources (game design cards and thematic cards) and therefore the corner cut-outs were maintained.

The final version of the Mobile Game Design Guidelines cards set, which benefited from the experts' output in both content and design validations, is represented in Fig. 2. The complete set of cards can be seen in the project's website in the following link: G4N.



Fig. 2. Final design approach to the Mobile Game Design Guidelines cards set (example of each category).

5 Final Considerations and Future Work

As research indicates that creating games may increase the interest towards the addressed theme and a better understanding of the value of what is learned, giving young players the tools and opportunities they need to become game developers themselves may increase motivation for adopting positive attitudes towards nature and biodiversity preservation.

Developing a good UI is one of the main challenges when designing mobile applications. In mobile applications, namely in games, the user interface impacts the playing experience, immersion, and enjoyment and aids to maintain the users' engagement [35]. Knowing how to display and present game design elements (e.g. characters, rules, icons, points, achievements, commands, and other game elements) on a small screen of a mobile device is a fundamental feature when designing a game, as it may impact the interaction between the player and the game – the gameplay. This paper describes the G4N Mobile Game Design Guidelines cards development and validation process. These cards, a component of the G4N Toolkit to Game Design, were designed to support users during the mobile interface design process. Articulated in four categories – interface, interaction, performance and promotion – the cards summarize the essential guidelines about mobile game design that are mentioned both in literature and in industry, from fundamental design principles to UI design concerns and elements.

The Mobile Game Design Guidelines cards were validated through Expert Evaluation in two iterative evaluation cycles. Industry and academic experts in game design and development, mobile design and development, Human-Computer Interaction, and graphic and communication design field ($N = 9$) were invited to analyze and validate the Mobile Game Design Guidelines Cards. From the expert's perspective, the guidelines presented in the cards can be a useful guide along the process of constructing a game while promoting the acquisition of knowledge related to the mobile interface design field. Nevertheless, it was also mentioned that it should be mentioned that the information provided in the cards should be seen not as rules but as guidelines, and therefore could differ according to context.

The Mobile Game Design Guidelines cards were not yet validated by its target audience (i.e. younger students with and without knowledge and experience in the mobile game design field) and therefore additional evaluation cycles are needed. The next step of the cards' development and validation process will focus on the use and validation of this resource with students from upper-secondary and university courses with no specific experience in the mobile interface design field.

Acknowledgements. This work is part of the Gamers4Nature project Gamers4Nature (POCI-01-0145-FEDER-031047) that has the financial support of FCT - Foundation for Science and Technology (Portugal)/ MCTES – Ministry of Science, Technology and Higher Education and FEDER under the PT2020 agreement.

References

1. De Grove, F., Bourgonjon, J., Van Looy, J.: Digital games in education? A contextual approach to teachers' adoption intention of digital games for learning purposes. *Comput. Hum. Behav.* **28**(6), 2023–2033 (2012)
2. Giannakos, M.N., Jaccheri, L.: From players to makers: an empirical examination of factors that affect creative game development. *Int. J. Child Comput. Interact.* **18**, 27–36 (2018)
3. Huizenga, J., ten Dam, G., Voogt, J., Admiraal, W.: Teacher perceptions of the value of game-based learning in secondary education. *Comput. Educ.* **110**, 105–115 (2017)
4. Falcão, T.P., Peres, F.N., de Moraes, D.C., da Oliveira, G.: Participatory methodologies to promote student engagement in the development of educational digital games. *Comput. Educ.* **116**, 161–175 (2018)
5. Papavlasopoulou, S., Giannakos, M.N., Jaccheri, L.: Exploring children's learning experience in constructionism-based coding activities through design-based research Sofia. *Comput. Hum Behav.* **99**, 415–427 (2019)
6. Ke, F.: An implementation of design-based learning through creating educational computer games: a case study on mathematics learning during design and computing. *Comput. Educ.* **73**, 26–39 (2014)
7. Howland, K., Good, J.: Learning to communicate computationally with Flip: a bi-modal programming language for game creation. *Comput. Educ.* **80**, 224–240 (2015)
8. Beça, P., Aresta, M., Ortet, C., Santos, R., Veloso, A., Ribeiro, S.: Promoting student engagement in the design of digital games: the creation of games using a Toolkit to Game Design. In: 2020 IEEE 20th International Conference on Advanced Learning Technologies (ICALT), pp. 98–102. IEEE, Tartu (2020)

9. Harbuzinski, A.: Introduction to UX in Game Design: what are designers' secrets to making great games? <https://uxdesign.cc/ux-and-video-game-design-5d8bcc50be67>. Accessed 10 May 2021
10. Nemtsov, R.: UI Design for Mobile Games. <https://www.ilyon.net/ui-design-for-mobile-games/>. Accessed 30 Apr 2021
11. Smith, L.: Fun for your thumbs: how do you design essential mobile game UX? <https://www.trymyui.com/blog/2020/03/19/essential-mobile-game-ux/>. Accessed 12 May 2021
12. Ghadawala, M.: Tips to Keep in Mind to Develop Better UX Mobile Games. <https://www.devtothev.com/education/articles/en/173/tips-to-keep-in-mind-to-develop-better-ux-mobile-games>. Accessed 09 May 2021
13. Norman, D.: The Design of Everyday Things: Revised and Expanded Edition. Basic Books, A Member of the Perseus Books Group, New York (2013)
14. Dutz, T., Hardy, S., Knöll, M., Göbel, S., Steinmetz, R.: User interfaces of mobile exergames. In: Kurosu, M. (ed.) HCI 2014. LNCS, vol. 8512, pp. 244–255. Springer, Cham (2014). https://doi.org/10.1007/978-3-319-07227-2_24
15. Joyce, A.: 10 Usability Heuristics Applied to Video Games. (Nielsen Norman Group). <https://www.nngroup.com/articles/usability-heuristics-applied-video-games/>. Accessed 29 Apr 2020
16. Interaction Design Foundation: The Basics of User Experience Design. Interaction Design Foundation (s/d)
17. Preece, J., Sharp, H., Rogers, Y.: Interaction Design: Beyond Human-Computer Interaction. Wiley, New York (2011)
18. Greenberg, S.: Toolkits and interface creativity. *Multimed. Tools Appl.* **32**, 139–159 (2007). <https://doi.org/10.1007/s11042-006-0062-y>
19. Oulasvirta, A., Hornbaek, K.: HCI research as problem-solving. In: Proceedings of the 2016 CHI Conference on Human Factors in Computing Systems (CHI 2016), pp. 4956–4967. ACM, New York (2016)
20. Peters, D., Loke, L., Ahmadpour, N.: Toolkits, cards and games – a review of analogue tools for collaborative ideation. *CoDesign Int. J. CoCreat. Des. Arts* (2020)
21. Ledo, D., Houben, S., Vermeulen, J., Marquardt, N., Oehlberg, L., Greenberg, S.: Evaluation strategies for HCI Toolkit Research. In Proceedings of the 2018 CHI Conference on Human Factors in Computing Systems - CHI 2018 (2018)
22. Bonillo, C., Marco, J., Cerezo, E.: Developing pervasive games in interactive spaces: the JUGUEMOS toolkit. *Multimed. Tools Appl.* **78**(22), 32261–32305 (2019). <https://doi.org/10.1007/s11042-019-07983-6>
23. Cao, C., Sun, J.: Perceptual MR Space: interactive toolkit for efficient environment reconstruction in mobile mixed reality. In 2019 IEEE International Symposium on Mixed and Augmented Reality Adjunct (ISMAR-Adjunct), pp. 353–357 (2019)
24. Marín-Vega, H., Alor-Hernández, G., Colombo-Mendoza, L.O., Sánchez-Ramírez, C., García-Alcaraz, J.L., Avelar-Sosa, L.: Zeus - a tool for generating rule-based serious games with gamification techniques. *IET Softw.* **14**, 88–97 (2020)
25. Glenn, T., Ipsita, A., Carithers, C., Peppler, K., Ramani, K.: StoryMakAR: bringing stories to life with an augmented reality & physical prototyping toolkit for youth. In: CHI 2020: Proceedings of the 2020 CHI Conference on Human Factors in Computing Systems, pp. 1–14 (2020)
26. Taylor, S., et al.: Position: IntelliBlox: a toolkit for integrating block-based programming into game-based learning environments. In: 2019 IEEE Blocks and Beyond Workshop (B&B) (2019)
27. Väljataga, T., Tammets, P., Tammets, K., Savitski, P., Jää-Aro, K.M., Dias, R.: Designing learning experiences in zoos: a location-based game development toolkit. In 2017 IEEE 17th International Conference on Advanced Learning Technologies (ICALT), pp. 84–86 (2017)

28. Selander, S.: Designs for learning and ludic engagement. *Digit. Creat.* **19**, 145–152 (2008)
29. Murray, J.H.: Toward a cultural theory of gaming: digital games and the co-evolution of media, mind, and culture. *Pop. Commun.* **4**, 185–202 (2006)
30. Beça, P., Aresta, M., Santos, R., Veloso, A.I., Gomes, G., Pereira, M.: Supporting the game construction process: development of artefacts in the context of a toolkit to game design. In: Zagalo, N., Veloso, A.I., Costa, L., Mealha, Ó. (eds.) VJ 2019. CCIS, vol. 1164, pp. 99–110. Springer, Cham (2019). https://doi.org/10.1007/978-3-030-37983-4_8
31. Beça, P., et al.: Developing a toolkit to game design - the Gamers4Nature project: from concept to artefact. In: 15th Conference on the Foundations of Digital Games (FDG), Malta (2020, in press)
32. Beça, P., Ortet, C., Aresta, M., Santos, R., Veloso, A., Ribeiro, S.: Supporting the construction of game narratives using a toolkit to game design. In: Videojogos 2020 (12th International Conference on Videogame Sciences and Arts), Bragança (2020)
33. Laubheimer, P.: The 3-Click Rule for Navigation Is False. (Nielsen Norman Group). <https://www.nngroup.com/articles/3-click-rule/>. Accessed 10 Sept 2020
34. Laubheimer, P.: Tips to Keep in Mind to Develop Better UX Mobile Games. (DevToDev). <https://www.devtothe.com/education/articles/en/173/tips-to-keep-in-mind-to-develop-better-ux-mobile-games>. Accessed 12 Sept 2020
35. Nemtsov, R.: UI Design for Mobile Games. <https://www.ilyon.net/ui-design-for-mobile-games/>. Accessed 9 Sept 2020
36. Smith, L.: Fun for your thumbs: how do you design essential mobile game UX? (Try my UI blog). <https://www.trymyui.com/blog/2020/03/19/essential-mobile-game-ux/>. Accessed 12 Sept 2020
37. Long, S., Owen, H., Lloyd, G.: How to build mobile games with people in mind. (Medium.com). <https://medium.com/googleplaydev/how-to-build-mobile-games-with-people-in-mind-cdc480967fcc/>. Accessed 13 Sept 2020
38. Dori, A.: Game Design UX Best Practices. (UC Planet). <https://uxplanet.org/game-design-ux-best-practices-guide-4a3078c32099/>. Accessed 22 Sept 2020
39. Soegaard, M.: Visual Hierarchy: organizing content to follow natural eye movement patterns. (Interaction Design Foundation). <https://www.interaction-design.org/literature/article/visual-hierarchy-organizing-content-to-follow-natural-eye-movement-patterns/>. Accessed 30 Sept 2020
40. Guidelines: (Material.io) (s/d). <https://material.io/design/guidelines-overview/>. Accessed 03 Sept 2020
41. Heller, E.: A Psicologia das Cores Como as cores afetam a emoção e a razão. Editorial Gustavo Gili (2012)



Emotional Design in Multimedia Learning: Systematic Review

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Abstract. With technological advances and the growing popularity of mobile devices, learning has been occurring frequently in environments more distant from traditional ones. Several studies have shown interest in multimedia learning through a more affective dimension, and with special interest in emotional design. The aim of this study was to review articles that research the role of emotional design in multimedia learning between 2016 and 2021. The search was conducted in the Web of Science and EBSCO databases, resulting in a total of 20 eligible documents. The articles were reviewed in terms of multimedia supports used to present learning content, emotional design features most frequently found in the development of multimedia learning media, and effects of emotional design on the learning process. The results show a clear evidence that emotional design has positive implications for learning outcomes, however it is a rather complex concept, which gives it some inconsistencies.

Keywords: Emotional design · Multimedia learning · Systematic review

1 Introduction

Currently, with the advance of technology and the growing popularity of mobile devices, learning has been occurring frequently in environments more distant from traditional ones. In this sense, questions are raised about what features and supports of learning materials can trigger emotional responses in a multimedia learning.

According to Pekrun et al. (2002) students in an educational environment experience a wide range of emotions that are related to important factors influencing learning, such as motivation, learning strategies and self-regulation, and also to academic performance. In this sense, the concept of emotional design in the context of multimedia learning, first used by Um et al. (2012), consists of using several visual design features that influence students emotional states to facilitate multimedia learning.

In this study, the authors conducted a systematic review of the literature (SRL) updated on the impact of emotional design in multimedia learning, assuming that emotional design has beneficial characteristics for the multimedia learning process.

2 Theoretical Framework

Multimedia learning can be described as a learning method that involves both images and words, with the processes of selection, organization and integration being essential for a meaningful learning to occur (Mayer 2014). That is, the Cognitive Theory of Multimedia Learning (CTML) describes, that during multimedia learning, learners select relevant information, organize it into visual, verbal and mental models. And then they integrate these models together with prior knowledge (Mayer 2009).

However, it is Moreno's (2006) Cognitive Affective Theory of Learning with Media (CATLM), an extension of CTML, which introduces motivational and affective factors as mediators of multimedia learning, that provides guidance for the use of emotional design in multimedia learning (Moreno 2006; Moreno and Mayer 2007). Thus, CATLM argues for a cognitive function, associated with supporting the cognitive processing of the material, and an affective function related to the influence of learners' attitudes and motivations, important for the visual design of multimedia learning materials (Moreno 2007).

More recently Plass and Kaplan (2016) presented the Integrated Cognitive Affective Model of Learning with the Multimedia (ICALM), which is built on the previous two theories. This model argues "that affective processes are intertwined with, and inseparable from, cognitive processes, and that the cognitive-affective processing of multimedia stimuli involves affective processes that make demands on cognitive resources, and vice-versa" (Plass and Kaplan 2016).

In this sense, the Emotional Design Model proposed by Norman (2004) is an essential tool in the design and evaluation of learning materials in multimedia learning environments. This model presents three levels of emotional design: the visceral, the behavioural and the reflective. The visceral level is defined by the way users perceive the product through emotional responses. The behavioural level is associated with usability, according to the emotions produced by the design. Finally, the reflective level refers to the rationalisation and intellectualization of a product (Norman 2004).

According to Um et al. (2012), emotional design translates into the use of various visual design features that aim to make learning contents more attractive (through face-like shapes and with distinctive and appealing colours) in order to influence learners' emotional states and facilitate multimedia learning.

Students who learn with proven emotional design features obtain better results in comprehension and knowledge transfer, a more positive perception and a better motivation for learning (Mayer and Estrella 2014; Plass et al. 2014; Um et al. 2012).

Thus, it is intended to understand through this SRL the characteristics of emotional design in multimedia learning and its implications for the learning process.

3 Methodology

3.1 The Purpose and Research Question

This SRL has, as main goal, to understand the impact of emotional design on multimedia learning. It proposes to investigate through studies, conducted in the last 5 years,

whether emotional design, essentially of multimedia learning materials, affects learning outcomes.

Thus, the following questions were formulated, and the results were discussed as they related to the articles reviewed:

- What media devices and types of materials are used to present multimedia learning content?
- What are the characteristics of emotional design in the development of multimedia learning media?
- What are the effects of emotional design on the learning process?

3.2 Research Strategy and Procedures

The search was conducted in the Web of Science and EBSCO databases, in the period from 5 to 23 April 2021, according to the queries presented in Table 1.

Table 1. Queries used in the different databases

Database	Query
Web of Science	ALL = ("Emotional design") AND ("Multimedia Learning" OR "Multimedia-Based Learning" OR "Games-Based Learning" OR "e-learning") Timespan: 2016–2021
EBSCO	ALL = ("Emotional design" AND ("Multimedia Learning" OR "Multimedia-Based Learning" OR "Games-Based Learning" OR "e-learning")) Timespan: 2016–2021

3.3 Inclusion and Exclusion Criteria

The documents selected for the SRL responded cumulatively to the following inclusion criteria:

- They were published between the years of 2016 and 2021 (last 5 years);
- Articles published in journals indexed by Web of Science and in EBSCO databases;
- Scientific articles analyzed and reviewed;
- Included in the specific objective of this SRL;
- Present sufficient information about the relationship of emotional design in multimedia learning;

All documents that did not correspond the inclusion criteria were excluded from the SRL. In addition, articles to which the authors could not have access, review articles, meta-analyses, and duplicates were excluded. These and book chapters were also not selected for this review.

The inclusion and exclusion criteria were applied from the reading of the titles and abstracts of the articles. Only when the titles and abstracts did not allow an unequivocal evaluation, the articles were read in full.

3.4 The *corpus* of Analysis

The search in Web of Science and EBSCO provided a total of 36 and 16 potentially eligible articles, respectively. The application of the inclusion and exclusion criteria to this, set of 52 documents, led to the exclusion of a total of 31 documents.

In this sense, this process yielded the total of 20 eligible documents, which constituted the corpus of the analysis (Table 2).

Table 2. Number of documents excluded according to exclusion

Exclusion criteria	Nº of documents
Does not fall within the specific thematic scope of the SRL	12
Duplicated documents	14
Without access	2
Meta analyses	2
Systematic reviews	2

3.5 Data Extraction and Analysis

After being selected, the articles were read in full. Then, the documents were analyzed according to the research questions formulated. For the purpose of this paper, the main categories considered are: i) the multimedia supports used to present learning content, ii) the most frequent emotional design features in the design of multimedia learning media, iii) and what are the effects of emotional design on the learning process.

4 Results

4.1 What Media and Types of Materials Were Used to Present the Multimedia Learning Content?

The experimental process was analyzed considering the type of material used to present the multimedia learning content. In this sense, the participants' learning material was verified in 20 studies and was grouped by the type of media, that is, Static Content (text-image), Dynamic Content (videos and animation) and Interactive Content (games, web, apps). Regarding Static Content, 7 studies used text-image based media documents. According Dynamic Content, 2 used video and 4 used animations. Finally, considering Interactive Content, 1 used a game, and 6 used an interface, which allows navigation. These results can be seen in Table 3.

Table 3. Supports and types of multimedia learning materials

Content	Studies	Nº of documents
Static (text-image)	Désiron et al. (2021), Chung and Cheon (2020), Stárková et al. (2019), Ketzer et al. (2019), Navratil et al. (2018), Stark et al. (2018), Kühl and Zander (2017)	7
Dynamic (videos and animation)	Endres et al. (2020), Chiu et al. (2020), Lauc et al. (2020), Li et al. (2020), (Shangguan et al. 2020a; b)	6
Interactive (games, web, applications)	Javora et al. (2021), Münchow and Bannert (2019), Kumar et al. (2019), Le et al. (2018), Kumar et al. (2018), Münchow et al. (2017), Schneider et al. (2016)	7

4.2 What are the Characteristics of Emotional Design in the Development of Multimedia Learning Media?

According to the learning media of the 20 analyzed studies, 1 study used textual cohesion and cross-representational signaling (CRS), 1 study used contextual animation (animation of contextual elements through increased image movement and high dynamic contrast), 3 studies used decorative/seductive images, 1 study used motivational and instructional messages during multimedia presentations, 11 studies used colour, shapes, and/or anthropomorphic elements, and fonts, 2 used personal pronouns or metaphorical nouns in the text, and 1 combined the use of colour, a social agent, everyday language, symbols and drawn characters in a video. These results can be observed in Table 4.

Table 4. Characteristics of emotional design

Characteristics	Studies	Nº of documents
Textual cohesion and CRS	Désiron et al. (2021)	1
Contextual animation	Javora et al. (2021)	1
Motivational and instructional multimedia messages	Lauc et al. (2020)	1
Social agent, everyday language, symbols and cartoon characters	Endres et al. (2020)	1
Decorative/seductive images	Chung and Cheon (2020), Ketzer et al. (2019), Schneider et al. (2016)	3

(continued)

Table 4. (*continued*)

Characteristics	Studies	Nº of documents
Colour/shapes/anthropomorphisms/font	Li et al. (2020), Kumar et al. (2019), Chiu et al. (2020), Shangguan et al. (2020a; b), Stárková et al. (2019), Münchow and Bannert (2019), Le et al. (2018), Navratil et al. (2018), Kumar et al. (2018), Münchow et al. (2017)	11
Personal pronouns/metaphorical nouns	Stark et al. (2018), Kühl and Zander (2017)	2

According to the studies reviewed, positive emotional design is essentially characterised by the use of warm or bright colours, and similar to the colour of the elements in reality, round shapes and expressive anthropomorphisms (Li et al. 2020; Chiu et al. 2020; Shangguan et al. 2020a, b; Stárková et al. 2019; Münchow and Bannert 2019; Kumar et al. 2019; Le et al. 2018; Navratil et al. 2018; Kumar et al. 2018; Münchow et al. 2017), use of sounds to characterize some elements (Li et al. 2020), handwritten typography, which represents a happy, young and attractive emotional state (Kumar et al. 2019, 2018) and personalization of the text with personal pronouns or positive metaphorical nouns (Endres et al. 2020; Stark et al. 2018; Kühl and Zander 2017).

Neutral emotional design is mainly characterized by using a monochromatic greyscale (such as black, white and grey) and simple geometric shapes, without anthropomorphisms and sound elements.

Negative emotional design, when studied, uses dark and contrasting colour shades, round shapes and anthropomorphic elements with angry expressions or cold imagery, typography that describes sad but attractive emotional state and negative metaphorical nouns (Navratil et al. 2018; Kumar et al. 2018, 2019; Stark et al. 2018).

4.3 What are the Effects of Emotional Design on the Learning Process?

Before presenting the effects of emotional design on the learning process, it is important to specify the sample of each study. In this sense, 3 studies used elementary school students aged 5–11 years, 2 studies used middle school students, only 1 study used high school students (first experimental study), and 15 studies used university students. These results can be seen in Table 5.

After the 20 studies analysed, the following results on the effects of emotional design on the learning process were obtained.

The study conducted by Désirón et al. (2021) conveys knowledge about the use of cohesion and signaling in nonprocedural educational material, taking into account different levels of understanding in the assessment of learning. Participants attributed

Table 5. The sample used in each study

Students	Studies	Nº of documents
Elementary	Javora et al. (2021), Lauc et al. (2020), Chiu et al. (2020)	3
Middle	Shangguan et al. (2020a; b)	2
High	Désiron et al. (2021)	1
University	Désiron et al. (2021), Endres et al. (2020), Chung and Cheon (2020), Li et al. (2020), Stárková et al. (2019), Münchow and Bannert (2019), Kumar et al. (2019), Ketzer et al. (2019), Le et al. (2018), Navratil et al. (2018), Kumar et al. (2018), Stark et al. (2018), Kühl and Zander (2017), Münchow et al. (2017), Schneider et al. (2016)	15

more attention to pictorial representation in the CRS condition compared to the no-signal condition. Thus, the results recommend the use of CRS, however when text-image documents are presented in digital format signage should be implemented as an on-demand feature. According to the authors, signposting could be activated when students have low reading skills or as a tool to learn gradually.

Regarding the research carried out by Javora et al. (2021), the results show that the motivational benefits in applying contextual animation may not be sufficient to trigger greater cognitive engagement and boost learning outcomes considering conventional educational games developed for children. However, contextual animation did not affect learning and was clearly preferred by children. Thus, its use may be beneficial when children choose the materials they wish to interact with.

According to Lauc et al. (2020) the application of motivational messages and multimedia instruction updated the teaching process and made it more attractive for students. Overall, students learned better and showed more interest and positive reactions compared to students who learned with conventional study methods. Thus, the use of multimedia motivational activities, even if only applied in the introductory part of the lessons, can effectively improve learning outcomes in the short term, however, the effect is not necessarily long-lasting.

The study by Endres et al. (2020), combining various emotional design elements in a video (drawn symbols and characters, warm colours, animations with social cues, a story about a social agent, and everyday language) shows that overall, emotionally developed learning material can trigger, and maintain, situational interest. This situational interest allows reducing the need for self-regulation on the part of learners in longer learning phases, leading to better long-term learning outcomes. In this sense, emotional design can be useful, particularly in longer learning phases and when it involves more complex learning materials.

Regarding the use of background images, according to the study developed by Chung and Cheon (2020) it is important to know what type of image arouses the user's sensitivity more, and which generates better recall and retention results of key concepts, namely in the informal context, in which visual resources are increasingly used in order to capture the attention and retention of information in a short period of time. The results

of this study suggest a possible advantage of negative emotional design, considering optimal levels of content arousal that may be more effective for learning, since the use of extremely exciting negative images are not recommended. Therefore, the use of positive images is also considered, which are less susceptible to increasing arousal levels if the possible adverse effects caused by negative images are taken into consideration.

The study by Ketzer et al. (2019) evaluates the effect of seductive details through the use of images and based on the mood of the participants. Participants in a positive mood fixed images for longer and more frequently than participants in a negative mood, which can be interpreted in terms of greater distraction based on mood. However, this did not translate into a more pronounced seductive detail effect in the learning test, indeed there was no seductive detail effect in either mood condition. Instead, including the images in the controlled sample, achieved better learning outcomes overall, while the analysis with the whole sample revealed a descriptive but not significant advantage in the same direction. Since the effect of inverted seductive details was restricted to one analysis, it should be interpreted with caution. However, the analyses converge in the sense that there was definitely no disadvantage for the groups with seductive images.

The results of the study by Schneider et al. (2016) show that images with positive valences or learning images promote retention and transfer performance. It was shown that the content of images within the learning environment regarding affective and contextual dimensions influences learning.

In turn, the research conducted by Li et al. (2020) aimed to investigate the effects of emotional design on learners' performance and emotions. Thus, the effect of emotional design was insignificant on student emotion, however, it was important on student learning performance, i.e., retention and transfer tests.

Kumar et al. (2019) likewise concludes that emotional design is a beneficial tool for improving student learning outcomes. The individual characteristics of the learner, represented as their emotional intelligence, were also found to be instrumental in the adaptation of design and technology students. They also investigated the potential benefits of negative design and found that it has similar benefits with positive design.

The research developed by Chiu et al. (2020) introduces two new factors: student experience and thinking skills. In this regard, emotional design increased the level of intrinsic motivation, however, the effect varied between students with different levels of expertise. The results suggest that using only one multimedia emotional design may have different effects on the development of different thinking skills.

For Shangguan et al. (2020a) positive visual emotional design (colourful and anthropomorphic design) can help maintain the positive emotions produced prior to learning, while positive behavioural emotional design (behavioural interaction with the learning material) can induce and sustain positive emotions. The combination of these different levels of emotional design can simplify learning performance.

Shangguan et al. (2020b) evaluated the effect of positive emotional design on multimedia learning and whether it is moderated by learners' prior knowledge. The results showed that positive emotional design did not induce more positive emotions than the neutral design group, although there was a tendency for it to facilitate more learning transfer and increase the mental effort of learners with low prior knowledge. There was

a tendency for high knowledge learners to perceive greater mental effort, satisfaction and to obtain better transfer scores compared to low knowledge learners.

On the other hand, Stárková et al. (2019) focused on a specific approach to emotional design, the anthropomorphisation of graphic elements in multimedia learning materials. This research clarifies that anthropomorphisms may not always be beneficial, however their inclusion in learning materials does not impair learning.

In contrast to the previous findings, the study developed by Münchow and Bannert (2019) found no superiority effect in the application of emotional design. The effectiveness of the emotional design procedure was not moderated by the previous effective states of the learner. However, there was a major influence of the student's positive affect on transfer performance.

Le et al. (2018) adds that the appealing colours and human face features included in positive emotional design can help learners focus on the details of the information, and, therefore, facilitate retention outcomes in the learning process. This research supports the use of heart rate as a reflective index of mental effort investment in emotional design research.

Navratil et al. 2018 investigated the influence of emotional design on learning with elaborative interrogations. Regarding the use of emotional design features, the results revealed that positive emotional design features can induce a positive emotional state. The processes supporting learning with elaborative interrogations appear to be significant for knowledge application. However, the positive emotional design features, may trigger a high cognitive load that may stop the supportive effect of elaborative interrogation on deeper understanding, i.e., it may hinder learning compared to learning by reading.

Whereas in the study conducted by Kumar et al. (2018) on design aesthetics for engineering students, negative aesthetics was found to have better learning outcomes compared to positive aesthetics. The difference in learning gain between positive and negative design was significant and negative design had higher learning gain compared to positive designs. The study concludes that learning environment design for engineering students depends only on their general preference for negative aesthetics or user interface as a whole and is not based on their gender or academic performance.

However, according to Münchow et al. (2017) results show that participants faced with a positive emotional design (bright and highly saturated colours and rounded shapes as design features) evidence superior results in comprehension and transfer when the initial affective state is strong. A positive affective state in the pre-experimental period, therefore, predicts comprehension and moderation of transference. The results support the idea that a positive affective state, induced by the design of the specific multimedia learning environment, can facilitate performance if initial affective states are taken into account.

The study by Stark et al. (2018) supports the emotional design hypothesis for textual elements. Both positive and negative emotional text design achieved better learning outcomes when compared to the control group. Emotional text design also facilitated elaboration processes, yet suppressed metacognitive processes during learning. Faced with a positive emotional text design the students' emotional state was not affected, however, after learning, the participants in the group with the negative emotional text design showed a worse emotional state.

Finally, in the study conducted by Kühl and Zander (2017) the results showed that learners experienced an overall increase in anxiety state when faced with a topic considered emotionally aversive. Regarding the personalisation principle a reversed personalisation effect was observed for transfer tasks. That is, students performed better when learning from a non-personalised message compared to a personalised message.

5 Discussion

This SRL examined the role of emotional design according to the type of material used in the presentation of content, the characteristics and its effects on the multimedia learning process.

Taking into account the type of material used in the presentation of multimedia learning content it was found that mainly text-image based multimedia documents, learning games and videos, animations and interfaces that allow navigation are used.

The studies are mostly developed on university students, however, more recent research has extended the field of investigation to high school students and children.

Regarding emotional design features in the development of multimedia learning media, research focuses mainly on the study of colour, shapes, anthropomorphic elements, fonts, as well as the use of personal pronouns and/or metaphorical nouns in the text. Also valid is the use of textual cohesion and signage, contextual animation in learning games and decorative/seductive images.

Through this SRL, the effects of emotional design on the learning process have been ascertained in the diverse field of research conducted so far. Several studies have shown to be consistent with the predictions of CATLM (Moreno 2006). In this regard, emotional design has been proven to be beneficial for test score retention and transfer (Li et al. 2020), that it affects cognitive processes through emotion, motivation and cognition (Chiu et al. 2020), that it allows learners to devote more cognitive resources, such as mental effort, to the learning process (Shangguan et al. 2020a), that prior knowledge affects learning outcomes (Shangguan et al. 2020b), and that affective and motivational factors in multimedia education stimulate cognitive engagement during learning (Le et al. 2018). However, Stark et al. (2018) admit that there are gaps in the research field regarding the role of metacognitive processes in multimedia learning.

6 Conclusion

Several studies have shown interest in multimedia learning through a more affective dimension, and with special interest in emotional design. The present study shows results of an SRL on the impact of emotional design on multimedia learning, through 20 articles published between 2016 and 2021.

The results of the SRL shows that emotional design is a rather complex concept which gives it some inconsistencies. There is a clear evidence that emotional design has positive implications on learning outcomes, however, it is essential to take into account the individuality of the learner, associating the content of learning materials according to, for example, prior knowledge, motivation for learning and mental effort.

The theme involved by the present RSL, as well as the objectives presented for its development, unveiled perspectives for susceptible future lines of research. The diversity of studies developed in the area of emotional design in multimedia learning, and which can be verified through the results of this RSL, predicts that future research will focus its attention on a specific theme taking into account for example a multimedia learning principle or a particular multimedia learning environment. Or, on the other hand, to enhance learning skills by employing virtual reality and augmented reality content in order to provide individual experiences.

As with any other study, this SRL also presented limitations. Thus, the first major limitation is associated with the current landscape we live in, due to the pandemic caused by Covid-19, which prevented rapid access to databases, as well as a very limited number of databases for searching potentially eligible documents. Despite the effort and transparency in the decisions made, it is also considered a limitation to the study that all SRL procedures were carried out by only two researchers.

References

- Chiu, T.K.F., Jong, M.-Y., Mok, I.A.C.: Does learner expertise matter when designing emotional multimedia for learners of primary school mathematics? *Educ. Tech. Res. Dev.* **68**(5), 2305–2320 (2020). <https://doi.org/10.1007/s11423-020-09775-4>
- Chung, S., Cheon, J.: Emotional design of multimedia learning using background images with motivational cues. *J. Comput. Assist. Learn.* **36**(6), 922–932 (2020)
- Désiron, J., Bétrancourt, M., Vries, E.: Cross-representational signaling and cohesion support inferential comprehension of text–picture documents. *Front. Psychol.* **11**, 592509 (2021)
- Endres, T., Weyreter, S., Renkl, A., Eitel, A.: When and why does emotional design foster learning? Evidence for situational interest as a mediator of increased persistence. *J. Comput. Assist. Learn.* **36**(4), 514–525 (2020)
- Javora, O., et al.: Is contextual animation needed in multimedia learning games for children? An eye tracker study. *J. Comput. Assist. Learn.* **37**(2), 305–318 (2021)
- Ketzer, N., Scheweppe, J., Rummel, R.: Is the seductive details effect moderated by mood? An eye-tracking study. *Appl. Cogn. Psychol.* **33**(1), 62–70 (2019)
- Kühl, T., Zander, S.: An inverted personalization effect when learning with multimedia: the case of aversive content. *Comput. Educ.* **108**, 71–84 (2017)
- Kumar, J., Muniandy, B., Wan Yahaya, W.: Exploring the effects of emotional design and emotional intelligence in multimedia-based learning: an engineering educational perspective. *New Rev. Hypermedia Multimedia* **25**(1/2), 57–86 (2019)
- Kumar, J., Muniandy, B., Wan Yahaya, W.: Exploring the effects of visual aesthetics in e-learning for engineering students. *Knowl. Manage. E-Learn.* **10**(3), 250–264 (2018)
- Lauc, T., Jagodić, G., Bistrović, J.: Effects of multimedia instructional message on motivation and academic performance of elementary school students in Croatia. *Int. J. Instr.* **13**(4), 491–508 (2020)
- Le, Y., Liu, J., Deng, C., Dai, D.: Heart rate variability reflects the effects of emotional design principle on mental effort in multimedia learning. *Comput. Hum. Behav.* **89**, 40–47 (2018)
- Li, J., Luo, C., Zhang, Q., Shadiev, R.: Can emotional design really evoke emotion in multimedia learning? *Int. J. Educ. Technol. High. Educ.* **17**(1), 1–18 (2020). <https://doi.org/10.1186/s41239-020-00198-y>
- Mayer, R., Estrella, G.: Benefits of emotional design in multimedia instruction. *Learn. Instr.* **33**, 12–18 (2014)

- Mayer, R.: Cognitive theory of multimedia learning. In: Mayer, R. (ed.) *The Cambridge Handbook of Multimedia Learning*, 2nd edn., pp. 43–71. Cambridge University Press, New York (2014).
- Mayer, R.: *Multimedia Learning*, 2nd edn. Cambridge University Press, New York (2009)
- Moreno, R., Mayer, R.: Interactive multimodal learning environments. *Educ. Psychol. Rev.* **19**(3), 309–326 (2007)
- Moreno, R.: Does the modality principle hold for different media? A test of the method-affects-learning hypothesis. *J. Comput. Assist. Learn.* **22**(3), 149–158 (2006)
- Moreno, R.: Optimising learning from animations by minimising cognitive load: Cognitive and affective consequences of signalling and segmentation methods. *Appl. Cogn. Psychol.* **21**(6), 765–781 (2007)
- Münchow, H., Bannert, M.: Feeling good, learning better? Effectivity of an emotional design procedure in multimedia learning. *Educ. Psychol.* **39**(4), 530–549 (2019)
- Münchow, H., Mengelkamp, C., Bannert, M.: The Better you feel better you learn: do warm colours and rounded shapes enhance learning outcome in multimedia learning? *Educ. Res. Int.* **2017**, 1–15 (2017)
- Navratil, S., Kühl, T., Heidig, S.: Why the cells look like that – the influence of learning with emotional design and elaborative interrogations. *Front. Psychol.* **9**, 1653 (2018)
- Norman, D.: *Emotional Design: Why We Love (or Hate) Everyday Things*. Basic Civitas Books, New York (2004)
- Pekrun, R., Goetz, T., Titz, W., Perry, R.: Academic emotions in students' self-regulated learning and achievement: a program of qualitative and quantitative research. *Educ. Psychol.* **37**(2), 91–105 (2002)
- Plass, J., Kaplan, U.: Emotional design in digital media for learning. In: Tettegah, S.Y., Gartmeier, M. (eds.) *Emotions, technology, design, and learning*, pp. 131–161. Elsevier, New York (2016)
- Plass, J., Heidig, S., Hayward, E., Homer, B., Um, E.: Emotional design in multimedia learning: effects of shape and colour on affect and learning. *Learn. Instr.* **29**, 128–140 (2014)
- Schneider, S., Nebel, S., Rey, G.: Decorative pictures and emotional design in multimedia learning. *Learn. Instr.* **44**, 65–73 (2016)
- Shangguan, C., Wang, Z., Gong, S., Guo, Y., Xu, S.: More attractive or more interactive? The effects of multi-leveled emotional design on middle school students' multimedia learning. *Front. Psychol.* **10**, 3065 (2020)
- Shangguan, C., Gong, S., Guo, Y., Wang, X., Lu, J.: The effects of emotional design on middle school students' multimedia learning: the role of learners' prior knowledge. *Educ. Psychol.* **40**(9), 1076–1093 (2020)
- Stark, L., Brünken, R., Park, B.: Emotional text design in multimedia learning: a mixed-methods study using eye tracking. *Comput. Educ.* **120**, 185–196 (2018)
- Stárková, T., Lukavský, J., Javora, O., Brom, C.: Anthropomorphisms in multimedia learning: attract attention but do not enhance learning? *J. Comput. Assist. Learn.* **35**(4), 555–568 (2019)
- Um, E., Plass, J., Hayward, E., Homer, B.: Emotional design in multimedia learning. *J. Educ. Psychol.* **104**(2), 485–498 (2012)



Designing Legal Interfaces: Transforming the Digital Services of a Legal Aid Clinic

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Abstract. CJ Digital is the academic and procedural platform implemented by the Legal Aid Clinic (LAC) of a private University in Colombia. This technological platform seeks to transform the academic space where students of the School of Law continue their training process by giving legal advice to people in vulnerable situations with the support of a professor. With the dissemination of Covid-19, the LAC platform underwent an accelerated validation of its functionality, which revealed usability issues and opportunities for improvement. Among the problems was the difficulty in managing and visualizing case files and the academic management by advisors. The article presents a case study of a LAC platform based on the relation between design thinking and systems thinking approaches applied to interaction design and user experience (UX). System thinking was used to understand the dynamics related to consultations and cases of the areas and legal clinics of the LAC. Design thinking was used to understand the needs and motivations of students and advisors. Based on the findings, we developed a concept for the platform that integrates to main features a new architecture for shared folder management and the development of a procedural timeline. Also, some support functions were improved, such as auto-save, editable grading rubrics, notifications, a text editor, and space for coaching, tutorials, and FAQs. These functionalities can make CJ Digital a national and international reference in creating and deploying legal services. CJ Digital remains a platform for the management of internal processes between students and advisors.

Keywords: User experience · System thinking · Participatory and interaction design · Legal services · Legal Aid Clinic

1 Introduction

More than 30% of the Colombian population does not know their rights or how to solve their legal needs, so they resort to legal advice [1]. Unfortunately, most of the lawyers who

offer this service are private, raising the costs of access to justice. For this reason, Legal Aid Clinics (LAC) provides free legal advice to vulnerable low-income populations and to train future lawyers. The importance of Legal Aid Clinics in Colombia is notorious since 33% of the population attended is in extreme poverty, and 59% of people with disabilities are served in these [1]. For law students, the LAC becomes a learning space where they can do their internships.

The Covid-19 Pandemic has brought new challenges and opportunities to the Legal Aid Clinics, mainly questioning how to continue providing service to users in a Pandemic situation. The answer seems simple in principle: to move services to virtual channels. However, this poses an even more significant challenge: how can a virtual channel effectively promote access to justice when most citizens who come to it do not have the digital tools or literacy to approach through this channel?; Moreover, how to integrate teachers and students virtually so that they can effectively provide services? According to data from the Excellence in Justice Corporation [2], 1 in 4 judicial offices manages their processes manually.

For the LAC of the Universidad de los Andes, moving into online justice services was a way to expand its response capacity. The main feature of this online service is to optimize their processes by migrating to a digital platform. In 2019 the first version of CJ Digital, a digital platform for the Uniandes LAC, included features like the reception of queries, management of admitted cases, legal and academic management, archiving of cases, and cases' reassignment.

Later in 2020, the Pandemic led to an accelerated validation of the platform and its services. These validations made it possible to identify elements that needed to be further developed and adjusted to improve the services provided by the LAC. In this phase of the platform, the idea was to focus on strengthening the platform's user experience and interactions concept, intending to facilitate collaborative and academic work in virtuality without losing sight of the real purpose of the LAC. To understand the LAC as a complex and dynamic system, the Design for Justice Lab conducted research that involves different actors with different interests and playing multiple roles in this context.

This paper presents a transdisciplinary design process by the Design for Justice Lab [3] to develop a new concept for CJ Digital. This concept includes improving some of the current features and new ones aiming to promote a seamless process. The first section illustrates the methodology used to build the design platform's proposal—the next section deeps into the main and supporting features of the concept. The third is a discussion section in which we show how system thinking, participatory design, and design thinking can be integrated to improve user experience and interactions in legal services. Finally, the paper ends with some conclusions and potential directions for future work.

2 Methodology

The Uniandes IT department developed the first version of CJ Digital to approach the LAC's digital transformation. The virtualization of these services was based on

improving the administrative and academic processes of the LAC. Digitizing information allowed students and advisors to handle cases virtually and asynchronously. However, due to the deterministic approach, usability problems became visible with the lack of some support functions for students and advisors.

To solve the performance and usability problems of the current platform, the Design for Justice Lab developed a research plan based on a systemic approach [4] to analyze the systemic complexity related to a virtual configuration of the LAC. This research required identifying the actors and parties involved and their interactions, the technological capabilities, and the functions related to the services provided. The systemic perspective was complemented with participatory and co-creation dynamics [5] to understand the motivations and values behind the different actors. Finally, the project's development was structured based on non-linear cyclical innovation models leveraged on Design Thinking [6–8].

2.1 Primary and Secondary Research

In the first stage of the project, the research stage, we made four fundamental approaches to the LAC and its current digital platform, CJ Digital:

1. We mapped the context of the Uniandes LAC.
2. We analyze the context of LAC at the national level.
3. We reviewed the processes and current operations of CJ Digital.
4. We conducted surveys to different actors of Uniandes LAC.

Uniandes LAC Context. Understanding the network analysis developed also requires understanding how Uniandes LAC works. The LAC comprises seven areas of attention (AA) and four legal clinics (LC). The AA provides a free judicial and extrajudicial social service to people who can demonstrate low economic resources in Constitutional, Administrative, Criminal, Labor, Civil, and Commercial Law. This service is provided by a law student and an advisor who assists a client with a legal need. The AA has seven sections: Conciliation, Family, Labour, Property, Criminal, Public, and Women. The LC seeks to implement the study of law to impact the social reality of different populations with specific legal needs. The LC has four sections: Program of Action with Equality and Social Inclusion (PAIIS by its Spanish acronym), Prisons Group, the Environment and Public Health Clinic (MASP by its Spanish acronym), and the Legal Clinic for Migrants (CJM by its Spanish acronym). CJM is the only one that also performs user-student counseling processes. The clinical areas work through the traditional legal aid clinic model with individual cases, while the legal clinics work mainly on social issues.

The social network analysis acknowledges that different interactions between the areas and the clinics determine the processes' complexity in the platform and demonstrates which clinics or areas are crucial to practice transformation. On the one hand, from this analysis, we found that the clinic/area that has the most significant impact on the LAC transformation is CJM. The above is because CJM is the only legal clinic that handles a bifunctional model in which both the legal office model and the legal clinic model work together. CJM can carry out joint cases with areas such as Labour, Criminal, Public, and Family, and clinics such as PAIIS. Thus, this degree of interconnectivity

makes it an actor with a high power level in the decisions and co-creation exercises to realize the new platform concept. On the other hand, the same analysis shows actors who do not have as much power and participation in decision-making and co-creation processes as Prisons Group, which have no specific connections to any area or clinic. However, to better understand the experiences of students and advisors, we needed to have participants from all areas and clinics regardless of their connections.

Analysis of the LAC Environment. We researched Legal Offices and Legal Aid Clinics in Colombia that virtually provide services to users [9]. We analyzed the Content Management Systems (CMSs) used to develop these Legal Offices' platforms with the help of <http://whatcms.org> [10]. Table 1 shows the analysis developed for five LAC in the main cities of Colombia.

Table 1. List of Legal Aid Clinics and their CMSs

University	CMS	Web framework	Programming language	Database	Web server	OS
Universidad de los Andes - Bogotá	Sharepoint	Microsoft ASP.NET (BIZAGI)	.NET	–	IIS	Windows Server
Universidad EAFIT - Medellín	SharePoint	Microsoft ASP.NET	–	–	IIS	Windows Server
Universidad ICESI - Cali	Joomla	–	PHP	–	Apache	UNIX
Universidad Autónoma del Caribe - Barranquilla	osTicket	–	PHP and Python	MySQL	Apache	CentOS
Universidad Pontificia Bolivariana - Medellín	–	Microsoft ASP.NET	–	–	IIS	Windows Server

As a result, most universities consulted use CMS software such as Drupal or Joomla and PHP as a programming language to manage the front-end content and provide a better user experience and interaction. Conversely, CJ Digital uses Bizagi, a BPM (Business Process Management). BPM is handy for process management, but it is not flexible for creating graphical interfaces and user interactivity. However, this situation provided us with opportunities to improve for the subsequent phases of the project. In conclusion, this LAC is the only one in Colombia with an advanced digital program. Although it does not have a user-friendly interface, it can handle several legal processes and allows advisors to follow up with students academically, an aspect that no other LAC in the country has.

CJ Digital Processes Analysis and Operation. We analyzed CJ Digital and the current platform processes. As a result, we identified actors and their interactions to understand the functions in each of the areas and legal clinics of the LAC.

First of all, we researched the LAC actors and their roles in their daily interactions based on the methodology proposed by Olaya and Gomez-Quintero [4] to guide the conceptualization stages in a System Dynamics model. In this process, we had inputs from students from different clinics and the support of the Coordinator and Director of the clinic.

As a result, we identified the main actors in the processes carried out by CJ Digital, their roles, their goals and interests, and their actions and decisions. The actions and decisions form a complex structure of continuous interactions that delimit the social system's performance we want to understand (see Table 2). The main actors involved in LAC processes are clients, secretaries, law students, advisors, the IT Department, Law School, and the Director of the LAC. Clients have not been included yet in the development of the tool.

From this analysis of actors, we found that advisors and law students had unmet needs essential to their goals and interests. The above meant that the first version of CJ Digital was built based on the processes rather than the goals, interests, and actions performed by the different drivers.

Table 2. Identification of actors and roles [4] involved in the Legal Aid Clinic processes.

Actor	Role	Goals and interests	Actions and decisions
Clien	Beneficiary Affected Supplier	Get his/her problem solved Reach the right end of the legal situation Maintain good communication with the LAC	Go and request attention in the LAC Provide all the documents Know the rights and duties of the case Decide to continue with the case or not
Secretary	Driver	Handle the work correctly within the LAC	Receive users Create the cases Connect the user with students Handle unforeseen events
Law student	Driver Supplier	Provide a solution to the legal problem posed by the customer	Deliver products requested by the advisor Attend users assigned

(continued)

Table 2. (*continued*)

Actor	Role	Goals and interests	Actions and decisions
Advisor	Driver Supplier	Oversee that the cases are solved in the right way	Follow up with students Review the students' products and workload Decide the legal strategy for each case
IT Department	Supplier	Ensuring the platform functioning	Make updates Prove technical service Provide all the documents
Law School	Intervener Supplier	Provide an educational learning space for its last semester students Provide a space that supports vulnerable people who need access to justice	Provide financial resources Provide advisors Intervene in the strategic decisions of the practice
Director of the LAC	Owner	Manage all the LAC processes Ensure positive practice results for students, advisors, and clients	Lead the students' and advisors' practice in the LAC

Secondly, we used Business Process Modeling Notation (BPMN) to build and understand the processes that currently take place in the Digital Platform. Throughout this graphic notation, we could describe the logic of the steps behind the first version of CJ Digital. In addition, we mapped a general process that unifies each of the processes carried out digitally with those still done in person. We did this to understand what was going on in the platform's back-end, integrate the new concept with the existing one, and facilitate communication with the developers.

Finally, to complement the stakeholder analysis of the LAC and the current operation of CJ Digital, we decided to understand the actors' influence in the system and the emerging behaviors of each of the areas and clinics that are part of it through social networks analysis [11].

Surveys. We wanted to get closer to CJ Digital's users' experience, especially with the Advisors and Students. For this, we created a survey to understand the actual situation with the platform and validate the context's previous research. The survey was deployed virtually through the LAC official channels and contained 14 questions that sought mainly to know the current platform's experience. The total number of survey respondents was 33, of which 13 were clinic students, three (3) clinic advisors, ten (10) area students, and seven (7) area advisors. For the survey analysis, we collected all the information gathered and carried out a qualitative pattern search.

The complete analysis of the survey brought different perspectives and possibilities of the digital experience of CJ Digital. First, CJ Digital's most appreciated features are the case filters (pending, supported, and queries) and task assignments. For example, assign one action to several people, follow-up dates, work instructions, methodology, and alerts. These functions currently only work for the areas (AA), but clinics (LC) also need a platform to assign tasks and manage their processes. For instance, a clinic advisor highlighted how to create improvements in the use and performance of the platform: "the possibility of managing and reviewing projects worked in teams and with partners. Alternatively, divide the categories by what we do: case representation, research, strategic litigation, rights education, and workshops with the population".

CJ Digital has a series of technical errors in handling forms to upload information and misunderstandings regarding how a user must fill out the conciliation area. Also, there is a great need to have an editable calendar, a shared repository, and a history that provides traceability of the processes. These needs are reflected in the platform's lack of means of communication.

2.2 Ideation and Co-creation Workshop

In October 2020, we conducted a two-session virtual workshop on ideation and co-creation. Thirty-seven (37) people attended the workshops, including six (6) area advisors, five (5) legal clinic advisors, eleven (11) area students, eleven (11) clinic students, two (2) people from the developers' team, the Director of the Legal Office, and the Coordinator of the Clinic.

This workshop aimed to understand in depth the observed dynamics of interaction between areas and legal clinics. Moreover, incorporating the various stakeholders' perspectives in the design and structuration of the processes allowed us to promote a sense of ownership for the future platform [5, 12, 13].

Finally, participants created the following Value Proposition Canvas (VPC), adapted to a table format for clarity due to the workshop. This Canvas integrates the proposals made in the sessions for areas and legal clinics (see Table 3), focusing on the students' and advisors' knowledge, expectations, problems, needs, and behaviors. In this way, the VPC shows potential value generators for the LAC users.

3 CJ Digital II: The Proposal

3.1 Concept Core

This new development focuses on the values of collaboration, communication, monitoring, and effective search for information, becoming a platform that facilitates collaborative, academic, and community service work in the LAC. This performance is done mainly by incorporating a timeline fed with the procedural documents of each case and an academic space composed of shared folders for inter-area, area-clinical, and/or clinical-clinical cases. In addition, this platform allows and develops collaboration among the different users. Furthermore, it unifies and facilitates communication within the LAC. Also, it facilitates tracking of the educational process to enable formative experiences for

Table 3. Value Proposition Canvas for areas (AA) and clinics (LC)

Customer profile		Value proposition	
Elements	Description	Elements	Proposals made
Pains	<ul style="list-style-type: none"> – Failure to receive notifications (AA) – Difficulty of articulation (LC) – Difficulty finding information (LC) 	Pain Relievers	<ul style="list-style-type: none"> – Ease of academic management (AA) – Ease of student-advisor communication (AA) – Allows collaborative case management (AA) – Quick and easy access to information (LC)
Gains	<ul style="list-style-type: none"> – Ease of communication and management of activities (Both) – Centralization and standardization of work and information (Both) – Traceability of procedural actions (AA) – Less effort and time in virtual activities (LC) 	Gain Creators	<ul style="list-style-type: none"> – Ease of communication and management of area and inter-area-clinical activities thanks to the standardization and centralization of processes (Both) – Quick and easy access to case information (AA)
User Jobs	<ul style="list-style-type: none"> – Academic management (Both) – Inter-area case management (Both) – Communication between advisor-students (AA) – Joint investigations (LC) 	Products & Services	<ul style="list-style-type: none"> – Notifications and reminders (Both) – Individual and group grading rubric (Both) – Collaborative text editor (Both) – Procedural timeline (AA) – Creation of a single folder per customer (AA) – Shared folder for organized document storage (LC) – Wall of updates (LC)

the formation of the Legal Clinic actors. Finally, it provides practical information search by synthesizing content employed as a monitoring and ongoing research mechanism. In conjunction with the university's IT department, a feasibility analysis was conducted to validate the main functions proposed for the new CJ Digital.

3.2 Main Features

Shared Folder for Cases with Different Diagnoses: This functionality arises from the needs of advisors and students who handle inter-area and inter-area-clinical cases. The aim is to create a single case in CJ Digital per client of the LAC. Suppose the client has different diagnoses or legal needs admitted. In that case, these diagnoses may be

carried in the same client's case (case is understood as the one created under a number provided by CJ Digital in this format: CJ-2020-0000). Figure 1 shows the document management architecture in SharePoint proposed for the second phase of CJ Digital.

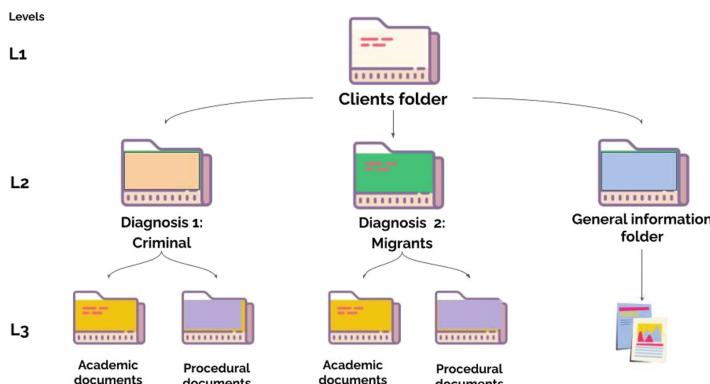


Fig. 1. Graphical representation of the document management architecture in SharePoint proposed for the second phase of CJ Digital.

Case Timeline for Advisors and Students: The procedural timeline was born as a response to the needs identified in the dynamics of the students' academic management and the advisors of the LAC. The platform also focuses on managing procedural documents, conceiving this feature as a folder of documents organized by the case history of the legal processes carried out with the client. Thus, this feature aims to centralize the access and management of documents for students, facilitate academic review processes for advisors, show updates of the cases, and facilitate the case history visualization. A video that shows the interaction of the case timeline can be seen on: https://youtu.be/_LWdTeHtEdY.

3.3 Supporting Features

Autosave/Timer: Although the current platform already had a button to save changes, it had to be activated manually. Moreover, the platform closed without prior notice after a few minutes of not operating without saving the progress. Therefore, the proposal consists of incorporating an auto-save function of the information filled by the students. If this would not be technically possible, a notification or timer should be included within the platform to prevent the loss of information provided by students.

Editable Grading Rubrics: Currently, CJ Digital I contains some grading rubrics that respond to the functioning of some legal clinics and all the areas. However, the four legal clinics in the LAC have other activities not included in those evaluated by the platform's rubrics. For this reason, we suggest incorporating individual and group rubrics that the advisors can design once a semester not to generate insecurity in the evaluation criteria

for students. We also suggest that the rubrics can be downloaded in Excel format and the possibility of generating a report of grades per student for the advisors' convenience. A video that shows the interaction of the rubrics can be seen on: https://youtu.be/uWZFUKQT_C4.

Text Editor: The areas and the clinics require a shared text editor to obtain the document's traceability. That is mainly to know when and by whom it was modified and the first version of the document for grading purposes.

Indicators Proposal: As commonly said, "what cannot be measured cannot be improved." For this reason, the proposal should promote continuous improvement through the management of indicators, which are created based on the success factors expected from a platform such as CJ Digital.

The collection of information from platform users and the management of indicators will provide the necessary feedback to know if the second phase's implementation achieves the expected results. It will also allow us to identify the critical factors that need improvement in future phases and modify, correct, or incorporate other necessary proposals. Therefore, for the creation of indicators, we propose success factors based on the platform's usability (ease of use), user experience (perception), and adaptability (digital change curve) of the platform.

4 Discussion

4.1 Integrating System Thinking and Design Thinking to Improve UX for Legal Services

System thinking includes many methodologies such as interactive planning, soft system thinking, and system dynamics. Its essence is to thoroughly understand a context by looking at the whole instead of the parts. A system involves an interconnected complex of functionally related components. "Failing to consider the systemic properties as derived from the interaction of the parts leads to sub-optimization of the performance of the whole" [14].

The integration of system thinking and design thinking occurs when the system's stakeholders being analyzed become designers of the shared vision of the future they want. These stakeholders can recognize the current situation and make decisions based on what is suitable for the system.

At this point, the role of the team is to piece it all together. Here is where combining system thinking and design thinking comes in handy. Using systems thinking allows having a broad view of the context while using design thinking allows to narrow it down to user experience. Having both approaches helps avoid unintended consequences that may emerge when the context does not suit the user. For example, when a change is introduced in a system, it affects other parts of it. Taking only one of the approaches could lead to missing the perspective of the system's behavior, leaving aside elements that would leverage both situations that were addressed initially and those that emerge during the project's development [14].

Today, design practitioners consider the importance of including all users in the design process. This stand is shown, for example, in the approach of human-centered design and participatory design, in which the design team observes and interacts with all the possible stakeholders before making any design decisions [12, 13]. However, taking all these inputs creates a challenge for the design team, mainly because most of these perspectives do not align. Every user or stakeholder has different interests and motivations, and most of the time, these interests and motivations conflict with each other. For instance, one advisor would like to see all his cases in one dashboard, but each case is addressed to a different student. Therefore, either the advisor shares his dashboard with all the students or has one dashboard for each case.

Design for legal services is a very new area of study that integrates elements of design thinking [15–17]. However, the connection with systems thinking allows challenges to be addressed from a multidisciplinary perspective [3]. That is why integrating these two ways of thinking for digital transformation, particularly in legal services, has allowed us to bring new methodologies to understand and transform legal services in complex systems and positively impact society. In addition, this has allowed us to provide solutions to the current systems as they are digitized and do not replicate the problems that the processes already have manually in the digital world.

4.2 UX and Interaction Design for Complex Systems

UX and UI are excellent tools that help connect complex systems through touchpoints. Many of the touchpoints are interfaces for users to interact with each other, regardless of their role. However, for UX and UI design to be successful, it is not enough for it to be functional, that is, able to meet the needs of its users. If the user cannot complete a task, they will not use the product again. According to Walter [18], an interface must be reliable; the user must feel comfortable. Moreover, it must be usable; it must be relatively easy to perform basic tasks quickly through it. Furthermore, it must be pleasurable to use, allowing it to connect with the user's emotions. In the end, the idea of these interfaces is to provide purpose to users, is not really about the product, but how the users feel that they are becoming better versions of themselves [19].

Designing complex interfaces for complex systems will only make more complex the way users interact. Complex systems require agile interfaces, interfaces that conform to the needs of the users. In CJ Digital, students and advisors need the platform to become much more than a tool; it must allow them to play their role and contribute to society. The system becomes more complex if the platform only encounters functionality where information is entered without considering actors' goals and interests. Whereas if the platform responds to the interests of students and advisors, it will make them feel value and purpose in using it. The students' interests provide solutions to their clients' legal problems; while the advisors' interests are to monitor all cases properly.

Furthermore, when seeking to transform a complex system, one of the most challenging tasks is reconciling aesthetics with technological processes. Functionality usually prevails over usability, prioritizing the technical side over the human side. In this line, it is straightforward for the executing team to focus only on the processes and behaviors of the system to work correctly. While leaving aside that users' perspectives and interactions contribute to technology adoption, it is also crucial to make a handy tool.

It is essential to consider that users, mainly advisors, and students, communicate with computer-based interactive systems via user interfaces, so the user interface design has an enormous influence on system usability because its user interface reflects the functionality of a computer system. In addition, the interface also has an enormous role in smoother user adoption, which impacts the change management process [20].

This function vs. aesthetics topic was one of the biggest challenges we addressed to design the new concept. Because although the best way to carry out the digital transformation of the office was to implement a platform focused on Business Process Management (BPM), it had limitations in terms of the design of a user-friendly interface. However, these limitations did not prevent us from reconciling the concept of usability. Therefore, we addressed that the tool should reflect the processes and behaviors to be carried out in the system and that it should be easy for users to interact with it. In that line, the change management processes can also be carried out, which in the end, are what will ensure the success of the tool.

4.3 Participatory Design in UX and Interaction Design Concepts

Based on Robertson and Simonsen's [21] vision of participatory design, we comprehend that involving the people as active participants in the design project means that the process and its outcome are more likely to be accepted and sustained. Which is why we asked ourselves, who was being left out of the system? Who understands the practices and environments where new products and services will be used? After analyzing the ecosystem and conducting surveys, we found that the needs of the advisors were prioritized, as the user testing and ideation processes had been carried out with them in the first stage, but this was not the case for the students. In our exercise of designing for people in the plurality of the context, students became very important, as they expressed that the interface did not address their problems and needs. From this premise, we developed the ideation and co-creation workshops, creating a proposal that takes what already exists but transforms the points of contact and work tools to respond to the needs of the different users of CJ Digital.

5 Conclusions

The legal system is complex. CJ Digitalis is an example of how it is possible to integrate system thinking and design thinking to improve the experience of legal services and generate a positive impact on society, particularly within the framework of digital transformation. CJ Digital improves the quality of service to clients and the daily lives of students and professionals who work with the platform and promotes access to justice, with particular attention to the vulnerable population. In this way, this transdisciplinary research highlights the importance of participatory design, UX, and interaction design in complex systems, such as justice, as it comprehends the need to include the perspective of all actors in the design processes of these services. Although the implementation of CJ Digital II is still in process, its preliminary results highlight its potential and the possibility of replicating it with other Legal Aid Clinics in Colombia and other countries. In addition, it opens up an opportunity to study a new area in the academic legal sector.

References

1. La Rota, M., Lalinde, S., Uprimny, R.: Centro de Estudios de Derecho, Justicia y Sociedad (Dejusticia). Encuesta Nacional de Necesidades jurídicas Análisis general y comparativo para tres poblaciones (2016). https://www.dejusticia.org/wp-content/uploads/2017/04/fi_name_recurso_618.pdf
2. Corporación Excelencia en la Justicia: Decálogo para reinventar la justicia en el marco de la pospandemia (2021). https://cej.org.co/wp-content/uploads/2021/06/Decalogo_para_reinventar_laJusticia_en_la_pospandemia.pdf
3. De Francisco Vela, S., Guzmán-Abello, L., Pardo Rodríguez, S.: Design for Justice Lab. Interdisciplinarity in times of virtual education. In: the 6th International Conference for Design Education Researchers, Engaging with Challenges in Design Education 2021 (manuscript submitted for publication)
4. Olaya, C., Gomez-Quintero, J.: Conceptualization of social system: actors first. In: Proceeding 34th International Conference of the SD Society, Delf, Holanda (2016)
5. Sanders, E.B., Stappers, P.J.: Co-creation and the new landscapes of design. *CoDesign* **4**(1), 5–18 (2008). <https://doi.org/10.1080/15710880701875068>
6. Owen, C.L.: Design research: building the knowledge base. *Des. Stud.* **19**(1), 9–20 (1998). [https://doi.org/10.1016/s0142-694x\(97\)00030-6](https://doi.org/10.1016/s0142-694x(97)00030-6)
7. Beckman, S.L., Barry, M.: Innovation as a learning process: embedding design thinking. *Calif. Manage. Rev.* **50**(1), 25–56 (2007). <https://doi.org/10.2307/41166415>
8. Kumar, V.: 101 Design Methods: A Structured Approach for Driving Innovation in Your Organization. Wiley, New York (2012)
9. Ministerio de Justicia y del Derecho: LegalApp. Consultorios Jurídicos Virtuales. (2020). http://www.legalapp.gov.co/Consultorios_Juridicos_Virtuales. Accessed 6 Oct 2020
10. whatcms: Detect which CMS a site is using - What CMS? <https://whatcms.org/>. Accessed 17 Dec 2020
11. Newman, M.: Networks. Oxford University Press, Oxford (2018)
12. Sanders, E.B.N.: From user-centered to participatory design approaches. In Design and the Social Sciences, pp. 18–25. CRC Press (2002)
13. Buur, J., Matthews, B.: Participatory innovation. *Int. J. Innov. Manag.* **12**(03), 255–273 (2008)
14. Pourdehnad, J., Wexler, E., Wilson, D.: Systems & design thinking: a conceptual framework for their integration. In: 55th Annual Meeting of the International Society for the Systems Sciences 2011, pp. 807–821 (2011)
15. Hagan, M.: A human-centered design approach to access to justice: generating new prototypes and hypotheses for interventions to make courts user-friendly. *Ind. JL Soc. Equal.* **6**, 199 (2018)
16. Perry-Kessaris, A.: Legal design for practice, activism, policy, and research. *J. Law Soc.* **46**(2), 185–210 (2019)
17. Santuber, J., Krawietz, L., Owoyele, B., Edelman, J.: A framework theory of legal design for the emergence of change in the digital legal society. *Rechtstheorie (RT)* **50**(1), 41–57 (2019)
18. Walter, A.: Designing for Emotion. A Book Apart, New York, Nueva York (2011)
19. Hulick, S.: The elements of user onboarding (2014). Useronboard.com
20. Seneler, C., Basoglu, N., Daim, T.: Exploring the contribution of information systems user interface design characteristics to the adoption process. *IJBIS*. **4**, 489–508 (2009). <https://doi.org/10.1504/IJBIS.2009.025203>
21. Robertson, T., Simonsen, J.: Challenges and opportunities in contemporary participatory design. *Des. Issues* **28**(3), 3–9 (2012). https://doi.org/10.1162/desi_a_00157



From Digital to Living Waste Denial: A Condition of the Liquid Society

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Abstract. Within the master’s course design for communication of Università degli Studi della Campania “Luigi Vanvitelli”, it was analyzed in a thesis project an emergency urgent contemporary: the denial of waste production.

Obsolete objects which are precious only for a short time, then became waste. The waste we produce is not only tangible but is often much more difficult to weigh like the digital or the living one.

For this purpose, in the context of design for emergency, it was decided to tackle a specific invisible but very cumbersome emergency: the refusal of waste.

The intent is therefore to represent the rejects of our contemporaneity, through a lay dissemination, with the aim of creating a different point of view on the subject. Making visible what we refuse to look at because we consider it out of tune, dangerous, useless, now deprived of its role in society. Refusal is understood in its broadest interpretations: from solid refusal to digital refusal up to moral refusal.

To address the issue, an editorial system has been created that is developed over three years. The magazine deals with three types of waste over the course of a year, related to the fourth theme, the leitmotif of the previous ones. Within each issue, specific sections collect and tell the rejection through different languages and interventions by professionals from various fields. Psychiatrists, photographers, illustrators, journalists, museum directors and other figures contributed.

Keywords: Digital waste · Emergency design · Editorial design · Social responsibility

1 The Waste We Refuse

On Google, the word refuse produces about 447.000.000 results. 447.000.000 of waste.

From the definitions of the term refuse, a double meaning is gathered: a concrete, tangible rejection, the excrement, the unwanted; and that of the action of refusing, of not wanting, of opposing.

Rejected are the scraps that we ourselves think, create, produce, use, deny, abandon, destroy, exorcise. To create them is a light consequence, sometimes very fast. A consequence against which we are powerless, because it is imposed by the system in which we live, imposed by the cycle of nature. The waste exists when its matrix exists.

In the city of Leonia, described by Italo Calvino [1], the true passion of the citizens is not so much enjoying the new as the act of expelling, of moving away from oneself. Because refusing makes us feel cleaner, lighter, atoned for. As if by removing all that is outdated, broken, ugly, wrong, it makes us less degradable. Waste reminds us of time which deteriorates things, which deteriorates us. Refusals, like us, follow a cycle and we reject the end.

It's not about consumption, the use and the consequently waste. Bens of exchange, relationship, reciprocity, acceptance and coexistence with rejection. This is not a change, but an already existing condition. Waste is part of our contemporaneity and is often inevitable. The paradox of rejection in the perception we have of it. Rejected are visible-invisible: bulky, smelling, messy, yet socially invisible. We refuse to look at them, we enjoy rejecting them but we would like our refusal to destroy them. And this is what makes them even more detestable: their indestructibility, their resistance. Because a rejection lasts much longer than a new thing, which can sometimes last even a few moments.

Refusal taken into consideration is the action of man to deny, reject, and therefore produce waste. The rejects are such because they are not useful for a practical need or to satisfy an aesthetic feeling. When what is socially defined as refusal acquires an aesthetic or moral value for someone, it immediately ceases to be refusal because it is accepted.

We think of the new design trends of regarding the discarded, trends such as the “Thinkered” and the “Informe” [2] collected and analyzed in “Design e Delitto” by Francesca La Rocca.

2 New Emergencies

Why the refused are to be considered an emergency of our society? Why the need to talk about the rejected?

In September 2015, the governments of the 193 member countries of the UN signed the 2030 Agenda for Sustainable Development. An action program for people, the planet and prosperity.

It incorporates 17 Sustainable Development Goals, SDGs - into a large action program for a total of 169 ‘targets’ or milestones.

The Development Goals represent common goals on a set of important development issues: ending poverty, ensuring sustainable patterns of production and consumption, making cities and human settlements inclusive, safe, long-lasting and sustainable, to name but a few. ‘Common goals’ means that they concern all countries and all individuals.

Starting from these points, a specific invisible emergency was identified, but very cumbersome in our contemporaneity: that of the refusal of waste, in other words of our denial of waste. Waste is the symbol of the acceleration of times, as well as their waste, and they represent what we want to remove at all costs, until we forget about it.

A new design attitude within the theme of permanent emergency is addressed in “First things first”, by Daniela Piscitelli [3]. The author faces the responsibility of the graphic designer in the various narratives aimed at creating what Moren, a French philosopher, calls “terrestrial identity”.

In what Bauman defined as “liquid modernity” [4], there is a culture of waste, a “civilization of excess, surplus, waste and waste disposal”.

Desires that do not have time to be satisfied that are already being replaced by new desires, creating new hierarchies in which the vertices are occupied by those for whom there is perfect coincidence between the arising of a desire and its realization. “The dizzying pace of change devalues everything that might be desirable and desired today, marking it from the start as tomorrow’s waste, while the fear of being discarded that exudes from the experience of the whirlwind pace of change causes desires to be greedier, and change itself is more rapidly desired... “To this conception of desire is connected consumption on credit, the inability to wait and postpone experiences, the devaluation of the concept of beauty that today renounces any traditional idea of perfection in favor of that of eternal mutability, the management of human relationships as if they were products to be consumed. “The liquid-modern culture (...) appears as a culture of disengagement, discontinuity and forgetfulness” in which “we are all in and on the market, at the same time, or interchangeably, customers and goods” and in which “what we all, it seems, fear (...) abandonment, exclusion, being rejected, disowned, discharged, dumped, stripped of what we are”.

3 The Magazine Project

3.1 Vision of the Project

The project was developed as a thesis in design for communication master course, within the scenario of design for emergencies. The magazine project is aimed at the paper industry, specifically those companies that deal with the production of paper for editorial and graphic printing. Each year these companies devote large budgets to the creation of paper samples. These objects are intended to present new papers and new printing possibilities both to printers and those who work in the field of graphics. For the realization of the samples, graphic designers, illustrators and photographers are called to give life to the new cards proposed. The use of these objects is therefore limited to a technical-exhibition function and the contents that are inserted have the only purpose of emphasizing the qualities of the paper without giving further significant value to the object. The aim of this project is therefore to propose a new strategic approach for paper mills by introducing a logic of corporate social responsibility in their products. Through the creation of an editorial project that will replace, or rather, implement the paper samples. Therefore, proposing to maintain the main function of the samples: showing a wide variety of papers, finishes and printing techniques. At the same time this approach gives a social value to the project, becoming the spokesperson for a social, political and environmental emergency: waste. Specifically, the design choices made are reflected in the prototype of the first issue.

The magazine aims to involve an audience as heterogeneous as possible, but the chosen language is aimed at a mainly young target, that of millennials: today from 20 to 40 years old.

The magazine’s distribution channel automatically sectorizes the target to an audience of readers belonging to the field of graphic design, but aspires to reach an audience whose cultural, disciplinary and territorial origin are as heterogeneous as possible. The

magazine aims to create a critical cultural debate that can embrace different fields, from scientific and research to philosophical and cultural, up to reaching the mass audience through social channels.

The magazine deals with a specific invisible but very cumbersome emergency: the refusal of waste. It represents the unwanted of our contemporaneity through secular dissemination, with the aim of creating a different point of view on the subject. Making brutally visible what we refuse to look at because we consider it out of tune, dangerous, useless because it is now deprived of its role in society.

In order to change our point of view on this issue, the magazine asks designers, illustrators, photographers, artists, activists, journalists, citizens and therefore figures from different fields, to offer their vision on the subject, to rethink our perception of the gap and therefore propose stimulating approaches.

There is an urgent need for a dialogue that will help us review our habits of thought, which will distance us from observing the world without its complexities. It is the complexities that help us to look at complex issues such as waste with critical thinking.

3.2 The Editorial Plan

A three-year publishing system has been developed to address the issue. The publishing system takes the form of a quarterly printed magazine that deals with three types of waste over the course of a year, related to the fourth theme, the leitmotif of the previous ones. The fourth number is always, in fact, a revelation that arises from the correlation of some elements of that year's numbers.

To establish the arguments, present in each issue, a three-year editorial plan has been developed, a structure that can be expanded over time.

Six fundamental topics have been established, always present in each issue.

Three types of waste were chosen for each year, one for each of the first three numbers. The theme of the fourth issue always arose from a transversal reading of the previous ones.

The relationship between the four themes and the six topics gives rise to six different specific subjects for each issue. Taking the example of the first issue on abandoned waste, the digital section describes digital cemeteries, abandoned blogs, disused domains. While doing a horizontal reading, in the human theme: the first number talks about addictions, the second about handicaps and the third about diseases; these three subjects are concretized in the fourth subject, the common thread of the previous ones, "mortal beings". That is our fear of death, fear that arises when we deal with issues such as drug addiction, disease or dysmorphism. These people then become waste because our fear, in this case, leads us to reject them (Fig. 1).

3.3 The Content Structure

The content structure was designed as a basic structure for all numbers.

In cyan the six main articles that deal with the six topics that emerged from the editorial plan. Each article is entrusted to a different professional figure, who can provide a different point of view on the proposed topic.

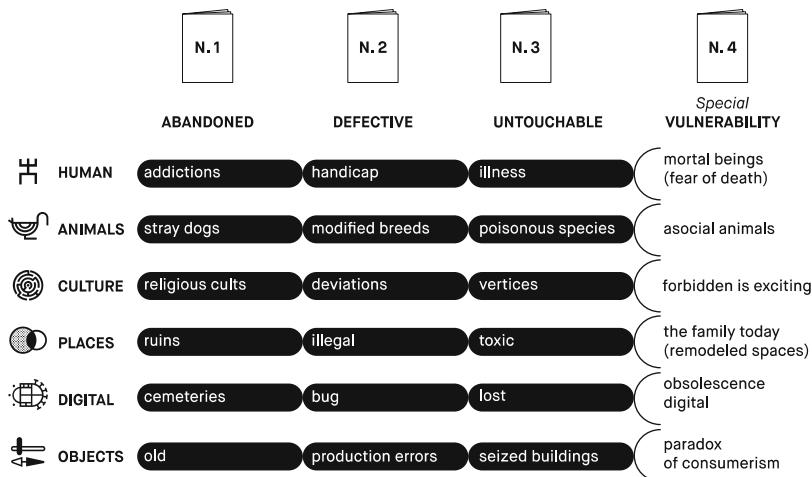


Fig. 1. A scheme illustrating how the topics to be treated are attributed within the editorial system.

In yellow the central section dedicated to graphic, photographic and illustration insights.

The resulting structural section is in magenta (Fig. 2).

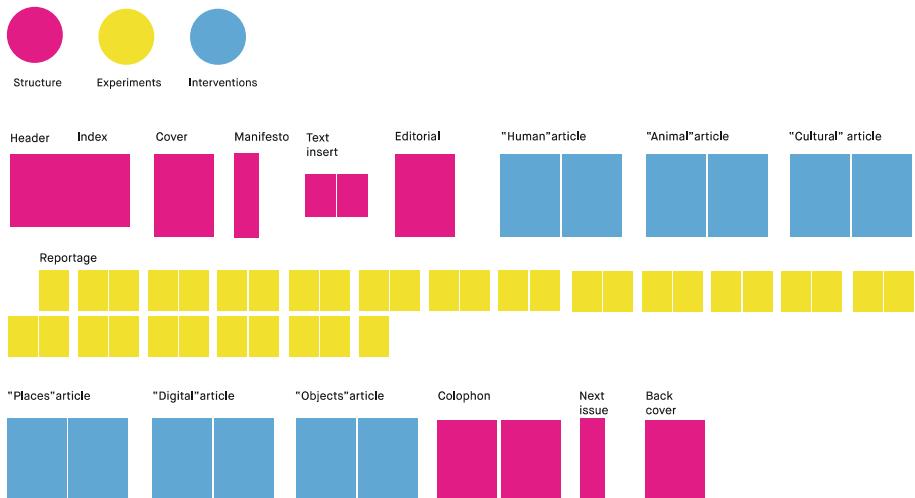


Fig. 2. A scheme illustrating the content structure.

3.4 The Pictogram System

In order to help the reader to find their way both within the magazine and between the different issues, an index of symbols was created. Each of the six topics is represented by

a pictogram, designed starting from the symbols of rock art cataloged and provided by the “Nadro Museum”. [5] A prehistoric language, clearly abandoned, rejected, because it is obsolete. Some pictograms are more literal and immediately attributable to the topic described; others are more metaphorical (Fig. 3).

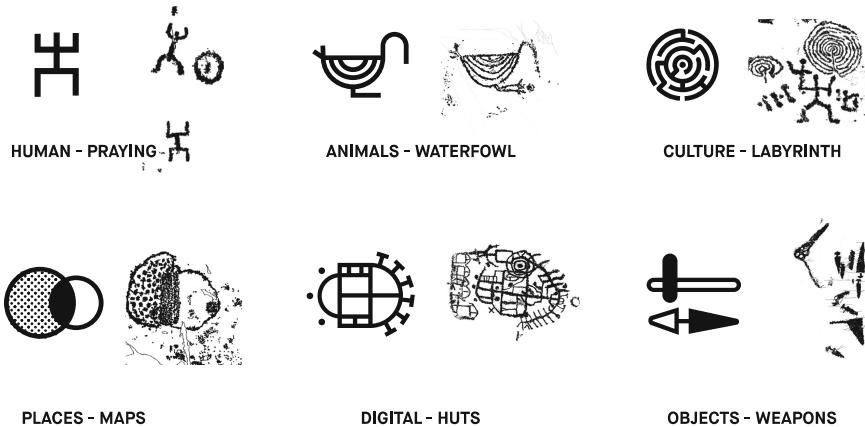


Fig. 3. The pictogram system, derived from primitive symbols of rock art.

3.5 The Covers and the Graphic Style

Twelve covers were designed for the different magazine issues. Each year the numbers offer a graphic reinterpretation of waste cultures, already introduced by the cover image. The latter, however, is always hidden by a precious dust jacket that reveals only a part of it at the bottom. By creating, in fact, a refusal (Fig. 4).

The magazine investigates every year a graphic style belonging to a different throwaway culture. Reinterpreting their identifying traits.

Counterculture refers to that movement which is radically opposed to mainstream society.

It is the real attempt to go far beyond the dominant culture at a given historical moment, quickly becoming synonymous with giving a voice to the weakest, the marginalized. Just think of the sexual revolution and the vindication of women's rights, or even going against respectability and the British bourgeoisie by giving birth to the punk movement, which literally means of poor quality, with all its verve and provocative charge.

Counterculture that in Italy was fully embraced already in the 70s, a period in which attempts were made to give a voice to the people, to political phenomena through a series of movements that in the graphic field are reflected with means such as flyers in front of the entrance to schools, workplaces or neighborhoods, all produced in mimeograph style.

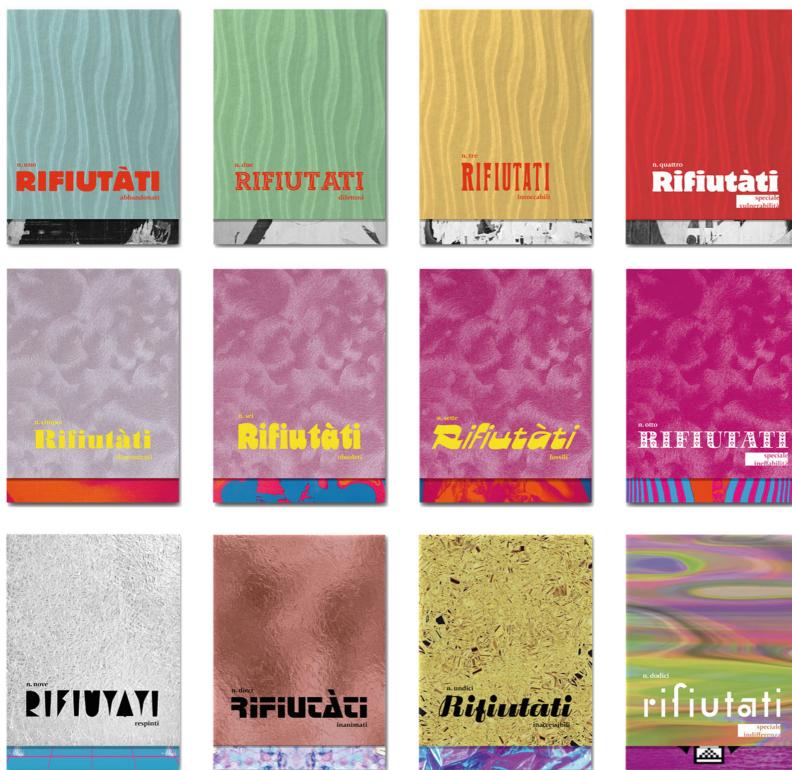


Fig. 4. The twelve covers designed for the different magazine issues.

3.6 The Typography

The font chosen for the first issue is the Capitolium designed by Gerard Unger for the 2000 Jubilee but never used on the occasion of the celebration. The history of this typeface is an example of a rejected font. In the following years Unger decided to make some changes, adapting it in particular to printing for newspapers, and today the font is used in various editorial projects [6].

For each issue a different font has been dedicated for the header and for the internal texts, for the choice of fonts a search is carried out among the rejected ones.

Closed tipotheques because unable to update and their materials such as lead alloy or wood characters have been preserved by foundations and museums.

Discarded letters, understood as physical characters in wood, discards because leftovers of incomplete policies.

Typographic projects that after years of use, aside of the customer, have been replaced with other fonts. Or more easily typographical projects that have never been created or applied. Fonts never digitized or illegally digitized.

Outdated fonts, which strongly characterize a style that is now outdated or rejected. An example of this is the “Triennale” typeface strongly linked to the Fascist period and therefore hardly accepted.

Versions snubbed by the graphics because they are less rigorous than the original version, too naive or simply wrong. Like Comic Sans or Adobe's version of Franklin Gothic.

3.7 First Issue

For the realization of the first issue of the magazine, people from different working fields were involved who, fascinated by the theme, provided their contribution in the form of texts, illustrations and photographs. Psychiatrists, high school students, museum directors, journalists and photographers have enriched this issue with their different interpretations of the same theme.

Furthermore, the guidelines provided to the authors for the drafting of the texts were functional to the stylistic freedom of editorial contributions.

The layout allows a very fast reading, in distressing sections due to the rhythm given to the pages. The goal is to convey the concept of quantity, production and accumulation of waste.

The general structure of the journal is divided as follows:

A first structural part with orientation index.

and introductory sections to the topic, first general waste, then specific to the topic.

Three articles for the first three subjects of the theme. The texts are always free from images, because they are treated in such a way as to be themselves evocative of the theme addressed.



Fig. 5. First Issue's cover

A section of graphic, photographic and illustration experiments, which recount the six subjects of that issue reinterpreted according to the style of the throwaway culture proposed that year.

The next and last three articles.

The last structural section of the magazine, then the biographies, the credits, the presentation of the next issue with the indications for contributing to the contents and the colophon (Figs. 5, 6, 7, 8, 9 and 10).



Fig. 6. Internal pages: manifest



Fig. 7. Internal pages: text inserts



Fig. 8. Internal pages: special insert



Fig. 9. Internal pages: human section article



Fig. 10. Internal pages: reportage

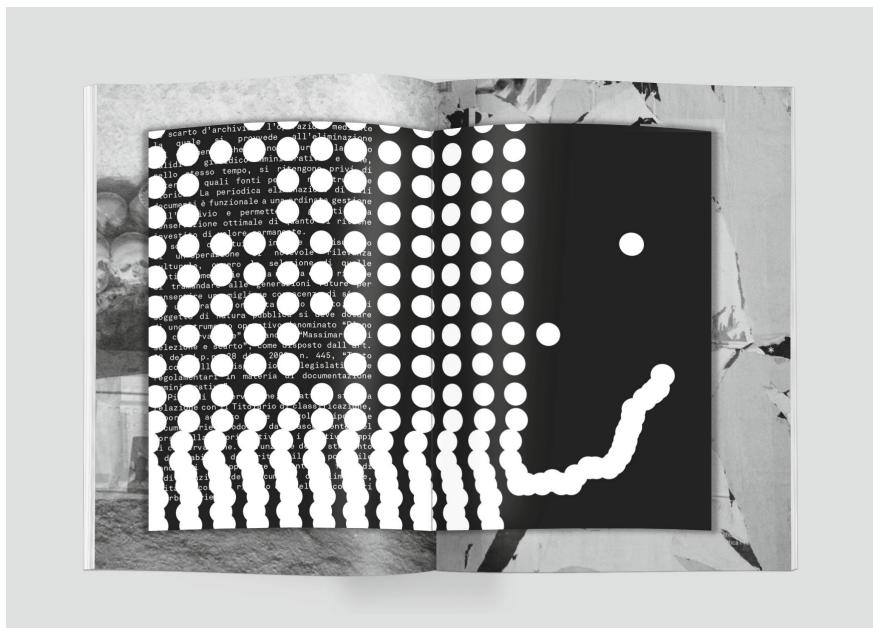


Fig. 10. continued

4 Conclusions

In this historical period, information is ever faster and more concise, so *Rifiutati Magazine* readjusts the speed of digital reading to a paper format that collects selected content and amplifies the message, with the support that welcomes them.

The challenge of the magazine was therefore to preserve the preciousness of the paper product by introducing a logic of corporate social responsibility for the paper mills that produce samples to present the novelties of their products to stakeholders.

For this purpose it is proposed to introduce a strong theme of our contemporary: the denial of waste production.

Today it is urgent to talk about what we choose to ignore, to become more aware of our complex condition as contemporary citizens.

Through an editorial system, scheduled for the next 3 years, the magazine is published quarterly in paper format. The refusals it proposes to address are the result of a scheme designed so as to be able to create topics that are always updated and specific within the macro-category of refused.

A constantly evolving graphic style recycles from the past and revisits from the contemporary, beyond typography that becomes a reason for study for the recovery of lost fonts. The magazine involves very heterogeneous professional figures, inviting us to talk about a topic that concerns us all with the aim of always obtaining very different and always very broad points of view.

Rifiutati Magazine wants to open our perception on the discrepancies of things, on the complexity of the phenomena that we are used to evaluate with little imagination and, last but not least, to offer a design experiment for social sustainability.

Acknowledgement. The authors would like to thank the Department of Architecture and Industrial Design DADI at which the degree thesis, with first supervisor professor Daniela Piscitelli, was carried out.

References

1. Calvino, I.: *Le città invisibili*, Palomar S.r.l. e Arnoldo Mondadori Editore S.p.A., Milano (1993)
2. La Rocca, F.: *Design e delitto*, Franco Angeli, Milano (2016)
3. Piscitelli, D.: *First things first: comunicare le emergenze*, LISt Lab, EU (2019)
4. Bauman, Z.: *Modernità liquida*, Editori Laterza, Roma (1999)
5. Medici, P., Gavaldo, S.: *L'arte rupestre di Foppe di Nadro*, vol. 2: Catalogo delle rocce incise, Edizioni del Centro, Capo di Ponte - Brescia (2019)
6. Vendetti, A.: *Bentornato a casa Capitolium: intervista a Gerard Unger*, in *Catalogo Aiap Design Per 2017*, Tipografare, Roma (2017)



A User Experience Design Process in Mobile Applications Prototypes: A Case Study

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Abstract. More and more importance is being given to the best usability and user experience that a user should have when using digital products. In this context, it is essential to recognize its importance in the design and prototyping process of user applications. As such, a Workshop was structured and developed, supported by a UX Design process, to create high-fidelity prototypes of applications for mobile devices. As a result of this Workshop, six prototypes were obtained and for each one of them the generic functionalities prototyped are indicated. One of these prototypes was selected and presented in this article as a case study. It is possible to demonstrate the use of a UX Design method for its creation, based on 5 plans: Strategy, Scope, Structure, Skeleton and Surface. Thus, it is verified that the adoption of a UX Design method can enhance the best user experience of a mobile App.

Keywords: UX design · User experience · Mobile app prototype · Workshop

1 Introduction

UX Design is an area of design that has as its object of study and project, essentially, the user experience of digital products and services. Such experience involves users' perception of value, as well as how they interact with digital products and services, through their appearance and how they feel and remember such interactions. User experience has existed since humans interacted with the first object. The interaction produced learning, and this became an experience. However, since the emergence of digital technologies, there has been a need to study the continuous improvement of user experience, in which the user is the focus. However, this scope goes beyond usability [1] to the emotional side of the user, thus provoking an emotional response to what he has just done, with the mission of transforming ordinary experiences into exceptional ones. A product that is not easy to use, efficient and effective is a product doomed to non-use. In this context, a Workshop about the User Experience process was held in a higher education academic environment. One of the advantages of this Workshop comprised the concentration of groups of participants, stimulated to develop a comprehensive vision, in a respective project area, in order to contribute and develop solutions to problems presented, as well

as seeking to deepen possibilities/opportunities for exploring a method, technology and generation of new solutions, and the expansion of design culture as a differential. This paper is organized into five sections. The current section introduces the scope of the article, followed by a section framing the fundamental concepts of usability and user experience design. In the following sections the methodology used is indicated and the development of the workshop is described, ending with the conclusions section.

2 Usability and User Experience Design

When referring to the term usability, authors such as Jacob Nielsen [2], Ben Shneiderman [3] and Patrick Jordan [4] are fundamental references to understand this concept. Generally, the word “usability” refers to the use of methods to improve the ease of use of a product [5]. It focuses on three fundamental concepts: effectiveness, efficiency and satisfaction [6] as represented in Table 1.

Table 1. Usability fundamental concepts.

Effectiveness	Efficiency	Satisfaction
Analysis of objectives and how they can be achieved	Relationship of Effectiveness with the amount of resources used	It is established by the users' comfort and acceptability of the product

Effectiveness is related to the analysis of objectives and how precisely they can be achieved. Efficiency refers to the relationship of effectiveness to the amount of resources used. And satisfaction is established by the users' comfort and acceptability of the product and can be calculated by objective and/or subjective methods. Interaction is apprehended by use or experience with other products, and those that people use intuitively are those that have similar characteristics to those developed/experienced previously. The past is relevant in experience, thus transferring between products and probably also between contexts, so that performance is affected by the degree of familiarity one may have with technologies.

Currently, the term UX (User Experience) has gained prominence in its field as a fundamental part in the design of a digital product, with the purpose of creating user loyalty through a positive experience, providing satisfaction. The UX is determined by the various stages and participants involved in its process. For the realization of a feasible experience, it is essential to exist a combination of properties and aspects able to trigger this particularity, from actions taken by the user, as well as the surrounding space embedded in it and the product, service or system in question.

According to the study prepared by Roto et al [7], in order the UX process may occur, there are several properties and characteristics to be respected, namely in its context of use, there are physical aspects (environment, external noises, climate), the tasks to be developed (its purpose, its time, the importance of use) and socio-cultural factors (social norms, beliefs, fashions, languages). There is also a process/relationship between

the user and the system, which we can consider that the user suffers from momentary aspects (feelings, emotions, moods, will), predispositions and characteristics (personality, experiences, principles) and its limitations and capabilities (communication, skills, sensory sense) while the system embraces differentiating characteristics, highlighting its efficiency, its simplicity, its adaptability and purpose, all this is determined by the user, through its usefulness, originality, complexity and reputation [7].

A well-known methodology for promoting a good user experience was proposed by Jesse James Garrett [8]. This is composed of 5 layers, from abstract to concrete, called: Strategy, Scope, Structure, Skeleton and Surface (Fig. 1).

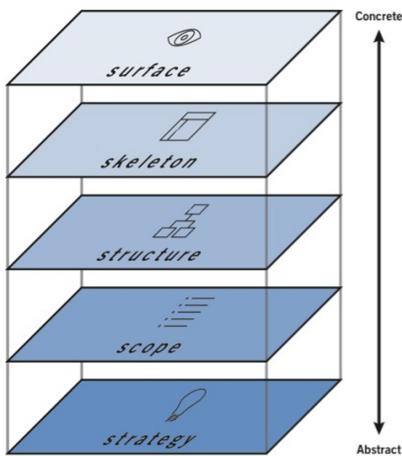


Fig. 1. The 5 planes of UX from Jesse James Garret [12].

Each layer/plan is dependent on each other and is analyzed in an increasing manner from the most abstract to the most concrete [8]. The Strategy is the first layer of this process, which aims to obtain a general perception of the issues involved in the initial situation of the problem, that is a collection of the main information related to the project and, mainly, of the user's needs. This layer is fundamental to any decision in the UX process, and it is here that the personas of the application are created. The next layer is called Scope and establishes the functional aspects to be developed in the application, establishing the user's role. The third layer is called Structure and its objective is to define how the product will work. It is here that the more abstract questions of strategy and scope become more concrete and will determine the user experience. The next layer is called Skeleton and it defines the navigation systems, corrections and adjustments to interface elements and the development of all screen wireframes. Wireframes are represented in a schematic document, often detailed, used to represent the behavior of the visual elements of the various screens. Wireframes emerge as a way to unify the interface and the navigation design. The last layer is called Surface and focuses on the visual treatment of the app and the elements of visual communication. The visual elements can be manipulated and emphasized through visual communication techniques, which corresponds to the objective of a message [9]. These elements should interfere

with the aesthetics and functions of the app. The visual elements, colors and typography are defined with respect to usability issues and this layer will act as a fusion of content, functionality and aesthetics of the final product.

Following, the adopted methodology is presented, and the development of a Workshop subordinated to the UX process in the development of an App for mobile devices is described.

3 Workshop Methodology

Nowadays, Apps for mobile devices have become indispensable allies in everyday life. Problems that used to require time are now solved with a few taps on the screen of a smartphone or tablet. In this sense, the idea of developing a Workshop directed to the UX process arose, in which several participants were invited to design a high-fidelity non-functional prototype of an App, under the theme of social intervention, with the goal of disseminating useful information, satisfying the needs of potential users. It was also indicated the need to obtain a practical and objective App, with a simple, attractive and efficient visual interface, for the best satisfaction of the user.

Thus, a Workshop was prepared and developed with a duration of about 40h, spread over 5 weeks. This activity aimed to develop a hi-fi prototype, for the creation of a mobile application (App), through the implementation of a user-centered methodology, to discuss the designer's role in digital processes and also to stimulate research and investigation. It was also intended to validate critical and project skills, at the level of visual conception, design and usability of an application for a mobile device, as well as the selection of the most appropriate tools and methods for each phase of the project, and the acquisition of knowledge about technological media for the production of visual communication in digital media. The group of participants was made up of 21 students, 11 females and 10 males, aged between 20 and 25. All participants had a degree in design and attended a master's degree, at the Polytechnic Institute of Viana do Castelo (IPVC). The participants were challenged to develop a high-fidelity mockup, applying methodological steps of the user experience (UX) process. During the workshop, authors like Donald Norman [10], Marc Hassenzahl [11] and Arrow Walter [12] were referred to. These authors were essential in the understanding of concepts like emotion, aesthetics and simultaneously the understanding of how the user perceives the product.

4 Workshop Development

As Nielsen [13] argues, interfaces should not contain additional or irrelevant information that competes with the main information. In this sense, in the first stage of the Workshop, the participants proceeded, in pairs, to explore a theme of their choice. In total, six projects of an application were developed, as shown in Table 2, using Adobe Illustrator and Adobe XD software [14]. Most of the participating groups opted for the Social/Community Platforms theme. Within this theme, the App entitled "Poder do Voto" was developed, that allows voters to carry out their right to vote, in a simplified way, offering to all citizens the power to vote, whether they are nationals, emigrants, people with travel difficulties or others. The "Espólio de Design" proposal enables the creation of a digital

collection of projects developed, over the years, in the various IPVC Design degrees, with the aim of providing a quicker and greater knowledge of the projects and activities developed, enhancing the possible recruitment of designers graduated by the IPVC. The “O’Clock – Plataforma Comunitária” proposal consisted in the prototype of a free App that provides information in real time, about the status of a given train and/or bus. It is possible to obtain diverse information, such as possible delays, line changes and other eventual unforeseen events, according to the user’s needs. The content is shared among users who are registered in the App, being a sharing community and not a professional public transport service. The App’s main goal is to help users before, during and after the arrival of the desired public transport, thus facilitating the planning of their own day, being aware of any delays or cancelled transports. Thus, it promotes mutual help between a community of users, with the goal of improving the population’s daily commute.

Table 2. Themes and names of the apps prototypes developed by the workshop participants.

Children’s Healthcare	Health Monitoring	Social/Community Platforms
		<i>Poder do Voto</i>
<i>Bem-me-quer</i>	<i>Hema</i>	<i>Espólio de Design</i>
		<i>O’Clock – Plataforma Comunitária</i>
		<i>Onde Vamos</i>

Within the Children’s Healthcare theme, the prototype “Bem-me-quer” was developed. It consisted of an application for children with Autistic Spectrum Disorder (ASD) in school age between 8 and 15 years. This App’s main objective is to complement and help the development of social and affective skills by encouraging, in various ways, physical and verbal contact, in a caring way, in children with autistic spectrum in their family environment and small social groups. Within the Health Monitoring theme, the “Hema” App was developed, with the objective of helping in the decision-making process, about the state of health of a user, through notifications. In the case of a user demonstrating risk symptoms, it would be advised to adopt healthier habits related to its diet.

4.1 UX Design of the “Onde Vamos” App

It was decided, in this article, to analyze in detail the UX Design process of the “Onde Vamos” App, since of all the proposals developed during the workshop, this was the one that came closest to the established objectives, concerning the application of the methodological steps of the user experience (UX) studied process. This App, in addition to reducing the unnecessary use of paper, facilitates the dissemination of information about the cultural agenda of a municipality, town or village, with some level of detail. It also provides a network of spaces and events that allow the user to choose their destination, through graphic and informative demonstration, that allows guiding and

helping people in relation to a space or event, using biographies, photos and feedback from other users.

Strategy

Thus, the methodology applied in the UX process will be described. Therefore, the project was started by establishing the Strategy. In this first step, a future scenario was envisaged through the definition of the problem that was intended to be solved. Initially, several similar Apps were analyzed, and no platforms were found that met the objectives defined by the Workshop participants. Other types of platforms were also analyzed, such as Tatoo, Airbnb and Google Maps, since, within the theme, these were some of those that had similarities with the intended solution. In addition to the functionality requirements, the usability and aesthetics of the respective platforms were also analyzed. The next step was to develop Personas, with the goal of creating a stereotype of a user to help to decide about the product's characteristics, navigation, interactions and the aesthetics that the App should have. The Personas, illustratively, represent the variation of needs of a real user, for taking decisions about the development of the App, with the goal of better enhancing the UX [8]. These Personas are idealized in order to make them consistent, creating identities around these characters, defining names, physical characteristics, details and specific information, based on the results of previous research. Questions are asked around the personas to help to keep the users in the designer's mind, during the development of the project. The definition of the Personas was important in this first stage of the App development, since it allowed the development of a narrative focused on providing the best user satisfaction when using it.

Scope

Then, the Scope layer was implemented, where the problem to be solved was materialized. The Scope can be divided into functional specifications and content requirements. The functional specifications consist of the functionalities that the App should support. Content requirements, on the other hand, refer to the information that needs to be provided to the user. For the App “Onde Vamos” those are presented in Table 3.

Table 3. List of functional specifications and content requirements of “Onde Vamos” App.

Functional specifications	Content requirements
User account creation	Login with personal data, email or Facebook
Set the route to the desired destination	Access to GPS and user location to set trajectory
Interests and highlights feeds	List of likes, comments and clicks
Categories of the 6 types of destinations	Icons and category identification
Description on possible destinations	Textual and visual data

(continued)

Table 3. (continued)

Functional specifications	Content requirements
Feedback from the public	Calendar with all events created in the app with start and end date
Agenda	Database of places and tags categorized by the user
Search engine	

Usually, when speaking about Scope, it happens in the begin, middle and end of the project. However, in an agile methodology as adopted here, it is possible to modify the Scope when it is necessary.

Structure

Following, comes the Structure layer, which can be proposed in the form of a navigation flowchart, with the goal of structuring the user's interaction with the App. It is divided in two parts: the Interaction Design and the Information Architecture. This latter term is referred by the Richard Saul Wurman designer [15], who states that the information architect is the individual who organizes patterns inherent in data, transforming what is complex into something clear and who creates the structure or map of a given piece of information, in order to enable others to create their own personal path towards knowledge [15]. In the App project under development, the information architecture gathers the present concepts and segments in a logical way, that the information will originate the functionalities to be developed. This step enables the development of functionalities more objective and understandable.

Skeleton

After the detail regarding the organization of the application content, a first sketch was made to visualize the graphic layout. These understandable drawings, usually without colors, called wireframes (Fig. 2) help the designer to perceive the set of interactive elements present in each of the App screens.

The definition of wireframe is derived from the concept of waterfall, which is defined as a model where the structural process is schematic and sequential, being designed from top to bottom. With the evolution of digital editing software, such as Adobe Photoshop [14], more flexible versions of waterfall image schemes emerged, which later gave rise to wireframes [16].

In the “Onde Vamos” App the wireframes were developed through sketch drawings, in order to show the content of each screen. Thus, the first versions of the App screens were designed in a simple way, without the use of colors or images (Fig. 2) allowing for greater flexibility in adding and removing features to be developed, without concern for the final aesthetics of the App, since they are first schematic sketches.

Surface

The Workshop was followed by the Surface layer, where the visual elements that outweigh their meaning and the emotions, they may eventually generate are relevant, since

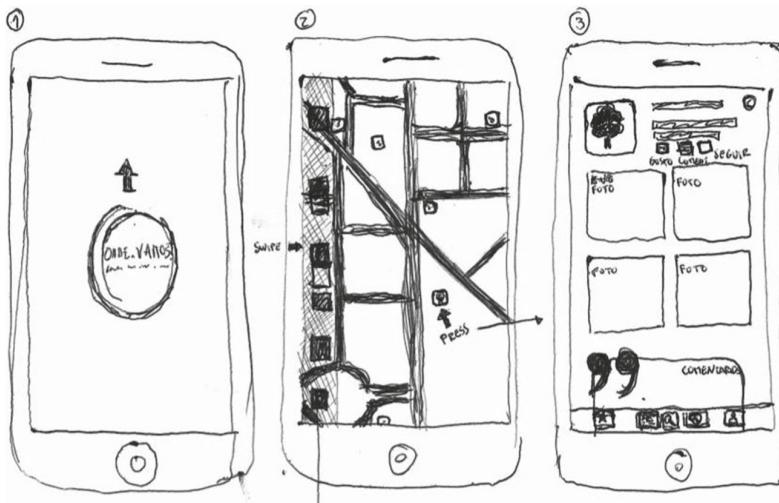


Fig. 2. First wireframes of the App “Onde Vamos”.

this is a project used by different age groups, so its accessibility and readability are crucial. In this sense, screen colors influence the communication of a product/application and help integration into the users' imagination. In addition, colors affect people's emotions and provoke various sensations. Currently, there are several websites that check the overlay of text on colors and help to identify the best compositions, in order to ensure a better readability. For the present project, the “contrast checker” of WebAIM [17] was used. Fig. 3 is an of the text color over the background color.



Fig. 3. Logo for the “Onde Vamos” App



Fig. 4. “Onde Vamos” App categories



Fig. 5. List of icons available for use in the “Onde Vamos” App.

The hexagonal shape of the App’s logo (Fig. 3) consists of a six-sided polygon, each one representing the categories: events, exhibitions, gardens, monuments, libraries, and agenda, as shown in Fig. 4.

Iconography

As for iconography, an icon is considered a small graphic illustration, that is, a visual sign, which is part of the composition of an interface, as well as other visual elements, and has become essential for all people who use some digital device.

The appearance of icons in digital interfaces has transformed the computational language into a common language for anyone, even if they don’t have any technological knowledge. Digital icons, also called physical or virtual buttons, are holders of functions. Therefore, these are thought and developed to create interaction with services and/or products, with the intention of presenting answers to the user, simplifying the way they work. The adequate development of a product or service is understood as intelligent, since it responds to the user, and exposes a joyful tendency to look, as mentioned by [10], attractive products work better, since when the design arouses pleasure in the use of a product, mistakes are not so valued. In this sense, it was essential to create an iconographic system that would suit the service in question. Therefore, a line easy to understand and intuitive was developed, so it be perceptible by various users. The construction of the iconography of the “Onde Vamos” App is based on the silhouette of the various informative icons, in order to integrate with the rest of the application design. These icons are easy to understand, can be used in small format, such as on the screen of a smartphone, without losing their readability (Fig. 5).

Screen Layouts

A screen layout can be created for various platforms, printed or virtual, and represents the organization of the elements of a design in relation to the space it occupies. An overall design layout is an important aspect of the interface because it facilitates navigation by the user, allowing the user to interact with pictures, layouts and sounds, alluding to a real experience. The layout of the graphical interfaces of electronic devices has a dynamic nature, that is, it can be changed even while it is being manipulated. Those changes depend on user needs and technological innovations.

Several high-fidelity screens were developed for the “Onde Vamos” App, seeking to meet the functional specifications and content requirements previously established, such as the disclosure of cultural, children’s and sports activities, concerts and exhibitions, the location of these events, sharing opinions and suggestions of other users, among other functionalities. Some of these screens were implemented using Adobe XD [14] and are shown in Fig. 6.

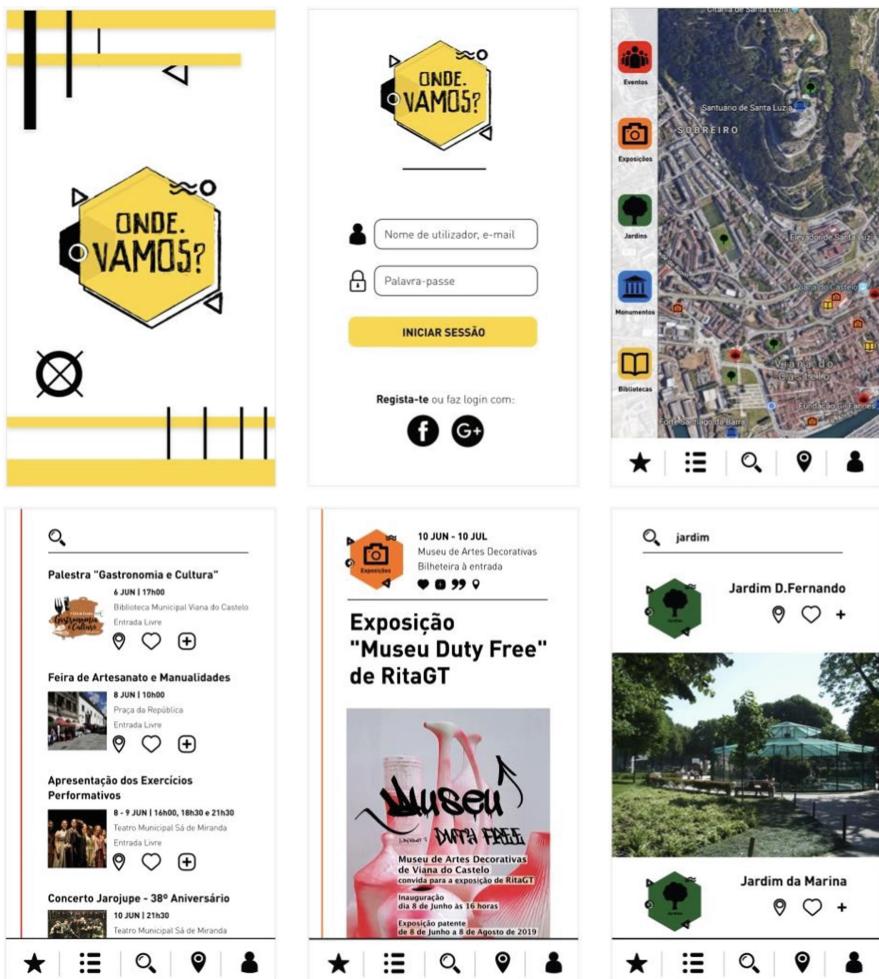


Fig. 6. Several screens of the “Onde Vamos” App.

Thus, the App prototype previously described was developed according to the methodology proposed by [8] and it presents an easy and intuitive navigation between the various screens, enhancing a good user experience and allowing the highlighting of three adjectives that characterize the overall concept of the application: disclosure, sharing and approach between users, promoting a good user experience.

5 Conclusions

It is important to mention that UX Design is a multidisciplinary area that grows at a fast pace and includes several competencies mentioned throughout this article. In this sense, the workshop developed with the students allowed them to obtain a deep

knowledge about this area. It instilled in the participants the UX methodology, focused on user experience, proposed by Jesse Garrett [8]. This five-step methodology allowed the young design students to develop practical skills and understand the dynamism of the digital content and tools used in mobile application development. Besides the theoretical contents, the students had the opportunity to develop practical activities that culminated in a final high-fidelity prototype. Some of the advantages in the development of this type of prototypes are the ease of creation, modification and iteration; the quick identification and correction of usability problems; portability and ease of use for the team involved in the project, as well as it can be used to define the system requirements.

From the results obtained, which can be seen in the prototypes of the Apps developed, it can be seen that the participants understood that UX Design is not only limited to the development of the product itself, but the experience goes far beyond the functionalities, or the way users use these digital products.

We can thus refer that the participants acquired theoretical and practical knowledge, and in the future, they will be able to integrate teams capable of producing digital projects that can more than communicate, but rather provide their contribution to society, developing accessible projects and pleasant interactions, promoting the best user experience.

References

1. Bass, L.J., Gornostaev, J., Unger, C. (eds.): EWHCI 1993. LNCS, vol. 753. Springer, Heidelberg (1993). <https://doi.org/10.1007/3-540-57433-6>
2. Nielsen Norman Group. <http://www.nngroup.com/articles/usability-101-introduction-to-usability>. Accessed 3 June 2021
3. Shneiderman, B.: Designing the user interface: Strategies for effective human computer interaction. Addison-Wesley, Reading (1987)
4. Jordan, P.: An Introduction to Usability. CRC Press, London (1998)
5. ISO.ORG: International organization for standardization, Guidance on usability, ISO 9241-11 Part 11. Accessed 3 June 2021
6. Nielsen, J.: Usability Engineering, Morgan Kaufmann, San Francisco (USA). ISBN 0-12-518406-9 (1993)
7. Roto, V., et al.: User Experience White Paper: Bringing Clarity to the Concept of User Experience. <http://www.allaboutux.org/uxwh> (2011). Accessed 7 June 2021
8. Garrett, J.: The Elements of User Experience: User-Centered Design for the Web and Beyond. New Riders, Berkeley (2011)
9. Dondis, D.: La sintaxis de la imagen. Introducción al alfabeto visual. Gustavo Gilli, Barcelona (2003)
10. Norman, D.: Emotional Design: Why We Love (or Hate) Everyday Things. Basic Books, New York (2004)
11. Has, M.; Tractinsky, N.: User experience - a research agenda, Behav. Inf. Technol. **25**(2), 91–97. <https://doi.org/10.1080/01449290500330331>. Accessed 3 June 2021
12. Walter, A.: Designing for Emotion. A Book Apart, Nova Iorque (2011)
13. Nielsen Norman Group. <https://www.nngroup.com/articles/definition-user-experience/>. Accessed 5 June 2021

14. Adobe Software: <https://www.adobe.com/pt/>. Accessed 4 June 2021
15. Wurman, R.: Information Architects. Graphis, New York (1998)
16. Timetoast: History of Wireframing timeline. <https://www.timetoast.com/timelines/23833>. Accessed 8 June 2021
17. WebAIM: <https://webaim.org>. Accessed 3 June 2021



An Industry-Academia, Multidisciplinary and Expertise-Heterogeneous Design Approach: A Case Study on Designing for Mobility

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Abstract. The purpose of this article is to provide a better understanding of how to effectively develop design projects that simultaneously leverage industry and academic partners, participants from various disciplinary backgrounds, and various levels of expertise to solve complex problems. The article reports a single case of an ongoing project focused on designing smart and connected devices for mobility, which integrates the dimensions of interest. Our findings highlight the importance of careful planning of the collaborative process, contemplating offline and real-time communication opportunities, identifying cross-boundary roles, and considering the development of shared expertise and knowledge within the team. By confronting these findings with key literature, we offer five recommendations to inform similar future projects.

Keywords: Design · Boundary crossing · Complex problems · Innovation · Project coordination

1 Introduction

The nature of the open socio-technical problems [1] being tackled by institutions in society requires alternative working models that go beyond single actors and siloed monodisciplinary approaches. Different literature streams advance specific alternative models, yet they are still explored in a fragmented and dispersed way, revealing a need for further integration and synthesis. Advocates of the Open innovation paradigm [2] argue that inter-organization collaborations leverage distributed knowledge that together can contribute to the co-production of new innovative solutions for existing problems. Here, Industry-Academia Collaborations (IACs) emerge as one particular mode of collaboration that brings its own set of challenges and opportunities [3]. The use of multidisciplinary approaches is also conceived as a way to discover novel ways of tackling

complex problems, which would not be accessible with monodisciplinary approaches [4, 5]. Additionally, it is acknowledged that individuals with different levels of expertise [6] in design might perform differently when being assigned to specific activities [7]. In certain work settings, teams promoting interactions between individuals with different levels of expertise might enable the creation of new knowledge that can be instrumental for solution generation and evaluation [8]. In light of those observations, Industry-Academia Collaborations, multidisciplinarity and expertise-heterogeneous teams present alternative working modalities to support organizations in tackling contemporary problems. This work lies at the intersection of those three modalities of work, and aims to provide an understanding on how to effectively develop design-led projects that simultaneously involve industry and academic partners, participants from various disciplinary backgrounds, and with various levels of expertise to solve complex problems. It therefore responds to recent calls to systematize and boost the potential of IACs [9] and to explore the transference, multidisciplinary, and collaborative approaches [10].

In its aim, the project reported herein addresses a problem that can be described as ‘wicked’ [1, 11]. Urban cycling is an inherently complex activity that occurs in a dynamic context, socially negotiated amongst other road or path users such as automotive drivers, other cyclists, and pedestrians. When combined with the search for smart technological solutions capable of facilitating or enhancing the cycling experience, this challenge becomes even more nuanced and multi-layered. As with any wicked problem, the focus of this project was subject to redefinition and resolution in different ways over time, it was to some extent subjective rather than objectively given, any possible solution has no ultimate test of validity, and any testing of solutions should take place in a real-life setting [12]. With this in mind, the project team was assembled not because of an arguably elusive shared understanding of design, its underlying assumptions and pathways to implementation, or because it possessed an agreed approach and methodology [11]. Rather, the project necessitated a purposely heterogeneous team, in three core respects. First, it brought together industry and academia capabilities in the form of an established technology development organization and a university. Second, it combined individuals from diverse engineering and design backgrounds. Third, it leveraged novice-expert interactions through the inclusion of individuals at differing levels in their career. The research team was therefore uniquely placed to critically observe the development of the project and gather data on its effectiveness.

This paper makes two main contributions for extant design literature. It integrates different research streams on design, computer sciences, management science, knowledge management to provide a more robust understanding of how to conduct projects that simultaneously enable the collaboration between industry and academia, across disciplines, and involving different levels of expertise. Additionally, it provides an inside view of an ongoing short-term design-led project and details how this informed recommendations for conducting similar projects. The rest of the paper comprises four additional sections. In the following section, relevant literature is reviewed according to three core themes of this paper: industry-academia collaborations, knowledge diversity, and levels of experience and expertise. In the third section, we describe our work approach, providing detail about the team composition, how collaboration was established and sustained in light of the restrictions created by the Covid-19 pandemic, and the design process

implemented. In the fourth section, discussion of our experiences and findings in the context of relevant literature helped uncover five recommendations that we propose for similar projects in the future. Finally, we conclude the paper by summarizing its main content and identifying avenues for further work.

2 Related Work

2.1 Academia and Industry

Designing effective technology is a dynamic and unpredictable pursuit, predicated on complex socio-technical factors and ultimately validated by market acceptance. To this end, the Open Innovation paradigm advocates inter-organization collaboration as a pathway to technological advancement, incorporating internal as well as external ideas into sustainable business models [2]. Open Innovation therefore thrives on an abundance of knowledge that is freely transferred between the various institutional actors involved, who in turn contribute to the co-production of more competitive products and services [10]. One renowned example of inter-organization partnerships in this domain are Industry-Academia Collaborations (IACs), which have recently been analysed at length [9]. IACs are the cornerstone of contemporary applied research and development, often being an indicator of potential real-world impact and a requirement for obtaining funding. Nevertheless, implementing IACs in practice produces varying results, which can be explained at least in part by understanding the boundary between an organization and external actors as a semipermeable membrane [3]. This means knowledge flows through it to varying degrees and at different rates. This is conceptualized in the model proposed by Wohlin [13], which contemplates five levels of closeness between industry and academia. In the first three levels of this model - named ‘Not in touch’, ‘Hearsay’, and ‘Sales pitch’ - the link between industry and academia is non-existent or extremely tenuous. It can therefore be argued that true IACs only take place at levels 4 and 5, where a two-way connection occurs between industry and academia with a view to collaboratively identifying a problem and working towards a solution (‘Offline’ at level 4 and as ‘One team’ at level 5).

A considerable amount of work has gone into identifying barriers to successful IACs, as well as advancing best practices to address them. While it is beyond the scope of this paper to delve too deeply into these topics, we refer to the work of Garousi et al. [14] for a comprehensive analysis of this literature. In brief, those authors identified ten categories of challenges. The largest of these categories, labelled ‘mismatch between industry and academia’, includes differences in objectives (citing [15–17]), reward systems (citing [18–20]), and time horizons. Garousi et al. [14] observe that the latter may constitute the most common challenge, as it was mentioned in over a quarter of all studies surveyed. Importantly, challenges and best practices are interconnected, therefore early awareness of potential IAC challenges is crucial for planning and risk management of such projects. Although progress has been slow to date, it has been noted that it is timely to take advantage of strong bilateral enthusiasm to systematize and increase efforts towards fruitful industry-academia collaborations [9].

2.2 Leveraging Knowledge Diversity

Innovation is likewise boosted by the availability of and recourse to diverse knowledge. Indeed, combining various areas of expertise may help uncover novel ways of solving complex problems that would not be possible if a more domain-specific approach were taken [4, 5]. Such collective creativity [21] tends to occur by combining disciplines or knowledge domains, conceptualized as three distinct but related approaches. From least to most integrated, these are: multidisciplinarity, where collaboration occurs between disciplines but disciplinary boundaries are not crossed; interdisciplinarity, where some cross-pollination occurs between disciplines working towards a coordinated and coherent goal; and transdisciplinarity, where disciplines fully merge amongst themselves. For a current and comprehensive discussion of these terms, we recommend the work of Moirano et al. [22]. Those authors argue that collaboration across disciplines is also integral to the development of learners in an educational context, who gain substantially in cognitive functions such as originality, fluency and flexibility, and problem-solving skills in real-world settings. However, despite their compelling and multi-layered benefits, any type of collaboration involving various disciplines is not without challenges. Ironically, the knowledge diversity that can be harnessed as a vehicle for creativity and innovation may also act as a barrier to such processes [23].

Here, as with the IACs discussed above, it is worth considering the literature on boundaries in order to identify a possible way forward. We begin by summarizing the three principal types of knowledge boundary, as described in [24]. A syntactic knowledge boundary happens when there is no shared syntax, thus fostering concern that information is not properly processed across a given boundary. A semantic knowledge boundary happens when, even though there is a common syntax, differing interpretations of the common syntax make communication and collaboration difficult. Pragmatic knowledge boundary happens when actors are resistant to transforming their existing knowledge and skills to achieve a common goal. The concepts of boundary crossing objects [25, 26] and individuals [27] have been explored as ways to negotiate these knowledge boundaries. These constitute artifacts or people that are flexible enough to allow different groups to work together without consensus, but also robust enough to maintain a common identity across different contexts [26]. Boundary objects need not be tangible and may include figures of speech or renaming a concrete phenomenon in a metaphorical manner, especially in the sharing of tacit knowledge and understanding between people [28]. More recently, it has been noted that a design approach itself can serve as an interactive boundary object, as it facilitates interactions across disciplines [29].

2.3 From Novices to Experts

Individuals have different levels of proficiency in applying their skills and the implications of progressing from lower to higher levels through practical experience or education are well known. Notably, Dreyfus and Dreyfus [6] propose that, during the development of a skill, individuals go through five levels (novice, advanced beginner, competent, proficient, and expert) and operate differently. Those differences include that more skilled individuals might change from relying on abstract principles to their concrete experience, or that they might shift their understanding of a situation from a compilation of

equally relevant parts to a whole in which only certain parts are essential. The Dreyfus Model of general skills development is originally grounded on studies of chess players, army tank drivers, air force pilots and commanders [6, 30, 31], although later studies expand the focus and considerations to healthcare professionals such as nurses [32], educators [33] and others. Based on an understanding of how expertise is built, studies derive specific implications for instruction to facilitate a successful progression [34].

The design research community also makes specific efforts to depict the nature of design expertise [35, 36] and to provide a better understanding of the differences between novices and experts in design. While adopting the Dreyfus Model as a theoretical basis to better appreciate the development and progression from lower to higher levels of design skills by design students, academics reflect on some of the limitations of the general skills development model, propose a version of the framework centred upon design, and call for more research on the transformations of designers [7]. Other studies continue to elaborate further on the behavioural and cognitive distinctions between design novices and experts during design processes and contribute to the consolidation of knowledge on those individual differences [37, 38]. Conversely, some academics shift the focus to the implications of interpersonal novice-expert interactions in design engineering activities, which implies a change in the unit of analysis from skilled individuals to heterogeneously-skilled groups [8]. Empirical evidence on the matter reveals that such interactions create new opportunities for knowledge sharing and knowledge creation [8]. In other words, evidence suggests that while being integrated, novices and experts might have the opportunity to learn from each other's experiences (knowledge sharing) and to expand the existing knowledge base (knowledge creation) that was previously available for each.

3 Work Approach

This case study reports on an ongoing short-term project that leverages an industry-academia collaboration, multidisciplinarity, and heterogeneous competency levels to foster the development of smart and connected devices for sustainable mobility. This section describes the work approach adopted and key developments achieved so far (four months).

3.1 The Team

The project team includes eight participants that differ in their roles, backgrounds, and skills. These include two final-year undergraduate design students (#7; #8) who are doing their internship in the project's industry partner and are directly tasked with designing the connected devices for mobility. These student interns are co-supervised by a senior design scholar (#3) and by an engineer who works as a senior project manager in the organization (#5). The team also includes a senior scholar and researcher (#4) who is involved as the project manager and coordinator from the academic institution, a head of the engineering department (#6) who is involved as a representative of the company, and two post-doctoral design researchers (#1; #2). Further details about the team are summarized in Table 1.

Table 1. Summary of project team characteristics.

Institutional provenance	No. of team members	IDs
Academia	4	#1, #2, #3, #4
Industry	2	#5, #6
Academia-industry internship	2	#7, #8
Principal knowledge domain	No. of team members	IDs
Design	5	#1, #2, #3, #7, #8
Engineering	3	#4, #5, #6
Expertise in role	No. of team members	IDs
0–3 years	2	#7, #8
4–9 years	3	#1, #5, #6
10 or more years	3	#2, #3, #4

3.2 The Collaboration Approach

Due to the constraints created by the Covid-19 pandemic, all project participants had to work in a distributed manner, either from home or from their institutions' facilities, located in different geographical areas. That distributed working modality introduced challenges for the desired direct and continuous collaboration between project participants. For asynchronous sharing, the team used Microsoft Teams, in particular for preliminary information that could affect or inform the design activities. Many challenges were minimized through the use of digital technologies that allowed team members to meet online synchronously.

Two types of online sessions were held with all team members. First, an early project kick-off session was held via Zoom (digital platform), to provide an overview of the project aims, introduce the different team members and their roles, suggest the project coordination model, and to propose the design brief and the general design process that would be followed, in particular by the undergraduate design students. Second, there were three general project-progress sessions, lasting between 90 and 120 min. Here, the focus was for all participants to share their feedback on the evolving design concepts for the connected devices.

The team members also had frequent synchronous meetings between different participants right from the start of the project, to enable collaboration. Notably, there were 60-min weekly online meetings between the two student interns (#7; #8), their industry co-supervisor in the organization (#5), and a researcher (#1) to follow their progress on the design activities and provide feedback. Those sessions always took place via Zoom, although sometimes some participants (#5, #7; #8;) were able to meet in person at the organization. The two undergraduate design students (#7; #8) also had weekly meetings with their academic supervisor (#3). Sometimes there was the opportunity to merge the aforementioned sessions to provide an integrated industry-academia view on the progress. When appropriate, the researcher (#2) and/or the coordinator from the academic institution (#4) were invited to take part in those weekly sessions.

3.3 The Design Process

It was agreed at start of the project that the design work developed by the student interns would follow the four main steps of the Double Diamond framework (Fig. 1), although the micro activities involved in each stage were defined in partnership with their supervisors (#5; #3). The students were encouraged to learn about the company, the technologies and products of interest, and its customers, in order to understand and (re)frame the original brief during the first two stages and to design suitable concepts for connected devices for sustainable mobility during the last two steps.

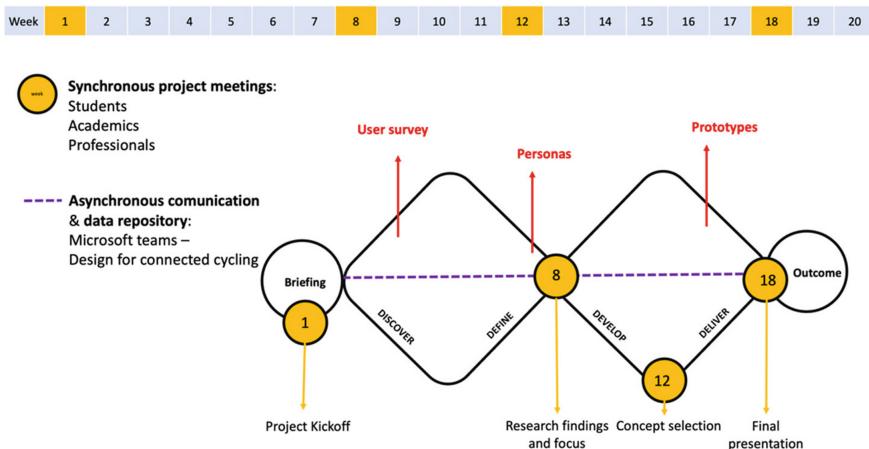


Fig. 1. Project plan including timeline, main synchronous team meetings, and sample design activities.

The following section describes three project elements of particular interest because they very clearly functioned as boundary objects in that they responded to the information needs [26] and work requirements [39] of all team members, irrespective of their individual knowledge or experience characteristics. In line with the original concept put forward by Star [25], the examples provided below were shared and shareable across different problem solving contexts. These research and design activities were informed by a Human-Centred Design (HCD) approach, employing recommended methods for each phase of the HCD process [40]. These were selected in light of several considerations, not least of which was their appropriateness for use while restrictions related to the Covid-19 pandemic were in place.

User Survey. For the *Understand and specify context of use* phase of the HCD process, a survey of cyclists' experiences was conducted through an online questionnaire. This method was deemed particularly appropriate as it would allow a diverse audience to be reached in a relatively expedient manner, which suited the project's objectives and timeframe. The questionnaire was designed for the purpose of this project and included sections on participant demographics, cycling habits, and consumer preferences related to bicycle accessories and technologies. This questionnaire was widely circulated across

six countries (Portugal, Spain, France, Germany, Switzerland, Brazil) and obtained 190 responses.

Personas. Personas were used for the *Specify the user and organizational requirements* phase of the HCD process. Results from the aforementioned survey were used to develop four personas following the goal-based approach proposed by Cooper [41]. Of these personas, three were male and one was female, roughly representing the gender distribution of the survey respondents (55.8% identifying as male, 41.1% identifying as female, and the remainder preferred not to say). The four personas are mapped in Fig. 2 according to the contexts in which respondents reported cycling more often (from rural, on the left on the image, to more urban areas, on the right), and according to their reported cycling frequency (from less frequent, at the top, to more frequent, at the bottom).

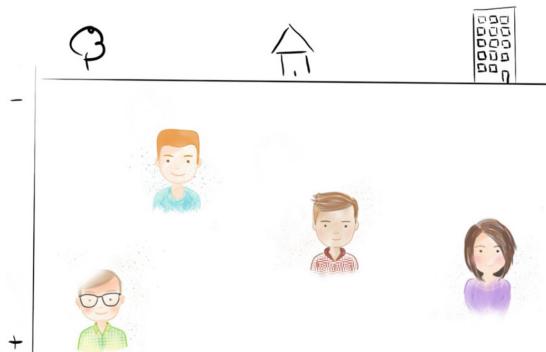


Fig. 2. Positioning of the personas according to contexts of cycling on the horizontal axis (from left to right, rural to city-based contexts) and frequency of cycling on the vertical axis.

During a team meeting (no. 8 in Fig. 1), preliminary design concepts and user requirements were discussed using the personas. Seven team members took part in this meeting, including user researchers, designers, developers, and team leaders.

Prototyping. Design concepts were developed primarily by the student interns, with input from all team members at various stages of the project. Group meetings (see Fig. 1) as well as more dedicated interactions with the student interns and their evolving concepts allowed several types of product considerations to be incorporated, including but not limited to human factors, form factors, materials, and technical feasibility. This was naturally an iterative design process, commencing with ideation and producing two final design concepts. Each concept was more or less robustly prototyped, according to its stage of development. Figure 3 shows the final prototypes for each concept.



Fig. 3. Final prototypes for the two design concepts: on the left, a sensing box; on the right, an LED information display.

4 Reflections

Although this IAC project is still ongoing, many achievements have been made in four months. At this point, we are able to share some experiences regarding various aspects of this multidisciplinary collaboration and to reflect on our progress thus far. We discuss these here, highlighting our recommendations for similar projects in the future.

Taking the model of industry-academia closeness proposed by Wohlin [13], we position our work between levels 4 and 5. The circumstances precipitated by the Covid-19 pandemic meant that much of the work was conducted remotely, corresponding to level 4 of this model in which actors from academia work towards a solution offline. The model then suggests that a pre-packaged solution is offered to industry, which may lack the relevance or specificity to be implemented in practice. However, the collaboration approach adopted in this project meant that team members had an abundance of opportunities to feed into draft solutions and to respond to subsequent iterations, either through occasional in-person interactions (e.g., between the student interns and their supervisors) or through the regular online meetings. We argue that these were instances of working as one team (level 5 of Wohlin's model), which were facilitated by the early definition of an appropriate communication plan comprising synchronous and asynchronous channels to be used by all throughout the project. Responding to the call by Garousi et al. [9] to inform more productive industry-academia collaborations, our first recommendation is that, **even if co-located teams are not feasible, the work plan should include from the outset sufficient and robust opportunities for collaboration in real time**. Such synchronous moments of collaboration must be inclusive of all team members, from both industry and academia.

There was considerable knowledge diversity within the team, whose members' backgrounds included multiple branches of two main disciplines - design and engineering. In this context, elements such as the user survey, personas, and prototypes served as boundary crossing objects [25, 26], enabling all team members to convene around shared knowledge within the scope of the project. This is in line with [28, 29]. More interesting, though, was the role played by boundary crossing individuals [27] within the project. The more consistent boundary crossing was undertaken by the student interns, who were closely supervised by a design scholar and by an engineer within the partner industry and

who therefore necessarily operated between academia and industry, as well as between the disciplinary boundaries they comprised. Similarly, the two post-doc researchers also operated as boundary spanning individuals, as their work connected them to all information areas within the project (ranging from the student interns to more senior team members) and therefore uniquely placed to disseminate new information and ideas amongst the rest of the team [27]. This lends evidence to our second recommendation, which is to **formalize the requirement for boundary crossing roles at the start of the project and to be explicit about who will play those roles**. This requires having appropriate skills to not limit their work to their knowledge domain.

Concerning individual competency development through different levels, this project revealed various findings that might be relevant for future initiatives. This project supports the idea by Dorst and Reymen [7] that design students can reveal different levels of individual competency in relation to a single domain (in this case, design) or project since the types of activities conducted by each student intern were very diverse, and they were not equally skilled in those activities. Similar observations were made about the academics and professionals with different backgrounds who were involved in the project. That means that the characterization of individuals in a single level of competency might be ineffective at times, since individual team members might be novices in some activities while simultaneously experts in other activities that are associated with the same overarching domain (researcher, designer, engineer, etc.). Based on that observation, we recommend **an early focus on obtaining a more granular understanding of individual skills for specific tasks, as opposed to inferring expertise from an overall domain, to expedite team building and project coordination activities** (e.g., division of labour).

The project further revealed that the combination of a learning-by-doing approach (in which opportunities were created for team members with different roles and responsibilities to apply their skills in project activities) and a more structured instructional approach (joint expert feedback sessions) became complementary in supporting the individual competency development. Notably, while the first enabled participants to execute tasks and develop tacit knowledge that is not easily articulated or communicated, the second provided access to more formalized knowledge and created some room for reflection upon the doings. With that in mind, we suggest that **future projects should not only include opportunities for learning-by-doing, but also more structured learning initiatives** to allow individuals to uplift their skills.

Moreover, our findings support the argument that novice-expert interactions in design engineering activities can contribute to creating new (specific) knowledge [8]. In this case, the interactions proved to be essential for creating new knowledge (concepts, ideas, models) concerning sustainable mobility and connected devices, which over time have become shared across the team members involved in the project. That suggests that team members in general also gradually evolved to more skilled professionals in designing connected devices for mobility due to the lived experiences accumulated throughout this project. Interestingly, it was apparent during the project that the new shared knowledge on cycling devices was facilitating the communication between team members. In light of these observations, we recommend that future endeavours should not only take into consideration individual skill development, but also the formation of new knowledge

and skills shared at the group level as they might work as intangible boundary objects that enable a better understanding between individuals [28].

Finally, in this section we have highlighted the main findings and recommendations that we believe might have the potential to inform comparable projects in the future. Still, we are aware that these observations are based on a single and ongoing case, and therefore they should be taken mindfully. Further studies on design projects that lie at the intersection between industry-academia collaborations, knowledge diverse and competence-heterogeneous individuals should be pursued to validate or challenge the main points made in this article.

5 Conclusions

This paper reports on an ongoing short-term collaborative project, which aims to develop innovative concepts for smart and connected cycling. This project brings together a heterogeneous team in terms of three core factors that are known to enhance innovation potential: (i) industry-academia collaboration, (ii) knowledge diversity, and (iii) different levels of experience and expertise. Effectively assembling such a diverse team to work together towards a common goal can incur known challenges, which here involved additional limitations related to the Covid-19 pandemic. In this case study, we describe the project progress focusing specifically on the initial planning, team collaboration, and how the design activities are being implemented throughout the project. We conclude by reflecting on the project outcomes so far, framed within relevant literature on pathways to industry-academia collaboration, integrating knowledge diversity, boundary negotiations, individual competency development, and knowledge implications led by interpersonal novice-expert interactions. In doing so, we offer main empirical findings and five recommendations for similar collaborative projects in the future. We believe this paper makes a timely contribution to current discussions around multi-actor design projects in different cross-boundary contexts.

Acknowledgments. This work is supported by European Structural and Investment Funds in the FEDER component, through the Operational Competitiveness and Internationalization Programme (COMPETE 2020) [Project nº 039334; Funding Reference: POCI-01-0247-FEDER-039334]. This work has additional financial support from Project Lab2PT - Landscapes, Heritage and Territory laboratory - AUR/04509, with financial support from FCT/MCTES through national funds (PIDDAC) and co-financing from the European Regional Development Fund (FEDER) POCI-01-0145-FEDER-007528, in line with the new partnership agreement PT2020 through COMPETE 2020 – Competitiveness and Internationalization Operational Program (POCI).

References

1. Rittel, H.W.J., Webber, M.M.: Dilemmas in a general theory of planning. *Policy Sci.* **4**, 155–169 (1973). <https://doi.org/10.1007/BF01405730>
2. Chesbrough, H.W.: Open Innovation: The New Imperative for Creating and Profiting from Technology. Harvard Business Press, Boston (2003)

3. Fey, C.F., Birkinshaw, J.: External sources of knowledge, governance mode, and R&D performance. *J. Manage.* **31**, 597–621 (2005). <https://doi.org/10.1177/0149206304272346>
4. Baer, J.: The importance of domain-specific expertise in creativity. *Rooper Rev.* **37**, 165–178 (2015). <https://doi.org/10.1080/02783193.2015.1047480>
5. Wowk, K., et al.: Evolving academic culture to meet societal needs. *Palgrave Commun.* **3**, 1–7 (2017). <https://doi.org/10.1057/s41599-017-0040-1>
6. Dreyfus, S.E., Dreyfus, H.L.: A Five-Stage Model of the Mental Activities Involved in Directed Skill Acquisition. California Univ, Berkeley Operations Research Center (1980)
7. Dorst, K., Reymen, I.: Levels of expertise in design education. In: Proceedings of the 2nd International Engineering and Product Design Education Conference, 2–3 September 2004, Delft, pp. 159–166. Delft University of Technology (2004)
8. Deken, F., Kleinsmann, M., Aurisicchio, M., Lauche, K., Bracewell, R.: Tapping into past design experiences: knowledge sharing and creation during novice-expert design consultations. *Res. Eng. Des.* **23**, 203–218 (2012). <https://doi.org/10.1007/s00163-011-0123-8>
9. Garousi, V., et al.: Characterizing industry-academia collaborations in software engineering: evidence from 101 projects. *Empirical Softw. Eng.* **24**(4), 2540–2602 (2019). <https://doi.org/10.1007/s10664-019-09711-y>
10. García-González, A., Ramírez-Montoya, M.-S.: Systematic mapping of scientific production on open innovation (2015–2018): opportunities for sustainable training environments. *Sustainability* **11**, 1781 (2019). <https://doi.org/10.3390/su11061781>
11. Buchanan, R.: Wicked problems in design thinking. *Des. Issues* **8**, 5–21 (1992). <https://doi.org/10.2307/1511637>
12. Coyne, R.: Wicked problems revisited. *Des. Stud.* **26**, 5–17 (2005). <https://doi.org/10.1016/j.destud.2004.06.005>
13. Wohlin, C.: Software engineering research under the lamppost. In: ICSOFT 2013 - 8th International Joint Conference on Software Technologies, Reykjavík, Iceland (2013)
14. Garousi, V., Petersen, K., Ozkan, B.: Challenges and best practices in industry-academia collaborations in software engineering: a systematic literature review. *Inf. Softw. Technol.* **79**, 106–127 (2016). <https://doi.org/10.1016/j.infsof.2016.07.006>
15. Misirli, A.T., Erdoganmus, H., Juristo, N., Dieste, O.: Topic selection in industry experiments. In: Proceedings of the 2nd International Workshop on Conducting Empirical Studies in Industry, pp. 25–30. Association for Computing Machinery, New York, NY, USA (2014). <https://doi.org/10.1145/2593690.2593691>
16. Runeson, P.: It takes two to tango – an experience report on industry-academia collaboration. In: Verification and Validation 2012 IEEE Fifth International Conference on Software Testing, pp. 872–877 (2012). <https://doi.org/10.1109/ICST.2012.190>
17. Sandberg, A., Pareto, L., Arts, T.: Agile collaborative research: action principles for industry-academia collaboration. *IEEE Softw.* **28**, 74–83 (2011). <https://doi.org/10.1109/MS.2011.49>
18. Eldh, S.: Some researcher considerations when conducting empirical studies in industry. In: 2013 1st International Workshop on Conducting Empirical Studies in Industry (CESI), pp. 69–70 (2013). <https://doi.org/10.1109/CESI.2013.6618476>
19. Kaindl, H., et al.: Requirements engineering and technology transfer: obstacles, incentives and improvement agenda. *Requirements Eng.* **7**, 113–123 (2002). <https://doi.org/10.1007/s007660200008>
20. Morris, P., Masera, M., Wilikens, M.: Requirements engineering and industrial uptake. In: Proceedings of IEEE International Symposium on Requirements Engineering: RE 1998, pp. 130–137 (1998). <https://doi.org/10.1109/ICRE.1998.667818>
21. Parjanen, S.: Experiencing creativity in the organization: From individual creativity to collective creativity. *Interdis. J. Inf. Knowl. Manage.* **7**, 109–128 (2012). <https://doi.org/10.28945/1580>

22. Moirano, R., Sánchez, M.A., Štěpánek, L.: Creative interdisciplinary collaboration: a systematic literature review. *Thinking Skills Creativity*. **35**, 100626 (2020). <https://doi.org/10.1016/j.tsc.2019.100626>
23. Parjanen, S., Hyypiä, M.: Innotin game supporting collective creativity in innovation activities. *J. Bus. Res.* **96**, 26–34 (2019). <https://doi.org/10.1016/j.jbusres.2018.10.056>
24. Carlile, P.R.: A pragmatic view of knowledge and boundaries: boundary objects in new product development. *Organ. Sci.* **13**, 442–455 (2002). <https://doi.org/10.1287/orsc.13.4.442.2953>
25. Star, S.L.: The structure of ill-structured solutions: boundary objects and heterogeneous distributed problem solving. In: Gasser, L., Huhns, M.N. (eds.) *Distributed Artificial Intelligence*, pp. 37–54, Morgan Kaufmann, San Francisco (CA) (1989). <https://doi.org/10.1016/B978-1-55860-092-8.50006-X>
26. Star, S.L., Griesemer, J.R.: Institutional ecology, “translations” and boundary objects: amateurs and professionals in Berkeley’s museum of vertebrate zoology, 1907–39. *Soc Stud Sci.* **19**, 387–420 (1989). <https://doi.org/10.1177/030631289019003001>
27. Tushman, M.L., Scanlan, T.J.: Boundary spanning individuals: their role in information transfer and their antecedents. *AMJ*. **24**, 289–305 (1981). <https://doi.org/10.5465/255842>
28. Koskinen, K.U.: Metaphoric boundary objects as co-ordinating mechanisms in the knowledge sharing of innovation processes. *Eur. J. Innov. Manage.* **8**, 323–335 (2005). <https://doi.org/10.1108/14601060510610180>
29. Tharchen, T., Garud, R., Henn, R.L.: Design as an interactive boundary object. *J. Organ. Des.* **9**(1), 1–34 (2020). <https://doi.org/10.1186/s41469-020-00085-w>
30. Dreyfus, S.E.: Formal models vs. human situational understanding: inherent limitations on the modeling of business expertise. *Office Technol. People*. **1**, 133–165 (1982). <https://doi.org/10.1108/eb022609>
31. Dreyfus, H.L., Dreyfus, S.E., Athanasiou, T.: *Mind Over Machine: the Power of Human Intuition and Expertise in the Era of the Computer*. The Free Press, USA (1986)
32. Benner, P.: Using the Dreyfus model of skill acquisition to describe and interpret skill acquisition and clinical judgment in nursing practice and education. *Bull. Sci. Technol. Soc.* **24**, 188–199 (2004). <https://doi.org/10.1177/0270467604265061>
33. Lyon, L.J.: Development of teaching expertise viewed through the Dreyfus model of skill acquisition. *J. Schol. Teach. Learn.* **15**, 88–105 (2015)
34. Persky, A.M., Robinson, J.D.: Moving from novice to expertise and its implications for instruction. *AJPE*. **81** (2017). <https://doi.org/10.5688/ajpe6065>
35. Lawson, B.: Schemata, gambits and precedent: some factors in design expertise. *Des. Stud.* **25**, 443–457 (2004). <https://doi.org/10.1016/j.destud.2004.05.001>
36. Cross, N.: Expertise in design: an overview. *Des. Stud.* **25**, 427–441 (2004). <https://doi.org/10.1016/j.destud.2004.06.002>
37. Kavakli, M., Gero, J.S.: The structure of concurrent cognitive actions: a case study on novice and expert designers. *Des. Stud.* **23**, 25–40 (2002). [https://doi.org/10.1016/S0142-694X\(01\)00021-7](https://doi.org/10.1016/S0142-694X(01)00021-7)
38. Jagtap, S.: Shaping products: differences between expert and novice industrial designers. Presented at the (2018). <https://doi.org/10.21278/IDC.2018.0159>
39. Star, S.L.: This is not a boundary object: reflections on the origin of a concept. *Sci. Technol. Human Values* **35**, 601–617 (2010). <https://doi.org/10.1177/0162243910377624>
40. Maguire, M.: Methods to support human-centred design. *Int. J. Hum. Comput. Stud.* **55**, 587–634 (2001). <https://doi.org/10.1006/ijhc.2001.0503>
41. Cooper, A.: *The inmates are running the asylum*. Sams (1999)



Design Attributes for the Development of Digital Solutions: An Exploratory Study from the Perspective of Professionals Connected to Digital Transformation

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Abstract. Digital technology plays a significant role in everyday life, being increasingly integrated at home, work and leisure activities. Its pervasiveness has been changing consumption habits and social interactions. As a result, the number of digital platforms and services grew exponentially and it is expected to continue to expand in future years. In a world that offers a wide range of digital products to people, it is crucial to develop meaningful products. Taking this into account, it seems important to focus on understanding which attributes should be considered in the development process of digital platforms and services to work towards optimal solutions for society. A sentence completion task was employed to uncover the motivations, emotions and beliefs of a small sample of individuals who work for a Digital Transformation company. The results highlighted the significance of content, usability, aesthetics, customization and trust. Furthermore, a reflection on the themes suggests that usability is foundational, that content and aesthetics arouse interest and customization elicits positive reactions. Remarkably, it was found that a lack of trust causes discomfort and may negatively impact the use of digital solutions.

Keywords: Digital Transformation · Sentence completion · Design attributes

1 Introduction

Technological advances are so deeply ingrained in daily life that its presence often goes unnoticed. Digital devices are used to order food, interact with other people through social media, schedule medical appointments, watch TV series, read news online, among other day-to-day routines. As a case in point, in the domain of e-commerce, according to the report “Digital 2020 Portugal” [1] presented by the companies We Are Social and

Hootsuite, 88% of internet users in Portugal searched online for a product or service, and 65% made a purchase.

Before the COVID-19 pandemic, technology was already widely acknowledged. Still, the crisis clearly highlighted the substantial impact of technologies for the better and for the worse. Social distance and isolation caused people to change their habits and their dependence on technology became more pronounced. The leading global professional services company Accenture [2] predicts that people are going to do everything they can virtually—“If I can do it online, I will.”

These circumstances pose considerable challenges for designers—there is a need to find solutions for public health issues, to improve online customer experience, video conferencing platforms, distance learning solutions, etc. In the words of Tan [3], “As our globalised information economy continues to evolve, designers have had to develop their practices in response to the ever-increasing demands that modern design problems place on their profession” [3, p. 1].

Consequently, designers need to stay sharp and understand behavioral shifts to improve peoples’ experience with products. This matter is not new though, since designers are used to dealing with the uncertainty of “wicked problems” [4, 5]. As observed by Buchanan [5], “The problem for designers is to conceive and plan what does not yet exist, and this occurs in the context of the indeterminacy of wicked problems, before the final result is known” [5, p. 18].

As part of ongoing research in Digital Transformation, this study aimed to reflect on the design attributes required to support the development of digital products and services based on the experience of professionals working in the field. After all, “Understanding what things are valued by people, and why, is essential for understanding their feelings toward new solutions, and what actions can be expected” [6, p. 22]. Moreover, it was also intended to explore the potential of a projective technique entitled sentence completion to understand individuals’ perceptions.

2 Methodology

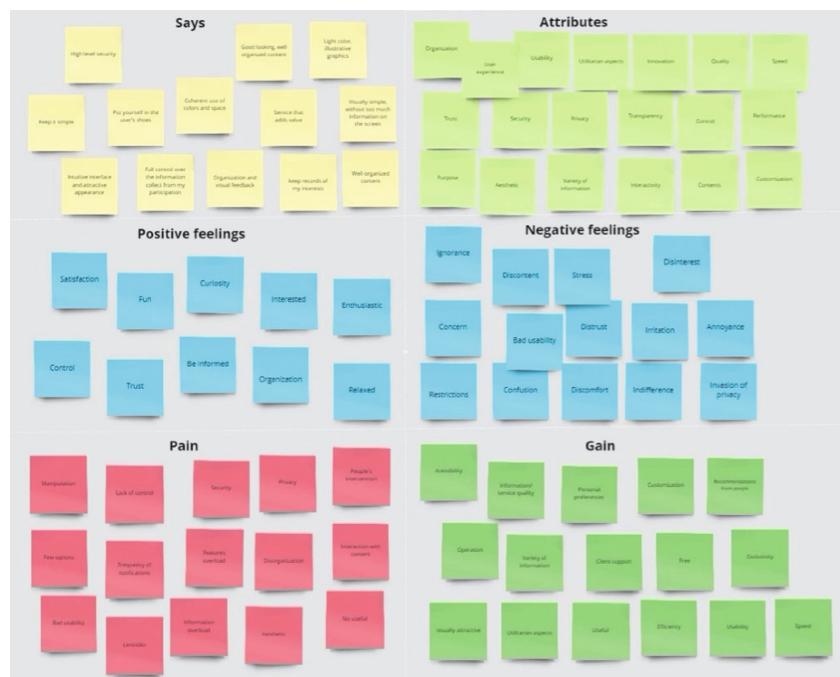
Sentence Completion is a projective technique used in Psychology and Consumer Research that provides qualitative data on peoples’ motivations and values [7]. As the name suggests, it is a task that is composed of stems, i.e. beginning of sentences, that must be completed freely by people with the first words that come to their mind.

The study was conducted during July 2019, in the north of Portugal. A total of 13 people (6 male and 7 female) were recruited for the survey, with 22 to 45 age bracket. Although the respondents had distinct jobs, they all worked for a Digital Transformation company: DTx-Colab.

Created with Google Forms, the questionnaire included a sentence completion task and open questions. Firstly, the participants were asked to mention two digital products or services—one they like and another they dislike. The latter was inspired by Jordan’s research [8] on pleasure in product use. Secondly, they had to briefly describe the products and complete a set of sentences (see Table 1). Afterwards, they were instructed to state the aspects that influence the future use of digital products, and the attributes they value when they are using them.

Table 1. Sentence stems, main topics and author(s).

Stems	Main topic	Author(s)
What interests me the most in the digital product is...	Positive aspects	Jordan, P. W. (1998)
Compared to other digital products this is...	Overall perception	Kujala et al. (2014)
What surprises me in the digital product is...	Elements that attracted attention	Norman, D. A. (2004)
When I think about the platform I feel...	Linking feelings with pleasurable/displeasurable products	Jordan, P. W. (1998), Kujala et al. (2014)
What interests me less in the digital product is...	Negative aspects	Jordan, P. W. (1998)
The problem of the digital product is...	Negative aspects	Kujala et al. (2014)

**Fig. 1.** Empathy map.

The data collected from the survey was downloaded to a spreadsheet in Excel file, which was further exported into NVivo 12 Mac. The questions were examined separately by the researchers, who grouped and labeled expressions or words with similar meaning

into different categories. Afterwards, the data was used to build an empathy map to get a better understanding of individuals needs [9]. The map was created using Miro, and it was divided into 6 quadrants: Says, Attributes, Positive feelings, Negative feelings, Pain and Gain (see Fig. 1).

3 Results and Discussion

What do people expect from a digital product or service? What do they value and what emotions do these type of products arouse? This section presents the positive and negative associations that participants made to digital products. Selected excerpts, stacked bars and tables illustrate the results. Also, relevant literature is drawn to provide explanations or present distinct perspectives on the subject.

3.1 Positive Aspects of Digital Products and Services

A variety of digital platforms was mentioned by the participants—Fig. 2 illustrates the ones that pleased them. By looking at the answers given to the sentence “What interests me the most in the digital product is...” (Table 2) it was possible to identify that individuals privileged digital solutions that are more task-related, i.e. that meet their utilitarian needs [10]. Google Calendar, Gmail e Money Manager are some examples that were given by the individuals. This finding is in agreement with “Perceived usefulness,” which is a component of the Technology Acceptance Model (TAM) that crucially influences individuals’ intention to use technology [11, 12].



Fig. 2. Digital platforms that pleased the participants.

Furthermore, references were found to usability: some participants commented that they appreciate the digital platforms being simple and easy to understand. However, the most repeated topic revolved around content. This result is consistent with Vaynerchuk [13], who claims that “at the end of the day, it’s not really about whether someone has time for your content or not. It’s about whether or not they find it interesting” [13, para. 16].

Although the words chosen by the participants to show their positive feelings were diverse (interest, enthusiasm, relaxation, power, etc.) there was one word that was mentioned more than once—trust (see Fig. 3). It is widely accepted that people like a product

Table 2. Categories identified regarding the stem “What interests me the most in the digital product is...”

Category	Examples
Utilitarian needs	Its usefulness for traveling; easy access to scientific articles; help/information in cost management; not having to remember appointments; functionality
Content	Quality of content; possibility to subscribe to content that I like; to have access to content that I cannot physically access; personalized recommendations; content variety
Usability	The speed and efficiency; the interface is easy to use and understand; the simplicity to access multiple product categories

or service not only because it works efficiently, but also for subjective reasons [14–18]. Thus, in addition to usefulness and ease of use, aspects such as safety, meaning, aesthetics, satisfaction and fun should be considered in the development of products and services. Moreover, data reveals that now more than ever people “want a resource they can trust, that can make them feel safe when everything seems uncertain, and that offers support when so much seems to be overwhelming” [20, p. 2].



Fig. 3. Word cloud from the answers to the stem “When I think about the platform I feel...”

Another attribute that was found in the data was aesthetics and the way the information is organized. Indeed, creating functional and useful products is not enough, they should also be attractive and pleasurable [16, 19, 21, 22]. One participant was surprised with the “organization and visual feedback.” As for the aspects that can influence future usage, the participants said “intuitive interface and attractive appearance,” “well-organized content.” Additionally, when individuals were asked about what they value on a platform, aesthetics was empathized. Some of the visual aspects that positively impacted the participants were: “light color, illustrative graphics,” “Visually simple, without too much information on the screen,” “coherent use of colors and space.”

Through the empathy map (see Fig. 1), it was found that customization is also important to people. They seem to enjoy creating products with unique characteristics, according to their personal preferences. Enabling people to customize their product elicits positive reactions and, thus, increases the chances of the experience being pleasurable and fun [16]. Interestingly, in the 1980s, Cross [23] was already commenting on the importance of designing in a personalized way.

3.2 Negative Aspects of Digital Products and Services

Regarding the digital platforms that displeased the individuals, a variety of solutions for utilitarian needs was also identified. However, social media APPS were particularly noticeable (see Fig. 4). Three themes emerged from the participants' thoughts on what they disliked about the digital products—content, usability and trust (Table 3). Part of this result reflects those of the previous section, demonstrating the significance of content and usability.



Fig. 4. Digital platforms that displeased the participants.

Table 3. Categories identified regarding the stem “What interests me less in the digital product is...”

Category	Examples
Content	Recurrent notifications; amount of features becomes confusing; the exposure and criticism that arises when something is published or shared
Usability	Slow and not being user-friendly; disorganization; not being able to easily find the location for the desired service; it has counter-intuitive features
Trust	Concern about security; to keep track of my interests and advertising

Indeed, most of the participants pointed out usability issues, while others expressed discontent with content. The respondents complain when they perceive products as being slow and when they feel the number of features or notifications is considerable. Conversely, it seems they feel satisfied when the system works efficiently and they feel in control. This further supports previous studies, for instance Jordan [19] and Hancock et al. [16]. Nonetheless, despite being foundational, usability tends to be overlooked [24]. Figure 5 displays the words used by participants to express negative feelings.



Fig. 5. Word cloud from the answers to the stem “When I think about the platform I feel...”

In addition, a lack of trust was found as a matter of concern. This issue was visible in the comments participants made in two stems (“What interests me less in the digital product is...” and “The problem of the digital product is...”). Clearly, the participants complained of discomfort with data protection and security, alongside privacy and transparency. In this regard, finance applications and social networks emerged as examples. One participant indicated that there is no “transparency regarding the use of data,” whereas another respondent was not satisfied because the product tracks his interests. When the individuals were asked to state the features that might influence their future use, the topic appeared again, as can be seen in the following excerpts: “high-level security” and “full control over the information collected.” It is interesting to note that trust, security and transparency are topics that are currently under discussion as can be seen from reports on emerging technologies [25–27].

4 Conclusion

In a world that is increasingly mediated by digital technologies, it is crucial to reflect on what really matters and makes sense to people. The aim of this study was to understand which attributes should be considered in the development of digital solutions and why. By exploiting the perspectives of professionals who work for a Digital Transformation company, it was possible to uncover their views as consumers of the products themselves, and what might influence their work-related decisions.

This paper highlights the importance of content, usability, aesthetics, customization and trust when people interact with digital products. Usability and aesthetics were considered fundamental—this was evident in the participants’ comments. Nevertheless, a concern with personal data emerged. The participants expressed insecurity due to a lack of transparency and privacy, which in turn negatively impacted their usage of digital products. It is interesting to notice a genuine concern of people who work on a daily basis with digital products with security and data protection. It may be assumed that this issue will receive more attention in the future.

As stated in the introduction, another goal of this research was to examine the sentence completion technique. The method proved to be accessible and useful for the purposes of this research. It was possible to easily get mixed opinions using an online platform. Thus, this technique can greatly facilitate reaching more participants and studying a more varied and heterogeneous sample.

To conclude, this research has raised important attributes in need of further examination. Also, the prospect of being able to cross-reference data from different audiences regarding their experience with digital environments may serve as an incentive for future research.

References

1. DataReportal.DIGITAL 2020: PORTUGAL. <https://datareportal.com/reports/digital-2020-portugal>
2. Accenture: COVID-19: 5 new human truths that experiences need to address (2020). https://www.accenture.com/_acnmedia/Thought-Leadership-Assets/PDF-2/Accenture-COVID-19-New-Human-Truths-That-Experiences-Need-To-Address.pdf50
3. Tan, S.: Towards an integrative approach to researching design expertise. *Des. Stud.* **74**, 101017 (2021). <https://doi.org/10.1016/j.destud.2021.101017>
4. Rittel, H.W., Webber, M.M.: Dilemmas in a general theory of planning. *Policy Sci.* **4**(2), 155–169 (1973)
5. Buchanan, R.: Wicked problems in design thinking. *Des. Issues* **8**(2), 5–21 (1992)
6. den Ouden, E.: Innovation Design: Creating Value for People, Organizations and Society. Springer, London (2012). <https://doi.org/10.1007/978-1-4471-2268-5>
7. Kujala, S., Walsh, T., Nurkka, P., Crisan, M.: Sentence completion for understanding users and evaluating user experience. *Interact. Comput.* **26**(3), 238–255 (2014)
8. Jordan, P.W.: Human factors for pleasure in product use. *Appl. Ergon.* **29**(1), 25–33 (1998). [https://doi.org/10.1016/S0003-6870\(97\)00022-7](https://doi.org/10.1016/S0003-6870(97)00022-7)
9. Gibbons, S.: Empathy Mapping: The First Step in Design Thinking (2018). <https://www.nngroup.com/articles/empathy-mapping/>
10. Solomon, M.R., Bamossy, G.J., Askegaard, S., Hogg, M.K.: Consumer Behaviour: A European Perspective, 6th edn. Pearson Education, Harlow (2016)
11. Teo, T., Noyes, J.: An assessment of the influence of perceived enjoyment and attitude on the intention to use technology among pre-service teachers: a structural equation modeling approach. *Comput. Educ.* **57**(2), 1645–1653 (2011)
12. Heinz, M.S.: Exploring predictors of technology adoption among older adults (2013)
13. Vaynerchuk, G.: How to tell a story on social media (2019). <https://www.garyvaynerchuk.com/how-to-tell-a-story-on-social-media/>
14. Hassenzahl, M., Tractinsky, N.: User experience—a research agenda. *Behav. Inf. Technol.* **25**(2), 91–97 (2006)
15. Hassenzahl, M.: The interplay of beauty, goodness, and usability in interactive products. *Hum. Comput. Interact.* **19**(4), 319–349 (2004)
16. Hancock, P.A., Pepe, A.A., Murphy, L.L.: Hedonomics: the power of positive and pleasurable ergonomics. *Ergon. Des.* **13**(1), 8–14 (2005)
17. Desmet, P.M., Hekkert, P.: Framework of product experience. *Int. J. Des.* **1**(1), 57–66 (2007)
18. Norman, D.A.: Emotional Design: Why We Love (or Hate) Everyday Things. Basic Civitas Books (2004)
19. Jordan, P.W.: Designing Pleasurable Products. Taylor & Francis, Philadelphia (2005)

20. McKinsey: Adapting customer experience in the time of coronavirus (2020). <https://www.mckinsey.com/~media/McKinsey/Business%20Functions/Marketing%20and%20Sales/Our%20Insights/Adapting%20customer%20experience%20in%20the%20time%20of%20coronavirus/Adapting-customer-experience-in-the-time-of-coronavirus.ashx>
21. Hassenzahl, M., Platz, A., Burmester, M., Lehner, K.: Hedonic and ergonomic quality aspects determine a software's appeal. In: Proceedings of the SIGCHI Conference on Human Factors in Computing Systems, pp. 201–208 (April 2000)
22. Lachner, F., Naegelein, P., Kowalski, R., Spann, M., Butz, A.: Quantified UX: towards a common organizational understanding of user experience. In: Proceedings of the 9th Nordic Conference on Human-Computer Interaction, pp. 1–10 (October 2016)
23. Cross, N.: The coming of post-industrial design. *Des. Stud.* **2**(1), 3–7 (1981)
24. Hartson, R., Pyla, P.S.: *The UX Book: Agile UX Design for a Quality User Experience*. Morgan Kaufmann (2018)
25. Deloitte: Ryerson, Deloitte partner to offer privacy certification (n.d.). <https://www2.deloitte.com/ca/en/pages/risk/articles/Privacybydesign.html>
26. GPAN IA: Orientações Éticas para uma IA de Confiança (2019). <http://escola.mpu.mp.br/servicos-academicos/plano-de-atividades/inovaescola/curadoria/3-ciclo-de-debates/inteligencia-artificial-e-internet-das-coisas-oportunidades-e-desafios/ethicsguidelinesfortrustworthai-ptpdf.pdf>
27. IEEE: Ethically Aligned Design (2018). https://standards.ieee.org/content/dam/ieee-standards/standards/web/documents/other/ead_v2.pdf



Lemon's Pitch: An Attempt to Induce Audio-Visual Synesthesia in Live Music Performances

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Abstract. People who make music communicate their art through sound; whether through voice, instruments, a combination of both, or a digital composition. This is the medium they use to communicate something, to transfer a message. In addition, artists also make a great effort to be visually recognized (whether by choice or by imposition of the times) through various platforms, with music videos, album covers, social media, etc. The need to link sound and image can lead to a different quality of perception, approaching the concept of *synesthesia*. Recognizing the importance of synesthetic objects as an augmented way of musical expression, a research was carried out tracing a chronology of experiments that intersect music, colors and light; revealing the possible translations of this perception. Subsequently, interviews were conducted with singers and musicians about their needs and wants regarding the expression of their music. Through the interviews conducted, the artists expressed the need for having something available to accompany the music and capture the mind of the spectators (also visually), especially in more intimate venues. From these requirements, three different objects were produced, for the expressed need to communicate the various frequencies of music, combining sound, light and color. The induction of a synesthetic stimulus, via a synchronized rhythmic audio-visual signal, intended to enhance the experience of listening to live music. This paper presents "Lemon's Pitch" a system of objects that respond to audio input by producing a color and light "show," aimed at inducing a synesthetic experience in concert audiences. Future research is expected to test these interventions with a real audience.

Keywords: Product design · Synesthesia · Lighting design · Sound design · Music visualization · Multimedia technologies

1 Introduction

People who make music communicate their art through sound; whether it is through voice, instruments, a combination of both, or a digital composition. This is the medium they use to communicate something, to transfer a message or an emotion, or just enjoyment. Currently, artists also make a great effort to be visually recognized (be it by choice

or imposition of the times) through the various platforms, with music videos, album covers, social media, etc. It is indicative that, although music streaming platforms allow users to search for an artist, song or album by writing its title, artists continue to produce images that allow users to recognize them visually. Each record and sometimes each individual track has a specially chosen image that identifies it and shows the evolution of the artist and their music over time.

The same thing happens when it comes to the performance; it is not just about singing and playing. The more artists can hone their possibilities, the more they try to organize the space, the lights, the clothes, and a whole range of things related to the performance. Live performances and music videos are two elements that, while maturing over time, preserve part of the artist's identity. Certain artists complement their shows with videos and effects, while others prefer white lights and to perform showing only themselves and the musicians. Likewise, in the videos, there are usually elements of continuity; it is their second means to give us something closely related to their music.

Music is so powerful that it has the ability to envelop the listeners and “transport” them elsewhere. Bringing people into their world and letting them live the story of each track is the peak of what artists can give with their music, especially when it comes to live performances. The focus there is on the music and on the transmission of sound; however, to be able to transport the audience “into another world,” it is necessary to take care of many other aspects, especially involving another sense that humans rely on: sight. The mix of sight and hearing has the ability to make the audience experience stronger and more captivating sensations including some that may share characteristics of synesthesia. In live performances, the audience is captured by the sight of the performers, emphasized by light and video effects—it is in the design of the visual that the success and completion of the sound side of the performance is achieved, allowing the audience to escape from the real world.

Yet, not all artists are able to offer the audience such an experience. This can depend on various reasons: not all venues hosting musicians are equipped or have a space that allows them to put in lights or scaffolding, or, when the space allows it, it is not always possible to buy or rent such equipment. Moreover, this would require a longer organization and a specialized technician—therefore, this opportunity, with all its psychological and physiological implications, is often missed.

This project aims to tackle this gap, by materializing the combination of light, sound and color in a portable format that artists can bring to their performances. The induction of a synesthetic stimulus, via a synchronized rhythmic audio-visual signal, aims to enhance the experience of listening to live music.

1.1 Methodology

The research here presented is explorative and qualitative in nature. It began with a literature review, in which the phenomena of synesthesia and psychoacoustics were explored. Furthermore, it allowed the investigation of synesthetic experiences and the culture linked to them. This resulted in a chronology from around 1700 to the present days, characterized by light machines, with representations of music and projections of colors. The chronology was formed by reviewing texts, old newspapers, online articles and forums.

Secondly, interviews with singers and musicians were conducted, aimed at perceiving their needs in the field of live performance.

Subsequently, the project entered a more conscious phase, taking into account the requirements gathered from the interviews, and three prototypes were produced.

2 Literature Review

2.1 The Phenomenon of Synesthesia

Only a very small part of humanity—about 4%—, for genetic reasons, is able to experience synesthesia: that is, when the perception of objects, images, sounds, writings or any other stimulus crosses more than one sense producing a wider, more involving and complex perception. Nevertheless, this does not mean that attempts to induce it cannot be done. The most common synesthesias concern the association between letters, numbers, or days of the week and colors, or between images and sounds. Synesthesia, however, is not a choice, it is not the subject that associates color, rather it is his brain that does it without this being demanded, without the possibility of separating the two. The skepticism of many psychologists about this phenomenon comes from the fact that the associations of characters and colors are not the same for all people with synesthesia. Only one case has been collected in which there was a congruence of results between several people with synesthesia [1].

Synesthesia occurs due to the presence of some particular genes [1]. Commonly, those who express a simple synesthesia also have a 50% chance of expressing other more complex types. The genes responsible for this phenomenon are present in about one in 23 people, but being recessive makes it rare to identify subjects who express its characteristics. It is even rarer to find those who express more modes, i.e., more complex synaesthesias.

Many people, especially musicians, have tried to ask synesthetes—people who experience synesthesia—for collaboration to translate sounds into colors with their help. Wassily Kandinsky, the renowned painter, tried to write a translation algorithm between the various senses, unfortunately failing. This was because, as explained above, synesthesia is not the same for all individuals and does not have a universal language. However, this does not mean that those who do not carry this particularity in their genetic heritage do not have the opportunity to experience it in an induced way. Some psychologists have accompanied by artists, and experimented and studied the characteristics of synesthesia, looking for traces of it even in those who do not seem to experience it. Some authors claim that synesthesia is a phenomenon that any person can experience and sometimes does so even on a daily basis, unconsciously. Synesthesia is part of a perceptual spectrum of which we are all part, only everyone is at a different part so that for some people the perception is innate and for others it is not [2].

If we were asked “what pitch is the taste of a lemon: high, middle or low?” [2], it would be natural to respond that the taste of the lemon corresponds to a high note—emphasizing a sort of hidden map that exists in our brain and creates connections between the various perceptions, between our five senses. Also in linguistics, these fusions between the senses are highlighted as in the example of “Bouba/Kiki Effect,” where one could say that commonly the first word recalls something round while the second word refers to

something sharp. In addition, there is the case of McGurk Effect, where images can affect the listening to the extent that we believe we hear words that are different from how they were actually pronounced or reproduced [2].

Whether it is sight, hearing, touch, taste, or smell, synesthesia studies the contamination between two or more senses, different or repeated, triggered by a single stimuli (when it occurs naturally). When induced, synesthesia can require more than one input. An example of induced synesthesia can be achieved by combining music with an image, a video, dance, or any other element that helps music to be more captivating for the listener.

2.2 Psychoacoustics

Why is it important to consider sound as the starting point of this particular experience? Psychoacoustics is a field of research that may answer this question. Psychoacoustics deals with understanding the perception of sound and music. A perception that is not passive, but more a conscious perception, which differs from person to person and has much more to do with people's taste and subjectivity.

Acoustics and psychoacoustics differ: while the former studies the refractive propagation of sound, the latter studies the human perception of it. In fact, the sound waves that physically enter our ear canal are not the ones we actually hear. Listening depends and changes from individual to individual, both due to physical factors such as the environment and the listener's ear, and due to psychological factors such as one's own experience and state of mind—which is why it is extremely difficult to study a person's perception. In addition to physical barriers, each person has different thresholds that are set by their own brain, and all sound waves outside these thresholds are not processed to be read by the brain and therefore are not heard because of a difference, not physical but psychological. Consequently, the perception of sounds is dictated by spatial characteristics, by the auditory characteristics of each individual, by the origin of the source, and by a frequent phenomenon called “masking.” This phenomenon corresponds to the superimposition of sounds, during which for some physical and perceptive characteristics of some sounds manage to prevail over others by masking them [3].

When we talk about music, psychoacoustics becomes even more precise and complex because the creation of a sound track must follow much stricter rules than sound waves from other sources or with other purposes such as speech. Those who make music nowadays have a series of instruments at their disposal that allow them to control the tones, the harmony of the notes, and the rigid timing and beats of the musical tracks. However, although a track may be technically perfect, it does not mean that this perfection will actually correspond to a pleasant perception of it. This is because timing, duration, rhythm, timbre, disturbance, intonation, and harmony are absolutely subjective and must be tested by listening, as described by Terhardt [4] in the psychoacoustic evaluation of musical sounds.

Gersema [5] described the work carried out by the Brain and Creativity Institute in collaboration with the Los Angeles Philharmonic Association and the Heart of Los Angeles (HOLA), providing support to the thesis that music allows a maturation and progression of the brain, especially when provided at a young age.

Another important impact of listening to music from an organic point of view is the production of dopamine. Various situations lead to the production of this neurotransmitter, which is vital for our body as it allows us to regulate certain motor functions, sleep, prolactin production, as well as feelings of pleasure and satisfaction. In fact, its production is commonly linked to food intake, sexual activity, and drug use [6]. If it were not already extraordinary that music, a human invention, can produce such an important neurotransmitter, even more extraordinary is the fact that music is a trigger of an abstract type.

2.3 A Chronology of Light, Sound and Color Objects

The idea of a close correlation between the harmony of musical note sequences and their precise and direct translation into the color spectrum dates back to Aristotle and Pythagoras. It is on this perception that the most relevant experiments have been based, which from around 1700 [7, 8] to the present day have allowed experimentation in this field, ranging from painting to the construction of mechanical objects, passing through electronics, musical instruments, and even television and graphics.

1730. Based on William Moritz's chronology [9] we encountered what was defined as the color organs—in a time when there was no electricity and therefore the light for these instruments was provided either by the contrast between the absence and presence of natural light or later through the use of candles. The Ocular Harpsichord was designed by Louis Bertrand Castel and aroused so much interest in Paris that some artists composed music to be played with it and a book was written about it in German. However, the instrument was not very reliable mechanically because it was composed of a large number of mechanical elements [9]. It consisted of a frame inside which six boxes were filled with slides of different colors, covered with small curtains, and each time a key was pressed on the harpsichord, the corresponding curtain opened, allowing the slide behind it to be illuminated. This whole system of pulleys and curtains, and in its later edition even 500 candles, to be used in the evening, constituted a delay in transmission, making the music seem disconnected from the colors. In addition, it was a fragile, noisy, and smelly system because of the candles. Many other instruments were created later, trying to find alternatives to colored glass, such as liquids, or glass placed in darkened places.

1830. Around 1830, during the Victorian era and at the request of the Queen, numerous experiments were carried out, some of which had strictly to do with the use of light. Many of these objects aimed to create optical illusions to see how far the brain could be fooled and whether it could be trained to recognize these tricks. The games became very popular among people and were a fun way to educate; because of this educational side of them, they were always given a Greek name. One of these in particular would be considered the earliest form of cinema, the magic lantern. It consisted of a projector, still very artisanal, formed by a tube at the end of one of its sides, where there was a candle. The whole thing was contained in a box or *camera obscura*, which had a hole on the other side of the tube.

Later, the lanterns were improved both by the addition of a series of lenses and by the use of more carefully painted slides with more detail to make the projection more

realistic. However, the biggest advance in this technology was the switch from oil-lamp illumination to the use of oxy-hydrogen lamps. This type of lamp used a chemical reaction between the two elements, the resulting temperature increase of which caused a piece of limestone to glow—the invention being called “limelight.” The “limelight” gave its name to the stage lights that were later used in theatres, which were also obtained by this chemical reaction. Apart from this addition to the vocabulary, the word “slide” (also used as slideshow) also comes from the movement made when moving from one painted slide to another.

After this advancement in magic lanterns that preceded the cinema of the 19th century, the most beautiful images from all parts of the world and the most extravagant events began to be transferred onto the 8x8 cm lantern slides and became iconic [10].

1877. Another example of a color organ, of which there are unfortunately no more examples, is that of Bainbridge Bishop, who had long been interested in designing musical instruments with light effects that could be implemented in churches. His famous instrument, based on Newton’s theory of colors [11], consisted of a semi-circular panel placed in front of the lengths of the organ pipes for which it was designed, where light from a window or an electrical circuit was projected. At the level of the siphons, colored glass was illuminated when the keys were pressed and projected onto the panel the color established according to the score. According to this color rule, the lower notes formed the background color of the panel for the light of the higher ones.

1893. With the arrival of the later organs, whose operation had greatly improved with the use of electric light, the idea of projecting colors began to spread elsewhere. It was thanks to the designs of engineer Preston S. Millar’s “chromola” that the moving lights used in New York during Alexander Scriabin’s opera *Prometheus: The Poem of Fire*, which had precisely to do with synesthesias.

Rimington’s famous invention was the “clavier à lumières.” This particularly famous color organ, whose only specimen was unfortunately destroyed, consisted of a classic organ keyboard on which were placed color markers for each note. The basis of Rimington’s work was the idea that, just as in music, images were perceived by nerve endings, and that therefore, just as there are harmonic sounds, there are harmonic images that accompany and complete them. His instrument had to be used by skilled hands and was equipped with a mirror that allowed the musician to keep an eye on what the instrument was projecting in order to make changes to the images in real time [12].

1916. Baranoff-Rossiné’s project is interesting, both in terms of its operation and its meaning. Unlike the instruments analyzed previously, his “optophonic piano” might seem contradictory, since it does not always associate the same translation in terms of images and light with music, but always gives a different translation. It is a keyboard that does not play, but projects; each key in the keyboard casing is associated with a series of colored glasses and lenses, mirrors that can be colored or have graphic elements, or geometric shapes [13]. When a melody is played on this particular piano, the keys move the position of the glass, the projecting light or change the position of the screen, increasing and decreasing in speed, translating the melody into an ever-changing image, not only as the music progresses but each time it is played [7, 8].

1935. In 1930 Fred Bentham joined Strand Electric, a manufacturer of lighting control consoles. Its first console was the “strand remote control,” designed by Bentham in 1935. It was designed for theatrical performances and revolutionize the control of stage lighting, which, until then, had required the use of mechanical equipment. The strand remote control allowed the lighting engineer to have everything under fingertip control on a single console like a church organ. The great change brought by this console, besides the compactness that allowed a single technician to have more than 200 buttons under control, was that the panel that allowed it to turn on or off, lower or raise the intensity, and change the color of the whole system simultaneously, by groups of lighting circuits or by individual lights [12].

1920s. Mary Hallock Greenewalt devoted practically her entire career to this ever-widening field of sound and color instruments. Greenewalt’s most famous instrument, the “sarabet,” was patented in four different versions, the last of which contains interesting technology. It is an object similar in effect to the color organs, but inside it has a resistor with a fluid transmitter, this fluid allowed an increase and a reduction in its resistivity work. In simpler terms, the transmission between one element and another was less mechanical and sharp and more increasing or decreasing [14].

“Illuminating means” is a sculpture of Atlas holding up the world, and inside the globe he holds, which opens in half, there is a phonograph. Underneath the phonograph there is an electric light, which, reflecting inside the lower hemisphere, passes to the side of the vinyl player and then projects its rays inside the upper hemisphere [14]. Greenewalt’s suggestion was to place as many colored films and other objects as possible on this area where the light passes through, so that the light, which moved in time with the music, created different effects depending on the colors and the way they were positioned, and depending on the music.

1920–30. The combination of technological, artistic, and scientific innovation led to the interest of different personalities and professionals in color music. Singers, dancers, artists, critics, and psychologists interested in synesthesia met in numerous congresses dedicated to the subject. Charles Blanc-Gatti, a Swiss musician, was present at some of the congresses and had built his own color organ, which he used for some demonstrations [9]. This device was distinguished by the images of the musical instruments placed on the sides of the projection and by the division of the projected colors according to the bass (red), middle (yellow-green), and treble (violet) of the performed track.

1939. The “kaleidakon” was a 100-foot tower that represented a magnification in the expression of color-music instruments. Used during the London Daily Mail Ideal Home Exhibition, the giant tower, whose screens were white and whose structure was made of metal, rose from inside a swimming pool. The tower lit up differently as the tune progressed and only two people controlled this impressive light and sound show, Quentin Maclean with his Compton organ and a dedicated lighting technician [15].

1977. In 1970, the company Atari was beginning to enter the world of videogames and was preparing to develop the first high-tech tools that would later allow it to enter this new context. The Atari video music system, developed in 1977, remains significant for the images that it allowed to be shown once connected to a display—a primordial video

game, but one that did not involve human interaction being animated by an audio signal. From the appearance of a stereo, it produced geometric images of various colors (mainly rhombuses) that changed shape size and color depending on the signal and had some buttons and knobs that allowed the user to alter the images produced [16].

2000. In 2000, Jack Ox and David Britton brought the color organ into its digital dimension and named it “the virtual color organ.” It had the capacity, through a computational system and a virtual MIDI system (Musical Instrument Digital Interface), to produce sounds and correlate them with three-dimensional images, bringing the spectator into a virtual space, CAVE (Cave Automatic Virtual Environment), where the performance came to life. Here, we are no longer talking about an instrument, but about a three-dimensional experience [7, 8].

2019. Almost all Nourathar Studio’s projects aim at synesthesia; however, the “chromaticaster” is particularly akin for being a tangible object, used in association with music, and for its similarity to the color organs. The user’s interaction through a keyboard, where each key is associated with a color, allows the images shown on the monitor to be altered [17].

The chronology, although made up of few documented testimonies and concerning some objects that have unfortunately been destroyed, leads us to some important considerations. From the words of some testimonies of color organs we realize that the experience of using these instruments could not be encapsulated in documentation because they were simply much more astounding live. This leads us to focus on a kind of experience that is not a graphic work or a project that aims to be disseminated mainly through a representation, but something that needs to be enjoyed live. Moreover, we are left with the concept of projection, which was an important part of the success of these instruments, making them unpredictable and mysterious, reinforcing the idea of working on something mechanical and performing a projection of an abstract image, whose director is the music itself and cannot be controlled, remaining unpredictable.

3 Interviews with Musicians

In order to advance with the development of a product that could induce a synesthetic experience in concert audience, we conducted interviews with musicians asking for information about the experience in the field of music of each participant. A total of eight people were interviewed (Table 1).

Table 1. Participants interviewed.

Participant	Occupation	Age	Nationality
Vasco R. Casais	Musician, electronic and lighting technician, manager and video editor	42	Portuguese
João Dias	Singer, musician, post-producer	25	Portuguese

(continued)

Table 1. (*continued*)

Participant	Occupation	Age	Nationality
Daniele Mango	Singer, musical theatre singer	34	Italian
Vincenzo Zagaria	Electronic music DJ and architect, post producer, founder of a studio and label	34	Italian
Silvestro Genovese	Self-taught singer	24	Italian
Sara Vanderwert	Singer, musician and producer	24	Italian
Raffaella Calafato	Singer	31	Italian
Helen Tesfazghi	Singer, chorister, producer, musical theatre singer	40	Italian

3.1 Procedure

Prior to conducting the interviews, the script was tested and refined ($n = 1$). Once the final sequence of questions had been drawn up, an email was sent to each participant asking for consent to record the interview, which was held (due to the current Covid-19 pandemic) via videocall in all eight cases. Despite the protocol of questions, we tried to let the interviewees express themselves in a fluid and linear discourse and, for this reason, we decided to write down the interview by topic and not by single question—these were as follows:

- Music genre and instruments;
- Amplification and other instruments;
- Performance venues;
- Lights and visual.

Results and Conclusions. Most of these artists play a musical genre or use instruments that generate rhythmic melodies such as Soul, Funk, R&B, House, and Electronic. Whether virtual or not, they all make use of at least one instrument in addition to the voice, up to groups of seven or more members. The use of loop stations and keyboards is also widespread. In terms of the design of a new product, the presence of many instruments producing bass is a very positive thing as these are the easiest frequencies to isolate and use as a source. However, this would penalize certain musical genres such as the traditional music of artists such as Vasco and would not enhance all the instruments, voices, and horns present in the groups that these singers and musicians represent. It would be desirable to display more elements of the music, which we understand through this contribution to be rich in nuances and genres.

Some artists perform acoustically on some occasions, which can happen only in very small venues or during online streaming. Commonly, like all the other artists, they use amplification equipment. Vincenzo plays sounds exclusively digital for his music, but makes variations in real time when performing live, as all the others. The largest part of the amplification is usually provided by the venue. In terms of the design of a new product, this translates into the choice of using a microphone as input as it would allow the product to work during acoustic performances. The possibility of connecting the

instrument to the mixer would be a viable option but it means adding a cable. The size must allow for portability as most of them are involved in transporting equipment.

All the artists interviewed have performed in a wide variety of locations, from the smallest venues and bars, to clubs and festivals. The difference between these venues is not only dimensional but also in the experience they give to the performer, all of them describe performances at festivals as adrenalin-fueled, while those in bars and clubs as more intimate. Some artists highlighted the importance of interacting with the public, which is usually stronger in small spaces, where visual involvement is fundamental. It turns out that in larger events the involvement is already given by the situation and by the music, while in smaller events this involvement work depends on the performer. This makes it possible to focus attention on the events in which the design project can find its place, and in the experience it offers, which can be of greater support to the artist in involving the public. It is probable that the product, in order to remain transportable (a requirement identified in the previous topic), is more suitable and visible in small spaces, which are the same where the visual aspect of the performance is highlighted.

Regarding the visual aspect of the performances, two main themes came out of the conversations. The artists communicate visually not only with body language, but also with clothing and lighting. Each of them uses clothing for different purposes. The second element refers to lighting; we notice from the answers of the participants that this is not always guaranteed during all the events. All participants performed on stages equipped with lights but it is not such a common experience. All eight of them consider lighting to be a fundamental element that accompanies the music and transforms the environment like few other things. Unfortunately, for reasons of budget or skills, not everyone has this opportunity at their disposal. Simplicity and autonomy of operation are important in order to offer a product that is not technically too complex to configure and operate in harmony with the music as conventional stage lights do. An easy to use object would allow even those with less expertise in the field of electronics to bring a visual experience to their performances.

4 The Project: Lemon's Pitch

Lemon's Pitch (Fig. 1) is a system of three machines that instantly translate sound into light. The aim is to enclose one of the infinite interpretations of sound in a portable object. In order to achieve this result, the system is made up of elements that take up some features of the ancient color organ and produce visual effects by using white light and materials that, depending on their use, create shadows or let the light pass through them, changing their color and creating beams. The input is the music, specifically in those prototypes the input is provided by environmental sound caught by a microphone, but the implementation of the audio input directly from a mixer can be achieved. All three elements are composed of a body consisting of a low cylinder with an opal Plexiglas front that acts as a projection screen. Inside, there are voltage and current regulators, LEDs, microphones, three-way filters for dividing the frequencies, three different types of motors for each element, and an Arduino which is the microcontroller that coordinates everything (Figs. 2, 3 and 4).

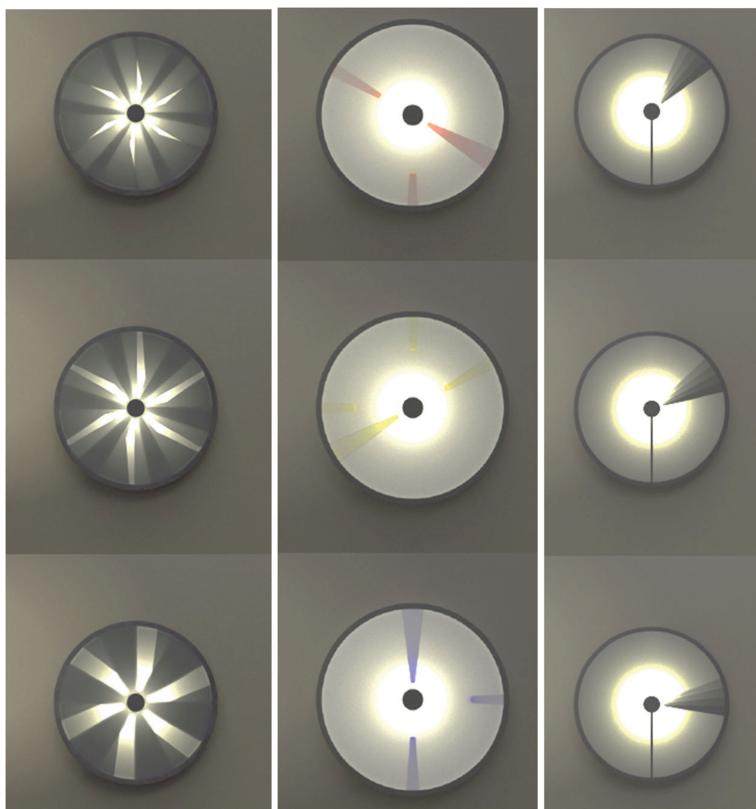


Fig. 1. The three resulting prototypes in their various stages.

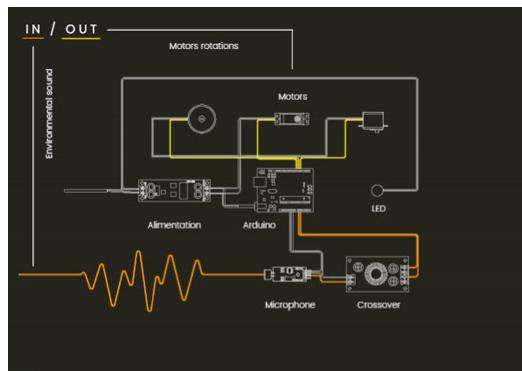


Fig. 2. Components scheme with inputs and outputs.

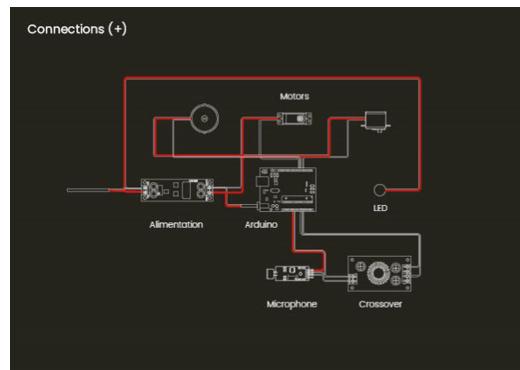


Fig. 3. Components scheme with positive connections.

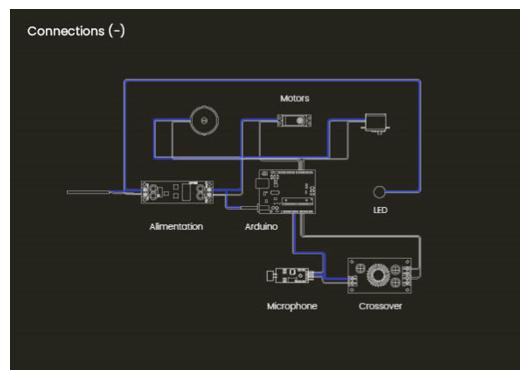


Fig. 4. Components scheme with negative connections.

The first machine is formed by a servo motor and two disks that depending on the effect we want to achieve can be made of plexiglass or MDF. The values that Arduino takes from the frequency filter are inserted into a proportion considering reference values of the environmental sound. The proportion relates the perceived volume to the value of the degrees, translating this value into a rotation of the motor arm that can range from 0 to 30°. One of the two frontal disks is connected to the motor which, by rotating, reveals a design. The observer can appreciate the design thanks to an LED light which projects the image onto the opaline surface. Thanks to the proportion calculated by Arduino, the two discs will let through an amount of light proportional to the volume of the set frequency.

- Input

The input is the sound (coming from the microphone) whose frequencies are filtered by the crossover that sends only the basses signal to the Arduino.

- Output

The signal processed by the microcontroller, which makes a proportion between the frequency level and the number of degrees the servo motor has to perform, in a range from 0 to 30° (Fig. 5).

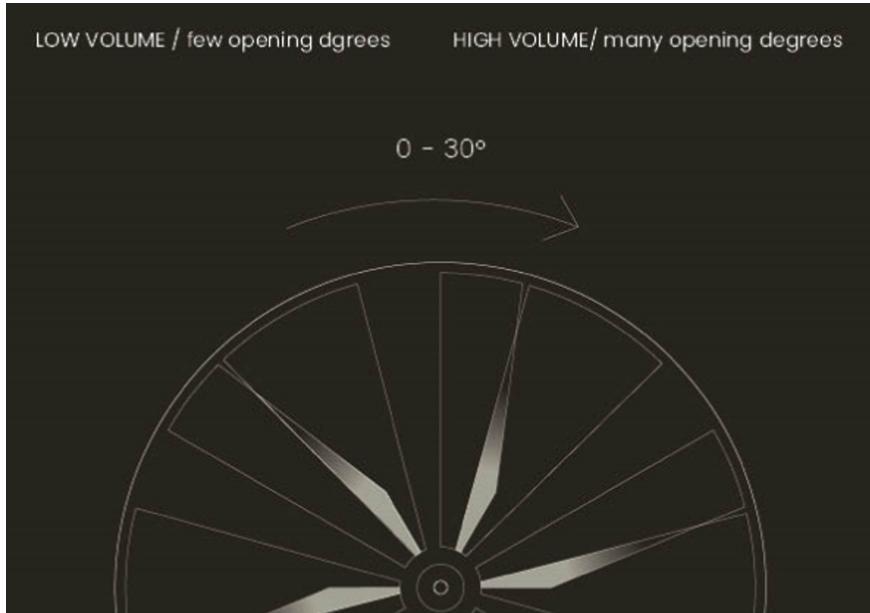


Fig. 5. The working of the first prototype (inputs and relative rotation).

The second machine is the only one that does not consist of a servo motor but of a motor called “Step-by-Step”— i.e., it can perform continuous rotations exceeding 360°, unlike the previous ones. This machine, based on the volumes of the set frequency, causes an arm moved by the motor to make rotations around the central LED; the speed of completion of the rotation depends on the sequence of volumes perceived. A colored or shaded ray is projected on the surface whose rotation depends on the music.

– Input

The sound coming from the microphone whose frequencies are filtered by the crossover that sends them to Arduino divided into basses, middle and treble.

– Output

The signal processed by Arduino is sent to the servo motors that are divided into three groups, each of which responds to a frequency. The response of the motors is a rotation from 0 to 90° sharp and an immediate return back (Fig. 6).

In the third prototype we find all the common elements described above, with the addition of 10 Mini Servo Motors. The operation is similar to that of the previous but the effect is completely different—the signal is sent to Arduino and depending on the

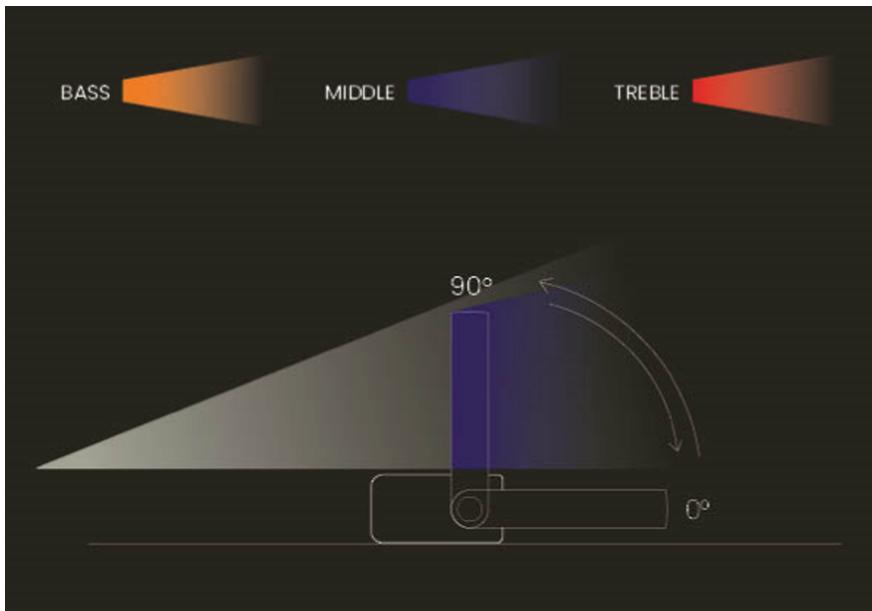


Fig. 6. The working of the second prototype (inputs and relative rotations).

volume a group of motors is set in motion. The motors are placed horizontally provided with a semi-transparent colored Plexiglas or MDF arm. When the sound enters the microphone, the perceived value sets in motion one group of motors which rotate the arm of an amplitude of 90° and then immediately return to zero. The motors placed in a radial pattern around the central LED bring the arm into such a position that the light strikes, casting its shadow on the opaline front surface. The effect is that of colored beams or shadows suddenly appearing in different positions on the surface depending on the volume.

– Input

The input is the sound coming from the microphone whose volume is sent to the Arduino.

– Output

The microcontroller sends an output to the stepper motor whose response is a complete rotation of 360° degrees and whose speed depends on the level of the volume (Fig. 7).

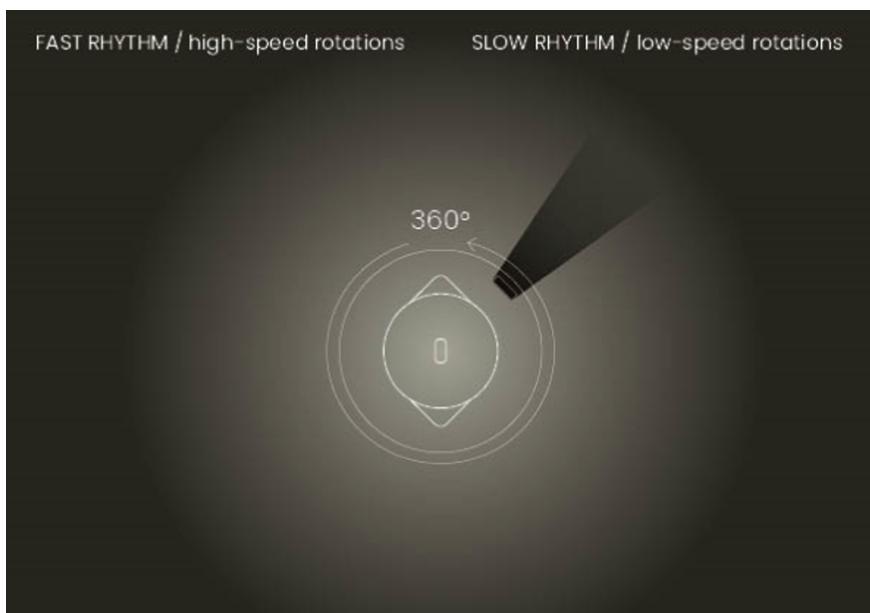


Fig. 7. The working of the third prototype (inputs and relative rotation).

5 Conclusion

Can synesthesias be induced? The answer to this question is as difficult as it is uncertain. Synesthesia is part of human perceptions and connects senses without people being aware of it. Synesthesia exists in all things, even the smallest, people have just never been able to distinguish it. Product design was the means used here to explore and try to achieve it. All available tools were brought into play to achieve this experience: the literature review gave identity to a phenomenon; the study of the chronology was revealing to the possible translations of this perception; the interviews were the basis for the design of the fusion of sound and light in an attempt to induce audio-visual synesthesia. The product design made it tangible.

Being aware from the beginning—hence the title of this paper being “an attempt”—that the limitations caused by task would lead to a challenge, it must be said that it was not possible to test the prototypes to know if the audio-visual experience actually leads to synesthesia. This possibility is left open for the future experiments to come. One of the infinite numbers of possible translations of sound into light has been made available to users, hoping that the experience may constitute a new, shareable and engaging perception. With this project we aimed to accompany the beauty of music in a dignified form by helping artists in the difficult but rewarding task of making listeners minds’ travel. Through this project we produced a set of objects that respond to audio input by producing a color and light “show,” aimed at inducing a synesthetic experience in concert audiences.

References

1. Cytowic, E.: *Synesthesia*. The MIT Press, Cambridge MA (2018)
2. Copeland, L.: Feel the Music—Literally—with Some Help From New Synesthesia Research. Smithsonian Magazine (2017). <https://www.smithsonianmag.com/science-nature/feel-the-music-with-help-from-synesthesia-research-180961660/>. Accessed 23 June 2021
3. Ziemer, T.: Psychoacoustic music sound field synthesis (Vol.7). Springer, Cham (2020). https://doi.org/10.1007/978-3-030-23033-3_9
4. Terhardt, E.: Psychoacoustic evaluation of musical sounds. *Percept. Psychophy.* **23**(6), 483–492 (1978)
5. Gersema, E.: Children's brains develop faster with music training. USCNews (2016). <https://news.usc.edu/102681/childrens-brains-develop-faster-with-music-training/>. Accessed 23 June 2021
6. Salimpoor, V.N., Benovoy, M., Larcher, K., Dagher, A., Zatorre, R.J.: Anatomically distinct dopamine release during anticipation and experience of peak emotion to music. *Nat. Neurosci.* **14**(2), 257–262 (2011)
7. Filimowicz, M.: Video sonification. *Parsons J. Inf. Mapp.* **2**(2), 1–2 (2010)
8. Filimowicz, M.: Audiovisual Aesthetics #5|Visual Music. Medium (2020). <https://medium.com/sound-and-design/audiovisual-aesthetics-5-b29c9471020>. Accessed 23 June 2021
9. Moritz, W.: The Dream of Color Music, And Machines That Made it Possible. Animation World Magazine 2 (1997). <https://www.awn.com/mag/issue2.1/articles/moritz2.1.html>. Accessed 23 June 2021
10. Leonard, M.A.: Laterna Magica—The simple device that changed the way we view the world. Canon, (n.d.). <https://www.canon-europe.com/view/laterna-magica/>. Accessed 23 June 2021
11. Trilnick, C.: Bainbridge Bishop. IDIS. (n.d.). <https://proyectoidis.org/bainbridge-bishop/>. Accessed 23 June 2021
12. The Strand Archive: Strand Light Console, (n.d.). <https://web.archive.org/web/20110807214351/http://www.strandarchive.co.uk/control/manual/lightconsole/lightconsole.html>. Accessed 23 June 2021
13. Rossiné: Optophonic Piano (n.d.). <https://baranoff-rossine.com/optophonic-piano/>. Accessed 29 Feb 2021
14. Antebi, N.: Industrial Light and Magic. Topic 24 (2019). <https://www.topic.com/industrial-light-and-magic>. Accessed 23 June 2021
15. Transpontine: History is made at night. Kaleidakon: 1930s light show (2012). <http://history-is-made-at-night.blogspot.com/2012/03/kaleidakon-1930s-light-show.html>. Accessed 23 June 2021
16. Dessem, M.: The coolest thing at this year's E3 just might be this Atari Video Music System from 1977. Slate (2019). <https://slate.com/culture/2019/06/e3-national-videogame-museum-atari-music-system.html>. Accessed 23 June 2021
17. Nourathar Art & technology Studio. <http://www.nourathar.com/about>. Accessed 23 June 2021



The Phenomenological Turn: From Data Visualization to Perceptualization

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Abstract. While language can portray, evoke, and show fictional worlds, paradoxically, it stops showing when we turn it into logocentric data. The limitations of 2D visualization and its logocentric approach to data have given rise to the technical and conceptual concerns of the project which seeks to understand what underpins spatial imagination in literature and its translation. The paper discusses how the prototyping of 3D equivalents of culture-specific objects depicted in William Faulkner's *The Sound and the Fury* and its translation lays the groundwork for immersive methodologies of exploring the anthropological dimensions of mental places constructed in the production of original and the translated literature.

Keywords: Fictional topographies · Data perceptualization · VR ethnography

1 Introduction

This paper will consider the challenges and opportunities of using 3D and VR technologies in researching how one's environment and material culture shape literary imagination and its transformation across cultures. One such challenge concerns how we go about showing in what ways fictional topographies depicted in the original text differ from those in translation. The premise of the project is that literary translation does not replicate a writer's sense of place. Instead, it is rooted in the immediate environment and memories of a translator who builds an alternative, if not radically different, fictional world, which is reflected to a large extent in the language of translation. Since 2D visualization techniques tend to be logocentric when it comes to textual data and thus inadequate to show the experiential make-up of a literary text, the project sets out to explore in what ways the application of 3D technologies could foreground intercultural differences in spatial imagination and consequently produce a visual critique of mental topographies within which literature and its translation operate.

Since the politics of a translator's invisibility has been widely discussed in translation studies¹, our focus is on overcoming the methodological limitations inherent in the logocentric representation of the individual experiences of place. To bring forth what remains hidden in 2D visualization, the project seeks to perceptualize data as a site of ethnographic exploration of where a sense of place comes from, how it shapes the literary

¹ See a seminal work by Venuti (2008).

imagination of that place, and how the meaning of that place changes in translation. The discussion of what limits our ethnographic engagement with the factual and the imaginary situatedness of literary topographies will also draw on the limitations of the conceptual language used to describe and explain our attempt to trigger a paradigmatic shift from the graphic to the phenomenological representation of spatial information that underpins the portrayal of fictional worlds. The discussion of the contrasting visual tropes of the American barn and the Lithuanian klojimas from William Faulkner's *The Sound and the Fury* and its Lithuanian translation will provide an example of the speculative work being done on the Virtual Ethnography and Literature across Languages (VRELL) project.²

2 The Spatial Turn and Invisible Imagination

The spatial turn has affected how we deal with many traditional questions in the humanities, including history, geography, and literature. Cartographic studies, for example, have expanded to include not only historical but also fictional maps. Literary cartography is also on the rise. It ranges from theoretical discussions of how literature and cartography intersect, thus producing new perspectives on the role of spatial imagination³, to digital humanities projects that map imaginary topographies based on literary evidence.⁴ Literary spaces evoke, remind of, and arise from personal encounters with the factual. Imaginary topographies whose descriptions and maps we find in the works of William Faulkner or J.R.R. Tolkien are rooted in their familiar places. The fictional county of Yoknapatawpha, for example, featured in many novels and stories by William Faulkner is based on Lafayette County, Mississippi, and its capital Oxford. The stories that take place in the fictional setting are often thought to be of an autobiographical character.⁵

While digital technologies have no doubt contributed to the growth of knowledge in humanities research, they have also produced new blindspots or added to the existing asymmetries in scholarship. Although Soja (2009, p. 12) argues that the spatial turn is a "response to a long-standing if often unperceived ontological and epistemological bias in all the human sciences, including such spatial disciplines as geography and architecture", some spaces are routinely more privileged. Spatial imagination in literary translation is one such overlooked area. Unlike the dynamic interrelationship between a writer, his emotions, and his familiar landscape, neither the origins nor the role of a translator's gaze in transforming fictional worlds is examined in cartographic studies. The common assumption or at least the expectation is that a translator will respectfully and thus mechanically replicate the landscape and its objects as the writer might have imagined them. Our premise that spatial imagination is not transferred from the original

² The ongoing work and documentation of this project is featured on its website at <https://vr-ell.com/>.

³ See Ander Engberg-Pedersen's edited book *Literature and Cartography: Theories, Histories, Genres* (2017).

⁴ See the Chronotopic Cartographies project led by the University of Lancaster in collaboration with the Alan Turing Institute: <https://www.lancaster.ac.uk/chronotopic-cartographies/>.

⁵ See Watson (2000) for a discussion of biographical and auto-fictioning features in Faulkner's novels.

text to its translation but instead derives from a translator's sense of spatiality grounded in her cultural and material habitat has prompted our search for the ways of showing this difference between the perceptual centres of the writer and the translator. The VRELL project started with the experiment of modelling the 3D representation of a barn as featured in William Faulkner's novel *The Sound and the Fury* and its Lithuanian translation as *klojimas*. The Lithuanian choice evokes an architectural form and place whose agrarian purpose and cultural meaning differs from that of the American barn. When we place these two words side by side, our attention is commanded by their written form while their experiential and embodied aspects become less visible and graspable. Hence the purpose of experimenting with showing the difference between these two words, or rather between what they may have evoked for the writer and the translator, is two-fold. First, we seek to foreground those experiential differences that underpin the lexical choices of the writer and the translator by building their representations with 3D techniques. Once completed, the 3D models will be embedded in immersive narratives created with Unity. In their digital reconstruction, these culture-specific objects have already emerged as visual tropes of cultural memory, belonging, and nostalgia. Therefore, we use the process of 3D and immersive modeling as a means of anthropological and ethnographic engagement with the perceptual and cultural aspects of spatial imagination in literature and its interpretation by the translator.

Our understanding of what is inherent in the translator's sense of place is limited to a large extent by how we model the linguistic make-up of texts in visual ways to explore their experiential embodiment. The following two sections will break down the issue into two problems that the digital reconstruction of spatial imagination needs to address. On the one hand, the field of data visualization is driven by statistical methods which compress rich information into abstract data points. On the other hand, we turn the experiential aspects of language into logocentric data.

3 From Data Points to Data Gestalts

How we represent language and text in visual terms is conditioned by what we conceptualize them to be. The universalist views of language and text treat them, for example, as systems or structures of logically or hierarchically organized units. The concept of text-as-hierarchy is akin to the computational ideas of communication whereby meaning is assembled and dissembled into parts that relate to each other in some objective ways.⁶ These computational views, however, disembody the experiential aspects of text. Alternatively, phenomenological perspectives put language production back in its context or look at the world through a lens of language. Gadamer's view that we are in the world by being in language (Roy and Bayo 2011, p. 32), for example, poses a complex problem for modelling and representing the use of language as something experientially

⁶ The field of formal semantics uses formal tools of logic and computer science to break meaning into building blocks. This strand of thinking of language in a combinatorial way has extended to cognitive theories of mental lexicon (Aitchison 2012) as well as digital humanities approaches to texts argued to be logical and 'ordered hierarchies of content objects' (DeRose et al. 1990; Renear et al. 1996).

dynamic. This philosophical relativism resonates with what physics calls the *observer effect* which refers to the power of observation to change the observed.

Although they are steeped in our experiences and memories of the physical world, fictional places and objects do not have hard boundaries, clear-cut shapes or a fixed set of features. Even though they might be captured by drawing a map, the boundaries of the imagined do not coincide with what might have conjured it up. The mental picture of a place is always unstable. After all, place is a temporal construct, whether it is the one we see in front of us, the one whose image we carry in our memory, or the one that we forge as part of our fictional worlds. Fictional maps also have a degree of abstraction or incompleteness. The maps of the imaginary Yoknapatawpha that Faulkner himself drew for *The Sound and the Fury* and other novels, for example, vary in terms of geographical details.⁷ Yoknapatawpha as a place evolved with each story that Faulkner forged. The words referring to various sites in his fictional worlds, such as pasture, cemetery, and church, evoke rich images. The details of his ever changing Yoknapatawpha, however, must have been shifting in his mind's eye, which is reflected in the depiction of how characters relate to the same objects. The pasture of Benjy in *The Sound and the Fury*, for example, is not the same pasture that Darl observes in *As I Lay Dying* since the meaning of the pasture is constructed through the eyes of each character.

If we assume that a translator writes from her psychological, emotional, and physical centres, our search for what has informed her lexical choices of depicting space and place should extend to her context. She might have done extensive research on a writer's places and might have actually travelled to those places, but it is her direct encounters that create a sense of memory far more compelling than what she can construe to constitute a writer's spatial awareness. Being a multidimensional construct that comprehends material, factual, mental, and other dimensions of spatiality⁸ and multiplicity of feelings, a sense of place resists being represented as a data point despite many ways that we have invented to datify information these days.

The question arises as to how and whether we can capture the richness of fictional topographies by means of 2D visualization. Visualization research has evolved into the field of information design that operates within a set of scientifically valid or rhetorically effective rules (Tufte 1997). The tendency is to translate information into values or data points and map them along the Cartesian coordinates. By subjecting information to regimented and regimenting principles of scientific inquiry, the algorithmic compression and manipulation of data values allows us to arrange complex information into visual patterns.⁹ Information design seems like an elegant solution to the complex problems of communicating, sharing, and storing our knowledge. The driving force behind these visuals is to create a vantage point to tell a story in rhetorically compelling ways. However, such visuals are roadmaps to storytelling rather than stories themselves. Regardless

⁷ See the Digital Yoknapatawpha project at <https://faulkner.iath.virginia.edu/>.

⁸ Soja (1996) coined the term 'thirdspace' to expand the scope of how we can conceptualize space beyond the two dimensions of constructing it as either material or mental.

⁹ Despite various conceptual, speculative, and playful attempts to engage with data through artistic research, speculative design (Drucker 2009), or data-diaries as a response of data humanism to quantified-self approach (Lupi and Posavec 2016), visualization research gravitates towards this scientific form of visual knowledge production.

of whether information design is executed well or poorly, the resulting visuals can hardly capture the gestaltic¹⁰ effects of words to summon and be summoned by a sense and perception of space. In the digital reconstruction of how Faulkner and his translator might have seen the world of Yoknapatawpha through their eyes, the dilemma is how to go about textual data as gestalts. Since gestalt is a cognitive effect that resists being computed as a discrete object, the challenge lies in the productive use of the absence of boundaries and specific references.

4 Saying and Showing

What the translators inscribed on the fictional world of Yoknapatawpha in their versions is reflected to some extent in their lexical choices. Close inspection of how they rendered Faulkner's recurring words reveal tectonic shifts in the landscape of the novel. For example, the repetitions of the noun *house* in the Dilsey chapter were occasionally rendered with the words referring to regional architecture specific to the environment and context of the translators (Salciute Civiliene 2021, p. 188).

However, here we face the fundamental problem of how the evocative and experiential make-up of a text could be designed as information experiences. The Wittgensteinian distinction between saying and showing (Moore 1987) captures the limits of how and what we can know by using logocentric means such as the written forms of words to represent what they may have brought to one's mind. Word tables, word clouds, and the like are the examples of logocentric visuals. Figure 1 represents the differences in the choices that eight translators made to render the word *barn* in the Benjy chapter of Faulkner's *The Sound and the Fury*.

The visuals in Fig. 1 highlight discrepancies between Faulkner's consistent use of the words signifying sites and objects and the translatorial choices. Some translators created several locales instead of one. Some choices also seem inaccurate. For example, the Lithuanian translator (LT) rendered the word as *klojimas* ("stackyard", "granary") or *arklių aptvaras* ("horse enclosure"). Both Polish translators (POL1 and POL2) also create distinct spaces by using *stajnia* ("stable") and *obory* ("cowshed"), which corresponds to the French (FR) choices of *écurie* ("stable") and *étable* ("barn").

In Fig. 1, each word acts as an index pointing to its own visuo-orthographic form, which points out to where exactly the translators parted ways with Faulkner. Yet even combined with visual elements such as colours and lines, the indexical structure of the visuals is declarative rather than demonstrative. The discovery of inaccuracies raises the question as to where those "mistakes" come from: some sort of linguistic and cultural incompetence or one's existential relationship with the text? The premise that they evidence a translator's authentic being in the world presents an interesting case

¹⁰ Here it is important to emphasize the difference in how gestalt is defined by cognitive psychology and how the term is being adapted in design theory. In rejection of mechanistic views on human perception dominant in the traditional psychology of the 19th century, the prominent founders of Gestalt psychology Koffka and Köhler argued based on experimental evidence that humans tend to perceive and experience objects as complex wholes that are more than a combination of their parts. Design theory has simplified the term by equating it to various types of visual patterns illustrating how the human mind perceives information.

LT	RU1	RU2	POL1	POL2	FR	SP	ROM
klojimas	ZERO	сарай	stajni	stajni	l'écurie	establo	grajd
klojimas	сарай	сарай	stajni	stajni	l'écurie	establo	grajd
klojimas	сарай	сарай	stajni	stajni	l'écurie	establo	grajd
ZERO	стойлах	сарай	ZERO	stajni	l'écurie	establo	ZERO
ZERO	сарай	сарай	obory	obory	l'étable	establo	grajd
klojimas	сарай	сарай	obory	obory	l'étable	establo	grajd
klojimas	сарай	сарай	obory	obory	l'étable	establo	grajd
klojimas	сарай	сарай	obory	obory	l'étable	establo	grajd
klojimas	сарай	сарай	obory	obory	l'étable	establo	grajd
klojimas	сарай	сарай	obory	obory	l'étable	establo	grajd
klojimas	сарай	сарай	obory	obory	l'étable	establo	grajd
klojimas	сарай	сарай	obory	obory	l'étable	establo	grajd
klojimas	ZERO	сарай	ZERO	obory	l'étable	establo	grajd
аркыл aptvaras	сарай	сарай	obory	obory	l'étable	establo	grajd
klojimas	сарай	сарай	obory	obory	l'étable	establo	grajd
klojimas	сарай	сарай	obory	obory	l'étable	establo	grajd
klojimas	сарай	сарай	obory	obory	l'étable	establo	grajd
klojimas	сарай	сарай	obory	obory	l'étable	establo	grajd
klojimas	сарай	сарай	obory	obory	l'étable	establo	grajd

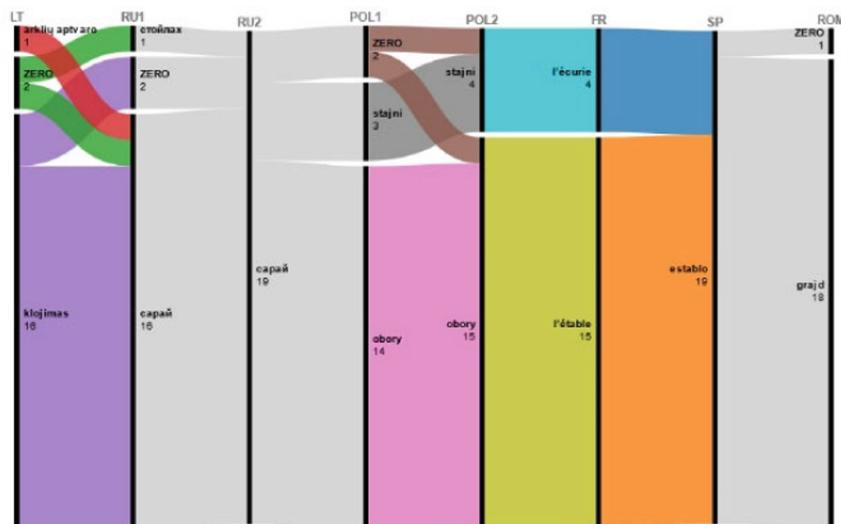


Fig. 1. Eight translations into six languages of the word *barn* found in the Benjy chapter from *The Sound and the Fury*: a table of translatorial variants (above), produced in Excel, and an alluvial diagram (below), produced with RawGraphs 2.0.

for a visually-driven anthropological inquiry into how the individual, material, imaginary, factual, and other dimensions of spatiality underpin the experience of literary imagination in translation.

There is an interesting tension between how Faulkner depicts the barn and what the Lithuanian choice of klojimas evokes. In the broader cultural context, both also emerge as rich visual tropes. The sound is the most fundamental topological difference between the barn and the klojimas. Faulkner's depiction of the barn as a building for storing grain and housing livestock such as cows, pigs, and horses is often acoustic, e.g. "The big cow and the little one were standing in the door, and we could hear Prince and Queenie and Fancy stomping inside the barn". Whenever the narrator relies on the visual details, they tend to be laconic, e.g. "Roskus was milking at the barn" or "Some birds sat on the barn door and watched him".

Since Faulkner brings animals into view, *tvartas* ("barn") would have been the most straightforward translation into Lithuanian. Traditionally, livestock was kept in the *tvartas*, while grain was stored separately in the klojimas. In Faulkner's novels, animals are often subjected to human violence (Colvin 2014), and the barn often emerges as a place of violence. The choice of klojimas as if removes these negative connotations and associations for the Lithuanian reader. It also establishes a reference to a culturally different structure whose agricultural purpose differs from that of the barn. As a domain of plants considered no less alive than humans or animals in Lithuanian folklore, the klojimas summon a different sound ecology of work performed under polyphonic singing as opposed to the sound of animal exploitation.

Canvassing how to visualize these two culture-specific architectonic structures in immersive ways created an interesting challenge: how to find a reference if the geography of search extends beyond one time, one place, and into the minds of both the writer and the translator? The building of the visual equivalents of the American barn and the Lithuanian klojimas has become a means of researching the factual and the imaginary sources of a sense of place, focused on perceptualizing cultural differences of fictional emplacement.

5 3D Modelling as Research: Anthropological Poetics of "Mistake"

According to the observer effect in physics, looking at something alone changes what we observe. Whether we see a translatorial choice as a mistake that betrays the author or as a trace of authentic being in the world is a watershed moment. The latter perspective presents a case for the anthropology of "mistake" in a translator's imagination. The techniques and practices of 2D visualization, however, lack the cinematic acuteness to follow the gaze of one who beholds the scene, whether actual or imaginary. Spatial imagination requires spatial means of observing.

Regional and national architectures may be placed on the continuum between different temporalities and localities since cultures communicate and migrate across space and time. American barns, for example, share many features with European rural architecture, especially English barns (Glassie 1975). They also demonstrate a range of purposes, e.g. animal barns, threshing barns, granaries, and the like (Hauser 2017). While the klojimas bears an affinity to the threshing barn, the presence of animals is central to Faulkner's barn, which has narrowed down our search for specific reference materials.

Imaginary places are factual in relative terms. The degree of the pseudo-historical and a-geographical nature of the imagined places and objects has prompted our search

for multiple references within and beyond the place where Faulkner lived and drew his inspiration for the Yoknapatawpha county. For example, while we know that a year after the publication of *The Sound and the Fury*, Faulkner moved to Rowan Oak in Oxford, Lafayette County, Mississippi, where he restored the barn amongst other outbuildings on the estate, we cannot tell how and whether it specifically informed the image of barns that keep cropping up in his other novels. The pseudo-historical and a-geographical materiality of the imagined places and objects raises many questions such as how exactly our visual equivalents of culture-specific objects should look; how many details we need to include to foreground the difference between the architectonic look and the cultural purpose of these two structures. Our photorealistic approach to 3D modelling has also been dictated by these questions.

Photorealism served as a rhetorical device to foreground differences in the architectonic make-up of the barn and the klojimas. Both structures are culture-specific. They are also objects entangled with their environments and people in terms of what causes determined their shape, size, materials, and the like; in terms of what people used to do inside and around those objects at different times of day and year; what ethnic and symbolic meanings were given to them through the use and interaction with those objects.

Since most of the time it is impossible to anchor a single factual or otherwise empirical source of reference, we have devised a set of dimensions for the iterative prototyping of our 3D models based on identifying the recurring features that would be culturally representative of the barn and the klojimas on some level. This iterative modelling has been instrumental in outlining the visual field of research.

The dimensions of selection revolve around the questions whether a reference object or its parts are representative, evocative, symbolic, emblematic, or prototypical to the immediate environment in which the writer and the translator produced their versions or to their historical context. For example, there is no evidence that Faulkner envisaged his barn as being painted in red in *The Sound and the Fury*. Nevertheless, we decided that our 3D model of the American barn will be red. Red barns are not common in all regions¹¹, though they are found in the Mississippi landscape which served as inspiration for his imaginary county of Yoknapatawpha. The red paint is also a prominent archetype in American art.¹² Unlike the American barn whose regional variation in architectonic detail is stunning¹³, the Lithuanian klojimas emerges invariably through the archival images as an unpainted building with a half-hipped roof¹⁴ and eaves wide enough to

¹¹ The practice of painting barns was not common until the 20th c. since “[p]ainting was considered extravagant, vulgar, and showy, and many farmers couldn’t afford it”, argues Bouland (1998, p. 120).

¹² To mention a few, the famous artistic portrayals of the red barn include Edward Hopper’s *Cobb’s Barns, South Truro*, 1930–1933, at the Whitney Museum of American Art (<https://whitney.org/collection/works/5865>); Kenjiro Nomura’s *The Farm*, 1934, at the Smithsonian American Art Museum (<https://americanart.si.edu/artwork/the-farm-18775>); Robert Alexander Darrah Miller’s *Solebury Hills* 1938.

¹³ The digitization project carried out by Cornell University Library in 2008 (<https://archive.org/details/cu31924015223765>) features a comprehensive compilation of archival documents and images showing the regional variation of the American barn with plenty of architectural details and construction plans.

¹⁴ A gable roof is more common in barns in the southern parts of Lithuania.

protect its walls from the bitter weather effects.¹⁵ The image of the red barn would stand out as a foreign element in the Lithuanian construct.

While our project is ongoing, we keep documenting our process of building 3D models and developing interactive scenarios with paradata that comprise of sketches, the screenshots of building fragments, and screenplays. On the one hand, we seek to illustrate our logic of selecting references, features, and other dimensions in the modelling process. While intellectual transparency is of primary concern in producing paradata for virtual heritage (Kafel-Bentkowska 2012), for us paradata present an opportunity to explore and outline the semiotic field of ethnographic search for what a spatial object or its place might have meant to the writer and the translator, especially when the direct observation of how their interactions with factual places might have informed the depiction of a fictional place is not possible or very limited. The concept sketches in Fig. 2 illustrate a fragment of how our modelling of the klojimas has evolved from broad assumptions to the choices based on analysing a number of archival images from the early 20th century and drawing on the regional studies of folk architecture.

One of our initial concept sketches of the klojimas, for example, included windows and a fieldstone base which we removed at a later stage. In most of the archival images that we accessed¹⁶ to prototype the visual equivalent of the klojimas, it appears without fieldstone foundations though old folk architecture shows some regional variation here. While the tall foundation made of large fieldstones, for example, was not unusual in granaries built for the sole purpose of storing grain to create the ventilating conditions, the klojimas, especially in the Dzūkija region (southern Lithuania), rarely had one. A more common way to support and raise a building was to place stones or wood blocks in the corners and the middle of the building (Andriušytė et al. 2008, p. 18). The size of the klojimas was also subject to regional variation. For example, it used to be the largest building¹⁷ on a farmstead (“sodyba”) in the Aukštaitija region (Bertašiūtė et al. 2009, p. 73). Yet the average Lithuanian klojimas is outsized by the average American barn.

Another architectonic aspect that accentuates the cultural otherness of the klojimas vis-à-vis the American barn is its roof with the wide and low-hanging eaves. The eaves provide shelter for logs or tools kept outside the building against the bitter weather effects, as featured in Fig. 2. The materials and the form of the klojimas’ roof varies in detail across the regions of Lithuania. We had to choose between dry vegetation and wooden shingles which used to be common building materials in the early 20th century.

Our 3D models and the immersive environment in which they will be embedded at a later stage are not illustrations. The models are being designed as stimuli to induce a sense of otherness and familiarity relative to the viewer. They contain enough detail to be recognizable as belonging to their respective cultures, but not too specific in regional terms. The barn model, for example, is supposed to be recognized as an iconic signpost of the American landscape while the iconicity of the klojimas would be conspicuous to the

¹⁵ For reference, Lithuania is rather far to the north and its climate is comparable to that of Canada.

¹⁶ The digital archive of the M.K. Čiurlionis national museum of art served as a major source of historical reference accessed through the integral information system of LIMIS (<https://www.limis.lt/en>).

¹⁷ In Aukštaitija, klojimas is commonly built 10–12 m in width and 12–20 m in length (Bertašiūtė et al. 2009, p. 101).

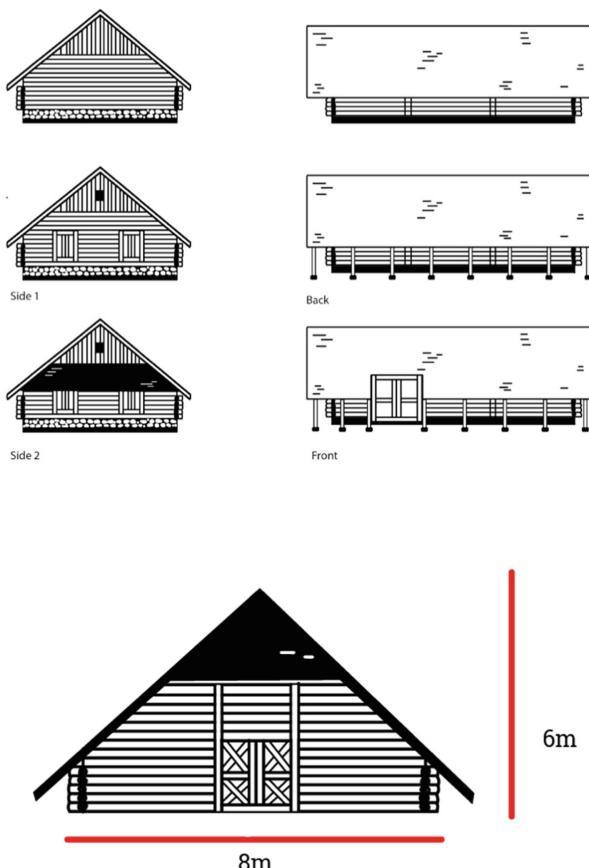


Fig. 2. Initial (above) and final concept sketch (below) of the klojimas. Design and reproduction courtesy of Sonja Doupnik.

Lithuanian viewer. While the models cannot reconstruct what images the writer and the translator entertained, they are built to condition experiences of cultural emplacement.

6 Towards VR Ethnography of Spatial Imagination

In the process of modelling, prototyping, and scripting, the klojimas has emerged as a site of cultural memory and yearning for the feel of harmony denied by Faulkner's barn. Apart from its agricultural purpose, the klojimas is also known as a socio-cultural space of ritualized labour that produced the genre of threshing songs and transformed itself into *klojimo teatras* ("the theatre of klojimas") at the end of the 19th c., which survived until nowadays.

The terms of visualization and reconstruction have grown too narrow to conceptualize the design of mental topographies. The concept of perceptualization has emerged in contemplating the scenarios of multi-sensory narratives in which the 3D models will be

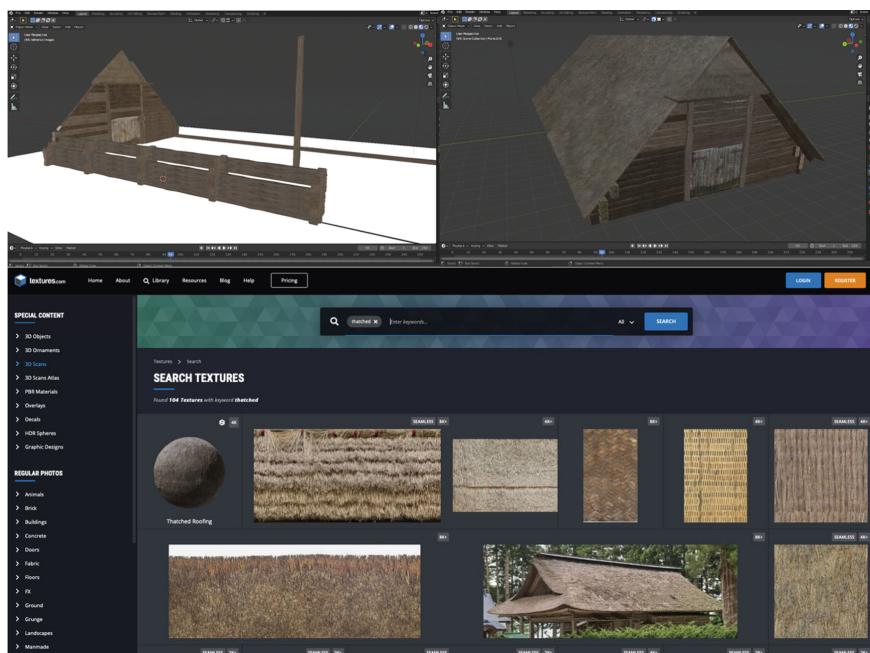


Fig. 3. Modelling and rendering the klojimas in Blender. Design and reproduction courtesy of Sonja Doupnik.

embedded at a later stage. To enhance a sense of the cultural, geographical, and historical specificity of each object, the passages of Faulkner's novel will be read aloud in English and Lithuanian. A sense of cultural nostalgia that accompanies the klojimas will also be induced by overlaying the narrative voice with the sounds of threshing songs and theatre recordings.

The term of reconstruction is also relative because our reference materials are many and speculative. The uncertainties faced in the process of prototyping multi-sensory models and their environments have been instrumental in producing a visual inquiry into literary imagination as an ethnographic site of subjectively embodied and culturally situated experience. It is a kind of ethnographic study that seeks to gratify a viewpoint that cannot be observed in a direct way for various reasons, including the fact that a writer or a translator may no longer be around or may not be willing or able to share their memories.

References

- Aitchison, J.: *Words in the Mind: An Introduction to the Mental Lexicon*, 4th edn. Wiley-Blackwell, Oxford (2012)
- Andriušytė, A., Baltrušaitis, V., Burinskaitė, I., Žumbakienė, G.: *Dzūkijos tradicinė kaimo architektūra. Etninės kultūros globos taryba* (2008)
- Anon: *Farm Buildings*. Sanders Publishing Co., Chicago (1905)

- Bertašiūtė, R., Vasiliauskaitė, V., Žumbakienė, G., Bortkūnas, R., Norvaišaitė, N.: Rytų Aukštaitijos tradicinė kaimo architektūra. Etninės kultūros globos tarybos sekretoriatas (2009)
- Boulard, H.: Barns Across America. American Society of Agricultural Engineers, St. Joseph (1998)
- Colvin, C. M.: "His guts are all out of him": Faulkner's eruptive animals. *J. Mod. Lit.* **38**(1), 94–106 (2014). Disability and Generative Form
- DeRose, S.J., Durand, D.G., Mylonas, E., Renear, A.H.: What is text, really? *J. Comput. High. Educ.* **1**(2), 3–26 (1990)
- DIGITAL Yoknapatwpha. <https://faulkner.iath.virginia.edu/>. Accessed 10 Feb 2021
- Drucker, J.: SpecLab: Digital Aesthetics and Projects in Speculative Computing. The University of Chicago Press, Chicago and London (2009)
- Engberg-Pedersen, A.: Literature and Cartography: Theories, Histories, Genres. The MIT Press, Cambridge and London (2017)
- Faulkner, W.: The Sound and the Fury. Vintage Books, London (2011)
- Folkneris, V.: Triukšmas ir įniršis. Translated by Violeta Tauragienė. Lietuvos rašytojų sąjungos leidykla, Vilnius (2003)
- Glassie, H.: Barns across Southern England: a note on transatlantic comparison and architectural meanings. *Pioneer Am.* **7**(1), 9–19 (1975)
- Hauser, S.C.: Barn: Form and Function of an American Icon. Voyageur Press (2017)
- Kafel-Bentkowska, A.: Processual scholia: the importance of paradata in heritage visualization. In: Bentkowska-Kafel, A., Denard, H., Baker, D. (eds.) *Paradata and Transparency in Virtual Heritage*, pp. 245–259. Ashgate, Farnham (2012)
- Lupi, G., Posavec, S.: Dear Data. Princeton Architectural Press, New York (2016)
- Moore, A.W.: On saying and showing. *Philosophy* **62**(242), 473–497 (1987). <https://doi.org/10.1017/S0031819100039048>
- Renear, A.H., Mylonas, E., Durand, D.G.: Refining our notion of what text really is: the problem of overlapping hierarchies. In: Hockey, S., Ide, N. (eds.) *Research in Humanities Computing*, pp. 263–280. Oxford University Press (1996)
- Roy, A., Bayo, O.: Hans-Georg Gadamer on praxis and hermeneutical understanding. *Comp. Lit. East West* **14**(1), 27–42 (2011). <https://doi.org/10.1080/25723618.2011.12015553>
- Soja, E.W.: Taking Space personally. In: Arias, S., Warf, B. (eds.) *The Spatial Turn: Interdisciplinary Perspectives*, pp. 11–35. Taylor and Francis, London (2009)
- Soja, E.W.: Thirdspace: Journeys to Los Angeles and Other Real-and-Imagines Places. Blackwell Publishers (1996)
- Salciute Civiliene, G.: VR ethnography: transcultural reimagining of William Faulkner's topographies in the sound and the fury. In: Griffin, H. (ed.) *AMPS Proceedings Series 20.2. Connections: Exploring Heritage, Architecture, Cities, Art, Media*, pp. 187–198. University of Kent, UK (2021)
- Tufte, E.R.: Visual Explanations: Images and Quantities, Evidence and Narrative. Graphics Press, Cheshire and Connecticut (1997)
- Venuti, L.: The Translator's Invisibility: A History of Translation, 2nd edn. Routledge, London and New York (2008)
- Watson, J.G.: William Faulkner: Self-presentation and Performance. University of Texas Press, Austin (2000)



Are We Ready for Smart Contact Lenses?

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Abstract. The aim of this study was to delve into the acceptability of smart contact lenses, to understand their viability on the market. We identified that the technology is being developed but the reaction it will have on potential buyers is not yet known. To achieve this, the Unified Theory of Acceptance and Use of Technology (UTAUT) model was used and adapted to an online questionnaire that was answered by 200 people, from Portugal (106) and Colombia (94). Considering that one is from Latin America and the other from Europe, two countries in opposite continents and with different cultures and contexts, the main hypothesis is that there will be a difference in the acceptance of smart contacts lenses between Portugal and Colombia. Additionally, it was hypothesized that people would be scared of using smart contact lenses and would be focused on the negative potential of the new product, like the lack of privacy. The main results did not reveal statistically relevant differences between the two countries (significant difference was found just for the Social Influence construct). Considering the whole sample, the results show that people tend to not be ready for smart contact lenses in their everyday life yet, but they are open to the idea of using them in specific situations that could help them improve their lives and work (healthcare, information), which is a great opportunity for interaction design.

Keywords: Acceptability · User experience · Usability · Smart contact lens · UTAUT model · Interaction design

1 Introduction

A good design of a product or service is not only justified by the fact that it takes advantage of a technology, responds to a cause, or fulfills a user's need—it must be accepted by potential users in order to be successful in the market.

With the advances in technology, the development of new smart devices combined with applications is increasingly more widespread. From Human implanted microchips (US2019/0043291A1, 2018) to personal devices for health monitoring, for example, research in the field of wearable technologies is receiving a lot of attention, appearing as an emergent area. Smart contact lenses are among the smart devices that most captured

the attention of researchers. With particular features such as having a small volume, being flexible, and convenient to wear, smart contact lenses are proposed to be used in various forms, such as displaying content directly into the user's retina, detecting blood glucose levels of the user, and capturing images.

We chose this product as our main research focus because, according to the technology development we encountered (as discussed in this section), we can predict that it will be launched in the near future. It is important to find out whether or not it will be accepted before the release, this way through interaction design we can adapt the product to the user's needs and interests. The first experience with the product will be influenced not only by its usability but also by their user experience.

In 2014 it was revealed in the *Nature Biotechnology Journal* (Senior 2014) that Novartis, in collaboration with Google, would implement a smart contact lens concept as a sensor to help people with diabetes measure the glucose level in teardrops. Although Verily—a Google health technology company—had announced through its blog in November 2018 that the project would be shut down, the interest in smart contact lenses is still growing.

Research in this field has been done by institutions and companies resulting in some patents, such as the one registered by the University of Washington (US 8096654 B2, 2012). For this patent, the active contact lens consists of a transparent substrate having a circuit formed of one or more semitransparent displays, a display drive circuit, a data communications circuit, one or more biosensors, an energy transfer antenna, and an interconnect network. According to the patent description, the active contact lens system was projected to perform two main functions: i) provide visual information to the user through a semitransparent display, and ii) incorporate biosensors that can, for example, monitor the user's physiological and immunological conditions. Park and colleagues (2018) also presented a smart contact lens for health monitoring purposes in which glucose levels could be monitored in real-time.

Another example are the smart contact lenses patented by Samsung Electronics Co. for augmented reality (US2016/0091737A1, 2016). In this case, the lens could be controlled by an external device, such a mobile application. With these lenses, the user could, for example, receive information about an object (e.g., a building, a place, or a person) he/she is looking at in real time in the retina. According to the patent description, as the display unit gives information about an object directly into the retina, the information may be seen clearly by the user.

Along with the popularization of augmented reality, smart contact lenses could be a suitable alternative for having an additional layer of information without having some of the problems reported by active smart glasses users. In this context, this paper aims to present a study about the acceptance of smart contact lenses by potential users. For this, the Unified Theory of Acceptance and Use of Technology—UTAUT (Venkatesh et al. 2003) model was used. Using this model, this study explored the acceptability of smart contact lenses and compared the results in two different countries, Colombia and Portugal, to understand its viability on the market, through an online questionnaire.

This paper begins by explaining the theoretical background, it presents the experiment conducted, and discusses its results.

1.1 The UTAUT Model

The UTAUT model is a technology acceptance model formulated by Venkatesh and colleagues (2003) in “User acceptance of information technology: Toward a unified view.” The UTAUT has the goal of explaining user intentions to use an information system and usage behavior right after. In this theory there are four key constructs: 1) performance expectancy, 2) effort expectancy, 3) social influence, and 4) facilitating conditions. The first three are determinants of the intention to use and behavior, and the fourth is a direct determinant of user behavior. To moderate the impact of the four constructs on the intention to use and behavior, gender, age, experience and voluntariness of use are suggested.

To develop the UTAUT model eight different models were revised by the authors (Theory of Reasoned Action—TRA, the Technology Acceptance Model—TAM, the Motivational Model, the Theory of Planned Behavior—TPB, the combined TAM and TPB, the model of Personal Computer Utilization, the Innovation Diffusion Theory, and the Social Cognitive Theory) (Venkatesh et al. 2003). After having established conceptual and empirical similarities across models, a unified model was presented. The model has been evaluated and improved in the following years. The UTAUT model is used for the evaluation of acceptance of technological products. This methodology provides information about the probability of use of a specific technology product and its acceptance tendency. With this model we can highlight two important constructs: the Ease of Use and the Perceived Usefulness—these are constructs that make reference to whether or not the users want to interact with the product, and this is why this methodology was chosen, to determine if the contact lenses would be a product or service that have the potential to transform interaction design, as a new element added to existing systems.

2 Methodology

2.1 Questionnaire

In this study, we used the UTAUT model modification presented by Heerink et al. (2009). This model uses a structured questionnaire (Table 1), in which each construct is represented by multiple statements. These statements are presented after a short film featuring the product. In each statement, participants were presented with a scale of one to seven points to rank the questions. The range moves from (1) “strongly disagreed” to (7) “strongly agreed.”

The UTAUT model has been widely used for the evaluation of SAR acceptance in many previous studies (Heerink 2011; Heerink et al. 2008, 2009a, 2010a; Mubin et al. 2010; Tay et al. 2013; Zaad and Allouch 2008) and has been found to be reliable. The original model is based on the following hypotheses:

H1. Intention to Use is determined by Perceived Usefulness, Perceived Enjoyment, Social Influence, Perceived ease of use and, and Trust;

H2. Perceived Usefulness is influenced by Perceived Adaptability and Anxiety;

H3. Perceived Enjoyment is influenced by Social Presence and Perceived Sociability;

H4. Perceived Sociability is influenced by Trust; and

H5. Social Presence is influenced by Perceived Sociability.

Table 1. UTAUT model overview and questionnaire used.

Construct	Definition	Questions
Anxiety	Evoking anxious or emotional reaction with using the system	<ul style="list-style-type: none"> - If I should use the smart contact lenses, I would be afraid to make mistakes with it - I find the smart contact lenses scary - I find the smart contact lenses intimidating
Attitude	Positive or negative feelings about the appliance of the technology	<ul style="list-style-type: none"> - I think it is a good idea to use the smart contact lenses - The smart contact lenses would make life more interesting - It is good to make use of the smart contact lenses
Facilitating conditions	Objective factors in the environment that facilitate using the system	<ul style="list-style-type: none"> - I have everything I need to use the smart contact lenses - I know enough of the technology to make good use of it
Intention to use	The outspoken intention of using the system over a longer period in time	<ul style="list-style-type: none"> - I think I will use the smart contact lenses during the next few days - I am certain to use the smart contact lenses during the next few days - I plan to use the smart contact lenses during the next few days
Perceived adaptability	The perceived ability of the system to be adaptive to the changing needs of the user	<ul style="list-style-type: none"> - I think the smart contact lenses can be adaptive to what I need - I think the smart contact lenses will only do what I need at that particular moment - I think the smart contact lenses will help me when I consider it to be necessary
Perceived enjoyment	Feelings of joy or pleasure associated by the user with the use of the system	<ul style="list-style-type: none"> - I enjoy doing thing with the smart contact lenses - I find the smart contact lenses enjoyable - I find the smart contact lenses fascinating

(continued)

Table 1. (continued)

Construct	Definition	Questions
Perceived ease of use	The degree to which one believes that using the system would be free of effort	- I think I will know quickly how to use the smart contact lenses - I find the smart contact lenses easy to use
Perceived sociability	The perceived ability of the system to perform sociable behavior	- I consider the smart contact lenses a pleasant conversational partner - I think the smart contact lenses are nice
Perceived usefulness	The degree to which a person believes that using the system would enhance his or her daily activities	- I think the smart contact lenses are useful to me - It would be convenient for me to have the smart contact lenses - I think the smart contact lenses can help me with many things
Social influence	The user's perspective of how people who are important to them think about them using the system	- I think the staff would like me using the smart contact lenses
Social presence	The experience of sensing a social entity when interacting with the system	- When interacting with the smart contact lenses I feel like I am talking to a real person - It sometimes felt as if the technology was looking at me
Trust	The belief that the system performs with personal integrity and reliability	- I would trust the smart contact lenses if they gave me advice - I would follow the advice the smart contact lenses give me

2.2 Participants

A sample of 200 individuals, originating from Portugal (106) and Colombia (94), was used for the study. Participants were mixed because there were no significant differences between them. This conclusion was made with the U Mann-Whitney Test in which Nationality x Usability was not $p > 0,05$. In addition to this, we conducted a Cronbach's alpha Test to measure the internal consistency and reliability of the questionnaire and this result was substantial. For 29 questions made $\alpha = 0,92$. If the result from the Anxiety construct were to have been excluded, this result will increase even more.

The range of ages were from 19–45 years old (77% of the participants), while 80,5% have completed higher education, and 73,5% had heard about smart contact lenses before. We found the latter surprising, as this is not something widely talked about in social

media platforms or news because it is something that has not been public yet and the participants have not been able to test it.

For this study the selection of the sample was random to increase the generalizability of the results. There was no age, gender or occupation bias. The requirement to be able to participate in the study was nationality. But we would like to add that because this was an online survey, we were making sure that our participants were people that used technology every day. Our inquiry was if they were interested in this kind of product.

2.3 Experimental Setup

To verify the acceptability of the smart contact lenses, a video was produced about them and some of their functions/uses, and presented to the participants before asking them to fill in the questionnaire. The video was a short brief about the smart contact lenses and what a human could do with them. The design strategy was as follows: first, a guideline was made, where it was planned to show a little of everything (positive, negative and neutral aspects) so there was a mix in the storytelling (fun, private and personal things, navigation and health functions). It was designed this way to not scare people, to show them a complete view of how they worked, and what could be done with them. After seeing this video people could build an informed opinion about the lenses. This video (Fig. 1) started by showing the unboxing of the smart contact lenses, and followed with a record of a day of a person with the lenses on.

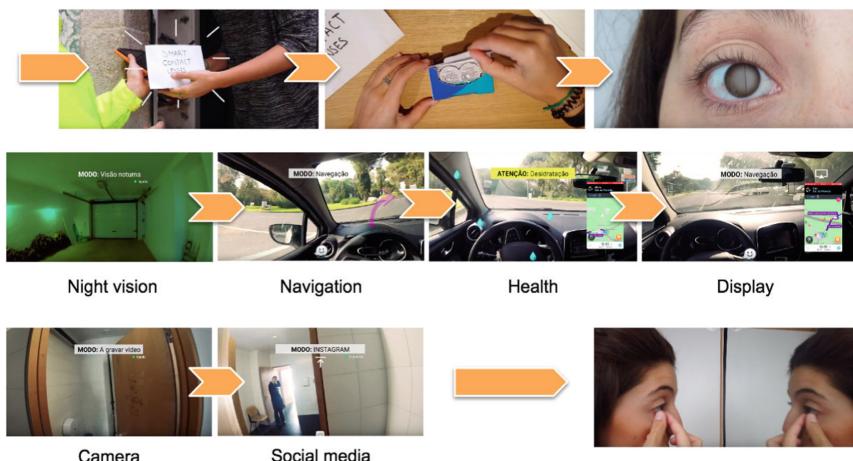


Fig. 1. Storyboard of the video shown before the questionnaire. It illustrates the different features and functions of the product.

The attention was first focused on how easily they could be put on and taken out—the ease of use, the lack of need to set up, the ability of the lenses to adapt to the user's eye like normal contact lenses do; then it showed night vision, presented as an innovative function; it highlighted the perfect vision that people have with them, which is like not wearing anything; it showed the possibility of connecting the lenses to mobile

applications and mobile phone, so they (for example) could guide the user to a location or show the indications on a display produced by the lenses; it showed the healthcare assistance feature, informing that the user's hydration was low; then a "mistake" was shown, filming and uploading to social media a video of private information without noticing; and lastly, the video finished with the user taking out the lenses (easily). The video can be seen here: <https://www.youtube.com/watch?v=7ADKZRudYKY>.

2.4 Procedure

With the video and the elements in it, participants were able to form an opinion about the smart contact lenses and their use. After this, a questionnaire was carried out about the smart contact lenses with twelve variables/constructs (presented in Table 1). Participants were asked to answer, from 1 to 7, if they disagree a lot or they agree a lot with the affirmation shown. The constructs were: Anxiety; Attitude towards Technology; Facilitating Conditions; Intention to Use; Perceived Adaptiveness; Perceived Enjoyment; Perceived Ease of Use; Perceived Sociability; Perceived Usefulness; Social Influence; Social Presence; and Trust. Every construct had at least one question, but there were some with two or three. In total, the questionnaire had 29 questions.

3 Results

3.1 The Comparison Between Portugal and Colombia

One of the initial goals of this study was to compare the results in two different countries i.e., Portugal and Colombia. Table 2 presents the results for each construct considering participants' nationality.

Table 2. T-Test – Group statistics.

Construct	Nationality	N	Mean	SD	SEM
Anxiety	PT	106	4.0375	1.70798	.16589
	COL	94	3.6346	1.77353	.18293
Attitude towards tech 6	PT	106	4.4434	1.59249	.15468
	COL	94	4.5529	1.75846	.18137
Facilitating conditions 8	PT	106	3.2170	1.55842	.15137
	COL	94	3.1436	1.63895	.16904
Intention to use 11	PT	106	2.6666	1.59902	.15531

(continued)

The only significant difference found between the Colombian and Portuguese answers was on the social influence construct in the T-Test - Independent Samples Test, where Colombians got higher results ($p<0.002$).

Table 2. (*continued*)

Construct	Nationality	N	Mean	SD	SEM
	COL	94	2.5388	1.57199	.16214
Perceived adaptiveness 14	PT	106	4.4372	1.34613	.13075
	COL	94	4.2522	1.15352	.11898
Perceived enjoyment 17	PT	106	4.0567	1.55036	.15058
	COL	94	4.3582	1.90744	.19674
Perceived ease of use 19	PT	106	4.2406	1.73923	.16893
	COL	94	4.6543	1.68010	.17329
Perceived sociability 21	PT	106	3.8019	1.65282	.16054
	COL	94	3.7340	1.68437	.17373
Perceived usefulness 24	PT	106	3.7326	1.76604	.17153
	COL	94	4.2201	1.98739	.20498
Social influence 25	PT	106	3.3679	1.86356	.18101
	COL	94	4.2128	2.02071	.20842
Social presence 27	PT	106	3.9151	1.31016	.12725
	COL	94	3.9787	1.32575	.13674
Trust 29	PT	106	3.7783	1.76079	.17102
	COL	94	3.9787	1.76878	.18244

3.2 Analysis

After recognizing that Anxiety (Table 3) was the only variable worth analyzing separately, following are the results for the 200 participants mixed together in each construct and question.

Table 3. Results of each question in the Anxiety construct.

Anxiety	Agree	Disagree	Neutral
If I should use the smart contact lenses, I would be afraid to make mistakes with it	54,5%	30,5%	15,0%
I find the smart contact lenses scary	34,0%	53,0%	13,0%
I find the smart contact lenses intimidating	36,5%	51,0%	12,5%

Anxiety

There is a trend for Portuguese participants to be more anxious about smart contact lenses than Colombians (Fig. 2), maybe for the same reason they give a higher importance to Social Influence.

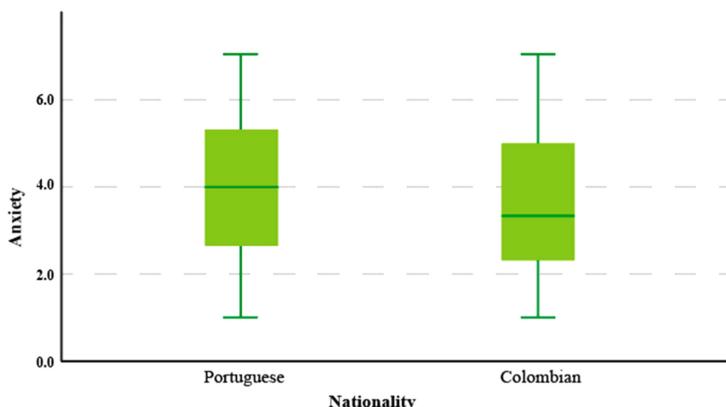


Fig. 2. Simple box plot showing the results of the Anxiety construct in both countries.

Perceived Enjoyment

The range in Colombia for Perceived Enjoyment is higher (Table 4 and Fig. 3), we can see this directly related to the lower level of anxiety with the product.

Table 4. Results of each question in the Perceived Enjoyment construct.

Perceived enjoyment	Agree	Disagree	Neutral
I enjoy doing things with the smart contact lenses	43,0%	34,0%	23,0%
I find the smart contact lenses enjoyable	46,0%	56,0%	18,0%
I find the smart contact lenses fascinating	52,0%	29,0%	19,0%

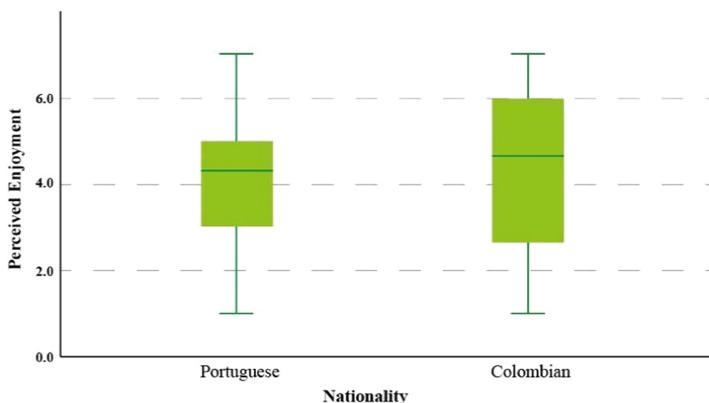


Fig. 3. Simple box plot showing the results of the perceived enjoyment construct in both countries.

Perceived Ease of Use

The fact of having higher or lower academic background did not influence the participants' answers nor the previous knowledge about them. However, even though the difference is not statistically valid we can highlight that it is interesting to find variations in the answers from the groups of age 25–35 and 36–45 in the Perceived Ease of Use construct, as can be seen in Table 5 and 6.

Table 5. Results of each question in the perceived ease of use construct.

Perceived ease of use	Agree	Disagree	Neutral
I think I will know quickly how to use the smart contact lenses	56,5%	30,0%	13,5%
I find the smart contact lenses easy to use	47,5%	34,0%	19,0%

Table 6. T-Test – Group statistics.

Construct	Age range	N	Mean	SD	SEM
Anxiety	26–35	72	4.0835	1.62108	.19105
	36–45	37	3.3681	2.04101	.33554
Attitude towards tech 6	26–35	72	4.2778	1.59738	.18825
	36–45	37	4.7476	1.91245	.31441
Facilitating conditions 8	26–35	72	3.0903	1.55039	.18272
	36–45	37	3.5135	1.77360	.29158
Intention to use 11	26–35	72	2.4303	1.45593	.17158
	36–45	37	3.1168	1.87128	.30764

(continued)

Table 6. (continued)

Construct	Age range	N	Mean	SD	SEM
Perceived adaptiveness 14	26–35	72	4.4168	1.23669	.14575
	36–45	37	4.3151	1.24676	.20497
Perceived enjoyment 17	26–35	72	4.1156	1.60253	.18886
	36–45	37	4.5946	1.96781	.32351
Perceived ease of use 19	26–35	72	4.2222	1.58089	.18631
	36–45	37	5.1622	1.81067	.29767
Perceived sociability 21	26–35	72	3.5417	1.45290	.17123
	36–45	37	4.0270	1.81026	.29760
Perceived usefulness 24	26–35	72	3.8058	1.68874	.19902
	36–45	37	4.3784	2.14327	.35235
Social influence 25	26–35	72	3.6667	1.86895	.22026
	36–45	37	4.0000	2.10819	.34658
Social presence 27	26–35	72	4.0625	1.11941	.13192
	36–45	37	3.7297	1.39241	.22891
Trust 29	26–35	72	3.9306	1.57065	.18510
	36–45	37	4.4189	1.91309	.31451

The only negative strong answers found on the survey were about the constructs: Facilitating Conditions (56,75% disagree with the statement; see Table 7) and Intentions to Use (67% disagree with the statement, see Table 8), showing that the participants of this study still need more information about the product and that they see this as very far in the future.

Facilitating Conditions

Table 7. Results of each question in the Facilitating Conditions construct.

Facilitating conditions	Agree	Disagree	Neutral
I have everything I need to use the smart contact lenses	35,5%	42,0%	22,5%
I know enough of the smart contact lens to make good use of it	16,5%	71,5%	12,0%

Intention to Use

The constructs: Perceived Adaptability, Attitude, Perceived Sociability, Perceived Usefulness, and Social Presence do not show strong reactions among the participants. In general the positive (agree with the statement) is close to/just pass the 50% of the

Table 8. Results of each question in the Intention to Use construct.

Intention to use	Agree	Disagree	Neutral
I think I'll use the smart contact lenses during the next few days	31,0%	57,0%	12,0%
I'm certain to use the smart contact lenses during the next few days	13,0%	78,0%	9,0%
I plan to use the smart contact lenses during the next few days	22,0%	66,0%	12,0%

answers but also the middle answer (those who are not sure enough to agree or disagree) on average is around 15% of the answers.

4 Discussion and Conclusions

This paper had as its main objective to realize if smart contact lenses would be accepted in two distinct countries—Portugal and Colombia. The initial assumption was that the two countries were not 100% ready, and that Portugal was more prepared than Colombia, due to its location in Europe. However, results showed that, based on the values for the Social Influence and Anxiety constructs, Colombia is more aware of the advances in technology, therefore, its tendency to accept is higher.

Overall, the acceptance towards the smart contact lenses was positive, as the two countries showed a positive attitude towards technology. In addition, the high level of the Anxiety construct was related with the mistakes users could potentially make and not with the fear of the smart contact lenses. That is a very good starting point for interaction design that aims to simplify and optimize the user experience so that the mistakes people think they could make will be reduced or rapidly bypassed without ruining the experience. We can see this also because the participants never experienced them in reality, so they did not have a clear opinion, but despite that they imagined themselves wearing the product.

Another conclusion that we take from these results is that the participants in our study know about smart contact lenses more than expected and think they are reliable; however, they see themselves using this wearable technology for specific purposes. This could be an interesting challenge for the development of interaction design in this area—exploring how this interface and its potential could result and be demonstrated for everyday life tasks.

References

- Amirparviz, B., Ho, H., Saeedi, E.: US 8096654 B2. U.S. (2012)
- Kim, T., Hwang, S., Kim, S., Ahn, H., Chung, D.: US2016/0091737A1. U.S. (2016)
- Fridin, M., Belokopytov, M.: Acceptance of socially assistive humanoid robot by preschool and elementary school teachers (2014)

- He, J., Mc Carley, J., Crager, K., Jadliwala, M., Hua, L., Huang S.: Does wearable device bring distraction closer to drivers? Comparing smartphones and Google Glass. *Appl. Ergon.* **70**, 156–166 (2018)
- Heerink, M.: Exploring the influence of age, gender, education and computer experience on robot acceptance by older adults. In: Kahn, P., Adams, J., Trafton, J. (eds.) 6th International Conference on Human Robot Interaction 2011. LNCS, pp. 147–148. ACM/IEEE, Lausanne (2011)
- Heerink, M., Kroese, B., Evers, V., Wielinga, B.: Responses to a social robot by elderly users. In: International Conference on Intelligent Robots and Systems 2008, pp. 2724–2724. IEEE/RSJ, Nice (2008)
- Heerink, M., Kröse, B., Wielinga, B., Evers, V.: Influence of social presence on acceptance of an assistive social robot and screen agent by elderly users. *Adv. Robot.* **23**(14), 1909–1923 (2009)
- Heerink, M., Kröse, B., Wielinga, B., Evers, V.: Assessing acceptance of assistive social agent technology by older adults: the almere model. *Int. J. Soc. Robot.* **2**, 361–375 (2010). <https://doi.org/10.1007/s12369-010-0068-5>
- Mubin, O., et al.: Using child–robot interaction to investigate the user acceptance of constrained and artificial languages. In: Avizzano, C.A., Ruffaldi, Emanuele, E. (eds.) 19th International Conference on Robot and Human Interactive Communication 2010, RO-MAN, pp. 588–593. IEEE, Viareggio (2010)
- Park, J., et al.: Soft, smart contact lenses with integrations of wireless circuits, glucose sensors, and displays. *Sci. Adv.* **4**(1), eaap9841 (2018)
- Santino R.: Tecnologia no seu olho: saiba o que lentes de contato inteligente podem fazer, Olhar digital (2019)
- Senior, M.: Novartis signs up for Google smart lens. *Nat. Biotechnol.* **32**(9), 856 (2014)
- Tay, B.T.C., Park, T., Jung, Y., Tan, Y.K., Wong, A.H.Y.: When stereotypes meet robots: the effect of gender stereotypes on people's acceptance of a security robot. In: Harris, D. (ed.) EPCE/HCII 2013. LNCS (LNAI), vol. 8019, pp. 261–270. Springer, Heidelberg (2013). https://doi.org/10.1007/978-3-642-39360-0_29
- Venkatesh, V., Morris, M., Davis, G., Davis, F.: User acceptance of information technology: toward a unified view. *MIS Q. Manage. Inf. Syst.* **27**(3), 425–478 (2003)
- Westby T., Bloms, E., Bengston, S., McMullan, P.: US2019/0043291A1. U.S. (2018)
- Yu, M., Zhou, R., Wang, H., Zhao, W.: An evaluation for VR glasses system user experience: the influence factors of interactive operation and motion sickness. *Appl. Ergon.* **74**, 206–213 (2019)
- Zaad, L., Allouch, S.B.: The influence of control on the acceptance of ambient intelligence by elderly people: an explorative study. In: Aarts, E., et al. (eds.) AmI 2008. LNCS, vol. 5355, pp. 58–74. Springer, Heidelberg (2008). https://doi.org/10.1007/978-3-540-89617-3_5

Society, Communication and Design



Descriptive Analysis of Posts Delivered by WeChat Official Accounts Targeting Portugal News During the COVID-19 Outbreak

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Abstract. Background: In the context of the ongoing COVID-19 pandemic, there is a recognized need to investigate the roles of mobile social media in disseminating up-to-date information. Several attempts have been made to analyze the hot topics which have been circulated across social media platforms and public information needs during the wave of COVID-19. In addition, user engagement behaviors have been the focus of much investigation in the search to strengthen communication efforts as well. There has also been substantial research undertaken on the roles of WeChat in terms of fighting COVID-19 in China. However, no known research has focused on official accounts which deliver posts about Portuguese news to Chinese living in Portugal during the COVID-19 crisis.

Methods: By employing content analysis after recruiting 895 posts published by four official accounts, the present study seeks to explore its topic categories, follower information demands and the engagement level.

Conclusions: The findings show that the topical categories of local news, updated data and policies and vaccination dominate the total of COVID-19-related posts during the period of observation. These four official accounts address urgent concerns of Chinese residents in Portugal by providing the latest news and reliable information sources. This paper also represents further strategies toward driving follower engagement by increasing media richness, regular posting, interaction and media convergence.

Keywords: WeChat platform · Chinese community · Portuguese news · COVID-19 pandemic

1 Introduction

Since the first coronavirus (COVID-19) case in Portugal was reported by health officials in March 2020, up to 25 February 2021, Portugal has passed seven hundred thousand confirmed COVID-19 cases, and the cumulative number of deaths caused by COVID-19 has reached over 13,000. Thus, there is an urgent need to minimize serious social and economic disruption caused by this unprecedented pandemic. To control the rapid spread of the COVID-19 virus, the state of emergency was declared by the Portuguese Prime Minister for the first time on 19 March 2020, when the government announced

a series of strict containment measures. In January 2021, Portugal returned to a new state of emergency to reverse the increasing trend in COVID-19 cases and deaths. In this context, propagating containment measures effectively is vitally important to protect the public from coronavirus disease.

According to the Frontiers and Asylum Report released by Portugal's Foreigners and Borders Service in 2019, there were around 27,839 Chinese residents officially registered in Portugal, accounting for 4.7% of the total emigrants. Meantime, there has been substantial growth in the number of Chinese students in Portugal since 2011, with over 6568 registrations at the end of 2019.¹ In prior studies, health communication activities harnessing social media exert positive influence on health-related behaviors and belief of vulnerable groups, such as migrants (Maldonado et al. 2020). During the wave of COVID-19, one of the greatest challenges faced by Chinese living in Portugal is how to understand the updated restrictions announced by the government as well as obtaining enough health information to fight against COVID-19. Traditionally, due to their limited level of Portuguese, Chinese residing in Portugal prefer using Chinese news media to obtain local news which are translated from Portuguese (Ziwei 2019). In tandem, it has been noted that the rapid penetration of social media provides new opportunities for Chinese diasporas in Portugal.

WeChat has become the fifth most-used social networking platform globally in 2020 that has a pivotal role in terms of delivering information, providing social services and establishing social connections (Jing and Wei 2016). It is a social interaction application whose functions include instant messaging, audio or video calls, mobile payments, online shopping and sharing moments. Moreover, any organization, company, or individual can register an official account to send multimedia posts to their followers. WeChat users also can subscribe to any official accounts, read their posts, click "like" or "viewing" and comment at the end of post to show their agreement. By 2020, the total number of WeChat active users had passed 1.17 billion all over the word, continuing a steady rise since 2012. According to the report Digital 2020, WeChat penetration rate also continues to grow in United States, Singapore, India as well as in Europe, for instance, the total of WeChat users in United States reached 19 million in 2020 (Statista 2020). In 2019, there were more than 20 million active official accounts on WeChat. Specifically, not only Chinese immigrants but also Chinese overseas students rely on WeChat to keep in touch with contacts and share life experiences (Park L. 2016; Yan 2018). On the WeChat platform, there are also active official accounts registered that post articles about Portuguese news every day, such as daily news, tourist information, lifestyle, recruitment information about Portugal and so on. During the wave of COVID-19, these official accounts bring real-time news as well as entertainment that encourage Chinese residents in Portugal to fight against COVID-19.

Recent developments especially have led to renewed interest in the thematic content analysis of online messages during the COVID-19 outbreak. In this regard, several studies have attempted to trace and code online messages in the ongoing COVID-19 pandemic, with the aim of understanding public attention, responses, and engagement (Carvajal-Miranda et al. 2020; Mheidly and Fares 2020). More importantly, exploring the

¹ Retrieved from: <https://www.englishforums.com/news/portugal-records-chinese-student-boom/>

association between characteristics of the information conveyed and user engagement behaviors can contribute to effective communication in the context of a global health crisis. According to previous studies, public engagement behaviors on social media platforms refer to following accounts, reading, sharing, commenting and liking posts (Drylie-Carey et al. 2020; Lee et al. 2016).

From this perspective, several studies have identified that the number of readings can present users' interest and needs, while the number of likes, shares, comments and followings can reflect user preferences and appreciation (Ma et al. 2020; Ratkiewicz et al. 2010). In other words, the degree to which posts gratify users' differential needs is directly associated with their usage and engagement behavior, such as viewing, retweeting, liking, commenting or media selection (Park H. et al. 2016). Therefore, in this respect, it has been reported that hashtag use, timely news and reliable information sources can significantly promote user engagement behaviors during the fight against COVID-19 (Bowles et al. 2020). Meanwhile, there is an unambiguous relationship of content type, titles and length to the number of likes, shares and comments (Chen Q. et al. 2020; Li L. et al. 2020). Moreover, previous studies have found an association between characteristics of posts, interactive features, public awareness and precautionary actions (Ngai et al. 2020). All of these studies reviewed here outline that analysis of social media posts can be performed to explore public opinions and improve health communication efforts during the global health emergency.

There are a large number of published studies that describe the critical roles played by WeChat in terms of delivering COVID-19-related information, promoting positive attitudes and providing social services as well as strengthening trust relationships between government and citizens during the COVID-19 pandemic (Bowles et al. 2020; Ma et al. 2020). In light of these benefits, several studies have been demonstrated that quantity, quality, format and content of posts exert influence both on user engagement behaviors and ultimate preventive behaviors (Liu P.L. 2020).

Taken together, prior studies have highlighted the importance of tracing online messages as well as taking user social media engagement behaviors into account. However, to date, no previous study has given sufficient consideration to the online messages or articles about Portugal delivered by official accounts via WeChat during the COVID-19 crisis. Therefore, this study is one of the first investigations to focus specifically on WeChat official accounts relevant to Portuguese news. There are three primary aims for this study: a) Trace and determine the content of COVID-19-related information disseminated by official accounts aimed at Portuguese news on WeChat, analyzing what is posted more frequently; b) By comparing the number of reads, follows, likes and comments, investigate which topics are most needed and gain more subscribers' attention. Meanwhile, analyze the differential degree to which official accounts satisfy users' information demands and promote their engagement behaviors; c) Offer communication strategies adapted to WeChat official accounts aimed at Portuguese news in order to strengthen communication in the context of COVID-19.

2 Methods

Sample Selection

Among the official accounts targeting Portuguese news, we selected those whose NRI ranked in the top four in 2020. The New Rank Index (NRI) is one of the overall reflective ranking systems to develop comprehensive assessments and evaluations of official accounts on WeChat (Liu Q. et al. 2017). In other words, NRI systematically reflects how active an official account is, as well as its growth rate, reading numbers, quality of services, quantity of posts and subscribers' engagement (Han F. et al. 2016). As a higher NRI score shows a higher level of influence, several researchers have utilized NRI to determine which official accounts are appropriate to study. Table 1 presents an overview of the four official accounts included. There are two main types of creators: individual and print media. The overall aim of these four official accounts is to provide practical information to Chinese community in Portugal by translating Portuguese media news and stories, as well as publishing the notices of the Chinese embassy in Portugal. In recent years, they have become central platforms for Chinese living in Portugal to exchange their experience and share stories. Given all users can subscribe any WeChat official accounts of its own record, these active followers can be recognized as who have interest or information demand for content published by these four official accounts.

Table 1. Basic information of four official accounts selected in this study

Creator	Official accounts	Active followers	New Index	Creation time
Individual	PUXIN BAO	53,263	631.8	2016-06-01
	RUADAPALMA	37,572	696.3	2019-07-09
Print media	PUHUA NEWS	88,164	701.9	2015-03-25
	PORTUGAL NEWS	4,449	311.5	2018-12-24

Data Collection and Coding

We collected all posts conveyed by the four WeChat official accounts between 14 December 2020 to 31 January 2021. A total of 895 posts were recruited. After removing posts which were irrelevant to COVID-19, content analysis was adopted to analyze 548 posts. In the meantime, in keeping with the classification provided by previous studies, coding was conducted to obtain further in-depth information on three main dimensions: topic, message format and user engagement behaviors (Zhang et al. 2019). The topics were generally grouped into seven categories as follows: a) updated data and regulations: these posts focus on statistics in terms of cases of infection, deaths, growth rate and proportion, as well as summarizing regulations issued by Portuguese authorities; b) national Portuguese news: which include all posts regarding real-time local news about COVID-19; c) news about the Portuguese economy: which concern the impact of COVID-19 on the Portuguese economy, benefits, allowances and subsidies; d) news

about COVID-19 vaccinations: this category covers all posts relevant to COVID-19 vaccination news, such as transportation, research and side-effects of vaccines; e) Chinese news and Chinese embassy notices: which refers to announcement released by Chinese embassy in Portugal, including airline boarding requirements, temporary closure of office, emergency services and other reminders about COVID-19; f) COVID-19 preventive measures: which include posts regarding precautionary recommendations and guidelines to reduce the chances of being infected with COVID-19; g) others: all those posts that can't be classified in the above categories. Then, we categorized the format of posts according to whether photos or videos were attached. Regarding followers' engagement behaviors, as the WeChat platform does not show the numbers of shares, we only extracted the number of views, likes and comments of each post relevant to COVID-19.

3 Result

Descriptive Analysis

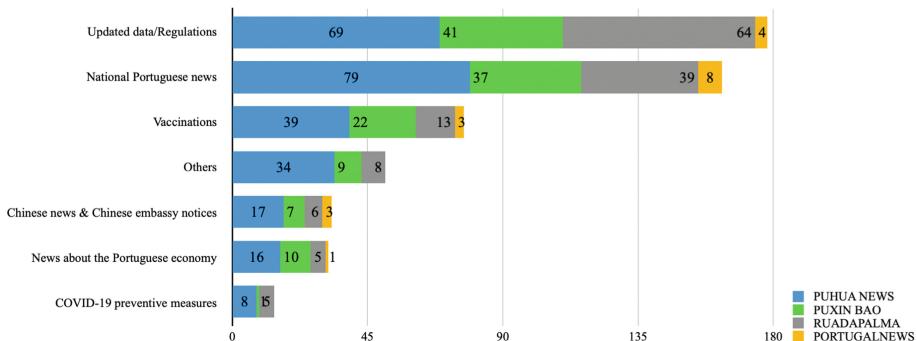
As can be seen in Table 2, within the observation period, COVID-19-related posts accounted for 61.2%, accumulating a total of 548 posts. RUADAPALMA and PUHUA NEWS posted significantly more than the other two. Within the analyzed sample, it was noted that these official accounts published posts regularly every day, except PORTUGAL NEWS.

From the data in Graph 1, it can be seen that the top three hot topics are updated data and regulations ($n = 178$), national Portuguese news ($n = 163$) and news relevant to COVID-19 vaccinations ($n = 77$), accounting for 32.4%, 29.7% and 14% respectively. It is apparent from the data that all four official accounts focus on these three topic categories. More significantly, PUHUA NEWS posted the most articles about local Portuguese news, accounting for 44.3%. PUXIN BAO paid more attention to updated data and regulations. It is notable that of the 548 articles, the number of posts regarding COVID-19 precautionary measures is the lowest. Most significantly, of the 548 posts, there were no rumors or false news. All posts give the source of the news and data cited.

Regarding the format of articles, the proportion of posts with video or photos was 85.4% ($n = 468$). Accordingly, RUADAPALMA has the highest percentages of multimedia posts, accounting for 95%, followed by PUHUA NEWS (84.3%) and PUXIN BAO (77.9%).

Table 2. The total number of posts delivered by four official accounts

	Total posts	COVID-19-related posts (%)
PUXIN BAO	169	127 (75.1%)
RUADAPALMA	306	140 (45.8%)
PUHUA NEWS	392	262 (66.8%)
PORTUGAL NEWS	28	19 (32.1%)
Total	895	548 (61.2%)

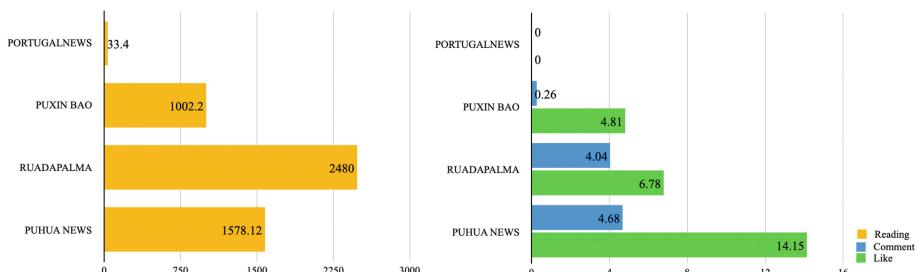


Graph. 1. The number of different categories of topics (n = 548)

Followers' Engagement Behaviors

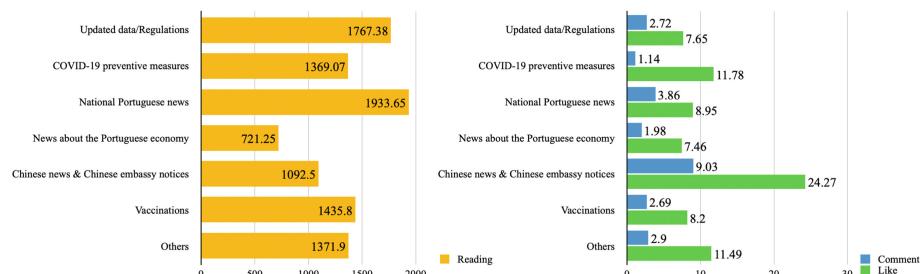
Out of a total of 895 posts, the number of readings and likes generated by COVID-19-related posts accounts for 69% and 80.1% respectively. From the data in Graph 2, of the four official accounts, RUADAPALMA received the most readings; moreover, its average comments and likes are higher as well. PUHUA NEWS has the highest number of readings followed by RUADAPALMA; it also has generated more likes than the other three. What is striking about the data in this graph is that in the number of readings, comments and likes, PORTUGAL NEWS falls far behind.

As shown in Graph 3, the average number of readings, likes and comments of different themes was compared in order to explore users' demands and agreement. This graph is quite revealing in several ways. First, it is apparent that posts about local Portuguese news have the most readings, followed by updated data or regulations and news regarding COVID-19 vaccinations. However, regarding the average number of likes, national Portuguese news and updated data or regulations ranked only fourth and sixth out of seven themes. The average number of likes generated by COVID-19 vaccination news is quite far down in this ranking. Similarly, the results show that the average number of comments received by these three topics is lower too. In contrast, what stands out in this graph is that posts about Chinese news and Chinese embassy notices generated the most likes and comments despite the lower total number of readings. In addition, the average number of likes generated by posts regarding COVID-19 preventive measures reached



Graph. 2. The average number of readings, comments and likes of the four official accounts

11.78, ranking second only to Chinese news. The appendix below illustrates the total number of readings, comments and likes of the seven topics.



Graph. 3. The average number of readings, comments and likes of the seven topics

4 Discussion

This study set out with the aim of reporting the main topics disseminated by four specific official accounts as well as followers' needs, preferences and engagement on WeChat. In general, the current study found that the COVID-19-related information collectively makes up most of the total posts during the observation period. These results seem to be consistent with recent studies indicating that there was an increased presence of COVID-19-related posts across various social media platforms due to the global spread of this unpredictable virus (Cinelli et al. 2020). In response to an unknown health threat, the public prefer to depend on mobile social media to receive and share information; meanwhile, timeliness is one of the determining factors that can contribute to easing public stress and anxiety during the grave global health emergency (Garfin et al. 2020; Han X. et al. 2020). It is appropriately notable that all posts published by these four official accounts are about the latest Portuguese news. Thus, they address followers' concerns about whether they missed important news due to their limited language level.

In accordance with previous studies, these results provide further support that posts regarding updated data and policies, COVID-19 vaccinations and local news were frequently published during the period of analysis (Leelawat et al. 2020; Szmuda et al. 2020). More recently, literature has emerged that offers contradictory findings about the presence of posts regarding economic and political information on social media platforms. Several studies have reported that economic topic categories dominate online information and gain increased public attention (Cinelli et al. 2020). This differs from the results presented here. However, there were also earlier studies which showed the notable absence of economic and political information across social media platforms (Garfin et al. 2020). As the reason for this inconsistency is not clear, a further study with more focus on this point is recommended. Moreover, posts related to COVID-19 preventive measures were not frequently disseminated by the four official accounts. This finding is somewhat surprising given the fact that the topical categories of precautionary recommendations are recognized as important elements in controlling the COVID-19

virus and account for a large portion of online messages during the fight against the COVID-19 pandemic (Basch et al. 2020). A possible explanation for these results might be related to the positioning of the four official accounts which provide information to Chinese community in Portugal. Further, in the context of the COVID-19 threat, there are a lot of official accounts that publish an unprecedented number of posts regarding protective measures through the WeChat platform and information aimed at the Portuguese situation is exactly what followers of the four official accounts need most.

Based on the review of existing studies, explaining the number of readings can help in exploring the interests and demands of followers (Ma et al. 2020). Consequently, the results of this study indicate that real-time local news, updated data and COVID-19 vaccinations are most needed among the followers. This is also in keeping with recent studies (Liao et al. 2020; Leelawat et al. 2020). In the meantime, the findings have shown that the number of posts regarding the seven topical categories delivered by the four official accounts is almost in line with followers' information demands. Therefore, the present study supports previous research which showed the vitally important roles of the WeChat platform on serving public information demands and even filling gaps in knowledge during the COVID-19 health crisis (Chen X. et al. 2020). As several studies have illustrated that knowledge enhancement is positively related to lower anxiety (Prasetyo et al. 2020). From this perspective, it can therefore reflect that these official accounts play critical roles in encouraging their followers to fight against serious health threats as well as handling their uncertainty.

On the question of user engagement behaviors on different official accounts, the comparison revealed that PORTUGAL NEWS and PUXIN BAO generated the least likes and comments. Several factors could explain this observation. Firstly, the PORTUGAL NEWS and PUXIN BAO posts were relatively less regular during the period of analysis. In light of prior studies, content publishing frequency has been considered as one of the key indicators to measure success and performance of influencers on social media platforms (González Romo et al. 2020). Another possible alternative explanation of our findings is that they are due to the format of posts. Previous studies have illustrated that an attractive format of posts on social media platforms can not only contribute to facilitating the propagation of information, but can also translate into higher interactivity (Card 2018).

Regarding the degree of engagement on the seven themes, previous studies have found an association between content of posts on WeChat with user engagement behaviors (Zhang et al. 2019). In the current paper, one unanticipated finding was that the most needed content generated less engagement, while the posts regarding COVID-19 preventive measures and Chinese news generated more likes and comments. The indications are in keeping with earlier studies, which suggestive these are more effective strategies for promoting user engagement rather than only releasing information across social media platforms (Ngai et al. 2020). Moreover, it seems possible that these results are due to the impact of positive emotional appeal and patriotism. In prior studies, it has been conclusively demonstrated that positive tone and empathic information have a significant influence on information sharing and positive attitudes towards a crisis (Fins et al. 2020; Rao et al. 2020). Among the posts concerning preventive measures and

Chinese news, prescribers use emotional language to tell Chinese stories and encourage Chinese people overseas to fight against COVID-19. Within the context of a global health crisis, this kind of narrative is more likely to resonate in the public mind.

To summarize, based on the above-mentioned results, these four official accounts have been relatively successful in improving followers' clarity of vision not only into the coronavirus pandemic but also into the local Portuguese situation. More significantly, these four official accounts limit the delay of information in emergencies and enable Portuguese news to reach the Chinese people overseas on time under crisis conditions. However, the findings of this article also indicate the necessity of exploring more flexible strategies to enhance effective communication during a crisis.

According to earlier studies, factors found to influence the depth of engagement on social media include media richness, content publishing frequency, content type and format, among others (Ashley and Tuten 2015; Veale et al. 2015). Therefore, in light of the unprecedented level of challenges caused by the case of COVID-19, the following lessons can be gathered, and strategies offered:

1) Official accounts have to attract their followers by satisfying their need for consistent information during public health emergencies. Furthermore, communicators have to ensure a clear voice to fight fake news circulating on WeChat. In brief, the four official accounts should highlight existing benefits that continue to address the urgent concerns of Chinese residents in Portugal in the context of the ongoing COVID-19 pandemic.

2) Multimedia content might be more convincing for user engagement behaviors and exert more lasting effects on ultimate health-related outcomes (Liu P.L. 2020). Therefore, it is important to optimize articles in terms of format and layout. On the one hand, apart from images, communicators also can take full advantages of WeChat platform to create videos and live streaming. Furthermore, it is crucial to adopt information publishing strategies for different topic categories. In this regard, for example, improving the design of data visualization when reporting updated data can facilitate understanding, while storytelling and cartoons can make content easier to remember as well as driving user engagement.

3) Specifically, the four official accounts failed to respond comments from followers. Thus, one of the strategies referred to as certain to enhance interaction with followers and personalize their usage experience is not only replying to each message, but also media convergence. To date, PUHUA NEWS² and PORTUGAL NEWS³ have portal sites, and similarly, PUXIN BAO created a mobile application and RUADAPALMA created a YouTube channel. There is abundant room for here for emphasis on media convergence forwardly to bring users more choices.

5 Conclusion

Overall, this is the first study that was designed to provide the content analysis of official accounts which publish posts about Portugal news on WeChat during the COVID-19 pandemic. Returning to the aims posted at the beginning of this study, it is now possible to

² Retrieved from: <http://www.puhuabao.pt>.

³ Retrieved from: <http://pt.haiwainet.cn>.

state that these four official accounts provide consistent COVID-19-related information for Chinese residents in Portugal as well as satisfying their information demands. In the meantime, the current analysis highlights the importance of increasing levels of user engagement. The communicators of the four official accounts can apply the results of this paper to ensure all posts are aligned with the requirements and expectations of their followers. These findings will serve as a base for future studies and highlight the potential usefulness of the WeChat platform among Chinese emigrants and overseas students.

Moreover, this particular research finding also points to the need to consider the growing mobile social media use by emigrants when policymakers and communicators promote effective communication strategies in the context of a global health emergency. Several limitations to this study need to be acknowledged. First, this study was limited by the lack of official statistics about the overall number of WeChat users in Portugal as well as data regarding the number of shares of posts recruited. The study was not specifically designed to evaluate factors related to user engagement behaviors by conducting regression analysis. The other important limitation lies in the fact that it is difficult to determine how many of followers of four official accounts belong to the Chinese community in Portugal. Further modeling work will have to be conducted in order to develop a more in-depth understanding of the relationships between characteristics of posts and user engagement behavior.

Abbreviations Not applicable.

Consent for Publication Not applicable.

Ethics Approval and Consent to Participate Not applicable.

Funding The proofreading of this article was supported by FCT in the scope of the Strategic Funding of the R&D Unit UIDB/03126/2020.

Competing Interests The author declare that they have no competing interests.

Author's Contributions C. Cheng and R. Espanha—Contributed equally to this research. The authors read and approved the final manuscript to be published.

Acknowledgements. None.

Appendix

The total number of reading, comments and likes

PUHUA News (n = 262)

	Reading	Comment	Like
Updated data/Regulations	128,149 (31%)	294 (24%)	774 (21%)
COVID-19 preventive measures	6,042 (1%)	14 (1%)	87 (2%)
National Portuguese news	167,738 (41%)	549 (45%)	1,088 (29%)
News about the Portuguese economy	1,521 (1%)	42 (3%)	187 (5%)
Chinese news & Chinese embassy notices	15,642 (4%)	65 (5%)	695 (19%)
News about COVID-19 vaccinations	55,210 (13%)	160 (13%)	454 (12%)
Others	39,167 (9%)	103 (8%)	423 (11%)
Total	413,469	1227	3708

PORTUGAL News (n = 19)

	Reading	Comment	Like
Updated data/regulations	119 (19%)	0	0
COVID-19 preventive measures	0	0	0
National Portuguese news	242 (38%)	1 (100%)	0
News about the Portuguese economy	22 (3%)	0	0
Chinese news & Chinese embassy notices	52 (8%)	0	0
News about COVID-19 vaccinations	200 (31%)	0	0
Others	0	0	0
Total	635	1	0

PUXIN BAO (n = 127)

	Reading	Comment	Like
Updated data/regulations	29,703 (23%)	7 (23%)	167 (27%)
COVID-19 preventive measures	1,143 (1%)	1 (1%)	4 (1%)
National Portuguese news	42,931 (34%)	10 (34%)	142 (23%)
News about the Portuguese economy	11,124 (9%)	2 (9%)	31 (5%)
Chinese news & Chinese embassy notices	3,253 (3%)	1 (3%)	24 (4%)
News about COVID-19 vaccinations	27,075 (21%)	5 (21%)	102 (17%)
Others	12,056 (9%)	8 (9%)	141 (23%)
Total	127,285	34	611

RUADAPALMA (n = 140)

	Reading	Comment	Like
Updated data/Regulations	156,624 (45%)	184 (33%)	422 (44%)
COVID-19 preventive measures	11,982 (3%)	1 (0%)	74 (8%)
National Portuguese news	104,274 (30%)	70 (12%)	230 (24%)
News about the Portuguese economy	10,413 (3%)	0 (0%)	21 (2%)
Chinese news & Chinese embassy notices	17,104 (5%)	232 (41%)	82 (9%)
News about COVID-19 vaccinations	28,074 (8%)	42 (7%)	76 (8%)
Others	18,742 (5%)	37 (7%)	45 (5%)
Total	347,213	566	950

References

- Ashley, C., Tuten, T.: Creative strategies in social media marketing: an exploratory study of branded social content and consumer engagement. *Psychol. Mark.* **32**(1), 15–27 (2015). <https://doi.org/10.1002/mar.20761>
- Basch, C.H., Hillyer, G.C., Meleo-Erwin, Z.C., et al.: Correction: preventive behaviors conveyed on YouTube to mitigate transmission of COVID-19: cross-sectional Study. *JMIR Public Health Surveill.* **6**(2), e19601 (2020). <https://doi.org/10.2196/preprints.19601>
- Bowles, J., Larreguy, H., Liu, S.: Countering misinformation via WhatsApp: preliminary evidence from the COVID-19 pandemic in Zimbabwe. *PLoS ONE* **15**(10), e0240005 (2020). <https://doi.org/10.1371/journal.pone.0240005>
- Card, K.G., Lachowsky, N., Hawkins, B.W., et al.: Predictors of Facebook user engagement with health-related content for gay, bisexual, and other men who have sex with men: content analysis. *JMIR Public Health Surveill.* **4**(2), e38 (2018). <https://doi.org/10.2196/publichealth.8145>
- Carvajal-Miranda, C., Mañas-Viniegra, L., Liang, L.: Online discourse in the context of COVID-19, the first health crisis in China after the advent of mobile social media: a content analysis of China's Weibo and Baidu. *Soc. Sci. Sci.* **9**(10), 167 (2020). <https://doi.org/10.3390/socsci9100167>
- Chen, Q., Min, C., Zhang, W., et al.: Unpacking the black box: how to promote citizen engagement through government social media during the COVID-19 crisis. *Comput. Hum. Behav.* **110**, 106380 (2020). <https://doi.org/10.1016/j.chb.2020.106380>
- Cinelli, M., Quattrociocchi, W., Galeazzi, A., et al.: The covid-19 social media infodemic. *Sci. Rep.* **10**(1), 1 (2020). <https://doi.org/10.1038/s41598-020-73510-5>
- Chen, X., Zhou, X., Li, H., et al.: The value of WeChat as a source of information on the COVID-19 in China. *Bull. World Health Organ.* (2020) <https://doi.org/10.2471/blt.20.256255>
- Drylie-Carey, L., Sánchez-Castillo, S., Galán-Cubillo, E.: European leaders unmasked: Covid-19 communication strategy through Twitter. *El Profesional de la Información* **29**(5) (2020). <https://doi.org/10.3145/epi.2020.sep.04>
- Finset, A., Bosworth, H., Butow, P., et al.: Effective health communication—a key factor in fighting the COVID-19 pandemic. *Patient Educ. Couns.* **103**(5), 873 (2020). <https://doi.org/10.1016/j.pec.2020.03.027>
- Garfin, D.R., Silver, R.C., Holman, E.A.: The novel coronavirus (COVID-2019) outbreak: amplification of public health consequences by media exposure. *Health Psychol.* **39**, 355–357 (2020). <https://doi.org/10.1037/he0000875>

- Romo, Z.F.G., Aguirre, S.I., Medina, I.G.: Pharmaceutical influencers on Instagram and their communication during the Covid-19 pandemic crisis. *J. Sci. Commun.* **19**(05), A04 (2020). <https://doi.org/10.22323/2.19050204>
- Han, F., Ge, Z., Zhou, R.: Reconfiguration and empirical study on the evaluation system of WeChat communication effect of Sci-Tech periodicals. *Adv. J. Commun.* **4**(01), 8 (2016). <https://doi.org/10.4236/ajc.2016.41002>
- Han, X., Wang, J., Zhang, M., et al.: Using social media to mine and analyze public opinion related to COVID-19 in China. *Int. J. Environ. Res. Public Health* **17**(8), 2788 (2020). <https://doi.org/10.3390/ijerph17082788>
- Jing, F., Wei, L.: A study on influential factors of WeChat public accounts information transmission hotness. *J. Intell.* **35**(2), 157–162 (2016). https://en.cnki.com.cn/Article_en/CJFDTotal-QBZ_Z201602028.htm
- Liu, P.L.: COVID-19 information seeking on digital media and preventive behaviors: the mediation role of worry. *Cyberpsychol. Behav. Soc. Netw.* **23**(10), 677–682 (2020). <https://doi.org/10.1089/cyber.2020.0250>
- Lee, S.Y., Hansen, S.S., Lee, J.K.: What makes us click “like” on Facebook? Examining psychological, technological, and motivational factors on virtual endorsement. *Comput. Commun.* **73**, 332–341 (2016). <https://doi.org/10.1016/j.comcom.2015.08.002>
- Liu, Q., Ni, J., Huang, J., et al.: Big data for social media evaluation: a case of WeChat platform rankings in China. In: 2017 IEEE 2nd International Conference on Data Science in Cyberspace (DSC), pp. 528–533. IEEE (2017). <https://doi.org/10.1109/dsc.2017.28>
- Leelawat, N., Tang, J., Saengtabtim, K., Laosunthara, A.: Trends of tweets on the Coronavirus disease-2019 (COVID-19) pandemic. *J. Disaster Res.* **15**(4), 530–533 (2020). <https://doi.org/10.20965/jdr.2020.p0530>
- Liao, Q., Yuan, J., Dong, M., Yang, L., Fielding, R., Lam, W.W.T.: Public engagement and government responsiveness in the communications about COVID-19 during the early epidemic stage in China: infodemiology study on social media data. *J. Med. Internet Res.* **22**(5), e18796 (2020). <https://doi.org/10.2196/18796>
- Liu, S., Yang, L., Zhang, C., et al.: Online mental health services in China during the COVID-19 outbreak. *Lancet Psychiatry* **7**(4), e17–e18 (2020). [https://doi.org/10.1016/s2215-0366\(20\)30077-8](https://doi.org/10.1016/s2215-0366(20)30077-8)
- Li, L., Zhang, Q., Wang, X., et al.: Characterizing the propagation of situational information in social media during covid-19 epidemic: a case study on Weibo. *IEEE Trans. Comput. Soc. Syst.* **7**(2), 556–562 (2020). <https://doi.org/10.1109/tcss.2020.2980007>
- Liu, Q., Zheng, Z., Zheng, J., et al.: Health communication through news media during the early stage of the COVID-19 outbreak in China: digital topic modeling approach. *J. Med. Internet Res.* **22**(4), e19118 (2020). <https://doi.org/10.2196/19118>
- Ma, R., Deng, Z., Wu, M.: Effects of health information dissemination on user follows and likes during COVID-19 outbreak in China: data and content analysis. *Int. J. Environ. Res. Public Health* **17**(14), 5081 (2020). <https://doi.org/10.3390/ijerph17145081>
- Maldonado, B.M.N., et al.: Engaging the vulnerable: a rapid review of public health communication aimed at migrants during the COVID-19 pandemic in Europe. *J. Migr. Health* **2020**, 100004 (2020). <https://doi.org/10.1016/j.jmh.2020.100004>
- Mheidly, N., Fares, J.: Leveraging media and health communication strategies to overcome the COVID-19 infodemic. *J. Public Health Policy* **41**, 410–420 (2020). <https://doi.org/10.1057/s41271-020-00247-w>
- Ngai, C.S.B., Singh, R.G., Lu, W., et al.: Grappling with the COVID-19 health crisis: content analysis of communication strategies and their effects on public engagement on social media. *J. Med. Internet Res.* **22**(8), e21360 (2020). <https://doi.org/10.2196/preprints.21360>
- Park, L.: WeChat red bags: how international students from China use social media while attending a public university in California (Doctoral dissertation, UCLA) (2016)

- Prasetyo, Y.T., Castillo, A.M., Salonga, L.J., et al.: Factors affecting perceived effectiveness of COVID-19 prevention measures among Filipinos during enhanced community quarantine in Luzon, Philippines: integrating protection motivation theory and extended theory of planned behavior. *Int. J. Infect. Dis.* **99**, 312–323 (2020). <https://doi.org/10.1016/j.ijid.2020.07.074>
- Park, H., Reber, B.H., Chon, M.G.: Tweeting as health communication: health organizations' use of Twitter for health promotion and public engagement. *J. Health Commun.* **21**(2), 188–198 (2016). <https://doi.org/10.1080/10810730.2015.1058435>
- Ratkiewicz, J., Flammini, A., Menczer, F.: Traffic in social media I: paths through information networks. In: 2010 IEEE 2nd International Conference on Social Computing, pp. 452–458. IEEE (2010). <https://doi.org/10.1109/socialcom.2010.72>
- Rao, H.R., Vemprala, N., Akello, P., et al.: Retweets of officials' alarming vs reassuring messages during the COVID-19 pandemic: implications for crisis management. *Int. J. Inf. Manage.* **55**, 102187 (2020). <https://doi.org/10.1016/j.ijinfomgt.2020.102187>
- Statista: Analysis, new mobile app top 1000 in 2019 (2020). <https://www.statista.com/statistics/387658/wechat-china-user-age/>
- Szmuda, T., Syed, M.T., Singh, A., et al.: YouTube as a source of patient information for Coronavirus Disease (COVID-19): a content-quality and audience engagement analysis. *Rev. Med. Virol.* **30**(5), e2132 (2020). <https://doi.org/10.1002/rmv.2132>
- Veale, H.J., Sacks-Davis, R., Weaver, E.R., et al.: The use of social networking platforms for sexual health promotion: identifying key strategies for successful user engagement. *BMC Public Health* **15**(1), 1–11 (2015). <https://doi.org/10.1186/s12889-015-1396-z>
- Yan, Y.: Facebook and WeChat: Chinese international students' social media usage and how it influences their intercultural adaptation (2018). https://epublications.marquette.edu/theses_open/471/
- Zhang, Y., et al.: Factors influencing user engagement of health information disseminated by Chinese provincial centers for disease control and prevention on WeChat: observational study. *JMIR mHealth uHealth* **7**(6), e12245 (2019). <https://doi.org/10.2196/12245>
- Ziwei, S.: Online news consumption by Chinese immigrants in Portugal (postgraduate dissertation) (2019). <https://repositorio-aberto.up.pt/bitstream/10216/124221/2/367187.pdf>



The Concept of Edge as Design's Power to Create Building's Surface

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Abstract. This text supports the notion of edge as design's power to create building's epidermis, based on the archaeological reasoning method [1]. The first section revisits the meaning of 'edge' to understand how to use it in design method, namely the semantical dimension of the word between interior and exterior, qualifying the need to rationalize the orders of architecture as Benjamino Vignola stated. To understand the concept applied to design involves revisiting Vitruvius's treaty. To recognize the concept of 'edge' in its real meaning involves understanding the surface as a complex organism. It implies addressing the experience of knowledge through cultural symbols and the media. The second section of the text presents a phenomenological understanding of the 'skin' and the 'epidermis' concepts. These two hypotheses propose considering new orders of architecture, in particular focusing on the new levels of architecture due to their semantic value. Elements with symbolic value, evoking historical experiences, intertwine and the creation of systems, referenced according to the context needs. To support this view, we aim to demonstrate that design enables the external surface of a building to be an image hypothesis, something ever renewable and embryonic. An efficient project, to the extent that it is productive and sustainable because it provides meaning for human life. Three case studies involving design graduate students illustrate this notion. The text ends with a reference to interpretation as a method for design that includes different types of analysis, and reflections and connotations.

Keywords: Productive reasoning · Design-methods · Scenarios construction

1 Introduction

Since the 60's, the nature of the buildings' epidermis project became an arbitrary aggregation, due to major contradictions and oscillations characterizing the western reality. The design of buildings' epidermis was manifest as answer to a new way of thinking, as image for the mass society. Designers chose discontinuity before continuity among things. This regarded benefiting the continuous discussion, change and renovation characterizing the 60's. In a period of continuous renovation as the liquid modernity [2], the constructive order in the project of the buildings' surface re-evaluated constitutive elements and values. The projectual choice regarded the individual and the reality as active actors co-intervening in their respective transformation processes, constituting a

step forward in the open process relating all (people, information, time, culture) that interacts incessantly in each reality.

In the 70's, according to thinkers such as Jean Baudrillard, Umberto Eco and Mario Perniola, the world was transforming into a repository of dangerous images. Jean Baudrillard, for instance, addressed the new problems generated by the means of communication: "what else do the media dream of besides creating the event simply by their presence? Everyone decries it, but everyone is secretly fascinated by this eventuality. Such is the logic of simulacra; it is no longer that divine predestination (...)" [3]. As if the application of the means of communication to the surface of buildings were a mere denotative exercise. Other authors such as Maurizio Vitta, Mary Douglas, Baron Isherwood, Andrea Branzi and António Petrillo, on the contrary, considered the image excess, characterizing reality since the end of the 60's, to be able to become an advantage for the experience of knowledge. As advocated by Margolin: "through the power of communications media, and particularly advertising, images become a persuasive means of motivating people to act" [4]. This meant namely that the exchange of goods was mostly regarded as a symbolic and affective process.

This text addresses the second hypothesis. As defended by Mary Douglas and Baron Isherwood [5] it regards interpreting the consume relations (mirror of reality that is also individual reality) as connections between objects and users. The objects transform into interpreters, providing communication with the user and enhancing the relationship among individuals. As if the objects, enlarging their secondary role [6], were also suited for the act of thinking, transformed into mediators for an experiential, interpretative and continuous interaction with the users.

As an application to design this means the symbolic process allows interpreting objects as carriers of memories through complex and mutating individuals living in a contradictory and metamorphic reality. According to Maurizio Vitta, it means that "... the designer's centrality is confirmed because the *consumption* of the use-object requires that it be continually transformed while it remains faithful in substance to its original function; and the task of expressing the cultural, aesthetic, or semiological values that interact behind that transformation is the designer's specific duty" [7]. The image excess is interpreted as a moment for reflection, to think discontinuity, in the sense of de-construing to construe again, being on the edge of something.

This text departs from the philosophical perspective that regards the project of the buildings' epidermis in a contemporary reality which is contradictory, discontinuous and mutating. This implies for instance that old concepts need revisiting, interpretation and requalification. The term edge understood as opportunity to rethink the role of buildings' epidermis, namely through the connections it may establish with all elements (people, material culture, information). The appropriation of the concept as a threshold between two things, that is no longer what it used to be and is not yet what it may become, interpreted as phenomenon of the today's reality. A surface that talks to the people passing by in the exterior and also in the interior spaces. On one hand, communicating onto the outside what happens inside, on the other hand, transmitting inside what happens outside. As if the building's epidermis were an open catalogue displayed to the individual, offering meaning to his existence.

The first section will regard the concept of edge as phenomenon in the 21st century reality, as a premise to think the project of buildings' epidermis. We are particularly interested in the methodological approach instead of the historical reference to Vitruvius or Vignola. The second section presents the application of this proposal in three case studies regarding the building's epidermis. Finally, the authors conclude that the (re)design of buildings' epidermis is an opportunity to engage the individual in his own reality.

2 The Edge as Interaction Between the Skin and the Epidermis of Buildings

2.1 The Edge as a Expression of the Twenty-First Century

For the purposes of this paper we will focus on the interpretation of edge as moment between the building's interior semantical dimension and the perception of the external building's surface, pondering the individual's experience in his involvement with the building's surface. According to Bruno Latour and Albena Yaneva “(...) a building is not a static object but a moving project, and that even once it has been built, it ages, it is transformed by its users, modified by all of what happens inside and outside, and that it will pass or be renovated, adulterated and transformed beyond recognition.” [8]. Therefore, the edge is a moment of interaction between a subject/user and an object/building. For Gilles Deleuze [9] the concept of edge implies a rapport between two different things. To interpret the interior-exterior rapport as opposing or mutually denying parties may cause misreading, because it forsakes the fact that all (hidden) hypotheses are able to become referent for an image.

Therefore, to interpret the concept regarding the difference between the concepts of interior and exterior of a building, excluding the search for oppositions between them, may allow the designer to ponder the building's surface and respective unfolding to the user. We intend to depart from the semantical dimension of edge between interior and exterior when the interpretative act attempts to afford meaning to the user, instead of merely creating signs, since the surface's external or internal quality depends on the relationship with the observer.

Regarding the wall, particularly as façade in classical architecture, it is impossible to exclude the premise that considers the functional structure of the components, proposing a modular system to perform the façade's management and rhythm, while presenting unitary reading, as an organism. In this sense, the crucial role of 'orders' should be taken into account, as defined in Vignola's treatise: “(...) perfect and regular disposition of the parts, all concurring to a beautiful whole) [10]¹.

The logic of the game between the parts and the whole transform the façade's project into an interpretation moment and a reference to Aristotle's reasoning relating the composition of the parts in the whole with the landscape: “(...) a beautiful thing – whether it is an animal or an entire operation – being composed of several parts, needs not only

¹ “Disposizione regolare e perfetta di parti, concorrenti tutte alla composizione di un bello insieme: l'ordine dunque è l'opposto alla confusione.” (Vi-gnola, 1862: 11).

to have them ordered, but also to hold a dimension that is not by chance.” [11]². In this sentence, Aristotle referred to the determination of the parts, the structuring of events and the composition of the Greek Tragedy.

Regarding the treaties, particularly Vitruvius’, the components constituting the façade/organism correspond to a system of signs related to nature. Concerning the three canons from the Vitruvius’s treaty: venustas, firmitas, utilitas, the orders responded to the architect’s ability to adapt the modules to the building, a consequence of the timely interpretation of the conditions characterizing the project’s setting. According to Vitruvius, all architects must answer these three factors assuming the indispensable conditions for a good architecture “Vitruvius points out that the three basic requirements are: Utilitas (usefulness to the function); Firmitas (strength of materials and structure); Venustas (beauty, aesthetics). These three words, used to define how a building must or should be, ultimately mean how architecture should be. Subsequently, the three Vitruvius’ components cannot be put in the same level but different levels; the latter takes precedence over the former and the middle one is the master key for the other two to combine.” [12]³.

The variety of differences characterizing the application of a same compositional module endangered the potential of the latter, transforming the wall into communication surface able to interact with surrounding things, which could either be the relationship with other buildings or with man. The wall in this case would reveal being a complex organism, presenting itself not only as the essence of bone and built, but also conceptually as a moment of communication and perception of a place characterized in its limits. It means that the wall has an important role in the definition of the surrounding space of a building. This episode allows analyzing the development of the wall as an autonomous element in the internal space articulation. The projectual development transforms the wall into a project without a project [13] an edge moment between the city (always changeable) and the internal space (always changeable) of the building.

For the individual to engage in an intuitive relationship of knowledge with the referent, cultural qualities must be assigned to the surface. Through cultural symbols, the designer may assign semiotic competence to the image of the building and allow the user to actively live both the aesthetic experience and the experience of knowledge;

² In this sentence, Aristotle referred to the determination of the parts, the structuring of events and the composition of the Greek Tragedy (translated from the Portuguese by the authors).

³ According to Vitruvius, all architects must answer these three factors assuming the indispensable conditions for a good architecture “Vitruvio sottolinea i tre requisiti fondamentali che sono: Utilitas (utilità nella funzione); Firmitas (solidità nella statica e nei materiali); Venustas (venustà, bellezza, estetica). Queste tre parole, utilizzate a definizione di come deve essere o dovrebbe essere una costruzione, stanno in definitiva a significare come dovrebbe essere l’architettura. Di conseguenza, le tre componenti vitruviane, non si possono porre sullo stesso piano, ma su piani diversi; dove l’ultima prevale sulle prime essendo la medesima la chiave principale per l’assemblaggio delle prime due.” (Vitruvius points out that the three basic requirements are: Utilitas (usefulness to the function); Firmitas (strength of materials and structure); Venustas (beauty, aesthetics). These three words, used to define how a building must or should be, ultimately mean how architecture should be. Subsequently, the three Vitruvius’ components cannot be put in the same level but different levels; the latter takes precedence over the former and the middle one is the master key for the other two to combine) (Sala, Cappellato, 2003: 70).

a surfaces' project, through the strong relationship between new and old instruments, rational and emotional. The edge concept interpretation is thus weighed in its significant value as something that allows solving a problem. In this case, it means interpreting the ambiguity of the concept as contemporary phenomenon and as a guiding premise to the action of the designer projecting the buildings surface.

The designer as an interpreter of the buildings surface, contributing towards the transformation of the individual in the context: a project between design and architecture. The edge of the objects' singularity, that results, according to Deleuze [9] in the possibility to fragment time, to alter space. In this case, it means to think the edge between external and internal, accelerating or decelerating time to project the buildings surface. Hence, the concept may be interpreted either as skin (both internal and external) either as epidermis (internal and/or external) while hypothesis of building surfaces. As Jean Nouvel stated in a dialogue with Jean Baudrillard, "if we want singular objects, then we'll have to use various kinds of analysis, reflection, connotation; we'll have to establish relationships among contradictory objects. In short, we'll have to start thinking." [14]. An interpretation that depends on the intersection between the complexity and the contradiction defining our age, and not automation, which in this case catalogues and opposes the apparent contradiction between exterior and interior.

2.2 Concepts of Skin and Epiderm

The word 'skin' in its function as a noun and often attributive usage, refers to the external limiting tissue layer of a body. The dictionary exhibits other meanings. The Latin pelle (skin) also reveals more than one possible meaning and since we intend to analyze and evaluate the impact of 'skin' in this investigation, it seems essential to consider all possibilities. To evaluate something requires considering all hypothesis, even if seeming weak conjectures. In design one must ponder satisfying hypotheses [15] before opting for one. Following the proposed interpretation method, associating the various meanings of the words, the first hypothesis to address is cutis. In design scope it is possible to interprets it as the 'skin' that provides for, in this case, it could be the building, or an outer shell of the building.

The word epidermis means the thin surface layer of the skin. In design, the epidermis can be interpreted as an image formed by a group of small parts in circulation, self-recycled and therefore sustainable, and also semitransparent. A very fine pellicle involving the skin, as if design worked on the epidermis (skin surface), and architecture regarded the underneath skin. Regarding the Latin equivalent to epidermis, summa cutis, also designating 'skin surface' and considering the term summa is the Latin word for sum, or comprehensive summary, we could infer that the epidermis sums up the skin. On the one hand, this notion may be construed as primal category: the appearance, confirming the notion of epidermis as a pellicle and on the other hand adding a new element: the essential part of the building's skin is the epidermis, once it concerns the image appearing for interaction with the user, arising sensations, causing emotions, captivating or repelling the user.

These two hypotheses suggest the following issues: how does this exterior layer, in the twenty-first century, tend for the building; and what does it mean to tend?

2.3 The Relationship Between the Appearance and the Body

As an interpretation tool, distance also allows appropriation of the figurative meaning of ‘cutis’, of ‘appearance’, of ‘skin’. Today, the problem of the relationship between appearance and the body of buildings must re-evaluate the main values and elements. It is an age in which the individuals circulate as water, diluting and gathering in instantaneous ephemeral moments. A projectual choice considering individuals and reality as agents in permanent transformation. The designer as interpreter moves in an open process, relating to external factors such as weather, space, people and culture. The relationship between elements, old and new, unveils the appearance the building must exhibit.

In the scope of the project of the buildings’ surface, this implies the designer accepts a difficult and contrary role considering as elements to analyse all parts contributing to define the building’s surface. Design does not replace architecture, but tends for it. Tending an existing building’s exterior, which therefore has an essence and multiple opportunities to manifest itself, nowadays, means thinking on a cover to externalize the building in its time and context. As stated in the Encyclopaedia Britannica, once tending means “to apply oneself to the care of: watch over” [16], the designer tending the building’s exterior would become the interpretative ‘over-viewer’, construing the building’s surface. The ‘secret’ lays in understanding which ‘appearance/skin’ tends for the ‘object/building’.

We have also considered Sartre’s contribution when reflecting on sensations, considered through the indirect method of ‘external perception’ (*Imagination*, 1936). Indeed, the designer that makes use of imagination recognizes the pondered sensation of understanding the exterior, as in the building’s being. According to Jean Paul Sartre, the sensation “(...) is reduced to a set of molecular motions. And the image, essential element of psychic life, will appear in due time for this reconstruction, there to take its previously determined place.” [17]⁴. Jean Paul Sartre will further add to his thinking that this ‘set of molecular motions’ is finally the image, which if considered immobile, suppresses imagination, which in turn may suppress thinking, construing and design.

The designer who imagines the external surface of the building as a ‘set of molecular motions’ ponders on a surface transformed into image. The hypothesis of thinking the exterior part of the building with no images is unlikely; for there would be no experience of sensation and subsequently the building would not manifest. Therefore, the designer who imagines the external surface of a building thinks about image hypothesis, as something ever renewable and developing. If the design project is also an imagination result, the designer ponders about the image as a building’s ‘skin’, knowing that it consists of parts in permanent motion. An ‘image/skin’ that through external perception expects to cause sensations to the user.

To assume the image characteristics as a scenario, and as building’s skin, is to consider that the skin has several layers, including the epidermis as upper layer of the building’s skin. Through external perception, the epidermis, while image, consists of an intelligent system of ‘patterns’ to be consumed in the first place, thus, the experienced sensation is immediate and fleeting.

⁴ Authors’ translation from the portuguese original: “(...) reduz-se a um grupo de movimentos moleculares. E a imagem, elemento essencial da vida psíquica, aparecerá a seu tempo nesta reconstrução, virá ocupar nela um lugar previamente determinado.”

3 The Edge as Interaction Between the Skin and the Epidermis of Buildings

To argue that the edge can be interpreted as building's epidermis, the authors analyze the use of the concept as building's epidermis in a Design research project/ teaching, involving Design graduate students from the Product Design course of Instituto Politécnico de Viana do Castelo, in Portugal (Fig. 1).



Fig. 1. The Screen project dynamic between world business and the school. Image by the authors.

Specifically, the SCREEN project is an opportunity to experiment new projectual scenarios, demonstrating design's abilities to materialise product systems. It was intended for the students to implement these systems into architecture to enhance new features interacting as new urban models.

Namely, the SCREEN project allowed graduating students to relate with two local productive entities. Two companies from Aveiro area that had never joint ventured; One from the scope of urban design, that had never participated in the design of building's epidermis; The other, a ceramic tile industry that had never ventured in this kind of solutions.

Methodologically, the challenge was to bond three players (the students and the two companies), promoting design research projects, and also the connection among distinct fields of knowledge in the edge between learning and working in the field.

During five months, students and businessmen worked together both at school and in the two companies, investigating and outlining their proposals for targeted hypotheses of vertical surfaces of buildings. This process equated new demands from users, such as purchasing a service/product not requiring the need/obligation to enter the distribution level, but its edge (Fig. 2).



Fig. 2. The students, the businessmen and the tutors in the companies. Image by the authors.

3.1 Project S.Temp

The project ‘S.temp’, developed by the 4 students departs from the need to discipline and order the complexity of exchanged information characterizing the current urban setting, such as weather or level of humidity, but also indication on locations and places easy to access.

Essentially, the project is addressed to tourists and to those seeking quick access to essential information when appropriating a place. The goal is to provide such information linking surfaces to a large screen [18]. The purpose is to inculcate onto the user experiences and sensations aiming at conveying touristic info in large cities. Pottery, as before, renews its supporting role of communication in everyday life, allowing a game combining the dual use close/manual and remote/digital. The system allows the user, by activating two levers, to select the area and type of service to request. One screen displays the search result and the other displays additional information. Once the search is completed, the system sends the requested info to the user’s mobile phone (Fig. 3).



Fig. 3. The project S.temp. Image by the authors.

3.2 Project S.Temp

This project’s core concept highlights the role of surfaces as narrative moment for a given place. Meeting in the actual space of the narrative, that moment is a connective element between the individual and the place (interior/exterior). In this case, the Urban-Frames

project developed by four students and regards the appropriation of urban surfaces as a contents catalogue of the internal space that is shown outwards.

As advocated by Umberto Eco [19] the information may be understood as a message that in this case reaches the recipient through the urban surface. This message will reach its purpose through its disseminator if transmitting an intense function meaning. The Urban-Frames project aims interacting with the user in a dynamic and playful way, offering new symbols for ancient rituals such as purchasing a book, namely innovative surfaces in ceramic revetments communicating the bookstore's product. The project envisages a panels system that upon identification of a determinate type of symbols provides reorientation towards a screen and a Bluetooth system connected to a specific zone. From there, the user can access catalogues, download information or access e-books (Fig. 4).



Fig. 4. The project urban-frames. Image by the authors.

3.3 Project Re-U-Night

This The Re-U-Night Project was developed by the 4 students integrated in the exercise of the phenomenon of the cycle as an open process.

The project Re-U-Night aims to raise awareness among users on sustainability issues and subsequently on recycling, simultaneously providing for a beverage service. On the façade, the image repetition evokes Andy Warhol's work 'Green Coca-Cola Bottles' (1962). The abstract surface created through image repetition is intended for decoding at the moment the user directly connects to the epidermis of the building. Re-U-Night is a product system for everyday use, in which the beauty of the ecological concept is ennobled by the innovative use of ceramic technology.

The system provides a series of components enabling communication and distribution of beverages and the containers' recycling. The recycling process is made through bottle shaped Portuguese tiles ('azulejos') offering a moment of leisure so as to allow the proper disposal of plastic or glass bottles and aluminium cans. In this sense, the project

Re-U-Night is an opportunity for the individual to upgrade his lifestyle downsizing the environmental resources consume (Fig. 5).

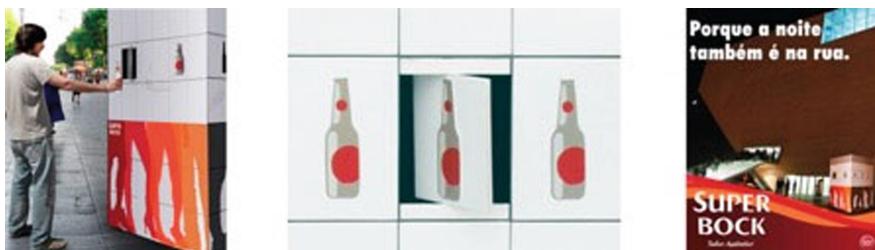


Fig. 5. The project re-u-night. Image by the authors.

A sustainable process that in this case proposes overnight consume and daytime recycling, in a playful approach.

4 Conclusions

This investigation, stemming from the edge concept ambiguity, intends to emphasize design method as a process to provide knowledge in two dimensions: product-service and interaction-experience. To include interpretation as a method for design means qualifying the design process, analyzing and pondering the relationship of the designer in context to understand how both designer and context are transformed.

Specifically, the façade's project, as part of the building's project, may be viewed as the essence of a projectual language, the starting point for a new experience between what is on the inside and what is on the outside of a building, a moment when the experience actually happens. The edge, the almost, the no return to the previous, the non-complete rejection of the previous (in this case considered interior space) and the posterior (external space), may be designated the threshold of the experience of ambiguity, which may be interpreted as a comprehension phenomenon. When the process of perception of what happens in the edge between both spaces includes the cultural context and therefore is not an isolated act, it rather constitutes ambiguity understanding, hence engaging a number of factors such as culture and time. Then, the semiotic process presents different meanings for the experience of the ambiguity of the buildings' façade project.

The designer assessing the cultural value has the predisposition to reach an innovative and sustainable response. Innovative solution because the designer, through interpretation, accepts time fragmentation and defines the answer including the cultural factor, becoming an ever-renovated solution. A sustainable answer because the process benefits from factors crisscrossing context, as time, communication or complexity, enabling interpretation while design process to be a cyclic method; recyclable and therefore sustainable. A cognitive and dialectical process because being a path open to contrary and contradictory ideas, becomes an innovative process conducting to other ideas; a vast process whose product's final quality will depend on the strength of the relationship among the parts constituting the façade's product system. The designer as interpreter

of the buildings' surface, namely the epidermis, takes the edge between the concepts of exterior and interior as an opportunity to interpret the complexity and ambiguity characterizing the liquid modernity. The alternative to assess and evaluate all appearances of the nature of the two concepts will allow him/her the right to choose when relating the individual to the world.

In this sense, it is a productive action in which design works with other disciplines, design tending architecture to interfere in the true reality, complex and difficult to define, instead of design operating on a dream-like reality. As culture carrier, design contributes towards preserving the buildings' identity and also to uphold emotions in people's lives. It engages the thought of the uniqueness of the epidermis of buildings as an inspiring model for interpretation that stems from a base concept, assessing and reassessing prior to forwarding responses. The design of interpreting buildings' epidermis is therefore hermeneutical and dialectical, and the epidermis is one of the components of the scenario that interacts with the user. Between the designer and the user then arises a new level of relationship, an experience of exchanging meaning instead of a mere opportunity to communicate a message.

For Design Teaching, the Screen project proves its value in the development of a learning process through practical work, as the future designer will require to find answers in investigation, which does not distinguish the cultural factor from the technological, rather entwines both to reach articulate and efficient reply. The process of creation is important in defining a successful methodology for the student and the future designer. Therefore, a program defined by the property of the solutions and by the particular issues, suit vital and critical to structure the cycle of the project.

Acknowledgments. This work was carried out with the support of The Foundation for Science and Technology (FCT), Portugal. The authors also acknowledge the Instituto Politécnico de Viana do Castelo (IPVC), Portugal.

References

1. Foucault, M.: *Das coisas nascem coisas*. Edições, vol. 70 (1998)
2. Bauman, Z.: *Modernità liquida*. Laterza: Roma-Bari (2005)
3. Baudrillard, J.: *Simulacra and Simulation*. The University of Michigan Press, Ann Arbor (1994)
4. Margolin, V.: Introduction. In: Margolin, V., (ed.) *Design Discourse: History, Theory, Criticism*. University of Chicago Press, Chicago, pp. 3–30 (1989)
5. Douglas, M., Isherwood, B. (2004) *O Mundo dos Bens: para uma antropologia do consumo*. Editora: UFRJ.
6. Eco, U.: *Semiotics and the philosophy of language*. Indiana University Press, Bloomington (1984)
7. Vitta, M.: The meaning of design. In: Margolin, V. (ed.) *Design Discourse: History, Theory, Criticism*, pp. 31–36. University of Chicago Press, Chicago (1989)
8. Latour, B., Yaneva, A.: 'Give me a Gun and I will Make All Buildings Move: An ANT's View of Architecture'. In: Géiser, R., (ed.) *Explorations in Architecture: Teaching, Design, Research*. Birkhäuser, Basel, pp. 80–89 (2008)
9. Deleuze, G.: *Difference & Repetition*. The Athlone Press, London (1994)

10. Vignola, G.B.: *Li Cinque Ordini di Architettura*. Pier Francesco Sanvito, Milano (1862)
11. Aristotle. *Poética*. Calouste Gulbenkian Foundation, Lisbon (2007)
12. Sala, N., Cappellato, G.: *Viaggio matematico nell'arte e nell'architettura*. Franco Angeli, Milano (2003)
13. Branzi, A.: Ten modest suggestions for a new Athens charter. In: Koskinen, I., Härkäsalmi, T., Mazé, R., Matthews, B., (eds.) *Proceedings of the 4th Nordic Design Research Conference (Nordes 2011). Making Design Matter*, pp. 26–27. Aalto University. School of Art and Design, Helsinki (2011)
14. Baudrillard, J., Nouvel, J., Hays, K.M.: *The singular objects of architecture*. (R. Bononno, Trans.). Minneapolis: University of Minnesota Press (2005)
15. Cross, N.: *Designerly Ways of Knowing*. Springer, London (2006)
16. Encyclopædia Britannica. Encyclopædia Britannica Online: <http://www.britannica.com>
17. Sartre, J.P.: *A Imaginação*. Difel, Lisbon (1988)
18. Lynch, K.: *A boa forma da cidade*. Edições, Lisboa, vol. 70 (1996)
19. Eco, U.: *Interpretation and Overinterpretation*. Cambridge University Press, New York (2002)



The Role of Visual Curation as a Contribution to the Development of Interfaces Between Academia and Business

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Abstract. By exploring the concept of image curation, this article presents a proposal for the applicability of image curation in the development of Projects of Design, exploring the role of visual curation as a contribution to the development of interfaces between academia and business. Due to the amount of data present in digital culture, content curation is an increasingly important activity in project development. In higher-education design formation, image curation allows safeguarding the project literacy on the one hand, through the definition and clarification of an organization of visual elements and defining a basis for dialogue on the projective possibilities. The proposed strategy for visual curation offers the possibility of being applied as a basis of dialogue with external stakeholders. Moreover, thus, in a context of learning in design, enabling another bridge between the Academy and the corporate fabric.

Keywords: Curation · Visual design · Visual exploratory models

1 Introduction

Design thinking uses the act of curation as a way to deepen the essence and definition of a problematic [1]. “In curatorship the acts of selection and organization add value.” “Together, these acts are an extraordinary source of value for a reality burdened with information excess.” [2] When designing “information maps”, designers can focus on the essentials for a particular user segment. This aspect of “curation” is fundamental to both design thinking and agile methodologies. In design thinking, curation happens with the identification of key insights and the creation of design criteria. These critical

activities allow us to use all “**that is**” research and translate it into a simple set of criteria to drive the generation of ideas in phases of “**and if**” [3].

The need for curation is also observed in digital technology, specifically in cured computing, which presents an era of personal computing, where choice is limitless, but experience is more relevant, and that relevance is needed, given the portability of devices and the amount of data they can hold and access. The experiences that have governed the interaction with digital technology in the more recent, due to a profusion of overwhelming information, presses the consumer to curate information. Consumers, today, can benefit from the curative act so their experience can be more relevant [4].

Related to the problem of curation of information sources, the use of physical and digital sources of exploratory phases by designers during the conceptualization phase of design projects is well established, especially when there is a collaboration and co-creation, the materials collected by the designer can result in the construction of *Mood Boards*, with the purpose of supporting the development and analysis of ideas, helping the designer’s argument about a project [5].

The visual digital media offer us configurations of mosaics of images, these evidence how the “design” patent in a community “creative” can affect the opinion of the users on the valorization and usefulness of certain contents for the rest of the community. Many of the existing “creative” communities are centered on the creator, focusing primarily on allowing public sharing to creators of their own content. However, communities can also be centered on curation, developing a greater focus allowing creators (or followers) to show or “cure” the work of others; the Pinterest platform is an example of this practice, allowing users to collect content on thematic “Boards”. Pinterest is an example of a community structured around the curation of social content. These digital design practices are not unique to this platform, as other communities (including *Deviantart*) also support curation, allowing users to select, organize, and share favorites [6].

Research on social networks shows the importance of curation in the elimination of some information, highlighting the ongoing user curation effort, an effort triggered especially due to the change of identity “positions” in identity projects. The conceptualization of social networks as a lasting exhibition highlights a form of work of constant curation. The enduring ‘exposure’ of personal data and the permanent “benchmarking” around the elimination of information highlight the problem of information exposure on social networks. Content not suitable for a consumer’s (or producer’s) identity project is removed. This concern with the “other” the public, the self-presentations contrast with the curative work that supports the maintenance of personal files by users [7].

The images provide a useful starting point for understanding visual consumption. Specifically, they allow:

Sensory anchorage: interpretation is anchored in the image;

Instant access: references to images can be made and verified in an iterative process;

Personal involvement: images hold and attracts our attention. Interpretation is both emotional and critical;

Broad-spectrum cognition: images involve a variety of cognitive processes;

Multiconnection: images are rooted in culture.

Curation makes information extraction much more efficient. The content curation is not about the collection of links or the loose construction of large amounts of information, the curatorship focuses on its “distribution” in a context with organization, annotation/identification and presentation. Content curators provide a personalized and scrutinized selection of the best and most relevant resources on a specific topic or topic [8].

There is a change in the understanding of curative activity to an authorial activity. There is currently a certain resonance between the idea of curation and the contemporary idea of the creative self, making aesthetic choices of location and consumption. [9]. The act of making the non-visible more visible can be a valuable contribution [10].

In the subject of image curation and giving as an example the world of art, there is also an authorship process, referring to the process of choosing and displaying images, defining and creating an itinerary. According to Rugg and Sedgwick [11] in 1972, the artist Daniel Buren wrote ‘Exhibition of an Exhibition’, where he stated: ‘Increasingly, the theme of an exhibition tends not to be the exhibition of works of art, but the exhibition as a work of art’ [12]. Author Buren refers specifically to the work of curator Harald Szeemann and his curatorship of *Documenta 5*, as well as to the emergence of the idea of the organizer of exhibitions as author. The “fragments” and other “details” exposed in most cases are totally foreign to the author’s exposition. The logic of the ecosystem is built for the purpose of curation (selection and organization) by the author of the exhibition.

According to Arnoulds [13] Digital culture opens new challenges to curation. The general public is in danger of being flooded with information outside the digital domain. It would be good to note the spectrum (new) methods and channels used to collect and select information and sources, under the new paradigm that all become more or less curators, the general public shows interest in participating in the curation act.

There is a growing use of the word “curation” to describe a set of practices that authors of digital blogs and other online spaces develop. While in previous times, the contents produced to credit an author would have been simply “written”, “edited” or even “created”, however, these practices do not capture all the activities or self-representative practices in the digital culture that the “curatorship” encompasses. The curatorship of a space does not only refer to the writing or other act of creation within it, the curatorship also refers to the act of collecting, distributing, assembling, disassembling and the movement through different phases. In other words, it is an exponential active practice in its scope, scope and nature compared to other practices, but it contains and subsumes [14]. According to the same author, the curatorship is a form of expanded authorship, comprising the relationships between texts of all types: moving image, still image, printing, among others.

According with Williams [15], individuals are capturing and storing an increasing amount of digital information about themselves, including documents, articles, work portfolios, digital images, and audio and video recordings. Computer processing, storage and software tools are increasing exponentially. Many questions arise from this increasingly empowered landscape of personal collection, dissemination and digital memory. The collection and management of personal information has deserved the attention of researchers for many years, particularly in the field of Human-Computer Interaction [eg.

[16]. However, the rapid increase in digital applications and storage capacity has stimulated interest in this field and has also opened up a new area of research according to Beagrie [17]. In particular, the way individuals use their personal computers. The authors adopt the term “personal digital archives” to refer to informal, diversified and expanding memory collections, created or acquired, accumulated and maintained by individuals throughout their personal lives, belong to them rather than to their institutions or other places of work. The personal archive of a living individual is a dynamic entity. New objects are created; others are changed; some are discarded. Professional curators of contemporary personal archives are engaged in creative activities, complementing the original content of an archive.

Also, regarding the amount of digital information managed by individuals, one of the great challenges in the interaction with the massification of digital mobile content, in which the practice of curation emerges as an authorial response, is the understanding of the screen’s conceptual affordances.

These affordances “guide” the curation not only of the large amount of digital information made available by the screens, but also the physical and emotional accessibility of this information. According to Rolo, Helena and Baldi [18] consumers have a higher propensity to engage with visual-information on screens due to its hybridity that comprehends both a utilitarian and playful modality. The conceptual affordances of screens outline that consumers are more likely to engage with screened-images when consumers access them privately while enjoying its materiality. Users comply with cultural adequacies when interacting with a certain product [5].

The need for curation is currently recurring, also in the context of learning, in visual literacy exercises, in the need for control over images collected for the purpose of an investigation [19]. Working with visual communication is an effective means to introduce and develop critical thinking - higher-order cognition that is essential to intellectual work [20].

According to Winifred [21] Designers can use maps to heal and synthesize their observations, and creating maps includes three basic activities: capture, curation, and analysis. By documenting a physical condition using a basic tool like the camera. The photographic camera captures, processes, manipulates and shares images in a matter of minutes. Although the time to obtain data is shorter, the complexity and amount of data makes curating difficult. In the design areas this information management problem means translating sense data, visual observation, data collected through different means to a readable output with impact on the design process. Maps and mappings can be an information curation platform.

2 Methodology

An interventionist experimental methodology is proposed. This methodology is framed in a pragmatic and instrumental dimension action research that according to Thiolent [22], socio-technical, committed to generating projects that work in the diagnosis of problems of a more punctual nature and in the realization of processes aimed at changes in the direction of the improvement of professional and educational quality.

The design thinking process of the Hasso Platnner Institute of the Standford Design Institute is used with methodology, referring to the theme of this research proposal,

this type of methodology allows professionals with various backgrounds to obtain more innovative solutions, because “design thinking allows high impact solutions to “emerge” naturally instead of being imposed from the top” [23].

The research in question contributes to the “Design Thinking Process” model in an enrichment of the first two phases, phase of empathy and definition, where a focus is developed on the final “user” instead of the author of the project. The problem definition phase considers that all problems are poorly defined at the beginning of the process, so the image diagnosis provides an image curation, contributing to a visual literacy on the object of project studies. The diagnosis “builds” a richer creative path by providing a greater argumentative capacity throughout and in the output of the project as mention in previous research (José Silva, Martins, et al., 2020).

The dynamics of the curation process always depends on external variables, reinforcing the concept of “orientation in space” circumscribed to the definition of the problem. The external variables allow correlations by amplifying the “echo” of the product or service, the meta-extensions of the product, reinforcing its updating.

3 Development

Designers when developing exploratory models in diagnostic phases have an increased ability to empower the project outcomes, Visual Universe Departments, not only of a product, but also of their associations. These exploratory and diagnostic phases become a literacy mapping that provides a temporal and foresight spatial orientation.

The subject regarding the “**The role of visual curation as a contribution to the development of interfaces between academia and business**”, is part of a logic of integration with society within different economic, cultural and social organizations, oriented towards an ecosystem of applied and multidisciplinary strategic research and training. A strong link between the Academia and the society is the result of teaching and disciplinary research, which we can call **Model 1**, and strategic research and training applied and multidisciplinary, which we can call **Model 2**. This relationship is evident in the emphasis on a solid disciplinary education of training as a basis for a high-quality multidisciplinary postgraduate degree. With a large involvement of teaching and research practices, a link can be developed between academic, research and graduate activities. In this way, an organic unit can monetize the surpluses generated through business-oriented research in order to subsidize academic and graduate activities.

There are different forms of knowledge production, according to the work of Gibbons et al. [24] e Scott [25]. The traditional view of academic knowledge based on individual disciplines, and the pure research resulting from these disciplines, are associated with **Model 1**. Its cognitive and social norms determine what are the significant problems, who can practice science and what constitutes a “quality science”. A more recent view considers that knowledge production is intrinsically transdisciplinary, trans-institutional and heterogeneous [26]. This second type of knowledge production - **Model 2** is problem-oriented, deals with knowledge developed in the context of application and (often) partnerships, and accommodates aspects of social responsibility. The interdisciplinary and multidisciplinary work element is the key to this Model. This **Model 2** is consistent with Alain Findeli’s vision of how Design can involve several disciplines without distorting the disciplinary strand of Design [27].

This research has the potentiality to contribute with new insights to the Design learning experience presenting several implicit challenges. A learning module should allow a contemporary view of the diagnostic problem. The communication of this module should communicate an “open” assembly structure, providing students with a “layout” of activities, promoting a critical view and a playful perspective and implementing a process rather than a formula. The learning experience develops a “conceptual tool” perspective including different concepts and stages of development. The visual exploratory evaluation also allows to reflect on the image curation and how this practice will influence later “intuitive” choices of visual information.

Through the structuring of exploratory models, students can develop different solutions for the different phases of the diagnosis, allowing different outputs of the project, in the phase of collecting visual elements, the symbolic elements, restricted to different cultures, gain a new relevance in argumentation and design logic.

The exploratory visual diagnostic study allows students to “think” with images, constituting these, objects of visual literacy.

The Visual Diagnostic Models are pluralistic and have a sequential nature. They allow the incorporation of different information filters and are coherent in the objective of providing an evaluation base capable of “orienting” and “nurturing” the conduct of the project in a sequential and convergent way.

The Visual Diagnostic Models allow different strategies, in the form of Visual Narrative Artboards (VNA’s), they allow creative itineraries, resulting from the composition of multiple visual cultural mosaics.

The visual elements resulting from VNA’s suggest narratives and these allow different visual associations and interpretations, driven and supported by the image reasoning, promote visual culture and help students, through a dialogue of co-creation in leveraging critical thinking.

The results of a recent published research article, **Innovation in Traditional Productive Sectors - Visual Curation in Design** [28], point to the application of the principle of visual diagnosis in the construction of strategies supported in image curation as argumentative support both in experimental development as well as in product communication.

4 Conclusion

Regarding the question of how visual curation in design provides the backbone for diagnostic practices and thus contributes to an interface between academia, specifically in the areas of design and companies, the development of interfaces through the development of diagnostic practices allows the development of exploratory practices that deal with the concept of visual curation, which connect a gap in the boundaries of academia and businesses. In this effort, design students, play a key role. As long as the focus remains in start-ups, avoiding unfair competition with existing design consulting services in the market. Initial contributions operate aspects related to the transfer of knowledge and training through visual literacy.

The proposed strategy deals with the development of internal partnerships practices, within the teaching organization bridging together knowledge in a transdisciplinary

perspective that according to Alain Findelli, it is not so much to contribute to the corpus of knowledge of each discipline gathered in the design solution, but to arrive at real design propositions aimed at improving a solution to the problematic of the project [27]. The concern of the research partners in a well-founded research is not to address their respective scientific communities, but the community of their end users.

The applications as well as the projects of design consultancy practices will “define” a laboratory practice for the development of valuable research in the Visual Design. The implementation in the context of practices referring to visual diagnosis, has the potentiality to reinforce communication practices and strategies between academia and companies.

References

1. Jeanne, L., Andrew, K., Kevin, B.: Solving Problems with Design Thinking: Ten Stories of What Works. Columbia University Press, New York (2013)
2. Eliot, B.: Overwhelmed? Welcome the Age of Curation (2010). In: www.wired.com/2010/05/feeling-overwhelmed-welcome-the-age-of-curation/. Accessed 3 Oct 2019
3. Jeanne, L., Randy, S., Daisy, A.: Design Thinking for the Greater Good: Innovation in the Social Sector. Columbia University Press, New York (2017)
4. Sarah, E.: Curated Computing: What's Next For Devices In A Post-iPad World (2010). In: Forrester. <https://www.youtube.com/watch?v=9jUArEriYDY&feature=youtu.be>. Accessed 13 Nov 2019
5. Porcheron, M., Lucero, A., Fischer, J.E.: Co-curator: designing for mobile ideation in groups. In: Proceedings of the 20th International Academic Mindtrek Conference on - AcademicMindtrek 2016, New York, pp. 226–234. ACM Press (2016)
6. Kim, J., Agrawala, M., Bernstein, M.S.: Mosaic. In: Proceedings of the 2017 ACM Conference on Computer Supported Cooperative Work and Social Computing - CSCW 2017, New York, pp. 246–258. ACM Press (2017)
7. Zhao, X., Lindley, S.E.: Curation through use. In: Proceedings of the 32nd Annual ACM Conference on Human Factors in Computing Systems - CHI 2014, New York, pp 2431–2440. ACM Press (2014)
8. Thilagavathy, P.P., DR.: The impact of content curation for personal/Informal learning. *Int. J. Sci. Res.* **5**, 1673–1676 (2016)
9. Hans, O.: Ways of Curating. Penguin (2014)
10. Colin, W.: Curation is Creation. Asymmetrical Press, Missoula (2014)
11. Rugg, J., Sedgwick, M.: Issues in Curating Contemporary Art and Performance. Intellect Books, Bristol (2007)
12. Buren, D.: Where are the artists? In: Hoffmann, J., (ed) The Next Documenta Should be Curated by an Artist. Revolver 2004, Frankfurt (2004)
13. Arnoldus, M.: Converging Pathways to New Knowledge: a Reflection on a Series of Online and Offline Conversations. *Mute Magazine*, Whitechapel (2010)
14. Potter, J.: Digital Media and Learner Identity. Palgrave Macmillan, New York (2012)
15. Williams, P., Leighton John, J., Rowland, I.: The personal curation of digital objects. *Aslib. Proc.* **61**, 340–363 (2009). <https://doi.org/10.1108/00012530910973767>
16. Malone, T.W.: How do people organize their desks? *ACM Trans. Inf. Syst.* **1**, 99–112 (1983). <https://doi.org/10.1145/357423.357430>
17. Beagrie, N.: Digital curation for science, digital libraries, and individuals. *Int. J. Digit. Curation* **1**, 3–16 (2008). <https://doi.org/10.2218/ijdc.v1i1.2>

18. Rolo, E., Nobre, H., Baldi, V.: Screens affordances in image consumption. In: Arai, K., Bhatia, R., Kapoor, S. (eds.) *Proceedings of the Future Technologies Conference (FTC) 2019*. FTC 2019, Advances in Intelligent Systems and Computing, vol. 1070, pp. 176--187. Springer, Cham (2020). https://doi.org/10.1007/978-3-030-32523-7_12
19. Leon, R.L.: Developing visual literacy in design students. In: Robin, Z., Bohemia, E., Digranes, I., (eds.) (2015)
20. Perkins, D.N.: *The Intelligent Eye: Learning to Think by Looking at Art*.title. Los Angeles, CA (1994)
21. Winifred, N.: *Data Visualization for Design Thinking: Applied Mapping*. Taylor & Francis, Abingdon (2017)
22. Thiolent, M.T.: *Metodologia da pesquisa-ação*. Saraiva (2009)
23. Brown, T.: *Design Thinking* 30 (2008). <https://hbr.org/>
24. Gibbons, M., Gibbons, M., CLHNSSPSMT, Gibbons, P.M., et al.: *The New Production of Knowledge: The Dynamics of Science and Research in Contemporary Societies*. SAGE Publications (1994)
25. Scott, P.: *The Meanings Of Mass Higher Education*. Society for Research into Higher Education (1995)
26. Cele, M.G.: Meeting the knowledge needs of the academy and industry. *Ind. High. Educ.* **19**, 155–160 (2005). <https://doi.org/10.5367/0000000053729789>
27. Findeli, A., Brouillet, D., Martin, S., et al.: Research through design and transdisciplinarity: a tentative contribution to the methodology of design research, pp 67–91 (2008)
28. Silva, J., Raposo, D., Neves, J., Ribeiro, R., Marto, I., Silva, F.: Innovation in Traditional Productive Sectors - Visual Curation in Design. In: Rebelo, F., Soares, M. (eds.) *AHFE 2020*. AISC, vol. 1203, pp. 73–82. Springer, Cham (2020). https://doi.org/10.1007/978-3-030-51038-1_11



Product Design for Senior Population: A Wearable System for Physical Protection and Fall Detection

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Abstract. An increasing aged population is an important issue in contemporary societies. Decreased hearing, vision, strength and coordination can hamper balance and increase the risk of falling, the leading cause of death by injury and non-fatal injuries requiring hospitalization. Thus, we aimed to develop a wearable system for physical protection and fall detection focused on elderly at risk of falling. This system comprises four products: (i) microfiber platform/suit with embedded protection pads in key osteoarticular areas; (ii) non-invasive fall detection sensor; (iii) intuitive smartphone application that communicates with the sensor and alerts caregivers about falls; (iv) discrete non-intrusive unisex vest. The system provides physical protection and faster assistance to falls, increasing the elderly population autonomy and fostering an active lifestyle. Thus, several aspects of communication are paramount in this product.

Keywords: Product design · Fall detection · Seniors · Physical protection

1 Introduction

Design helps companies, being a crucial part in the innovation, production and marketing of tradable goods, to meet the needs of consumers and users, as well as to increase the usability of those goods. Products that are safer and more user-friendly are beneficial for everyone, but especially benefit the more atypical groups, as is the case of the elderly [1]. An aging population puts these topics on top of the design agenda.

Aging is defined as the proper sequential deterioration of living beings which include weakness, increased susceptibility to diseases and adverse environmental conditions, loss of mobility and agility, and physical changes associated with increasing age [2]. The concept of growing older, but not old, is at the center of a new paradigm that relates to the demographic changes occurring in developed societies. This paradigm is fraught with problems but also opportunities, and will be the trend for the next decades

and generations. Due to the substantial increase of population over 65 years and the consequent decrease in the active labor population, systems of social security and health care are faced with complex survival problems. The health sector already felt some changes in response to these problems through the application of concepts such as “prevention before cure” and “rehabilitation before care” [3]. These concepts imply needs of proper monitoring beyond the traditional health care environments.

The global population is expected to reach a total 8.1 billion in 2025 [4]. This increase is particularly reflected on the elderly, consequently leading to an increase in chronic degenerative changes and kinesthesia changes derived from the aging process, making the elderly more susceptible to falls, as well as creating greater variations in sensory capabilities and body posture. This will limit their autonomy, creating dependence and reducing quality of life while increasing the need for medical care at home.

Falls are a major cause of functional disability [5] and death [6] in the elderly. Most falls in the elderly population derive from factors such as disturbances of gait and balance [7], chronic diseases [8], vision [9], among others. Falls can result in bone fractures [10–13] or in serious injuries that may require hospitalization [6, 14] and possibly prolonged treatment for the rest of the patient’s life. Another consequence of falls that involve loss of consciousness or immobilization [15] is the inability to trigger any emergency services or provide their location.

In this context, the aim of this work is to design and develop a solution able to improve the quality of life of elderly people at risk of falling, by reducing the impact of the fall while simultaneously providing active assistance to the person that fell. This solution should reflect the user-centered design process for people over 65 years.

Currently there are technologies of sensing and monitoring, and wireless communication [16–23]; and materials with high impact performance [24–26], able to increase the comfort and freedom of movement. There are also products for the protection of a specific region of the body of the senior population, such as the hip [27–29]. Protectors also exist for contact sports [30–32], including extreme sports [33–35]. Martial arts also encourage the use of protection products [36, 37] to reduce the effects of impact and bruises. However, all solutions mentioned have low levels of comfort for everyday use. Finally, protection products for military include ballistic protection and activities under extreme conditions [38, 39].

To the best of our knowledge, the state of the art does not identify products or systems that cover the physical protection, falls detection and their location in a single product platform adapted to a wearable osteo-articular protection, like a second skin, and focused on the functional and cognitive characteristics of the elderly at risk of falling.

2 Materials and Methods

The exposed design in this paper followed a development process consisting of seven steps interconnected and dependent on results achieved in each of these steps. These steps can be summarized in three points: (1) characterization of the problem of falls in the senior population, through a comprehensive review of the literature focused on the physical, economic and social impact; (2) transformation of the problem into needs, through a local analysis to real users over 65 years and the identification of key stakeholders; (3) exploratory study that aims to validate a solution through the design and

development of a platform embedded in wearable products for physical protection and active assistance, to improve safety of seniors in the event of a fall. In Fig. 1 we can see the flow diagram of the process among the seven steps.

The **first step** is to define and characterize the problem of falls in the senior population. In this scope, a key element in diminished quality of life of this type of population, a problem that extends to much of the world, even in countries with different geographical locations, habits and particular cultures, levels of major and minor development, different political systems and religions. We can say that the falls problem in the senior population reaches epidemiological levels, with global impact. Against this background the following questions were posed:

What is the physical, economic and social impact of falls in the senior population?
What is the geographical focus of this impact in the literature and how has it evolved?

The purpose of this analysis is to identify the incidence of references in scientific papers of falls in the elderly population, its geographic and cumulative evolution between the years 1995 and 2010. The analysis was based on the physical, economic and social impact falls in the elderly and on the conditions, causes and risk factors, physical consequences, physiological effects of falls, prevention strategies, mitigation and rehabilitation of falls, as well as economic consequences for health systems and social consequences. The part relating to the physical impact of falls in the senior population was recently published [40].

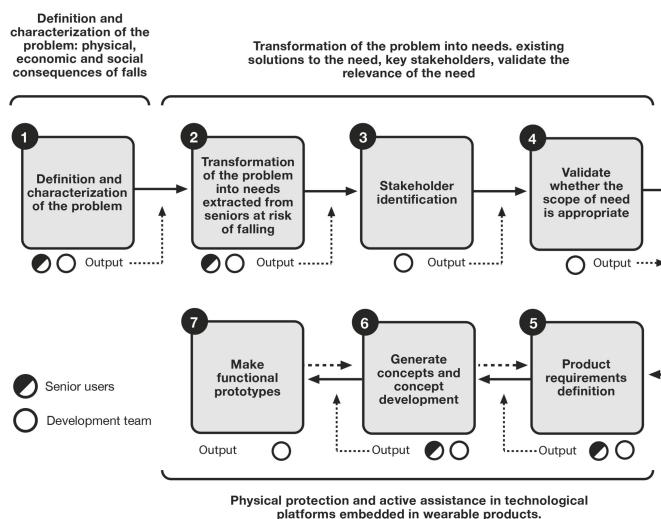


Fig. 1. Seven steps method for design and development of a wearable system for physical protection and fall detection.

After the conclusions drawn from the **first step** – definition and characterization of the physical, economic and social consequences of falls – and because this evaluation was centered solely in the literature, it is vital to identify the real needs of senior users. This implies to listen to the main targeted population and others interested in a wearable

system of physical protection and active assistance, their experiences, understand who they are, where they fall and the resulting consequences. In short, the need for a local assessment, very focused on senior user and the main people who interact daily with this type of population, as their family members, caregivers, therapists and doctors, this was the **second step** of the evaluation process. Thus, the instrument that we consider most suitable for the realization of this analysis was the use of a survey.

The **third step**, identification of stakeholders, which analyzes the direct and indirect interactions of all parties involved [41], aims to understand how those parties are affected by the needs, contributing to the definition of product requirements. The form used to identify and analyze those interested in the needs, consists of four points:

- First is the analysis of the events and consequences of the process in case of fall; this approach is the situational variables studied, the immediate and later consequences of falls, as well as those involved in the treatment and recovery;
- Second is the analysis of the cycle/economic process in case of fall; this step is followed by the cash flow from the fall to the treatment and rehabilitation of falls in different injury scenarios;
- Third is to identify the needs of key stakeholders, based on the identification of people, professions, agents and institutions identified in the preceding paragraphs;
- Fourth is to establish the profile of potential users of the system we want to develop (wearable products for physical protection and active assistance to seniors in case of a fall).

The **fourth step** aims to validate that there is no solution already available that integrates physical protection with a falls detection solution to the senior population, and that the need is really appropriate for this population group. In this context, the following questions were posed:

What other population groups and activities are at risk of falling?

Solutions that are able to minimize the physical effects of the fall?

Solutions that are able to foster care after falling?

To address these issues, general solutions for prevention, minimization of falls, as well as solutions for rehabilitation injuries from these falls were identified and analyzed. This included patents for physical protection and active assistance systems; as well as for prevention and detection of falls; location and tracking; technologies for health and wellbeing; and finally, portable monitoring technologies.

The **fifth step** is the definition of a prescriptive model to define requirements in developing wearable products for physical protection and assistance, focused on the active senior population at risk of falling. Three authors were selected from different years of publications related to the design and product development [42–44], and a fourth author with a recent publication, fully focused on the development of medical devices [41]. For each author an analysis of the methods that identify requirements and/or needs was done: the scope of the method; designation that each author assigned to the task; how each classified it, namely, the degree of importance; categories that can be placed; as well as the way they can be obtained from users; Finally, the description of the

application of different methods. Based on this analysis and it extracted information as well as the empirical experience of each participant, the information was organized in a prescriptive final model. This model was formed by conducting brainstorming by a team of experts in product development and situated in areas such as design, engineering, textile manufacturing, biomedical sciences and a panel of senior people.

After identification, quantification and classification requirements, the **sixth step** is the development of a solution for the combined need of osteo-articular physical protection and a more active and effective assistance in the event of a fall. This step is intended to demonstrate the development of this process, as well as some methods of transforming the needs into a solution and wherever possible, its validation.

The **seventh** and last step consists in making functional prototypes of the protective pads platform and the fall detection sensor and application. The goal of these prototypes is to allow validation of the entire system by testing it with real users and to identify potential improvements.

3 Results and Discussion

We start from an initial concept of a wearable solution for physical protection, namely a wearable textile platform (shirts and pants), second-skin type and which will be coupled with protection pads placed in areas associated to a higher risk of injury in the event of a fall. Additionally, this platform will also contain a sensor to detect falls and the respective geographic location. The ambulatory wireless monitoring system, non-invasive and non-intrusive to collect physical and environmental information, works through a mobile application that detects postural sensor information and sends an alert in the event of a fall, in the form of Short Message Service (SMS) e-mail; or pre-recorded automatic call to a family member or caregiver, with a report of this event being stored on a web server (Fig. 2).

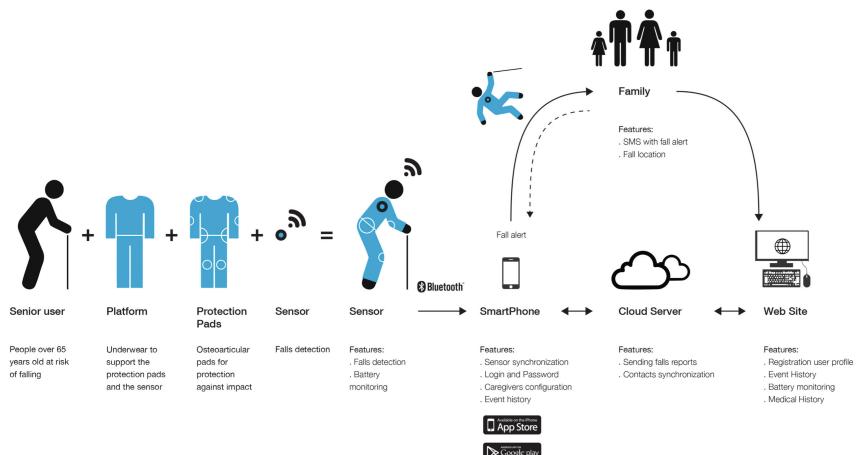


Fig. 2. Concept explanation for the system of physical protection and fall detection.

3.1 Wearable Platform and Osteoarticular Protection Pads

We have designed a wearable platform for osteo-articular protection, comprising a shirt and a pair of pants that can be worn underneath the clothes as second skin, as well as being more casual and sportier (Fig. 3). The cut is specific to daily use and offers great breathability in areas of highest perspiration, along with an innovative technique that we developed for bonding the pads to the platform.

The ergonomic design of the platform allows comfortable use and provides an ideal support for protection pads. It is made with a mesh of elastic microfibers for an optimal fit and feel, with a compression effect throughout the body to help fix the muscles and enhance blood circulation. The shape of the platform is adaptable to both sexes and is comprised of a collar (01) with a discrete geometry to be used under clothing and allows dressing the sweater comfortably. The sweater has side flaps (02) where Velcro® can be used to bond the sweater and the pants in order to fix both parts to the body and keep protections in their correct location when the user is in motion.

The sweater breathing system comprises small holes, typically between 1 and 6 mm, cut into the upper platform in the zones of greater transpiration (03, 04). These areas are in front and under the arms (03) and extend through the back of the sweater (04).

An upper abdominal strap for body fit (05) allows greater comfort in its use and enables adjustment for setting optimum body protection. This strap has two additional functions: (a) adjusting the platform to the body for comfort through the compression properties of the mesh, and (b) providing a location for mounting part of the protective hip pad and enabling the attachment system (02) between sweater and pants.

A chest pocket for sensor placement (08) allows the user to place the sensor in an easy and effectively way. It comprises a semicircular part with the shape of a pocket (08) that is thermo-bonded on the platform close to the chest of the user. Above the pocket there is a small hole (09) on the platform where the fixing part of the sensor will be placed. The initial procedure is to drop it into the pocket and then, as if it were a traditional button, the fixing part is placed within the clamping bore. This way we ensure that the sensor is placed in the correct position and also guarantee it is firmly attached to the platform, or vest, so users can have total freedom of motion.

An elastic band at the end of the pants' legs goes underneath the feet and helps to fix the pants and pads to the body (10), preventing the platform from being displaced due to the movements made by the users in their activities. The same procedure is applied in sweater pulses, in the form of elastic cuffs (11) that go around the hand, between the thumb and forefinger.

The bio inspired geometry of the protection pads provides a perfect fit to the body and adaptation to osteo-articular areas [45], without interfering with the typical movements of the joints (Fig. 4). The elastomer-impregnated 3D mesh provides high levels of protection and dissipation of energy from an impact [46]. The geometry of the protection pads mimics the bone formation of the joint they are intended to protect, enabling the protection to not interfere with the traditional movement of that joint, while at the same time protecting the bone regions that are more exposed to injury during an impact. On the upper platform (sweater) are inserted the protections of the elbows (12), shoulders (13), the scapula (14) and the clavicle (15). On the lower platform (pants) are inserted the protections of the sacrum (16), hip (17), knee (18) and ankles (19).

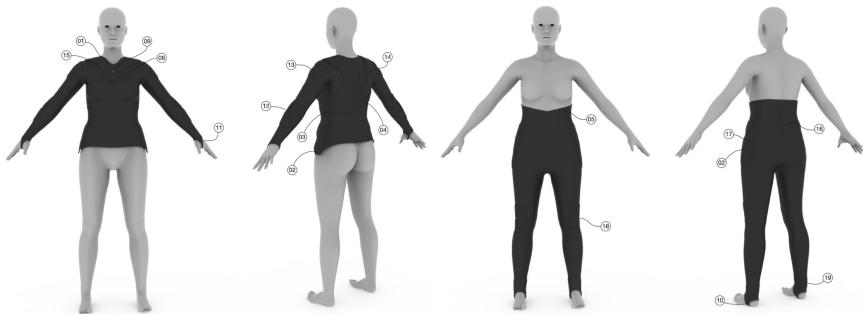


Fig. 3. Sweater and pants with protective pads dressed in a model

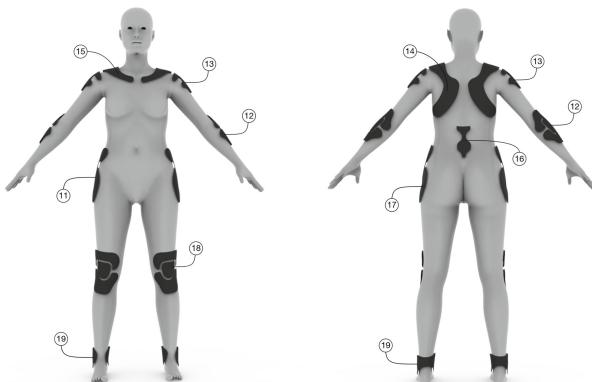


Fig. 4. Protective pads of the different osteoarticular areas

The protection pads are composed of a polyester 3D mesh embedded with an elastomer, which increases the absorption of impact energy. The thickness of the 3D mesh varies according to the desired degree of protection, enabling customized level of protection in different areas.

The process of placing protection pads onto the microfiber platform comprises putting the 3D mesh geometry on the platform, which is then covered with a piece of the same material with a slightly larger geometry to compensate for the 3D mesh thickness, being firmly located between the two layers of the microfiber. To allow the protection pads to be well fixed to the platform and not becoming displaced from their intended location due to the user's movements, a technique has been developed of thermo-bonded seams lining the entire perimeter of the geometry of protection. This technique eliminates the traditional seams, thus facilitating the manufacturing process and reducing possible discomfort caused by traditional seams in contact with the body. The technique developed for thermo-bonding of the seams uses a stamp with slightly larger thickness between 2 and 10 mm than the 3D mesh and the geometry of the transfer adhesive. This stamp allows bonding the microfiber parts without crushing the 3D mesh and avoiding the loss of compression mechanical properties of the protections. The entire process of

thermo-bonded seams is carried out in a heat press in which the base is fixed, and the upper part of the press is movable and the distance between the plates can be controlled.

3.2 Sensor for Fall Detection and Geographic Location

Fall detection capability is provided by a system based on a wearable sensor unit, a mobile application and a website. Each component can also be used independently.

The sensor unit is responsible for detection of falls and for creating alerts (Fig. 5). The sensor can also detect and characterize motion. It employs a communication module (e.g., Bluetooth Low Energy) (26), which will typically include an embedded processor (27), antenna (28) and BLE stack (29), although other hardware configurations can be used to enable the same function. A low power consumption mode is preferable (though not essential) in order to increase battery (30) life of the device. The sensor unit can be placed in a specific pocket (08) of the protection platform, a vest, or attached to a piece of garment through a standard button (Fig. 6).

The fall detection module comprises an accelerometer (31) and a microprocessor (27). For each measurement collected by the accelerometer, it connects to the microprocessor, and employs a pre-defined low pass filter to separate the acceleration components due to gravity and body motion from the measured signal. The first component is processed by a free-fall algorithm, to detect a person's free-fall, and signals when this situation happens. The other is a Signal Magnitude Area algorithm, which detects an increase of activity in all axes of the accelerometer and calculates the elder's posture. If the pattern of a fall is confirmed from these components, the microprocessor sends an alarm to the communication module, which in turns sends it to the smartphone application (Fig. 7). The sensor also includes two connectors (32) to program the microprocessor and the Bluetooth communication module.

In addition to the detection of falls, the sensor can be employed for monitoring physical activity and body posture like the acceleration and motion angles. For this purpose, it includes a gyroscope (33), which together with the accelerometer, provide detailed information on the user's motion and position. The physical activity, like acceleration and motion angles, together with body posture information is also relayed to the Application, and subsequently stored in the website database (Fig. 8).

The sensor was designed to be comfortable and minimally intrusive. It is lightweight and has a protective case (34), which features an on-off button (35) and a replaceable (36) battery casing (37). In the sensor case there are small holes for air circulation and cooling of the sensor (38). In the bottom part of the case, there are coupled parts for fixing the sensor (39, 40) to the protection platform and vest. A snap-fit locking mechanism is used to couple the two halves of the case (41, 42). The top part of the case also features a system for fixating the on-off button (43). In the printed circuit board button, a support is coupled (44) where the battery casing will be docked.

3.3 Smartphone Application

The Smartphone Application (Fig. 7) receives data from the sensor and alerts caregivers in the case of a fall. In addition, the application features all functions required to interact



Fig. 5. Sensor of falls detection and the operating system for fall alert

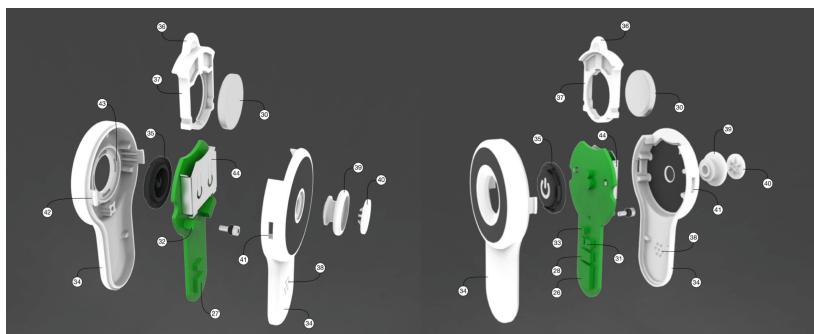


Fig. 6. Exploded view of the falls detection sensor with all of its components

with the systems, including (though not limited to): login configuration (46), configuration of alert contacts (47), fall notification (48), battery status notification (49), fall history (50), and synchronization with the website.

In the event of a fall, the application will also attempt to obtain the GPS (Global Positioning System) coordinates (51) for the smartphone (if the device has this capability), and include that information together with the fall alert. The alert, containing all pertinent data of the fall event, is sent via a text message, e-mail, or pre-recorded automatic call.



Fig. 7. Images with some features of the mobile application

3.4 Website

The website (Fig. 8) provides an access point for duly authorized users (e.g. caregivers, family members, or medical doctors) to access the information about monitored elders. It contains general information about the elder and associated sensors (52), as well as the medical profile (53) and the frequency with which falls have occurred (54). It features web services to communicate with the Smartphone Application and allows caregivers to analyze the fall history (55). The fall reports may include the date of the fall (56), the geographic coordinates where it occurred (57), the address of that location (58), also can directly link to a map showing the fall location (59).

Fig. 8. Images with some features of the mobile application

3.5 Vest

To allow using the sensor without wearing the protective platform, a unisex and comfortable vest was developed for placing the sensor near your chest (Fig. 9). Its shape was designed to be used during daily life activities, or even when exercising or playing a sport.

The vest is composed of elastic material and shaped in an “H” geometry (Fig. 9-right) using the same neck solution employed in the sweater (01) which covers the sternum on its front (60) and the vertebral area in its back (61). The lateral parts of the vest are comprised of four flaps (left and right) (62) between 30 and 150 mm which join the front and back in the abdominal region and are fixed by means of a Velcro® strap with an adjustable connector (63). This clamping system allows the vest to be adaptable to various body anatomies and can be dressed and undressed independently without the need for outside help. On the inside shoulders, two small pads, between 15 and 30 mm in width and between 40 and 70 mm in length, are glued (64), which increase the comfort in this region during a more intensive use of the vest.

As in the sweater, the vest also has a chest pocket for the sensor (08) that allows easy and effective placement of sensor. It comprises a semicircular geometry in the shape of a pocket (65) and that is thermo-bonded on the platform close to the chest of the user. Above the pocket there is a small hole (09) on the vest where the fixating part of the sensor will be inserted.

In the posterior and anterior lateral flaps are small holes (66), typically between 1 and 6 mm, directly cut into the material of the vest to provide improved air circulation between the skin and the vest, allowing the skin to breathe in these regions and thus providing optimum thermal comfort. This system is also applied on the back of the vest.

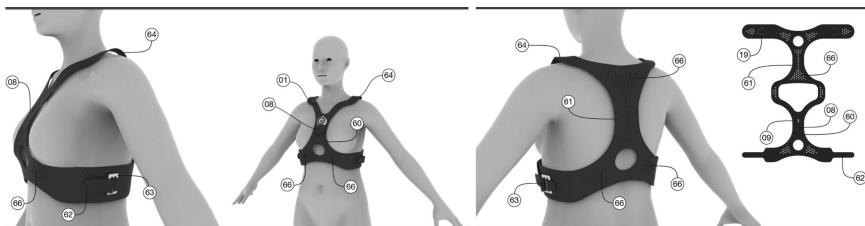


Fig. 9. Vest applied to a model with the sensor in the pocket and seen from behind.

4 Conclusions

The proposed method includes the effective participation of senior users in the design and development of solutions for physical protection and fall detection. However, participation had the most impact on the definition and characterization of the problem of falls in the elderly and in the transformation of the problems into real needs. The subsequent two phases, identification of key stakeholders and validating if the scope of need is appropriate, were executed by the development team without user involvement. In the

phases of requirements definition and generation of solution concepts, the participation of users was again very active, which in our view allowed the development of a solution that meets the real needs of the target population.

The solution described in this paper aims to reduce the risk of bone or articular fractures and injuries when a fall occurs. Also aims to improve faster active assistance in the event of a fall, as it is capable of alerting caregivers if a fall is detected. In a more subjective and qualitative way, this solution aims to contribute to the increasing levels of autonomy and quality of life of seniors, as well as promote active aging.

The team is preparing a validation test of the described products to obtain qualitative and quantitative data that allows improving the solutions. This test will be performed with functional prototypes of the products in real environment of use, with a group of both male and female seniors. Those results will be published in the future. The validation phase with real users will be the eighth phase of the proposed method.

Acknowledgments. Project PT21, n.º 13848, co-financed by the European Community Fund FEDER through COMPETE – Programa Operacional Factores de Competitividade (POFC). Foundation for Science and Technology (FCT) through UIDB/05256/2020 and UIDP/05256/2020, and programmatic funding of ID+.

References

1. Commission of the European Communities. Design as driver of user-centred innovation. Brussels: Commission Staff Working Document, SEC (2009) 501 final (2009)
2. Goldsmith, T.C.: Aging theories and their implications for medicine. June, Rev. 4/2008. Accessed April 2010 (2006). em: http://www.azinet.com/aging/anti-aging_medicine.pdf
3. Wichert, R., Norgall, T.: Aging naturally without being old – Technical solutions for social challenges. Essen: Universal Design: Best Pratice V. 1, Reddot edition, Verlag (2009)
4. Population Division of the Department of Economic and Social Affairs of the United Nations Secretariat, Word Population Prospects: The 2008 Revision, <http://esa.un.org/unpp>
5. Grabiner, M., et al.: Trunk kinematics and fall risk of older adults: translating biomechanical results to the clinic. *J. Electromyogr. Kinesiol.* **18**, 197–204 (2008)
6. Scheffer, A., Schuurmans, M., Dijk, N., Hooft, T., Rooij, S.: Fear of falling: measurement strategy, prevalence, risk factors and consequences among older persons. *Age Ageing* **37**, 19–24 (2008)
7. Peterson, E., Cho, C., Koch, L., Finlayson, M.: Injurious falls among middle aged and older adults with multiple sclerosis. *Arch Phys. Med. Rehabil.* **89**, 1031–1037 (2008)
8. Fletcher, P., Guthrie, D., Berg, K., Hirdes, J.: Risk factors for restriction in activity associated with fear of falling among seniors within the community. *J. Pacient Saf.* **6**(3), 187–191 (2010)
9. McClure, R., et al.: The population approach to falls injury prevention in older people: findings of two community trial. *BMC Public Health*, vol .10 p. 79. Accessed <http://www.biomedcentral.com/1471-2458/10/79> (2010)
10. Hayes, W.C.; Myers, E.R.; Robinovitch, S.N.; Van Den Kroonenberg, A., Courtney, A.C., McMahon, T.A.: Etiology and prevention of age-related hip fractures. *Bone* **18**(1), s77–s86 (1996).
11. Coimbra, A., Ricci, N., Coimbra, I., Costallat, L.: Falls in the elderly of the family health program. *Arch. Gerontol. Geriatr.* **51**(3), 317–322 (2010)

12. Yu, P., et al.: Prevalence and related factors of falls among the elderly in a urban community of Beijing. *Biomed. Environ. Sci.* **22**, 179–187 (2009)
13. Oliver, D., Healey, F., Haines, T.: Preventing falls and fall – related injuries in hospitals. *Clin. Geriatr. Med.* **26**(4), 645–692 (2010)
14. Stevens, J., Olson, S.: Reducing falls and resulting hip fractures among older women. *Home Care Provid.* **5**(4), 134–141 (2000)
15. Nyan, M., Tay, F., Mah, M.: Application of motion analysis system in pre-impact fall detection. *J. Biomech.* **41**, 2297–2304 (2008)
16. Bonnemaison, S., Macy, C.: Responsive Textile Environments. Canadian Design Research Network, Tuns Press, Canada (2007)
17. Zieba, J., Frydrysiak, M.: Textronics: Electrical and electronic Textiles. Sensors for Breathing Frequency Measurement. Lódz: Department for Automation of Textiles Processes, Faculty of Textile Engineering and Marketing Technical University of Lódz (2006)
18. Luprano, J., Caros, J., Ridolfi, A., Pasche, S., Gros, B.: New generation of smart sensors for biochemical and bioelectrical applications. Centre Suisse d'Electronique et de Microtechnique, SA, Neuchâtel (2007)
19. Kang, T., et al.: Sensors on Textiles Substrates for Home-Based Healthcare Monitoring. D2H2. 1st Transdisciplinary Conference on volume, Issue, 2–4 April (2006)
20. Smartlife HealthVest. In Smartlife Technology Ltd. homepage. Accessed December 13, 2009. <http://www.smartlifetech.com/technology/Health-Vest-/>
21. Luprano, J.: Biotex: Bio-Sensing Textile for Health Management. Biotex Project Office, CSEM Centre Suisse d'Electronique et de Microtechnique, SA, Neuchâtel (2006)
22. Vital Jacket. In Biodevices homepage. Accessed 9 Jan 2010. <http://www.biodevices.pt>
23. NuMetrex Cardio Shirt. In Numetrex homepage. Accessed 5 Dec 2009. <http://www.numetrex.com/about/cardio-shirt>
24. Brownell, B.: Transmaterial: A catalog of Materials that Redefine our Physical Environment. Princeton Architectural Press, New York (2006)
25. D3o. In d3o homepage. Accessed 19 Jan 2010. <http://www.d3olab.com>
26. Dow Corning Active Protection System. Accessed 24 May 2010. <http://www.activeprotectionsystem.com>
27. SafeHip Select Protection, Tytex Group. Accessed 7 May 2012. <http://www.safehip.com>
28. Posey Hipsters® Standard Brief, Posey Healthcare Products. Accessed 7 May 2012. <http://www.preventproducts.com>
29. GeriHip® Hip Protector Set of Brief & Pads, Prevent Products. Accessed 7 May 2012. <http://www.preventproducts.com>
30. EVX V Shoulder Pads, da Kooga Rugby – Rugby Boots, Shirts, Jerseys, Shorts. Accessed 8 May 2012. <http://www.kooga-rugby.com>
31. HexPad®Thudd Short with Extended Thigh, da McDavid Inc. Accessed 8 May 2012. <http://www.mcdavidusa.com>
32. Shockskin™ 5-Pad Sleeveless Impact Shirt, da ShockDoctor. Accessed 8 May 2012. <http://www.shockdoctor.com>
33. Spine Ergo, da POC Sports. Accessed 9 May 2012. <http://www.pocsports.com>
34. Spine VPD Tee, da POC Sports. Accessed 9 May 2012. <http://www.pocsports.com>
35. Hip VPD 2.0 Shorts, da POC Sports. Accessed 10 May 2012. <http://www.pocsports.com>
36. URB-1801 Chest Guard, da Urwa Industries. Accessed 10 May 2012. <http://www.urwaind.com>
37. Korpertech Body Armour, da BlitzSports. Accessed 10 May 2012. <http://www.blitzsport.com>
38. Model 71 Fragmentation, da Mars Armor. Accessed 10 May 2012. <http://www.marsarmor.com>
39. Ballistic Elbow and Knee Pads, da Point Blank. Accessed 10 May 2012. <http://www.pointblankarmor.com>

40. Terroso, M., Rosa, N., Torres Marques, A., Simoes, R.: Physical consequences of falls in the elderly: a literature review from 1995 to 2010. *Eur. Rev. Aging Phys. Act.* **11**(1), 51–59 (2013). <https://doi.org/10.1007/s11556-013-0134-8>
41. Zenios, S., Makover, J., Yock, P.: *Biodesign: The Process of Innovating. Medical Technologies*. Cambridge University Press, Edinburgh (2010)
42. Bonsiepe, G.: *Teoria e prática do design industrial*, 2a edn. Portuguese Edition, Portuguese Design Center, Lisbon (1992)
43. Page, A., Porcar, R., Such, M.J., Solaz, J., Blasco, V.: *Nuevas Técnicas para el Desarrollo de Productos Innovadores Orientados al Usuario*. Institute of Biomechanics of Valencia, Valencia (2001)
44. Ulrich, K.T., Eppinger, S.D.: *Product Design and Development*. McGraw-Hill higher Education, New York (2000)
45. Terroso, M., Marques, A.T., Simoes, R.: Bio-inspired design process in the development of human joint protections for seniors. In: *Proceedings of 3rd International Conference on Integration of Design, Engineering & Management for Innovation*, Porto, Portugal (2013)
46. Marques, M., Terroso, M., Freitas, R., Marques, A.T., Gabriel, L., Simoes, R.: A procedure for machanical evaluation of an undefined osteo-protective material. *Accid. Anal. Prev.* **75**, 285–291 (2015)



Inter ‘Face-To-Face’: Remote Co-creation for an Artifact

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Abstract. In times of uncertainty regarding the viability of collaborative and face-to-face research work with the Portuguese footwear industry, due to the circumstances of physical distance such as the one we are experiencing at present, this article aims to demonstrate a two-stage methodological strategy for a co-creation process via remote, as well as its limitations and future work. In this context, two questions arise that we intend to answer: How can co-creation work be carried out remotely with participants from different organizations? What are the advantages and disadvantages of this remote co-creation work? To answer these questions, in a first phase there is a study based on the literature review, comparing studies by authors on the advantages and disadvantages of virtual meetings compared to face-to-face meetings; and, in a second phase, emphasized by the experimentation of a co-creation work for an artifact, with master’s degree students in Image Design, were used Zoom audiovisual interface and collaborative online platform Miro. It’s argued, therefore, that the virtual encounters of a co-creation process for an artifact can, on the one hand, provide geographical and temporal advantages to the participants, on the other hand, provide technical difficulties that can create expected losses of efficiency. Since this whole process is primarily motivated by the current circumstances of confinement, due to the pandemic COVID-19, it is understood that the advantages of co-creation via remote will continue in the future, even in more favorable contexts.

Keywords: Remote Co-creation · Interfaces · Artifact · Design research · Footwear industry

1 Introduction

In these times of pandemic COVID-19 there was an urgent need to master remote communication, through audiovisual interfaces, in a worldwide spread. We are talking about virtual communication, where each person’s space is conditioned to a window through interfaces via online, and in which there are interactions of the participants in these virtual places.

Here a question arises, and which this article aims to expand, to what extent do these virtual meetings facilitate or affect communication?

This study intends to focus on the integration and communication of the participants, in the context of virtual meetings, unraveling for a mutual understanding of their new technological knowledge. After a first year of general confinement due to the pandemic, part of the world population inevitably used some of these audiovisual interfaces - Skype, Zoom, Whereby, Teams - or even collaborative online platforms - Miro, Mural, Slack. However, these meetings in virtual places can be unfavorable to an informal and spontaneous relationship of the participants - compared to a face-to-face meeting - and, which would be expectedly promoted by a face-to-face and social interaction.

Nevertheless, on this study we are going to discuss the efficiency of the form of communication currently in force remotely; and, in an article subsequent to this study, compare it with the efficiency of face-to-face communication.

2 Methods

In a first phase, we will analyze and expand this study through a literature review, either by understanding and naming certain concepts and practices - remote co-creation - and with this information to support the choices foreseen for this study. This is a phase in which a methodological strategy based on virtual meetings is dissect, as an interlocutor for co-creation work, with a result in the form of an artifact, device, or toolkit.

In a second phase, emphasized by experimentation, skills are gathered to create a poster for a phase of the research process - also collaboratively and remotely - as a test for future brainstorming and focus group, in remote co-creation with a multidisciplinary team in the footwear industry. At this test phase, was used the Zoom as audiovisual interface and the Miro as collaborative online platform, with master's degree students in Image Design (Faculty of Fine Arts of the University of Porto) for the realization of an imagery language, in the form of a poster, of this future stage of co-creation with the industry.

Through these two phases, we will find the answers to these questions: How can co-creation work be carried out remotely with participants from different organizations? What are the advantages and disadvantages of this remote co-creation work?

3 Literature Review

At this phase of the study are analyse interpellations by authors that corroborate advantages and disadvantages: *where to do*, on which virtual meetings are compared to the face-to-face meetings [1–7]; *how to do*, to promote a co-creation experience between teams [8–12]; and *what to do*, of an artifact that participants can be co-authors [13–15]. In the ambivalence of the terms and concepts, it's intended to differentiate the theories to be applied in the later phase of this article, in the experimentation.

3.1 Where to Do

In the literature review, we found a rise of a new open paradigm of work and innovation, making connection with cultural economic geographies of working, collaborating and sharing [1]. It's intended to clarify on this phase the different perspectives regarding a physical space, a flexible workspaces and a remote working, understand the advantages and disadvantages of methodologies based on a workplace.

Physical Space. New ideas come from seeing, smelling, hearing - being there. This sensory immersion is why people still fly to other places for face-to-face meetings with clients, customers, and colleagues, even in the information age; why phone or videoconferencing often doesn't do it [2]. According this comparation between virtual, physical and social places, virtual places cannot replace the face-to-face communication necessary for tacit knowledge sharing [3]; and people prefer communicating complex information face-to-face rather than digitally [4].

Co-workspace. Co-working spaces are framed as experimental spaces of chance encounter [16], that facilitate a collaborative work environment and facilitates conditions for networking and knowledge-sharing. There is an emerging open paradigm of work and innovation, through co-working spaces that promote externalisation of knowledge and the sharing of innovation practices [1]; even existing an language of open ‘platforms’ and ‘ecosystems’ [17].

Those who set up and convene such spaces do so not primarily for economic reasons, but from a genuine commitment to the ethical principles of co-working: collaboration, mentorship and skill-sharing [18].

Virtual Place. One of the advantages of remote interviews is that participants can be interviewed from the comfort of their own homes. In the section about nonverbal cues, we even considered how important the choice of location can be for the presentation of self, which in itself could generate useful data. Although this is a big advantage, it can also have a downside, in that the researcher lacks control over the participant’s physical environment during online interviews, which has implications for confidentiality. The volunteer will often choose her/his own environment and this might sometimes be someone’s bedroom or other personal space, or a public space [5].

In order to understand where, how and what are the best procedures that the participants of a remote communication should follow, according to Seitz in her study about qualitative interviews via Skype, recomended strategies including confirming a stable internet connection, finding a quiet room without distractions, slowing down and clarifying talk, being open to repeating answers and questions, and paying close attention to facial expressions [6].

3.2 How to Do

It's intended to clarify at this stage the different perspectives regarding their denomination, which is sometimes mistakenly designated, and therefore dissimilar, of co-creation, co-design and participatory design. The co-creation fosters a participatory mentality of

users and stakeholders, from the beginning of a project's development process to its implementation in the market [8, 9]; the co-design integrates the performance of users, through design methods and tools, at a certain point in the creative process [19–21]; the participatory design promotes the integration and participation of users at a certain stage in the process of developing a project [22–24].

Co-creation. Aims to involve a group of people - or work team with the same purpose - in any project where these people can share their opinion with other participants and influence the process or the final result of that project. In this sense, it is intended to understand ways of communication and collaboration, for a greater efficiency of co-creation work.

Co-creation sessions or activities should involve companies, users, stakeholders, academics and designers, that is, participants focused on innovation and design. In the book “The Field Guide to Human-Centered Design” reinforces that the purpose of a co-creation session is to convene a group of people from the community you’re serving and then get them to design alongside you. The goal is not just hearing their voices but empowering them to join the team [25]. The earlier co-creation activities are deployed in the design development process, the more impact it may have in successively creating value in all stages [9].

Co-design. The term co-creation is used to refer to “any act of collective creativity, i.e. creativity that is shared by two or more people”, and the term co-design is used in a more narrow sense to refer to the “collective creativity as it is applied across the whole span of a design process”. With focus on co-design in this narrower sense, that is, on creative cooperation during design processes—rather than on the co-creation, which also refers to creative cooperation during service delivery and usage, for example, to interactions between customers and service provider at service touch points [8]. Although, that it cannot be based on the assumption that all participants in the co-creation process have high technical and visualization capabilities [21].

Co-design is referred to as a cooperative creative activity, applied throughout the entire design process. By these definitions, co-design is a distinctive part of co-creation. For a co-design session to take effect, stakeholders must be given the appropriate tools [21]. Following this definition, the main benefit of the practice of co-design is to help organize joint creativity; through creative workshops, participants can explore and articulate a set of latent needs.

Participatory Design. While co-design promotes the teaching of skills and tools to users in a design process, in turn, participatory design emphasizes yet another factor of global involvement in the project; both of which are part of a user-centered design.

The design resulting from the participatory process can be regarded as a form of conversation among the designer and distinct stakeholders. These conversations facilitate collective learning and the alignment of objectives, as well as design expectations in a participatory conceptualization process [23].

Articulating various participatory design methods and practices, and articulating a range of benefits, such as: improving mutual learning and understanding, combining and integrating different people’s ideas, enhancing communication and cooperation between different people, and joint creation of new ideas [24].

3.3 What to Do

In the literature review, we found different terms to define something similar, all with the purpose of helping the user to perform a specific activity - we talk about an artifact, device, or toolkit. The terminology mentioned here is sometimes applied in an equivocal manner, due to the broad and subjective understanding that these terms contain.

Artifact. When viewed in isolation, an artifact can say very little or remain highly ambiguous. In fact, this ambiguity is intentional, as it creates opportunities for creativity, expression and discussion. The meaning of the artifact is revealed through stories told about it and the context in which it plays a role [26].

In this sense, artifacts are not mere instruments, but bearers of meaning, as well as facilitators and transformers of human action [27]. According to these bearers of meaning, a product or artifact, be it a prototype, manufactured object, or document has an informational set to be matched and tested against human interpretation [28].

The final design solution should not be presented as an artifact in isolation, but as an integrated product and service concept which anticipates future user needs, builds future proposals and encourages feedback [14].

Device or Apparatus. In a direct comparison between the terminologies under discussion, Sánchez Perera & Andrada de Gregorio state that although every device is an artifact, not every artifact is a device or a gadget. For the authors, devices are data storage units, like the prototypical hard drive, while artifacts are any objects designed to perform a specific function, usually to extend the material limits of the body [29].

The term apparatus means a kind of a formation that at a given historical moment has its major function the response to an urgency. The apparatus therefore has a dominant strategic function [30]. The devices will not be specifically a certain technology, a certain law, or a generality obtained by their abstraction, but as Agamben reinforces, quoting the philosopher Michel Foucault, the apparatus itself is the network that is established between these elements [30].

Further expanding the already large class of “Foucauldian” apparatuses, should be called an apparatus literally anything that has in some way the capacity to capture, orient, determine, intercept, model, control, or secure the gestures, behaviors, opinions, or discourses of living beings [30].

Toolkit. If it’s understood that the entire device is an artifact, can it also be said that the entire toolkit is an artifact? Through an “artifact-tool” can be obtained an “artifact-result”?

Toolkits are composed of a variety of components and are specifically confirmed for each project domain. People use the components of the toolkit to make artifacts about or for the future. Participants use toolkits to make expressive artifacts, discussing and coding them, creating and evaluating prototypes, often in iterative cycles [26]. For a set of components in a toolkit, people select from the components in order to create artifacts that express their thoughts, feelings and/or ideas. The resulting artifacts may be in the form of collages, maps, stories, plans, and/ or memories [31].

Thus, these methods and toolkits give people - designers and non-designers - the ability to do “things” that describe objects, concerns or future opportunities [26]; and in

this sense, a toolkit is a design interface which enables trial and error experimentation and gives simulated feedback on the outcome [32].

4 Experimentation

For the experimentation phase, it was intended to test a remote co-creation work, between master's degree students in Image Design (Faculty of Fine Arts of the University of Porto) and the researcher (PhD student in Design for the same institution). This collaborative work was provided by the Research Communication Workshop, organized by Santiago Mourão (PhD student in Design at Faculty of Fine Arts of the University of Porto), between 1st and 5th of March, 2021.

Initially, a briefing in the form of text and video was provided by the researcher, and two master's degree students, Marília Santos and Igor Oliveira Prado, were chosen at random to work on this proposal. The challenge was to develop an imagery language, through visual representations, for a stage of the doctoral research in progress by the researcher. In this stage, co-creation work is foreseen with a multidisciplinary team - product designer, footwear designer, graphic designer, design director, CEO, engineer, production director - through interviews, brainstorming and focus group methodologies; where the requirements for the elaboration of a toolkit to be supplied later to the Portuguese industry would be found.

The team formed between master students and researcher that reconciles the areas of fine arts - design - photography - video, was a guarantee for a fusion of ideas and unexpected solutions. Although this is an introductory work, using the methods of brainstorming and experimentation, it served as a motto for a co-creation work with unexpected and useful final results for the ongoing doctoral research.

This collaborative work was carried out remotely, using Zoom (see Fig. 1) for brainstorming as an audiovisual interface, and the collaborative online platform Miro (see Fig. 2) for experimenting with illustration, photography, collage and writing. On this platform were used (virtual) post-its for formulating ideas, identifying key themes; images of their own and of other authors were inserted to visually direct these ideas; thus finding patterns over the three consecutive days of experimentation work.

The final result titled *Inter'face-to-face'*, in poster format (see Fig. 3), represents the fusion of parts of hypothetical faces of footwear industry participants - from product designer, footwear designer, graphic designer, design director, CEO, engineer, production director - as an outcome that serve as pretext for discussion on the research topic of remote co-creation and will serve for the purpose of an introductory poster for the various brainstorming and focus group, to be carried out later with a multidisciplinary team of the footwear industry.

Although initially a final result could not be imagined, the briefing expectedly provided an ambiguity of possible results of visual representations, in the openness and receptivity intrinsic to the co-creation work between the master's degree students and the researcher.

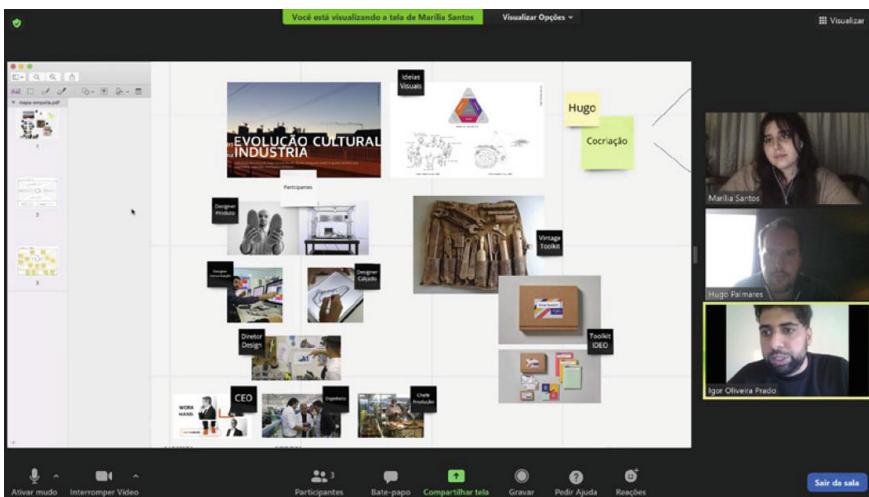


Fig. 1. Videoconference, via Zoom, of the co-creation work between master's degree students and researcher.

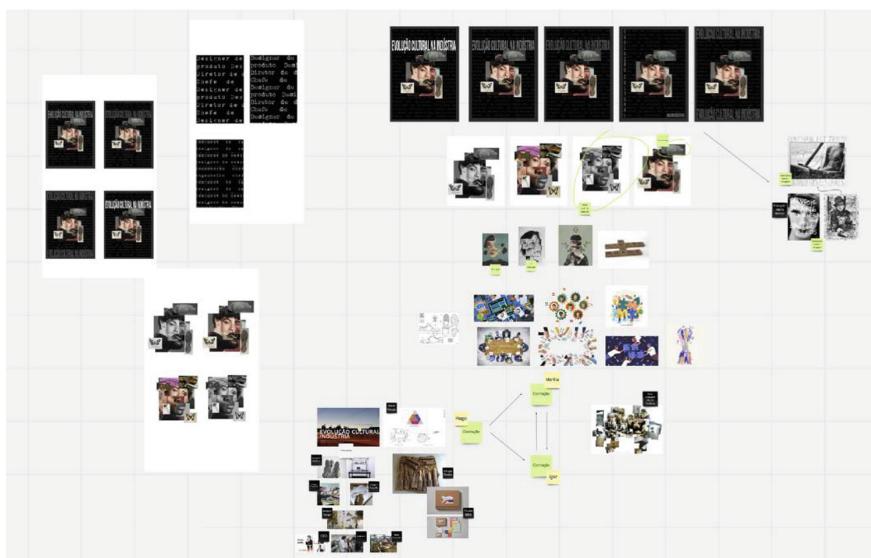


Fig. 2. Co-creation work through the online platform Miro, during three consecutive days.

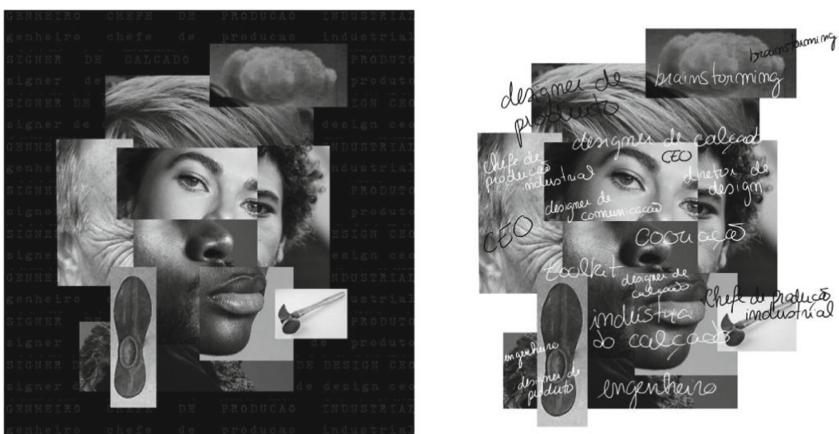


Fig. 3. Final result validated by the working group, titled *Inter'face-to-face'*.

5 Conclusions

Answers were found to the questions raised by this study about the remote co-creation, the work was carried out with participants without experience in the collaborative online platform Miro, however the productivity of the work on this interface was helpful for the co-creation process; and, the Zoom interface was used for brainstorming that were well processed and facilitated the remote work.

To mention the advantages and disadvantages of this remote co-creation work: on the one hand, the motivation and commitment of the work team was evident, also encouraged by the remote conditions that the participants were in, thus having the possibility of immediate (virtual) contact and feedback about the evolution of the work; on the other hand, the technical limitations were noted at the level of manual experimentation, instead of a work carried out only through digital tools. It thus proves that the virtual meetings for the co-creation of an artifact can provide geographical and temporal advantages to the participants; nevertheless, provide technical difficulties that can create losses of creativity and/or expected efficiency.

In this investigation we identified a gap to the fact that this co-creation work was done outside the context of the footwear industry, as we understood this study as pre-field study phase. In a stage subsequent to this study, the research will be carried out with participants exclusively from the Portuguese footwear industry, with the precaution that participants may not favorably master the digital tools demonstrated here.

It should be noted that this investigation results with focus on the footwear industry can be applied to other similar industries when it comes to remote co-creation.

Since this whole process is primarily motivated by the current circumstances of confinement, due to the pandemic COVID-19, it is understood that the advantages of co-creation via remote will continue in the future, even in more favorable contexts.

Acknowledgements. Research funded by Foundation for Science and Technology (FCT) - Grant: 2020 08088 BD; ID+ Research Institute for Design, Media and Culture; Heitor Alvelos (Ph.D.)

in Design Director, University of Porto); Santiago Mourão (Research Communication Workshop Organizer); Marília Santos and Igor Oliveira Prado (master’s degree students, University of Porto).

References

1. Lorne, C.: The limits to openness: Co-working, design and social innovation in the neoliberal city. *Environ. Plann. A Econ. Space* **52**(4), 747–765 (2020)
2. Kelley, T., Littman, J.: *The Art of Innovation: Lessons in Creativity from IDEO, America’s Leading Design firm*. Currency/Doubleday, New York (2001)
3. Nenonen, S.: The nature of the workplace for knowledge creation, PhD dissertation, Research Reports from Turku Polytechnic, No. 19, Helsinki University of Technology, p. 83 (2005).
4. Wagner, J., Watch, D.: *Innovation Spaces: The New Design of Work*. Brookings, April (2017)
5. Lo Iacono, V., Symonds, P., Brown, D.H.K.: Skype as a Tool for Qualitative Research Interviews. *Sociol. Res. Online* **21**(2), 12 (2016)
6. Seitz, S.: Pixilated partnerships, overcoming obstacles in qualitative interviews via Skype: a research note. *Qualitative Research*, pp. 1–7 (2015)
7. Riordan, N. O., Frédéric, A., Reilly, P. O: Innovation co-creation in a virtual world. In: ECIS 2012 Proceedings, p. 191 (2012)
8. Sanders, E.B.N., Stappers, P.J.: Co-creation and the new landscapes of design. *CoDesign* **4**(1), 5–18 (2008)
9. Sanders, L., Simons, G.: A Social Vision for Value Co-creation in Design (2009). <http://timreview.ca/article/310>
10. Kohler, T., Fueller, J., Matzler, K., Stieger, D., Füller, J.: Co-creation in virtual worlds: the design of the user experience. *MIS Q.* **35**(3), 773–788 (2011)
11. Mileck, L.H.S., Padovani, S.: Cocriação no mercado: um estudo exploratório de processos criativos de empreendedores. *Strateg. Des. Res. J.* **8**, 74–82 (2015)
12. Sjödin, D., Parida, V., Kohtamäki, M., Wincent, J.: An agile co-creation process for digital servitization: a micro-service innovation approach. *J. Bus. Res.* **112**, 478–491 (2020)
13. Harwood, T., Garry, T.: ‘It’s Mine!’ - Participation and ownership within virtual co-creation environments. *J. Mark. Manag.* **26**(3–4), 290–301 (2010)
14. Bucolo, S., Matthews, J.H.: Design led innovation: exploring the synthesis of needs, technologies and business models. In: Proceedings of Participatory Interaction Conference. Sønderborg, Denmark (2011)
15. Mariano, S., Awazu, Y.: The role of collaborative knowledge building in the co-creation of artifacts: influencing factors and propositions. *J. Knowl. Manage.* **21**(4), 779–795 (2017)
16. Hutter, M., Farías, I.: Sourcing newness: ways of inducing indeterminacy. *J. Cult. Econ.* **10**(5), 434–449 (2017)
17. Nambisan, S., Siegel, D., Kenney, M.: On open innovation, platforms, and entrepreneurs. *Strateg. Entrep. J.* **12**(3), 354–368 (2018)
18. Morgan, G.: Meaning and soul: co-working, creative career and independent co-work spaces. In: Taylor, S., Luckman, S. (eds.) *Pathways into creative working lives*. Springer, Cham, pp. 139–158 (2020). https://doi.org/10.1007/978-3-030-38246-9_8
19. Sanders, E.B.N.: From user-centered to participatory design approaches. In: Frascara, J. (ed.) *Design and the Social Sciences: Making Connections*, pp. 1–8. Taylor & Francis, London (2002)
20. Steen, M., Manschot, M., De Koning, N.: Benefits of co-design in service design projects. *Int. J. Des.* **5**(2), 53–60 (2011)

21. Ali, A., Liem, A.: The use and value of different co-creation and tools in the design process. In: Proceedings of the International Conference on Engineering Design, vol. 3, pp. 80–03 (2015)
22. Schuler, D., Namioka, A.: Participatory Design: Principles and Practices. Lawrence Erlbaum Associates, Hillsdale (1993)
23. Park (2012) quoting In: Ali, A., Liem, A.: The use and value of different co-creation and tools in the design process. In: Proceedings of the International Conference on Engineering Design, vol. 3, pp. 80–03 (2015)
24. Muller, M.J.: Participatory design: the third space in HCI. In: Jacko, J., Sears, A. (eds.) The Human-Computer Interaction Handbook: Fundamentals, Evolving Technologies and Emerging Applications, pp. 1051–1068. Lawrence Erlbaum Associates, Mahwah (2002)
25. IDEO: The Field Guide to Human-Centered Design. IDEO.org/Design Kit. Paperback: 1st Edition (2015)
26. Sanders, E.B.N., Stappers, P.J.: Probes, toolkits, and prototypes: three approaches to making in codesigning. *CoDesign* **10**(1), 5–14 (2014)
27. Broncano, F.: In media res: cultura material y artefactos. *ArteFactos*, pp. 18–32 (2008).
28. Hanington, B.: Methods in the making: a perspective on the state of human research in design. *Des. Issues* **19**(4), 9–18 (2003)
29. Sánchez Perera, P., Andrada de Gregorio, G.: Dispositivos, prótesis y artefactos de la subjetividad cíborg. *Revista de Estudios de Juventud*, vol. 102, pp. 41–54 (2013)
30. Agamben, G.: What is an Apparatus? And Other Essays. Stanford University Press, Stanford (2009)
31. Sanders, E.B.N.: Generative tools for co-designing. In: Scrivener, S.A.R., Ball, L.J., Woodcock, A. (eds.) Collaborative Design, pp. 3–12. Springer, London (2000) https://doi.org/10.1007/978-1-4471-0779-8_1
32. Franke, N., Piller, F.T.: Value creation by toolkits for user innovation and design: the case of the watch market. *J. Prod. Innov. Manage.* **21**(6), 401–415 (2004)



Id.Med - An Inclusive System to Identify Medical Drugs

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Abstract. The use of medical drugs is common and transversal. In order to improve the quality of life, a large number of people daily take some sort of medication. However, the information contained in lots of drugs packages, does not allow either the easy identification or the function of the drug contained. This problem is more common on groups that, due to their clinical condition (such as colorblind), education level (illiterate) or even age (elderly), have greater difficulty in distinguishing.

Thus, it is desired that the packages have an effective and direct form of communication, allowing those who use them, to have an easy and immediate comprehension, in order to avoid errors in its intake and consequently diseases or side effects caused by these accidents.

The current investigation, based on quantitative and qualitative methodologies, aims the creation of a duly sustained and proven system, either with the existing theory and the analysis of questionnaires and tests directed to the target audience, thus assuring its concept and form of construction.

The Id.Med, suggests a medical drug identification system all-inclusive to the entire population. A code of symbols is set on drug packaging, that through three identifying elements - pictograms, acronyms and colours - is easily understood by its users.

This investigation contributes to the knowledge of Design in health areas. A theme that is poorly explored, since design in health areas is seen as a secondary aspect of its process. However, it's important to keep in mind that design can also contribute to the well-being of the population.

Keywords: Communication and graphic design · Medication packaging · Identification system

1 Introduction

Medical drugs are seen as an essential benefit for health, an important tool for medical professionals, and contributes to the increase of the average life expectancy and quality of life of the populations.

With an increased use of medical drugs, there are gaps in the information on the current packaging, making it difficult to identify them. Proper identification and understanding of the information about these drugs is essential for an effective use and avoid errors or swaps in its consumption.

This paper follows upon a master thesis project, within the scope of Graphic, Communication and Inclusive Design, where this problem was deeply research and also, addresses the referred problem, which is not always recognized and can lead to medication errors (with a consequent worsening of health status), namely: the difficulty in identifying medical drugs packaging.

Drugs are mostly consumed by the elderly (individuals over 65 years old), but also by disabled people or with psychiatric disorders. In addition, considering the low level of education of many of the Portuguese population, we quickly realized the difficulty that exists in decoding the medical drugs packaging.

This difficulty, in the identification, is also associated with the similarity of the design of medical drugs packaging and the lack of specific or highlighted information.

Thus, the key question - which will guide the narrative and graphic structure of this investigation and is intended to be answered clearly and successfully is:

- How to create an identification system for medical drugs easily decoded by the entire population?

This study, aims to develop codes that help the distinction of various medical drugs for the general population and, particularly those groups with certain pathologies or with low literacy. Preventing errors in the consumption of the drugs, the appearance of side effects/serious illnesses are purposes of the study, as well improving the trust relationship between the doctor and/or pharmacist and the user.

2 Literature Review

To develop this research, an exhaustive survey of primary and secondary sources was made which, together with the questionnaires conducted to pharmacists and the proofs of concept carried out to the target audience, supported and validated the final result. In this document, it will be presented the most relevant issues for the understanding of the subject and its outcome. Nevertheless, more information can be seen in the Master's Thesis *Id.Med - Um Sistema de Identificação de Medicamentos Inclusivo* (Id.Med - An Inclusive Medical Drugs Identification System) [1].

Based on the research carried out and the support of health professionals, it was found that medical drugs can be organized by the nature of the disease, i.e., on what they work on. It is possible to divide them into sixteen types:

- Antibiotics/antibacterials: fight bacterial infection;
- Antifungals: prevent, inhibit or destroy the proliferation of fungi;
- Antivirals: act on viruses;
- Antiparasitic: eliminate parasites;
- Analgesics: eliminate or relieve pain;
- Anti-inflammatory: treat inflammation of tissues and their symptoms (pain and fever);
- Medical drugs that act on the central and peripheral nervous system;

- Medical drugs that act on the cardiovascular system;
- Medicines that act on the blood;
- Medical drugs that act on the respiratory system;
- Medical drugs that act on the digestive system;
- Medical drugs that act on the genitourinary system;
- Medical drugs that act on the hormonal system;
- Medical drugs that act on the locomotor system;
- Antiallergic drugs;
- Nutricon drugs.

The administration of medication is guided by doctors or pharmacists to prevent wrong ingestion. Pharmacists also have the role of educating users in a clear way, to combat risky attitudes and improve health care. The information must be personalized according to the culture, physiological or pathological status of each user [2].

Pharmacists should try to eliminate serious problems that may occur during the entire medication process. However, “the system is not always sufficiently safe, with errors occurring that may or may not cause harm to the patient.”¹ [3]. Outside the pharmacy, errors which pharmacists are unaware of and cannot fight can happen.

Health literacy is important to identify medications and to take them accurately. Reis, in his dissertation *O conhecimento sobre o medicamento e a literacia da saúde* (Knowledge about the medicine and health literacy) [4], concluded that “The factors that explain the variation in the level of knowledge about the medicine are the level of education, the index of understanding of the information and the frequency of reading health or medication information.”² [5]. Respondents to this dissertation showed that they had knowledge only of the medical drugs they consume, revealing difficulties when new drugs are added to their regimen. Thus, the same author reveals the importance of reinforcing the information provided by pharmacies, which is better understood and more sought after by users when they need information about medical drugs. “Reading health information is, in terms of health literacy, the most associated dimension, so the production of written information materials is justified and should be guided by the ease of use.”³ [6].

For the development of this Id.Med investigation, the population that consumes medical drugs was considered the target audience, but to guarantee the inclusiveness of the project, the characteristics of three groups were studied, since they revealed to have more difficulty in decoding a product:

- In the elderly, there is visual difficulty and memory degradation due to the interference of knowledge already stored with that knowledge obtained at the moment - interference

¹ o.v. (original version): “nem sempre o sistema é suficientemente seguro, ocorrendo erros que podem ou não, causar danos ao paciente.”.

² o.v.: “Os fatores que explicam a variação do nível de conhecimento sobre o medicamento são o grau de escolaridade, o índice de compreensão da informação e a frequência de leitura de informação sobre saúde ou medicamento.”.

³ o.v.: “leitura de informação sobre saúde é, em termos de literacia da saúde, a dimensão mais associada pelo que a produção de materiais informativos escritos se justifica e deve orientar-se pela facilidade da sua utilização.”.

caused by the increase in the time to process new information [7]. This prevents the use of very small symbols or that are difficult to understand.

- Illiterates are individuals who over the age of 10 (age of primary basic education), do not know how to read or write [8]. For those it is impossible to use written information.
- Colorblind people have a visual disturbance that does not allow them to distinguish all colors [9]. It prevents the use of nearby colors or shades.

Blindness could also be seen as a constraint. However, using braille (tactile writing system) as secondary support, would be a next step and something to be studied in another phase of the project.

Then, the medical drugs packaging and its design problems were studied. Despite being regulated by INFARMED (National Authority of Medicines and Health Products, I.P), there are several authors who recognize that the design of medical drug packaging is associated with uncertainties, confusion and daily difficulties to its consumers.

Packaging and blisters have problems in their communication, being one of the main causes of medication mismanagement. Most of these packages have the same shape and color, making their identification difficult (see Fig. 1), especially when taking several medications, in which all are similar [10]. Yet, changing the design of medical drugs packaging is not a simple and/or an easy process. “Design management that considers the systemic view presupposes that any change in components of the product system mutually affects all levels of the process.” [11].



Fig. 1. Similar packaging: Dicorynan - Medical drug that acts on the cardiovascular system; Lepicortinolo - Anti-inflammatory drug.

Based on the analysis of these authors, there are 36 variables in the medical drug chains production. Once the visual graphic part of the packaging is changed 31 variables will suffer. For instance, if any visual graphic aspect is changed, an high impact on the consumer is notorious, which can be positive or negative with this “new” packaging; at the distributor, who will need to recognize the new product; in the general management of the business; in legal regulation, which will have to be evaluated; in marketing, which will need new strategies; as well as many others [12].

Moreover, the process of developing a medical drug is very long. All stages are evaluated by the pharmaceutical industry, since the creation of the packaging and the whole process can take several years. According to the author Lorenzini [13], if a new packaging of medical drugs were created, the process of acceptance would further delay its placing on the market. Therefore, the industry opts for both packaging and images that we common observe, ensuring that there will be no obstacles to product validation.

This industry also focuses more on protecting its content, the drugs, and less on the design, function and inclusiveness of packaging (being comprehended by everyone).

The same author, also points out the importance of Inclusive Design: designers and other professionals in this industry must use this concept during their process. They must think about the product and the user. Thus the easy-to-use understanding is very important to keep in mind. It is also necessary that the target audience takes part in the development of the product or project from the beginning of the whole process - contact, analysis, interaction and discussion should be settled from the beginning.

As a possible solution, a code of symbols was constructed to identify a type of medical drug, taking into account the constraints of the target audience, the rules of design, studies based on theoretical and practical cases. So, a set of symbols was created, each one with three identifying elements, allowing the target audience to identify the element(s) - acronym, color or pictogram.

It was considered that, for the validation of the project, it would be necessary to undergo different tests that approves its criteria. So, all changes were assessed by the target audience using empirical methods. Three tests of concept were carried out. In the latter, all symbols showed an acceptance level above 67%, which is the percentage that validates the use of a pictogram by ISO 3864.

3 Methodology

To develop the project, a strategy based on reliable theories was planned. All steps of the project were successively evaluated and validated. The research comprises two components: a practice, which suggests the creation of an identification system for all-inclusive medical drugs; and a component of theoretical foundation and cases analysis. The following steps were designed:

- Analysis of the problem: understand the need to implement the project;
- Theoretical-practical foundation: study and citation of the theory of different areas and registration of fundamental data;
- Draft project proposals, based on the theory apprehended;
- Tests of concept with the target audience;
- Correction and creation of the final proposal, based on the tests of concept carried out;

Hence, the main research question as a starting point - is it necessary to create symbols to improve the identification of medical drug packaging? - and using a diversified methodology (quantitative and qualitative), an exploratory questionnaire was created for those who are most in contact with medicines, the pharmacists. This allowed to answer three important questions for the initial development of the investigation: "to observe what?; in whom?; how?"⁴ [14]. The results made it possible to come to the conclusion that the users find it difficult to identify the medicines; the target audience for this research are the final consumers of medical drugs; there exist subgroups for which the

⁴ O.v.: "observar o quê?; em quem?; como?".

use of colors, heavier typography or symbols, could help to distinguish the packaging of this type of drugs.

After assessing the problem, the theory study began - the literature review - which enabled the creation of proposals for the Id.Med code. However, dealing with this problem resolution may emerge serious health complications. Several authors, theories and projects were taken into consideration. Concluding that for such a project (in which including the entire population is essential), it is important to understand if these symbols are sufficiently noticeable as they are aimed to the whole. Thus, three tests of concept were made, in which, the symbols correction, between each test was based on the results and comments obtained by the respondents.

The first two tests of concept started with a memory and decoding test. Two versions of anonymous tests were created. Data concerning gender, age, profession and education level was required to understand the group difficulties.

The first version (aiming adults from 18 to 64 years old) and the second (for adults over 65 - elderly), consisted of two parts: a timed test and a survey with questions related to everyday medication. The first version also included questions related to the codes presented. The decision to remove the opinion questions in the second version was due to the fact that the cognitive and imaginary thinking of this age group is more reduced. However, it must be mentioned that it is an heterogeneous group, as adults aged 65 may be very different from adults aged 80, or dementia sufferers bearers. Still, adults over 65 were target to the second version test as they are considered elderly.

In both tests, respondents observed and tried to memorize (or decode) all the symbols presented with their meaning. When they believed that they had already learned them, they were asked to write in five minutes what each symbol represented (see Table 1).

Table 1. First and second tests of concept results.

1 st test of concept: decoding				Results: X/78 respondents total %				
CDV	SNG	RSP	DGT	GNT	SNC	LCM	EDC	
77/78 99%	77/78 99%	78/78 100%	74/78 95%	73/78 94%	66/78 85%	70/78 90%	62/78 79%	
ALG	NTC	ATB	ATV	ATF	ATP	ANG	AIF	
68/78 87%	43/78 55%	71/78 91%	69/78 88%	62/78 79%	48/78 62%	56/78 72%	53/78 68%	
<hr/>								
2 nd test of concept: decoding				Results: X/66 respondents total %				
CDV	SNG	RSP	DGT	GNT	SNC	LCM	EDC	
66/66 100%	66/66 100%	66/66 100%	62/66 94%	59/66 89%	58/66 88%	63/66 95%	56/66 85%	
ALG	NTC	ATB	ATV	ATF	ATP	ANG	INF	
59/66 89%	50/66 75%	63/66 95%	59/66 89%	57/66 86%	50/66 76%	50/66 76%	61/66 92%	

In these tests, the qualitative data also turns out to be very significant and relevant. More than half of the respondents said they had difficulties in decoding the drugs they consume and considered that the adding of these symbols would be beneficial. Through the tests, the created symbols were also considered easy to distinguish and assimilate.

The second test results were very positive (all symbols had an acceptance over 75%), nonetheless, the third test were different. Some of the respondents' comments, written during the second test, were very relevant. Thus, in order to clarify whether the suggestions made would help more in distinguishing the symbols, a comparison test was done.

The test was also anonymous, requiring the same data as the previous. Respondents observed the 16 symbols of the second test. However, they were explained that certain symbols underwent changes that needed to be evaluated. Thus, they were asked to choose between two versions of the same symbol: the first corresponded to the symbol shown in the second test and the second one with the suggested changes (see Table 2).

Table 2. Third test of concept results.

3 rd test of concept: comparation		Results: X/45 respondents total %
 V1-V2 		 V1-V2 
31/45 68,9%	14/45 31,3%	7/45 15,6%
 V1-V2 		 V1-V2 
16/45 35,6%	29/45 64,4%	9/45 20%
		36/45 80%

4 Project

4.1 The Code

As a starting point for the concept of creating the symbols, it was defined that they would have three components: their purposes (i.e., what they represent), satisfaction at the graphic level and the results obtained by the tests of concept carried out to the target-audience. Thus, in this section, only the results obtained after all the studies, surveys and tests carried out will be presented.

4.2 Pictograms

Medeiros, et al. [15] mention authors like Houts (2006), who defends the use of pictograms in health. Investigations show that inserting pictograms in health, as far as information is concerned, has a positive effect on awareness, comprehension, memory and adherence to the patient's treatment. It is known, that the majority of patients and of the general population finds it difficult to understand health information/data. Therefore, pictograms favor its comprehension. So, pictograms (and ideograms) are considered the

most appropriate signs to identify medical drugs for a certain type of system of the human body, because since childhood, they teach us to associate organs with their specific system. Thus, a representation of these would be more directly associated with their treatment. We tried to define which keyword would represent it and work on a symbol based on that term. For drugs that aim the treatment of a specific system in the human body the logical choice was the name of an organ or recognizable element that refers directly to the system (see Fig. 2):

- (1) Medical drugs that act on the cardiovascular system: heart;
- (2) Medical drugs that act on the blood: blood drop;
- (3) Medical drugs that act on the respiratory system: lungs;
- (4) Medical drugs that act on the digestive system: stomach;
- (5) Medical drugs that act on the genitourinary system: bladder;
- (6) Medical drugs that act on the central and peripheral nervous system: brain;
- (7) Medical drugs that act on the locomotor system: spine;
- (8) Medical drugs that act on the hormonal system: thyroid;
- (9) Antiallergic drugs: forbidden element;
- (10) Nutricon drugs: pear (fruit).

For the other types of medication, it was necessary to define a concept that resembled the action, format or what its name suggests. Ideograms were created (see Fig. 2):

- (11) Antibiotics/antibacterials: bacteria;
- (12) Antiviral: virus and its dissemination;
- (13) Antifungal: curves/propagation effect;
- (14) Antiparasitic: parasite;
- (15) Analgesic: acts on a pain point;
- (16) Anti-inflammatory: reduces inflammation.

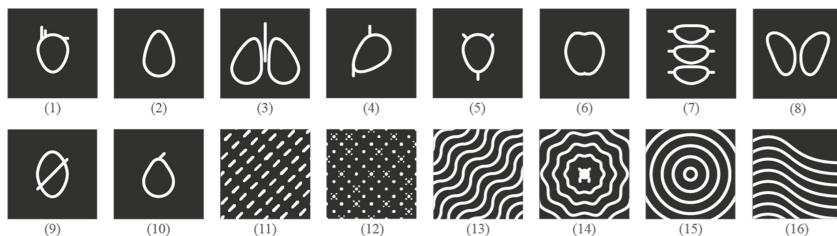


Fig. 2. Id.Med pictograms and ideograms.

In the short Medeiros, et al. [15] investigation, on the use of pictograms in healthcare, pictograms were created to represent the correct ways of medication intake and use. After its creation they tried to validate them by means of interviews. Six pictograms were presented, four of which had positive results regarding legibility and comprehension by the respondents. The other two didn't get the same positive outcome, as the negative

legibility was due to the feature thoroughness of those pictograms, which prevented understanding the drawings. In other words, the simple and more direct, the better to be recognized and memorized. So, it was important the use of less features, when drawing the pictograms, and use only main lines for the identification of the represented object.

4.3 Colors

Luciano Guimarães [16] in his study *A Cor como Informação* (The Colour as Information) reminds us that colours became a crucial tool of the means of communication nowadays. They will be in the future related as an attraction of imagetic messages. He also states that if images have this appealing strength, colourful images will have more.

Rodrigues [17] refers to Modesto Farina book, *Psicodinâmica das cores em comunicação* (Psychodynamics of color in communication), which points that colour can be used as an effective way of communication as it is easy to use even by people with limited abilities, such as the illiterates.

The use of the colour is a visual communication study basis. When it's used in a person as information, it has the ability of create three acts on him: impressing by the seen colour; expressing, causing emotion; and giving a meaning of his own, a sign [16].

In order to definite colours for each symbol representing the types of medical drugs, the study of chromotherapy (alternative therapy that uses colors as a way of treating diseases) was taken into account, as well as the colours commonly associated with each pictogram. Subsequently, for each of the symbols the following colours and their pantones - universal colour reference for graphic printing - were associated (see Fig. 3):

- (1) Medical drugs that act on the cardiovascular system: red (2035C) - chosen based on the popular association with the organ and the related symbology, love;
- (2) Medical drugs that act on the blood: dark red (7628C) - associated with its own color, but also in chromotherapy, red is used to treat anemia and blood circulation;
- (3) Medical drugs that act on the respiratory system: blue (660C) - used in chromotherapy for the lung treatment. It also reminds the air/sky, associated with oxygen;
- (4) Medical drugs that act on the digestive system: orange (7577C) - used in chromotherapy to help good digestion and positively reinforce the digestive system;
- (5) Medical drugs that act on the genitourinary system: yellow (107C) - refers to urine;
- (6) Medical drugs that act on the central and peripheral nervous system: bluish green (339C) - green is used by chromotherapy against nervous system diseases and variations in the colour tone, treat mental illnesses; related to the sense of calm;
- (7) Medical drugs that act on the locomotor system: light blue (656C) - light color that refers to the tones of the bones, as it is mostly presented by the mass media;
- (8) Medical drugs that act on the hormonal system: pink (2339C) - thyroid diseases are usually associated with women and, therefore, pink;
- (9) Antiallergic drugs: greyish brown (4253C) - colour of the spectrum less vivid, that is, with less saturation and, thus, associated with more negative ideas;
- (10) Nutricon drugs: green (7487C) - associated with healthy foods;
- (11/12) Antibiotics/antibacterials e Antivirals: golden and silver (111C and Cool Gray 6C) - colors associated with glory; both drugs fight organisms that are impossible

to see with the naked eye, but which have an overwhelming capacity to destroy our organism if they are not combated in a controlled manner;

- (13) Antifungal: brown (729C) - color related to the most known fungi, mushrooms;
- (14) Antiparasitic: dark violet (7643C) - color associated with insects and parasites;
- (15/16) Analgesic e Anti-inflammatory: blue and dark blue (3115C and 7692C) - colors associated with pain reduction by chromotherapy.

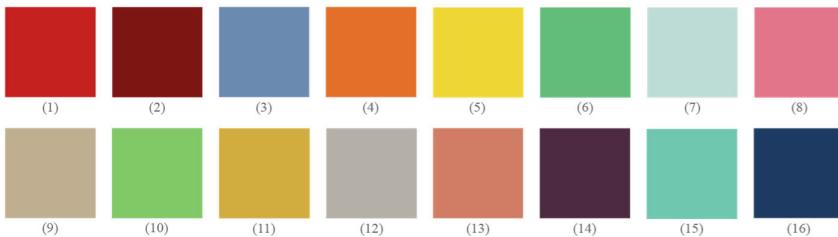


Fig. 3. Colors associated to each type of medical drug.

4.4 Acronyms

The importance of acronyms in modern communication is undeniable, but it must be rapid and pleasant to the sight and ear. So, when building an acronym, the following aspects should be taken into account: easy to read; euphonium, i.e., pleasant to the ear; suggestive, expressive or reminding some aspect of the entity; easy to memorize; not recalling an obscene, ridiculous or pejorative word [18].

The acronyms defined to go with the pictograms and colors proved to be an important complement in the decoding of the symbols, by associating the three letters to the name of the medical drug they represent. The following acronyms have been defined for each symbol (the acronyms represent the names in Portuguese) (see Fig. 4):

- (1) Medical drugs that act on the cardiovascular system: CDV
- (2) Medical drugs that act on the blood: SNG
- (3) Medical drugs that act on the respiratory system: RSP
- (4) Medical drugs that act on the digestive system: DGT
- (5) Medical drugs that act on the genitourinary system: GNT
- (6) Medical drugs that act on the central and peripheral nervous system: SNC
- (7) Medical drugs that act on the locomotor system: LCM
- (8) Medical drugs that act on the hormonal system: EDC
- (9) Antiallergic drugs: ALG
- (10) Nutricon drugs: NTC
- (11) Antibiotics/antibacterials: ATB
- (12) Antiviral: ATV
- (13) Antifungal: ATF
- (14) Antiparasitic: ATP
- (15) Analgesic: ANG
- (16) Anti-inflammatory: INF



Fig. 4. Acronyms associated to each type of medical drug.



Fig. 5. Id.Med code.

4.5 Id.Med

With all identifying elements created and by attaching them, the Id.Med code arise.

The pictograms and acronyms were placed on a square. The color of the medical drug they represent was added to each square. Then, there are two squares that can act alone. However, they were joined, for the success of this project, forming a rectangle with the three identifying elements (pictogram, color and acronym). As result, the final object of this investigation, the Id.Med code (see Fig. 5).

This small-size code, is placed in the packages (see Fig. 6), following a set of rules, which allows it to be easily noticed, but not having a great impact in the modification of the medical drugs packaging and, therefore, in its process chain.



Fig. 6. Id.Med code on medical drugs packages.

5 Critical Reflection

Taken into account the questionnaires carried out and its analysis, with all the information from the literature review and with the tests of concept made and approved by the target audience, it was possible to create an effective code, which identifies the 16 types of medication, found in pharmacies.

Not being allowed to follow a path of less is more, an iconic expression of Mies van der Rohe, the path found to overcome all the constraints, was to join all the identifying elements in a minimalist and coherent way. Enabling its use to the entire target audience and making it possible to each medical drug consumer to identify the code created and to choose its identifying elements: the pictograms, the color and the acronyms.

For the validation of the project present before, the target audience was tested and answered in three tests of concept, in which they were asked to learn the symbols and then refer to them. In these tests, it was confirmed that the population was unaware of the existence of so many types of medical drugs and that there are difficulties in decoding them. These tests were particularly important to validate each Id.Med symbol created. The tests allowed to validate an identification code of the drugs based on the real needs of the consumers, proving that it is a system that can be decoded.

During the investigation, hypotheses were identified regarding the error in taking medications, which allowed to limit the study area, as well as to find facts that defined the final result. The following hypotheses have been validated: errors in taking medication are related to the design of their packages; a large percentage of the population is unaware of the existence of all types of medical drugs and find it difficult to distinguish their packaging; a system that identifies the types of medical drugs will reduce errors in consuming them.

One hypothesis was inconclusive - elderly people, with increased cognitive difficulties or other types of illnesses and weaknesses, find it more difficult to identify medications. According to the theory, this group due to their schooling, illnesses, age, and others criteria, places this part of the population as weaker when learning new symbols. However, the tests of concept revealed that it is the effort of each respondent that determines the results. Even so, it is important to consider the weaknesses of the groups.

As in any research or project, there were limitations. The first came from the idea of creating an inclusive drug identification system for everyone. The blind population is not included in the hosts of this project. For these, an investigation and creation of an identification element, such as braille, would be necessary. The creation of a representative braille code for medical drugs should be developed together with specialists in the field, as well.

Due to the 2019 pandemic, the tests of concept carried out, allowed to test neither individuals known to be colorblind, nor illiterate ones. This last group, not knowing how to read or write, cannot answer an online test.

In the future, we intend to extend the tests of concepts and the entire research process of this project to all groups of the target audience. Ensuring the effectiveness of the Id.Med in reducing errors in taking medication. We also aim to develop the Id.Med in braille, for the blind, creating, finally, an all-inclusive code for the entire population.

Subsequently, would be to invest in the study of primary packaging, usually blisters, and learn forms of printing, so that it would also be allowed to insert the code Id.Med.

6 Conclusions

Id.Med, emerged with the goal of dealing with a problem that is not always recognized, but that frequently occurs: errors in taking medication. This adversity is due, in part, to the similarity of the design of the medical drugs packaging.

Visual communication of medical drugs packaging is an area important to interfere, as there are many types of medical drugs with similar packaging. It was important not only a study on the identification of packaging, but also on its production chain. These packages undergo various rules, which demands to follow a certain standard. In addition, its production involves different areas and which may have an impact in all of them when one is changed. Therefore, the total graphic alteration of a medical drug package would not be easy or possible.

Including the whole population was the main focus of this project. That's why, the target audience and its constraints were studied. It was divided into groups including conditions that make them less able to decode graphic elements: elderly population found it difficult to learn new, complex and small elements; colorblind people have a hard time decoding colours; and illiterate population don't know how to read or write.

Given those criteria and not being aware of the impossibility of creating an obvious, clear and of rapid identification system for the entire audience, or even visually altering the medical drug packaging, the solution was to join several semiotic elements in a single and small symbol, which allows each user to choose the element or set of elements that most easily apprehended. In this way, the Id.Med system was born - a set of symbols with three identifying elements: the color, the pictograms and the acronyms.

Id.Med tries to abolish errors in consuming medical drugs, empower consumers to identify the drug packaging, and reduce the extra effort of pharmacist on trying to solve this problem. With their support and of an informative brochure that allows the initial learning of the symbols these new identification elements will be better understood.

Nevertheless, this investigation is only the beginning of the Id.Med project, and it will continue to be developed. In addition to trying to solve the problem pointed out, it surely contributes to the knowledge of Design in health areas, particularly in packaging and graphics. There are several studies on semiotics, colour, typography and even communication, but when applied in medicine, more specifically, in medical drugs packaging, this theme is still poorly explored. Design in this area is still seen as a secondary aspect, but hopefully this research will also show that design in this area is important and contributes to the well-being of the population.

References

1. Pereira, M.: Id.Med - Um Sistema de Identificação de Medicamentos Inclusivo (2020). [Master Thesis, IADE Creative University]. <http://hdl.handle.net/10400.26/35141>
2. Santos, H., et al.: Boas práticas farmacêuticas para a farmácia comunitária. Ordem dos Farmacêuticos, 3ª Edição (2009).
3. Bohomol, E.: Erros de medicação: estudo descritivo das classes de medicamentos e medicamentos de alta vigilância. Escola Anna Nery Revista de Enfermagem **18**, 311–316 (2014). <http://scielo.br/pdf/ean/v18n2/1414-8145-ean-18-02-0311.pdf>
4. Reis, L.: O conhecimento sobre o medicamento e a literacia em saúde - Um estudo em adultos, utentes de farmácias do concelho de Lisboa (2010). [Master Thesis, Instituto de Higiene e Medicina Tropical da Universidade Nova de Lisboa]. https://run.unl.pt/bitstream/10362/6032/1/Conhecimento%20do%20Medicamento%20e%20Literacia%20em%20Saude_T_ESE%20Final.pdf
5. Reis, L.: O conhecimento sobre o medicamento e a literacia em saúde - Um estudo em adultos, utentes de farmácias do concelho de Lisboa, p. 87 (2010). [Master Thesis, Instituto de Higiene e Medicina Tropical da Universidade Nova de Lisboa]. https://run.unl.pt/bitstream/10362/6032/1/Conhecimento%20do%20Medicamento%20e%20Literacia%20em%20Saude_T_ESE%20Final.pdf
6. Reis, L.: O conhecimento sobre o medicamento e a literacia em saúde - Um estudo em adultos, utentes de farmácias do concelho de Lisboa, p.88 (2010). [Master Thesis, Instituto de Higiene e Medicina Tropical da Universidade Nova de Lisboa]. https://run.unl.pt/bitstream/10362/6032/1/Conhecimento%20do%20Medicamento%20e%20Literacia%20em%20Saude_T_ESE%20Final.pdf
7. Cancela, D.: O processo de envelhecimento. Psicologia.pt, o portal dos psicólogos (2007). <https://psicologia.pt/artigos/textos/TL0097.pdf>
8. Instituto Nacional de Estatística. Conceito, 2758 - Taxa de analfabetismo (2006). <http://smi.ine.pt/Conceito/Detalhes/546?voltar=1#Gloss%C3%A1rio>
9. Pereira, S.: Daltonismo. ITAD: Instituto de Apoio e Desenvolvimento (2019). <http://itad.pt/daltonismo/>
10. Sayuri, K.: Bulas e Cartelas de Medicamentos: Possíveis soluções de leituraabilidade através do Design Gráfico. Arcos Des., 2 (2011). <https://repositorio.unesp.br/bitstream/hadle/11449/134727/ISSN1984-5596-2011-06-01-4259.pdf?sequence=1&isAllowed=y>
11. Blum, A., Merino, E., Wagner, A.: Gestão de design e a cadeia produtiva: embalagens de medicamentos no sistema produto. Strateg. Des. Res. J. **7**, 34 (2014). <http://revistas.unisinos.br/index.php/sdrj/article/viewFile/sdrj.2014.71.05/4328>
12. Blum, A., Merino, E., Wagner, A.: Gestão de design e a cadeia produtiva: embalagens de medicamentos no sistema produto. Strateg. Des. Res. J. **7**, 39–42 (2014). <http://revistas.unisinos.br/index.php/sdrj/article/viewFile/sdrj.2014.71.05/4328>
13. Lorenzini, G.: Toward Inclusive Pharmaceutical Packaging: An Innovation and Design Process Perspective (2018). [PhD Thesis, Universidade Lund, Suécia]. [https://portal.research.lu.se/portal/en/publications/toward-inclusivepharmaceutical-packaging\(ed2137c3-7277-4fef-bbc0-3e21ce3cf049\).html](https://portal.research.lu.se/portal/en/publications/toward-inclusivepharmaceutical-packaging(ed2137c3-7277-4fef-bbc0-3e21ce3cf049).html)
14. Quivy, R., Campenhoudt, L.: Manual de Investigação em Ciências Sociais. Gradiva (2005)
15. Medeiros, G., Silva, P., Silva, A., Leal, L.: Pictogramas na orientação farmacêutica: um estudo de revisão. Rev. Bras. de Farmácia **92**, 96–103 (2011) <http://rbfarma.org.br/files/rbf-2011-92-3-3.pdf>
16. Guimarães, L.: A cor como informação: A construção biofísica, linguística e cultural da simbologia das cores. Annablume (2001)

17. Rodrigues, L.: Comunicação Visual das Embalagens de Medicamentos: Análise de embalagens de medicamentos já existentes e construção de elementos identificativos para novas embalagens (2016). [Master Thesis, ESAD, Caldas da Rainha]. <https://iconline.ipleiria.pt/handle/10400.8/2158>
18. Ledur, P.: Português Prático. AGE (2016). https://books.google.pt/books?id=7XeQDAAAQBAJ&pg=PT81&lpg=PT81&dq=importancia+das+siglas&source=bl&ots=mKWXObtoM_&sig=ACfU3U2dxGHCJOD6ZiFlksnlak-m5HBL5A&hl=pt-PT&sa=X&ved=2ahUKEwiQ96m8lMzpAhUMEBQKhbMFD9gQ6AEwCHoECAoQAQ#v=onepage&q=importancia%20das%20siglas&f=false



Case Study on the Experience and Perception of Rehabilitators and Caregivers of People with Parkinson's Disease in the Interaction with Clothing Assistive Devices: Narratives About Everyday Problems, in Portugal

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Abstract. Neurological diseases, such as Parkinson, may hinder the activity of dressing/undressing independently. Assistive Devices (ADs) are products that can improve handling performance, promoting user experience during dressing/undressing. In seeking to understand the relationship of these products, their way of use and the possible difficulties that prevent or hinder this activity, the study investigates their use and consequences for the possible independence promotion. This article presents a specific research which aims to understand In seeking to understand the aspects that make feasible, or not, the use of ADs to help dress/undress people with Parkinson's disease, through surveys and interviews with caregivers and rehabilitators in Portugal. We have discussed the typology, usability and interaction of these products, within the professionals' perception. The results of this empirical research were processed and encoded using the Atlas.ti software. The findings revealed that the non-use of the Assistive Devices is linked to: the difficulty of recovering the movement; environmental care structure, where there is a lack of support for stimulation and training; means for acquiring when the products are presented; and the possible social stigma caused by the unfamiliarity and interface design. The interviews also related the ADs' non-use to their design characteristics; and underlined the need to study new options for the effective promotion of independence. Despite a still limited sample, the conclusions already point out to the existence of a very expressive problem in the field of clothing design for people with Parkinson's disease, especially in the research and development of the fashion area.

Keywords: Clothing design · Assistive devices · Parkinson's disease

1 Introduction

Clothing is an integral part of the human being's identity. Changing and adapting are part of life's stages. However, these changes must be significant to well-being, offering pleasantness in the use of the product, which is considered a symbol of personality. The clothing market still does not include all stages of life. For example, for many years, clothing for older people was sold as the sleepwear segment, referring to disability or illness. This happened for being easier to wear, but with a stigmatizing appearance, which discouraged the users to keep their social life. The view of the elderly in social terms has changed a lot in recent years, but it still carries a negative burden, especially when aging is associated with the incapacity of some pre-existing diseases, such as neurological diseases. This type of pre-existing disease impairs functional dependence, including dressing/undressing and handling products.

Neurological diseases are recognized as the main cause of death in the world [1]. They are associated with functional dependence due to physical and psycho-cognitive limitations [2]; and consequently, due to the inability to perform activities of daily living (ADLs) [3]. Parkinson's disease (PD) is the second most common neurodegenerative pathology, whose motor disorders increase progressively functional dependence, especially when there is a loss of control and the difficulty in performing basic movements for survival [4]. It is estimated that 6.1 million people were diagnosed with PD worldwide [1], with a prevalence of between 100/180,000 inhabitants in Portugal [5].

The main motor symptoms identified in PD are tremor, stiffness, slowness and postural instability [4]. These symptoms compromise ADLs, such as self-care in hygiene, food, dressing/undressing and mobility. Also, these motor symptoms increase the need for help and care from third parties [6]. In fact, in almost all ADLs, the interaction with products occurs through a manipulation that involves coordination or/and precise movements in the grasping of hands and fingers. Examples of this type of problems are found in clothing products, which due to clothes, shoes and accessories shapes and modes of use, may make dressing and undressing difficult, challenging independence [7, 8]. Thus, the use of products that can assist in performing ADLs, in relation to manual dexterity and mobility restrictions, is suggested by professionals within rehabilitation practices [9, 10]. However, the effectiveness of their use, to the detriment of the need and type of the product, is little discussed in the literature about people with PD [11].

Assistive Technologies encompass products, devices, instruments and equipment that can be developed and/or adapted to improve the performance of the activity with the interface [3]. Specifically, in the categories of Technologies, Assistive Devices (ADs) involve the use of clothing (shoes and clothes) that assist the user in carrying out the manipulation activities of dressing/undressing, improving independence [12]. Especially as the manipulation difficulties demand systemic care that involves the services of health professionals who work with rehabilitation in the face of the limitations and difficulties of patients [13], the help of the caregiver in the dressing activity [9, 14] and the available resources related to ADs [11, 12].

In view of these aspects, it is important to understand the factors that affect independence in the activity of dressing/undressing in for people with PD and how to deal with this, considering the Clothing Designer's responsibilities to promote interaction easiness and usability of the products [15]. Despite the literature addressing this issue in different populations [16–18], these studies have not been discussing the aspects involved in the manipulation and perception of use in the routine of people with PD. And, when it is, articles involving the theme (PD, clothing activity and AD) do not bring data that can support the discussions, being that we've found some interventions [7, 19] dated from 20–40 years.

This fact is seen by the authors as essential to understanding the universe of the users and the relationship with the use of clothing products. As a population ages quickly and such products can become an impediment to maintaining independence. According to the Ministry of Labour, Solidarity and Social Security [20], Portugal is a country whose aging population exceeds the number of young people. So, the probability of this group having a chronic-degenerative disease that interferes with mobility is very high. There isn't national data that illustrate the behavior of Portuguese patients with Parkinson's in the interaction with everyday products, like clothing.

This paper is an excerpt of a doctoral investigation, aimed to understand how multidisciplinary work in the care of people with PD, about the usability of ADs of clothing, may promote independence in the interaction with products. The objective was to access the experience of such participants (Informal caregiver, Formal caregiver and Rehabilitation Professionals) understanding how the care support networks can provide a perspective that complements the perceived reality of the user (people with PD); in practical questions of usability, which can provide socio-cultural parameters about consumption, identity, relationship and interaction with the dressing/undressing activity involving ADs. We chose to start approaching professionals and caregivers, who would bring important information due to their experience with multiple patient profiles, thus clarifying those issues, before approaching people with PD. To this end, through the use of virtual interviews, questions were asked to clarify the actions undertaken by health professionals and caregivers to promote the independence of people with PD in Portugal, verifying aspects that facilitate and hinder the relationship with the use of ADs to assist dressing/undressing.

2 Methods

2.1 Participants

The research was disseminated in Portugal by sending 180 invitations by email to: I) Universities (undergraduate courses in nursing and occupational therapy and masters in rehabilitation); II) Technical schools (where there are training courses for direct action assistants - mainly those dealing with geriatrics and rehabilitation); Associations and Foundations of patients and professionals; III) Long-term Care Facilities (LTCFs), physiotherapy and rehabilitation clinics and iv) caregiver agencies. The purpose of these emails was to have a first contact with the profile of the participants, in order to be able to define the interview guides, as well as their appointment. This first contact was made by completing the Research Survey. Through this process, we achieved 33 participants. Of

these, 20 participants were excluded of this discussion for having, respectively, personal problems and interrupting the interview (1), just responding in relation to experience in another country (2), not having experience with the clothing activity (2), did not accept to participate in the interview to obtain more information that would complement the answers given in the survey (15).

Thus, for this analysis, 13 interviews were considered: the profile of the participants is detailed in Table 1, with the quantity of them in each category in parentheses (n). They were divided into three profiles: Informal caregiver (family member, friend); Formal caregiver (private caregiver, care assistant, LTCFs helpers, among others); and, Rehabilitation Professionals (Occupational Therapist, Nurse, Physiotherapist, among others). They were grouped by sex (female and male); occupation (health assistant, nurse, occupational therapist and physiotherapist); place where they had experience of provide care assistance (home, LTCFs, hospital and rehabilitation clinic) - which some participants had more than one option; the relationship and number of people (if they were a patient or family member/friend) - which also some participants had more than one option; and, the time (in years) of care experience for people with PD. The participants' experience does not make up a representative category of the facts [21] related to people with PD and, therefore, the results of this study should not be generalized. It is important to emphasize that these data are based on experimental research, to illustrate certain realities so far not discussed in the scope of product development. The authors sought to understand the perceptions based on the explanation given by the participants, of the different realities experienced and the decision-making attributed to the care of the people with PD, in order to identify the promotion of well-being provided by the AD.

Table 1. Participants description.

Profile (n)	Informal caregiver (2)	Formal caregiver (4)	Rehabilitation professionals (7)
Sex (n)	Female (2)	Female (4)	Female (6), Male (1)
Occupation (n)	Nurse (2)	Health assistant (4)	Occupational Therapist (4), Physiotherapist (1), Nurse (2)
Care place (n)	Home (2)	LTCFs (3), Home (1)	LTCFs (3), Home (1), Hospital (4), Rehabilitation Clinic (2)
Relation and Quantity (n)	Family member (2), Friend (1)	Until 5 patients (1), Until 10 patients (1), Until 30 patients (2)	Until 5 patients (1), Until 10 patients (2), Until 30 patients (2), Until 50 patients (2)
Time of care experience (n)	6–10 yrs (1), 11–20 yrs (1)	Less than 1 yr (3), 1–2 yrs (1)	3–5 yrs (2), 11–20 yrs (1), More than 20 yrs (4)

2.2 Procedures

The methodological procedures were based on an experimental, descriptive and exploratory approach [21], which was approved by the University Research Ethics Committee (Opinion CAAE 40707620.4.0000.5663). The data have a qualitative nature, addressing the experience of the participants through the processes of interaction with people with PD. We used a mixed-method of analysis, which consisted of transforming the qualitative data into codes to group the research findings [21].

We elaborated a Research Survey for the collection of preliminary data, released by e-mail and following the completion of four sections: I) Informed Consent Form, with information about the study and accepted by the participant; II) Data for the characterization of the sample, containing sociodemographic information; III) General information about the experience of care and assistance; IV) Perceptions about the experiences related to the activity involving the use of ADs. After filling it, for the participants who agreed to be contacted for the interview, the invitation was made, making an appointment by phone call or by digital platforms (Meet or Zoom), in which the discussion of the theme was deepened, based on the answers previously provided.

In seeking to understand the relationship of the products (and its particular characteristics), the way of use and the possible difficulties that prevent or hinder the activity from having a good performance, three issues were discussed: I) typology of the products involving the ADs: shoehorn, dressing stick, zipper puller (extension), zipper hook (stick), button hook (stick), elastic shoelaces, socks aid (for pull-on) and socks stick (for pull off); II) usability and user perception in the perspective of the participants; III) reported difficulties and limitations.

Once, the experience of use is not limited to succeeding in performing the task, suffering influences from the desire and appropriation that such objects will have to help in everyday life. The following inclusion criteria were adopted: I) Responses full of meanings, forming an objective sentence; II) Participants who had the experience of caring for people with PD; III) Participants who described practices in Portugal.

2.3 Data Analyses

After the transcription of the interviews, the analysis was based on the process of coding responses through the use of the *Atlas.ti* software (v. 8), seeking integration and a relationship between the concepts addressed by the participants. From the central ideas driven by the questions, the procedures [21, 22] were followed: I) labeling the general concepts and developing memos (about the ideas that were emerging) - that is, creating codifications according to the responses that involved the use of ADs (difficulties, rehabilitation); II) identification, categorization and grouping of concepts belonging to the same phenomenon; III) division of variations by subcategories; and, IV) selection of terms for the construction of diagrams.

Considering that the analysis of the results started from a qualitative narrative condition, no statistical analyzes were performed. For the categorization and discussion of the results, the number of participants in parentheses (n) will be presented.

3 Results and Discussion

In the approach with the participants, we asked whether the people with PD whom they provided assistance and/or care, used any AD related to dressing/undressing. All formal caregivers mentioned that the patients did not use any AD (Fig. 1) and some participants - mainly Rehabilitators - explained why this occurs.

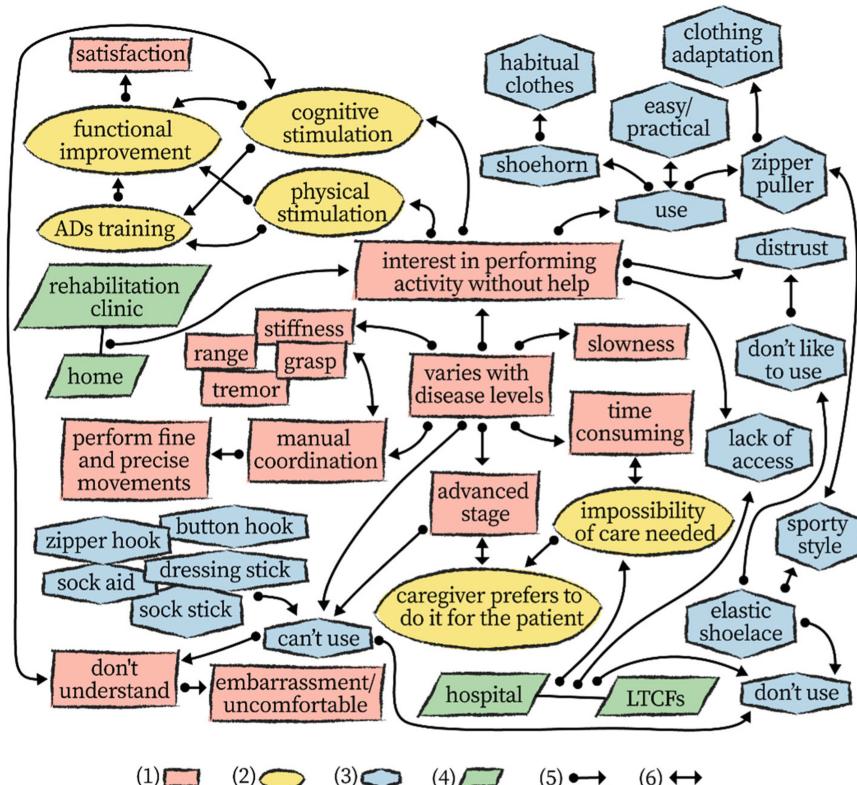


Fig. 1. Causes and associations of using or not the ADs. This diagram was redesigned according to the data analysis output in Atlas.ti. Legend: (1) Pink rectangle represents the characteristics of PD in relation to the activity of dressing; (2) Yellow ellipse represents care and rehabilitation; (3) Blue diamond represents the kind of ADs and the context of use; (4) Green parallelogram represents the place where participants had the experience of contact with the people with PD; (5) Arrow with a circular tip represents the cause or condition of the events; (6) Double-headed arrow represents the association of events.

The participants suppose that, considering that their patients were still with mild symptoms, they were able to adapt and perform alone. Non-use can happen due to the profile of the patients [23], whose disease is influenced by moderate or severe symptoms, making manipulation and (re)learning of movement-activity impossible. The operational logistics of care in the places of living, not only in homes but also in hospitals, disencourage the stimulation by professionals to maintain independence in the activities related to

clothing. They also reported difficulties, mainly due to the time required for the actions of presenting the ADs and training them within the activity. The lack of acquisition of these products by LTCFs and hospitals - which, “*rarely invest in it*” - was also mentioned by some participants. This fact is discussed by [24] - even if not related to PD, on the structure of basic care provided in institutions and the lack of policies aimed at stimulating the independence of the elderly in northern Portugal.

Thus, non-use was also influenced by the environment where people with PD live (Fig. 1), interfering in maintaining their independence. It was understood through the answers that the users who attended at their homes and/or seek rehabilitation clinics may be more conformed with the fact of the disease and understanding that its progression has no cure. So, there is a concern with maintaining the ability to live autonomously, independently [13], as well as the financial situation to invest in the treatment of ADL rehabilitation. Users who live in long-term institutions, due to the care logistics (number of employees available and time required to stimulate activity), have a great tendency to be replaced and, in a way, conditioned to have a person doing for them - even if they could still partially recover the skills to perform the activity [24]. According to the obtained answers, we observed that the culture influenced by the geographical position of the inhabitants of urban centers and interior regions and even more so, of the Atlantic archipelagos that constitute Portugal, may interfere in the acceptance and willingness to know and be interested in the use. Based on personal experiences, some professionals mentioned that there is a lack of information and disposal of products in specialized stores and even when they exist, they are not presented to the patients because they already predict that, due to their profile, they will not be interested, preferring many times that their companions do it for them.

The reports of some participants showed that, in some cases, the unfamiliarity of the ADs, in general, caused strangeness and stigma at first because it is something different from the usual and the object use distinguishes them from other people. In addition, they reported fear of suffering from some type of prejudiced situation. These results are similar to those found by [25] when they evaluated other ADs in Portugal - even if not associated with PD. Such objects can carry stigmatizing effects for users, who, through a negative stereotype - especially when there is some inequality (be it functional, social, etc.), mischaracterizes the individual's identity [26]. So, with the treatment, the professionals try to stimulate as much as possible and guide according to the clinical analysis, explaining that if the patient trained with the ADs, his/her skills could improve, and he/she would not depend on other people to perform those functions that were affected for advancing the disease [13]. Such findings were also found by [27] when they showed that 96.6% of the studied sample (elderly people with some kind of disability) do not use AD, even if they have difficulties in handling it.

Clinical analysis is essential to direct the use of ADs, since the symptoms of PD happen individually, so the functioning of the product can be effective for some people and not effective for others. Considering these ADs are almost all standardized in format, size, weight and design in general, this ends up influencing the use, as the user does not only want to know if it is a functional product, useful but if the appearance and design are pleasant [25]. There have been cases in which, when there is no prospect of improvement of the dysfunction with use, the ADs are abandoned. When users perceive

that, even though the strangeness of the unusual provides a certain discomfort in use, but with use, they manage to preserve their skills, they accept this new condition and end up appropriating the technology for the activity, which tends to be normalized. However, a study [12] carried out with people with and without difficulty in handling, showed that there were no significant differences regarding the use of a button hook, elastic shoelaces, shoehorn and socks aid, in which both groups do not use the ADs.

As discussed earlier, some participants mentioned about the non-use of the ADs, while other participants commented about at least one of the ADs presented by the authors. The most cited were - according to the number (in parentheses) of participants who cite the use: shoehorn (7) and zipper puller (6) (Fig. 1). The use of the shoehorn is described as more common because it is used by anyone, with or without motor restriction, mainly for the use of social/classic leather shoes, due to their rigid structure making it difficult to fit the foot in the opening. Thus, the use is common, naturalized, and not associated with a functional disability of the user [25], that ADs can highlight or draw attention to the disease or disability. Such findings, for elderly users, about the availability and frequency of use of the shoehorn were also found in the study by [12]. When motor restriction makes it difficult to manipulate other types of shoes, users end up using the product to also wear sneakers, among others. The zipper extender, in the shape of a cable, or ring - as mentioned by some participants, is also a more common fastening being easy to adapt in clothing or even, usually in sports-style clothing. The adaptation of this fastener is also mentioned with the insertion of a clip, office supplies.

The least mentioned products were (Fig. 1): button hook (2) and zipper hook (3), the manipulation of which requires manual dexterity to be accurate for fitting the products, both in the button slot and in the base of the zipper. The visual-motor skill is also important because the activity with the ADs is very thorough. For these products, the coordination of movements has to be done with both hands: with one the user can hold the fabric, giving stability to the movement that will be performed with the other to close/open the clothes. The elastic shoelaces (2), due to their design being mostly sporty and colorful, end up changing the appearance of the shoes, and users want to keep their style, preferring not to use it if they do not identify themselves with the product. The sock aid (2), dressing stick (3) and sock stick (5), are technologies that, in addition to handling control, need the user to have a reasonable range of trunk and arms, being impossible to be used in the advancing symptoms of PD, whose (most frequent) symptoms of tremor in the extremities and muscle stiffness can hinder or even make it impossible to interact and perform such activity.

It was reported by the participants that the non-use of ADs to aid the manipulation of clothing can occur with the influence of other diseases associated with the clinical status of patients, such as low visual-motor and spatial perception of the body, and, by psychosocial interferences - this is also discussed by [28]. These depend on an understanding of how the product works, the will generated by the physical and cognitive stimulus, and a predisposition to recover autonomy (Fig. 1). This is because it may be possible to recover some functions in the mild symptoms of PD, based on the guidelines and practices of (re)learning and training in the rehabilitation of the activity [29]. With the progression of PD, the person may not be able to perform the activity alone; often, another person will do it for him/her, with the substitution of performing the activity. In

such a circumstance, embarrassing situations can occur that discourage treatment and/or training, resulting in partial or total dependence on care.

It was also observed that the concern to remain independent is a major factor for the use of these interfaces, which can assist in the process for functional improvement. However, in addition to the factors that are influenced by the complex and individualized reality of the people with PD, the products themselves are standardized in their format and design in general, making it difficult for the user to adapt, since the disease affects them individually. If ADs would be personalized, perhaps such issues could be improved and contribute to the effectiveness of use. Since when the user has access to the product and proposes to learn and train the activity with it, its use can be conditioned to the acceptance of the benefit that the AD can offer to maintain independence. That is, even if the user is able to use the product and improve their ability to perform the activity more autonomously, given the functional benefit that the object can cause, an AD can intensify and be linked to stereotypes of disability. With this, the product can be seen as a symbol of social stigma, of the prejudice that the user may suffer and/or that he/she can generate by having this negative feeling in relation to the condition [26], so the benefit that the AD can offer is no longer desired.

The use of ADs is pertinent to assist in the activity usability. However, in the situations presented, its use can become another problem than not being able to perform the activity. If Clothing Designs were more accessible, it would make it easier for users to interact. For this, proposing more clothes and shoes with functional, aesthetic and symbolic characteristics relevant to users, without making the product something that will differentiate who has the disease or disability from other people. The availability and development of products that can promote autonomy in the face of these disabilities, still have few attractive resources, being at the same time efficient to the limitations. To demystify this stereotyped view of the disease, of the person, of the product, is relevant to make the issue common and natural, it is to make clothes easy to wear as a fashion trend, since clothing is an important part of social participation and inclusion [30]. For that, knowing the particular universes of the difficulties involving the scenario, the person, the disease and the product, are essential to clarify the aspects that involve the different (and individual) way of use.

It is possible to consider that, based on the findings of this study and on the lack of research, to prove the effectiveness of improving independence, most ADs aren't effective for the people with PD from whom the participants had the experience of care. In addition to what has already been discussed as influences on this non-use, it may also be associated with the lack of better options, since the design of the ADs is very limited and not attractive at all.

4 Conclusion

The purpose of this study was to investigate, through the use of qualitative methods, the perception of caregivers and rehabilitation professionals of people with PD, about the usability of ADs to assist in dressing/undressing products, such as shoes and clothes. From the proposed objective, it was possible to get closer to the universe experienced by people with PD, through the participants' experiences as support care networks,

involving the activity of manipulating and dressing/undressing clothing products through reaching the ADs.

The results, although they cannot be generalized due to the sample limitation, illustrate situations that can happen to the detriment of the disease symptoms and experienced scenarios, such as those described in the discussion (home, rehabilitation clinic, hospital and LTCF). We consider the period of application of this investigation as a study limitation, being Portugal in lockdown (January–April/2021) due to the Covid-19 pandemic. This fact may have influenced the dissemination of the survey and the participants' acceptance and interest in collaborating with the interviews since all participants are health professionals and work directly or indirectly with risk groups. The reduced number of participants restricts the broader discussion of the theme.

The multidisciplinary performance of professionals and caregivers, on the interaction with AD for the clothing activity by people with PD, supposed that the use can be minimal at the mild symptoms, due to the fact that people, even with limitations, can perform adaptively to the activity. At moderate or severe symptoms, the use can be also minimal, but it depends on the ability to manipulate and use the ADs, because, in many cases, it is necessary to have control and precision of the movements to be able to complete the activity. The reality of use is complex, as it involves parts of interactions that interrelate with external causes and phenomena, in addition to genetic and social conditions. The professionals' stimulation is influenced by the system in which the person is, and may interfere in the treatment for the (re)learning of the activity. ADs could provide some improvement in functional capacity, but for that, we need their design to be improved and targeted to the people's individual needs.

So, these products nominated assistive devices for dressing/undressing can promote independence if the user, in the process of rehabilitation, manages to regain some movement control through training in the activity. In other words, the product has its efficiency but is particularly dependent on the physical condition of users and also driven by the desire and acceptance to use. The products, in the function for which they were designed, can provide better independence in daily activities, but aren't a solution to the problems related to the inability to dress alone. Since, as mentioned above, other factors related to activity-product-user may be interfering in this relationship; factors such as the disease symptoms, the environment in which the person is living or has access to care; motivation, sociocultural support, financial resources, and especially the stigma related to the design of the AD - that isn't common to products found in the conventional markets. All these influences weigh the benefit and harm of use, being particular to the reality of each user.

Perhaps, the main problem found from the point of view of product development, about the cause for non-use, is linked to the design and appearance of the objects. Mainly because they aren't common and usual for the vast majority of the population. This factor ends up segregating and excluding those who use it. And, in social terms, people try to fit into social patterns in order to be accepted and normalized. This fact serves to confirm what we had already expected, from the point of view of product design, that in a sequence of studies so far discussed by the authors [8, 31–33], clothing can be difficult for such users and interface solutions are segregating because they end up stigmatizing the user.

Then, we believe that normalizing the use of these products is the first big step to insert more and more users into this assistive universe. For this, creating new options for existing ADs, with a more attractive design, can broaden the possibility of choice and identification with the object. As all as alternatives for clothing products that can offer more practicality and promote autonomy for well-being. Future studies foresee that the investigation of the theme will be extended to users with PD, addressing such factors in order to identify how clothing design can improve aspects of the usability of clothing products from simulated situations of use.

Acknowledgments. This work was supported by the grant 2019/24864–0, São Paulo Research Foundation (FAPESP); by the CIAUD, Lisbon School of Architecture, Universidade de Lisboa and FCT – Portuguese Foundation for Science and Technology. The support of the Universities, Institutions, Associations and their representatives was essential for the inquiry dissemination.

References

1. Dorsey, E.R., Elbaz, A., Nichols, E., Abd-Allah, F., Abdelalim, A., Adsuar, J.C., et al.: Global, regional, and national burden of Parkinson's disease, 1990–2016: a systematic analysis for the global burden of disease study 2016. *Lancet Neurol.* **18**(5), 459–480 (2019)
2. Perracini, M.R., Fló, C.M.: Funcionalidade e envelhecimento, 2nd edn. Guanabara Koogan, Rio de Janeiro (2019)
3. WHO. World Health Organization. International classification of Functioning, Disability and Health: (ICF). Switzerland (2001). <https://apps.who.int/iris/bitstream/handle/10665/42407/9241545429.pdf>. Accessed 21 Apr 2021
4. Singh, N., Pillay, V., Choonara, Y.E.: Advances in the treatment of Parkinson's disease. *Prog. Neurobiol.* **81**(1), 29–44 (2007)
5. Ferreira, J.J., Gonçalves, N., Valadas, A., Januário, C., Silva, M.R., Nogueira, L., et al.: Prevalence of Parkinson's disease: a population-based study in Portugal. *Eur. J. Neurol.* **24**, 748–750 (2017)
6. Radder, D.L.M., Sturkenboom, I.H., van Nimwegen, M., Keus, S.H., Bloem, B.R., de Vries, N.M.: Physical therapy and occupational therapy in Parkinson's disease. *Int. J. Neurosci.* **127**, 930–943 (2017)
7. Rahman, S., Griffin, H.J., Quinn, N.P., Jahanshahi, M.: Quality of life in Parkinson's disease: the relative importance of the symptoms. *Mov. Disord. Official J. Mov. Disord. Soc.* **23**(10), 1428–1434 (2008)
8. Marteli, L.N., Barbieri, F. A., Gerizani, G., Neves, É.P., Paschoarelli, L.C. Impact of Manual Coordination on Usability of Clothing Fasteners in People With Parkinson's Disease. *Ergonomics in Design* (2021)
9. Herczyk, J., Góra, J.: Nursing care of a patient with Parkinson's disease in domestic conditions. *J. Public Health Nurs. Med. Rescue* **1**, 15–19 (2016)
10. Lanzoni, A., Romano, E., Ranhoff, A.H., Clark, E.G., Holter, M.K., Jørmeland, C.: Occupational therapy in rehabilitation settings. In: Pozzi, C., Lanzoni, A., Graff, M.J.L., Morandi, A. (eds.) *Occupational Therapy for Older People*, pp. 77–99. Springer, Cham (2020). https://doi.org/10.1007/978-3-030-35731-3_5
11. Gaudet, P.: Measuring the impact of Parkinson's disease: an occupational therapy perspective. *Can. J. Occup. Ther.* **69**(2), 104–113 (2002)

12. Roelands, M., Van Oost, P., Depoorter, A.M., Buysse, A.: A social-cognitive model to predict the use of assistive devices for mobility and self-care in elderly people. *Gerontologist* **42**(1), 39–50 (2002)
13. Perry, S.I.B., Nelissen, P.M., Siemonsma, P., Lucas, C.: The effect of functional-task training on activities of daily living for people with Parkinson's disease, a systematic review with meta-analysis. *Complement Ther. Med.* **42**, 312–321 (2019)
14. Kumar, P.: Impact of assistance on the quality of life of older adults with activities of daily living & instrumental activities of daily living disabilities. Master of Science, Medical Gerontology - University of Dublin, 86 p. (2017)
15. Schiehll, L.O.: O processo de vestir como princípio para o design de vestuário: autonomia para mulheres com patologias músculo-esqueléticas. Doctorate in Design, FA-ULisboa, 311 p. (2017)
16. Pulliam, C.L., Heldman, D.A., Brokaw, E.B., Mera, T.O., Mari, Z.K., Burack, M.A.: Continuous assessment of levodopa response in parkinson's disease using wearable motion sensors. *IEEE Trans. Biomed. Eng.* **65**(1), 159–164 (2018)
17. Hssayeni, M.D., Burack, M.A., Jimenez-Shahed, J., Ghoraani, B.: Assessment of response to medication in individuals with Parkinson's disease. *Med. Eng. Phys.* **67**, 33–43 (2019)
18. Uzochukwu, J.C., Stegemöller, E.L.: Repetitive finger movement and dexterity tasks in people with Parkinson's disease. *Am J Occup Ther.* **73**(3), 1–8 (2019)
19. Beattie, A., Caird, F.I.: The occupational therapist and the patient with Parkinson's disease. *BMJ* **280**(6228), 1354–1355 (1980)
20. Ministry of Labour, Solidarity and Social Security. Portugal report: United Nations Economic Commission for Europe (UNECE) third review and appraisal of the regional implementation strategy (RIS) of the Madrid international plan of action on ageing (MIPAA), 38 p. (2017)
21. Gil, A.C.: Como Elaborar Projetos de Pesquisa. 6 nd edn. São Paulo, Atlas (2017)
22. Friese, S.: Qualitative data analysis with Atlas.ti. 2nd edn, Sage Publications, London (2014)
23. Paz, T.D.S.R., de Britto, V.L.S., Yamaguchi, B., Israel, V.L., Swarowsky, A., Correa, C.L.: Hand function as predictor of motor symptom severity in individuals with Parkinson's disease. *Gerontology* **67**(2), 160–167 (2021)
24. Imaginário, C., Rocha, M., Machado, P., Antunes, C., Martins, T.: Self-care profiles of the elderly institutionalized in elderly care centres. *Arch. Gerontol. Geriatr.* **78**, 89–95 (2018)
25. Correia de Barros, A., Duarte, C., Cruz, J.B.: The influence of context on product judgement - presenting assistive products as consumer goods. *Int. J. Des.* **5**(3), 99–112 (2011)
26. Biernat, M., Dovidio, J.F.: Stigma and Stereotypes. In: Heatherton, T.F., Klecl, R.E., Hebl, M.R., Hull, J.G. The Social Psychology of Stigma, pp.88–125. The Guilford Press, New York (2003)
27. Roelands, M., Van Oost, P., Stevens, V., Depoorter, A.M., Buysse, A.: Clinical practice guidelines to improve shared decision-making about assistive device use in home care: a pilot intervention study. *Patient Educ. Couns.* **55**(2), 252–264 (2004)
28. Mlinac, M.E., Feng, M.C.: Assessment of activities of daily living, self-care, and independence. *Arch. Clin. Neuropsychol.* **31**(6), 506–516 (2016)
29. Doucet, B.M., Franc, I., Hunter, E.G.: Interventions within the scope of occupational therapy to improve activities of daily living, rest, and sleep in people with Parkinson's disease: a systematic review. *Am. J. Occup. Ther.* **75**(3), 1–32 (2021)
30. Esmail, A., Poncet, F., Auger, C., et al. The role of clothing on participation of persons with a physical disability: a scoping review. *Appl. Ergon.* **85**, 103058 (2020)
31. Marteli, L.N., Das Neves, E.P., Medola, F.O., Paschoarelli, L.C.: Considerations on the advances in studies on clothing products development for older adults with Parkinson's disease. *MOJ Gerontol. Geriatr.* **4**, 151–153 (2019)

32. Marteli, L.N., Barbieri, F.A., Paschoarelli, L.C.: Conceitos sobre o envelhecimento, doença de Parkinson, usabilidade e estigma de produtos cotidianos. In: dos Santos Menezes, M., Paschoarelli, L.C. (eds.) Design: Tecnologia a serviço da qualidade de vida. 1ed.Bauru: Canal 6(1), 97–114 (2020)
33. Marteli, L.N., Barbieri, F.A., Fulco, M.A.S., et al.: Uma revisão integrativa sobre a atividade de vestir e despir vestuários por idosos com doença de Parkinson. In: Okimoto, M.L.L.R., Paschoarelli, L.C., Costa, C.A., Merino, E.A.D., Foggiatto, J.A. (eds.). Tecnologia assistiva: abordagens teóricas. 1ed.Bauru: Canal vol. 6, no. 1 pp. 109–118 (2021)



Traces of Chief Design Officers in Design History: The Cases of Olivetti, Braun, and Apple

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Abstract. This article aims to identify the traits of a Chief Design Officer, with the purpose of fostering a cultural dialogue between design and the corporate environment. In the synergy of such dialogue, it arises from reflections on the evolution of design management between 1950 and 2020 as a strategic resource and the urgency to integrate a Chief Design Officer in the organisational structure of companies.

This study is the outcome of an ongoing investigation based on a systemic literature review and case studies that seek to assess the role of design as a strategic, innovative, and competitive asset for businesses. The historical lens of analysis on design management and on designers' competences allows an evolving observation of the role of design management through the designer, from which three case studies are highlighted: Olivetti, Braun, and Apple. In this historical overview of several industrial sectors, one can find traces of individuals who played a key role in scaling up strategic design within the corporate structure, through their inclusion in top management, namely: Ettore Sottsass, Dieter Rams e Jonathan Ive.

The designers that have helped to reshape these companies are undeniable figures in the historical and contemporary landscape of design, and their role in the strategic and cultural construction of companies is indisputable. These are cases that also allow the historical observation of the relevance of a managerial vision, to understand the value and the disruptive factor resulting from the introduction of strategic design models in companies.

Finally, this article highlights emerging discourses that combine three different design strengths: strategy, leadership, and top management engagement.

Keywords: Design management · Leadership · Chief Design Officer

1 Introduction

1.1 The Affirmation of Design in Organisations as a Strategic Resource

Throughout the history of design management, design is envisioned as one of the main drivers of innovation, both in manufacturing and in the services dimension (Brown 2009; Verganti 2009; Liedtka 2014; Dorst 2015; Ostrom et al. 2015; Luchs et al. 2016). On the other hand, it is also perceived as critical for corporate brand differentiation (Noble

and Kumar 2010) and a resource that has a positive impact on the financial and non-financial performance of companies (Gemser et al. 2011; Design Council 2012). Recent studies prove that those companies that embrace a holistic and systematic approach to design, experience better financial results and achieve global positioning (Danish Design Center and DI 2018). The value that design can create for innovation is strongly affected by C-suite engagement, and design-led companies have 32% more revenues than other companies (Design Council 2014; McKinsey Quarterly 2018).

There are some examples of mainstreaming design into executive roles through the position of Chief Design Officer (CDO) - from Kia Motors to PepsiCo, Apple to 3M, Procter & Gamble to Nike, the Design Council to the City of London - all showing that design plays a significant role in delivering innovative and economically meaningful outcomes (Stuhl 2014; Hope 2018).

The success of these design-led companies highlights the need to place it in a strategic dimension as has been argued by several authors such as: Mozota (2003), Best (2006), Beverland and Farrelly (2007), Noble (2011), Stevens and Moultrie (2011), Wrigley and Straker (2016), Wolff and Amaral (2016) and Brown (2019). Design in the strategic realm is defined as the ability of designers to influence decisions and define future directions and visions on issues that affect the competitiveness of an organisation and its long-term sustainability, as well as the development and communication of a brand's core values, its positioning and the creation of new markets (Micheli et al. 2012; Micheli et al. 2017).

1.2 The Evolving Role of the Chief Design Officer

The scope of design management, as a resource based on the process, strategy, and skills shared by the structure of companies (Wolff and Amaral 2016), spans three levels: functional, visual, and conceptual (Svengren 1997). In turn, Mozota (2003), states that the designer's role in the corporate environment has three pivotal dimensions - strategic, tactical, and operational - and can be ascribed the ability to:

- strategically advocate the deployment of design throughout the entire organisation in dialogue with the value chain (*ibid.*);
- tactically management of corporate design functions which includes design operations, human resources, methods and processes (DMI 2020);
- to focus operationally through the development of new products and services (Chung and Kim 2011).

In this framework, the role of a CDO is located in the strategic dimension (Holland and Lam 2014), since the integration of design leaders in the C-level allows the strategic enhancement of design.

On the other hand, the affirmation of the CDO has been established in large organizations, by placing design at the executive level, with a leadership that defines the strategy, the policy, and the mission and the design action in companies (Best 2006), assuming a holistic vision about the company, its culture and society in general (Stuhl 2014). This role should also encompass communication attributes that induce the user to achieve more meaningful experiences, allowing the change of his perception about

the brand (Pallister 2015). Several interviews with several CDOs, also allow us to assess that a Chief Design Officer is a:

- Design leader who brings together the entire organisational ecosystem - management, design, technology, monitoring functions - ensuring design impact across the value chain through exploitation, experimentation, empathy and focus on the human being (Design Council 2014; Girling and Carney 2017);
- Cultural Interpreter, facilitator and mediator between multiple departments, people and relationships (Vries 2015);
- Creator of interdepartmental innovation synergies - e.g., R&D, Marketing and Design functions (Electrolux 2012);
- Moves in collaborative environments, nurturing creative and dynamic environments, in a cross-pollination of new ideas and diverse insights that reflect the heritage of the organisational context in which they operate (Chin 2015);
- Fosters solutions that tackle broader needs, rather than being focused on isolated products or services, cultivating long-term relationships and co-creating solutions with teams internal and external to the company (Girling and Carney 2017);
- Drives an internal culture of diversity and inclusion, valuing, and developing the potential of the whole team (Quinteros 2018).

In 2020, Dalrymple, Pickover, and Sheppard, published a study based on interviews with 200 CEOs where they argued that the expectations of the CDO role should be aspirational and entail transformation and not just execution. For that, the CDO should be focused on three core objectives: the user experience, the organisation, and the design team. This survey also reveals that the CDO's set of responsibilities is demanding but

Core Responsibilities	Main Skills		Mindset
To support the development of new innovative business models.	Commercial fluency	Leadership	Demonstrates ability and willingness to develop innovative, exciting solutions to business problems.
Improve experiences for customers by ensuring high-quality design, including ownership of all front-end interaction points.	Compelling communication	Demonstrable design talent	Takes collaborative approach required to understand organizational problems.
Drive design standardization across the organization.	General management	Community building	Is fascinated with how users experience products and services and has a hunger to improve those experiences.
Represent design at top level of the organization [CEO leadership meetings and board meetings]			Possesses significant personal and professional drive to improve standing of design internally.
Spread design by creating a common language and set of practices across organization.			
Develop the design team's skills by supporting conference attendance [other media], with the aim of optimising different skill sets.			
Represent organization's brand at functions and in press [conference presentation per year, articles,...].			
Nurture a thriving community of designers; build and maintain the design team.			

Fig. 1. The role of a Chief Design Officer in organisations: responsibility, skills, and mindset (adapted from Dalrymple et al. 2020)

measurable, with interdepartmental interactions, while skills and mindset should be tailored to an effective leadership rather than individual capabilities, as illustrated in Fig. 1.

2 Research Methodology

In order to investigate the hybrid territory of design management, a temporal arc was defined, stretching from 1950 to 2020, and outlined through literature and an analysis of current companies, designers, organisations and educational institutions. This historical analytical lens enables one to pose the following question: what are the commonalities that portray the designer's inclusion or proximity to executive functions, highlighting design in top management?

The economic enhancement and corporate culture of design have been evolving over the history of design management. As mentioned, this article is based on the analysis of three case studies where Olivetti and Braun, depict the first stages of design management assertion through the leadership of Ettore Sottsass and Dieter Rams, respectively. Apple stands for an iconic company with a design-led management model that has integrated Jonathan Ive as CDO since 2015.

2.1 The Olivetti Case: Ettore Sottsass

Ettore Sottsass (1917–2007) was a pivotal player in the history of Italian design, renowned for designing products for several industrial sectors. In 1958 he became a consultant in Olivetti's electronics division, a leading position which he held for 22 years.

Olivetti is a multinational company that manufactures office equipment and computer systems and was founded by Camillo Olivetti in 1908 through the development of typewriters (Augustyn et al. 2019). In 1990, Kicherer (1990) described Olivetti's evolution as one of the most respected Italian companies, having an international identity that stems from the symbiosis between technology, culture, and the inclusion of the design management philosophy in its corporate framework. This relationship between management and design took on greater meaning when Adriano Olivetti, an engineer by profession, became CEO in 1938 (MoMA 1952).

The design management success that Olivetti has achieved is based on the corporate policies established by Adriano Olivetti, which sought to hire both independent and outsider designers for managerial functions. The corporate identity came to embody two design studios: one under the direction of Ettore Sottsass, that included the office furniture programs, design of Olivetti Network Systems and Olivetti Synthesis; the other, under Mario Bellini responsibility, an independent product company - Olivetti Office - that covered a broad range of consumer-driven office machines and computers (Pulos 1992). The studios arose from the collaboration between executive roles, internal designers, and external designers, who are more than leaders of a team, characterized by Pulos (*ibid.*) as:

- Definers of the nature and the dynamics of design in the business;
- Cultural interpreters of new technologies, who were able to transcend purely functional solutions;
- Open-minded independent personalities, who sought new product configurations that featured radical technology.

Highlights of the products designed by Sottsass and his team include: Elea 9003 (1959), considered to be the first Italian computer; typewriters - Praxis (1964), Tekne (1964) and Valentine (1969); calculators - Logos 27 (1963), Summa-19 (1970) and Divisumma 26; and finally, the office furniture system in 1973 - Synthesis (Domus 2019).

2.2 The Braun Case: Dieter Rams

Dieter Rams is an undeniable reference who advocated the ten principles of “good design” that echo the ethics and values of the profession and from which new paradigms are drawn through the core tenet - “less is simply better” (Rams 2014). Such principles are depicted for instance in a wide range of Braun products, where Rams was the leader of the design department between 1961 and 1995.

Founded in 1921, Braun began as an appliance manufacturing shop, evolving into the radio industry, and in the post-war period the company focused on household appliances and other residential products (Polster 2010). Under the direction of the brothers Artur Braun and Erwin Braun, the company underwent a strategic change (Werner 2014; Pohl 2012), characterized by:

- an expansion of product ranges and by hiring Dieter Rams in 1951;
- more progressive and social responsible approaches;
- new relationships established with: Fritz Eichler and an extensive interdisciplinary network of consultants, designers and intellectuals of the time;
- and through the partnership with the Ulm School.

This deployment of a new corporate vision based on design language, had its first impact with the Braun SK4 radio-phonograph (1956), by Rams and Gugelot, which through an experimental design process, becomes an icon of a philosophy grounded in the tenets of modularity and minimalist lines (Domus 2020), which was followed by other paradigmatic products within the same philosophy.

As head of the design department, Dieter Rams stood for the systematic application of design featured by a new relationship between form and function and foresaw the principles of sustainability. On the other hand, he also introduced a more heterogeneous design language and established Braun as a design-driven company (ibid.; Schneider and Beuker 2001). In 1988, Dieter Rams joined Braun's board of directors as chief representative and in 1995 he was promoted to executive director of corporate identity of Braun, a position he held until his retirement in 1997 (Hustwit 2018).

2.3 The Apple Case: Jonathan Ive

Since 1996, just 4 years after joining Apple, Jonathan Ive has held a leadership role in the industrial design team. In 2013, he became Senior Vice President of Design and in 2015 he was promoted to the role of CDO, which he undertook until he stepped down in June 2019 (Hern 2015; Apple 2019).

Apple was deemed in 2018 to be the first public company to surpass the historic milestone of one trillion dollars, due to the increase in its share price (Davies 2018; Badenhausen 2019). However, its rise was uneven and in the late 1990s it even endured an eminent decline, before embracing a design-driven philosophy for innovation, which set the pace for Steve Jobs' return and the adoption of a new business model characterised by the alignment of new products, services and operational synergies (Heracleous & Papachroni 2016). The launch of the iMac G3, in 1998, was the turning point, placing Apple in the apex of innovation, by the enhancement of the user, the technological advances, the materials and the unique design that has enabled the rise of a new language of artifacts (Verganti 2009). As a result, in the first 2 months after entering the market, the iMac G3 sold over 278,000 units (Toguchi 2017).

Since then, Apple has become a success story of an innovative design-driven company reinventing the meaning of how people use computers, listen to music or more globally, the way individuals connect with technology. With Jobs, Jonathan Ive has developed such iconic products as the iPod, iPhone, and the iPad and by 2015 he holds 5000 patents (BBC 2015). Like Jobs, Ive embraced the philosophy of Dieter Rams, pursuing design under the principle of simplicity in a dialogue between integrity, essence, deference, style, and honesty (Shelley 2015).

In 2015, he takes on the role of CDO, and this is the first time Apple has ever placed a designer in senior management, having accrued, in Tim Cook's words, responsibility for the entire design process, with a keen focus on large-scale projects, new ideas and future initiatives (McGarry 2015; Fry 2015). This included Apple Park, the upgrades of the iPod, iPhone, iPad, the Apple Watch and AirPods, where, together with his team, he applied the principles of lateral thinking and attention to detail.

2.4 The Evolution of Design Management and Case Studies

As part of the research, a mapping of the history of design management was carried out, based on historical milestones, societal facts, relevant publications, and themes, diagrammatically displayed in Fig. 2, 3, 4, 5, 6 and 7. With this research and subsequent analysis it was intended to build a theoretical framework that would allow the construction of a baseline in the arena of design management and in the definition of the CDO profile.

The following diagrams were made based on literature review (Best 2006; Cooper and Junginger 2011; Mozota and Wolff 2019), and by gathering data about the three case studies.

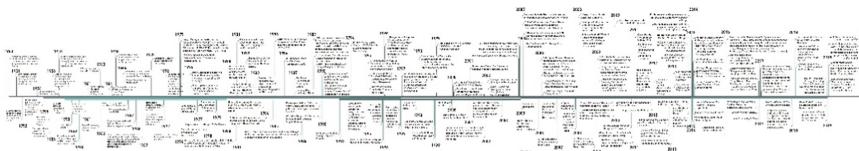


Fig. 2. Mapping the history of design management between 1950 and 2020 and case studies (source: compiled by the authors)

I.



Fig. 3. 1950 to 1974 - The prelude of design management (source: compiled by the authors)

This historical mapping allows one to visualize the evolution of design management and its correlation with the case studies through theories published between 1965 and 2020 and assumes five distinct stages as shown in Figs. 3, 4, 5, 6 and 7. In this confrontation between history and the previous case study analysis, it is aimed to cross-validate three design management models and their influence over the definition of the role of the CDO.

3 Preliminary Results

Junginger (2016) point out that design must transcend its genesis, so that it can drive a radical thinking that tackles human issues. This driving line of thought bridges the gap with strategic design, whereby the designer's role is reviewed from different perspectives, underpinned by prominent authors such as Buchanan (2015), Muratovski (2015) and Michlewski (2015).

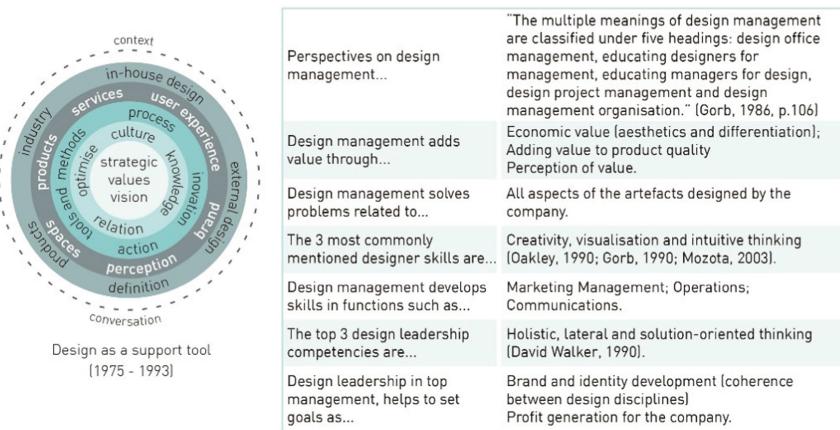
II.

Fig. 4. 1975 to 1993 - The institutionalization of design management (source: compiled and adapted by the authors)

III.

Fig. 5. 1994 to 2004 - The value of design management (source: compiled and adapted by the authors)

If, until 1975, the design landscape was filled by a considerable number of design studios and large design agencies, the evolving and the historical overview of design management seems to show that, progressively, design became a more centralized and corporate strategic asset, where designers acquired an increasing influence in companies. As large companies began to grasp the designer's skillset as a key business asset, design began to be integrated into the overall business strategy.

IV.

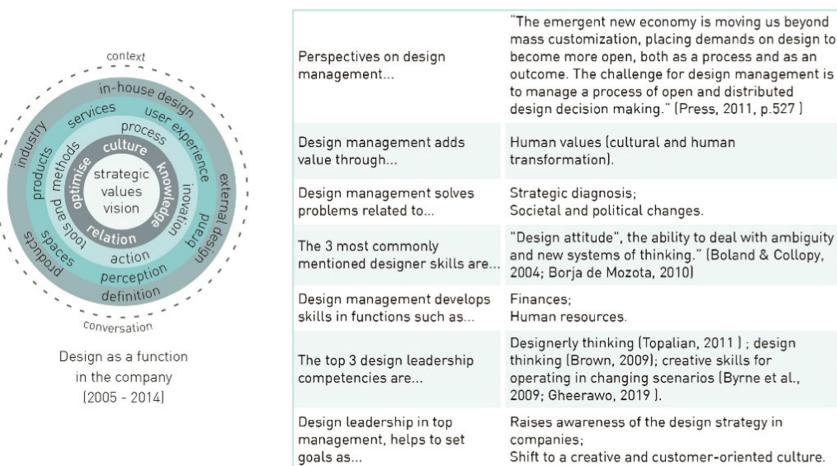


Fig. 6. 2005 to 2014 - The politics of design-driven innovation (source: compiled and adapted by the authors)

V.

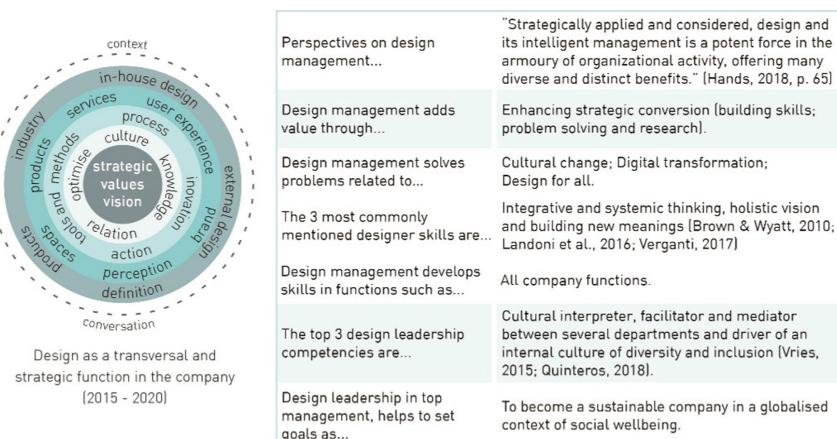


Fig. 7. 2015 to 2020 - Design management as a strategic dialogue (source: compiled and adapted by the authors)

These gradual trends were observed through the actions of Ettore Sottsass at Ollivetti, Dieter Rams at Braun, and Jonathan Ive at Apple. These designers played a decisive role in the history of design management, not only by shaping paradigmatic changes, but also by depicting management models where design assumes a proximity to the CEO, being the design:

- an external resource to the company;
- an internal resource in the company, through the role of design director;
- a strategic and internal resource in the company, through the role of CDO.

If companies such as Olivetti and Braun are seen as leading examples in the history of design management, either by outsourcing or by internalizing design, Apple can be seen as a benchmark of the growing reputation of design as a catalyst for business innovation, where designers are being invited to take on executive roles.

3.1 Building Bridges

The global market competitiveness that was witnessed in the early 21st century, has resulted in a new wave of business innovation that has been focused on designing user-centred experiences and systems. This required new thinking streams that challenged existing business models, called by Verganti (2009) as a transformation of meaning. This is conveyed into the concept of radical innovation which entailed a market, product, and industry transformation, shifting from complexity and high cost into simplicity, convenience, and accessibility, as seen in products such as the Valentina, the SK4, the iMac G3 and the iPhone. These companies have placed design at the top of the business agenda, where design is no longer just a practical discipline, but above all, a stream of thought that interferes directly with the upper management.

The corporate vision of Adriano Olivetti, Artur and Erwin Braun and Steve Jobs plus a new design attitude embodied by Sottsass, Rams and Ive, matched each other seamlessly. At Braun, the job of the design department was seen as a task to be shared and it was characterized by a tight cooperation with management, thereby becoming a source of inspiration for the company (Werner 2014). On the other hand, Adriano Olivetti, by bringing design consultants into the role of managers, allowed a continuous knowledge transfer, stimulating disruptive innovations that have turned Olivetti into a design-driven company. The partnership between Jobs and Ive, conveyed by the ground-breaking products that they developed, is summed up in Ive's quote: "Much of the design process is a conversation, a back-and-forth as we [Jobs & Ive] walk around the tables and play with the models" (Isaacson 2011, p. 346). As Rams (1983) argues, the decision to build a "good design" doesn't come from designers or the design department, but rather from the company's attitude to embed it in their goals, underpinned by a good corporate organization and decision structure.

Design, emotion, connection, engagement, interaction, are all featured in Sottsass, Rams and Ive's products. Exploring the relevance and meaning for consumers living in a multitude of real and digital cultures, is the key to create new economic value (Nussbaum 2010). Sottsass, Rams and Ive are, therefore, bridge-building figures, bringing knowledge about new meanings emerging in the design discourse of the time. They can also be deemed as mediators setting up relationships between interpreters of these meanings and the company's purposes (Verganti 2009).

4 Discussion and Conclusions

4.1 Triggers to Future Dialogues

In an effort to increase understanding about the importance of the role of a Chief Design Officer, a multiphase study was undertaken in this article, beginning with a systematic review of the literature about the history of design management and then proceeding with selected case studies analysis. The relation between history and the case studies that were presented reveal the openness that the corporate environment has been adopting, in the sense of a growing awareness of the role of design management within an organization, considering the resources, processes, and skills of designers.

Although, if the role of the CDO is comparable to historical cases is there really any value in its action, or will design remain stuck in business models, processes, and paradigms of the past? What new stories, meanings, and relationships can be unlocked through strategic dialogues that allow reframing the design arena, reassessing future goals, and recalling the underlying purposes of design management in organizations?

In addition, what we have seen in recent years with the rise of the CDO role, is a greater emphasis on design-driven leadership, by bridging internal and external inputs, or as pointed out by Dalrymple et al. (2020), on aspirational expectations, involving transformation and not just execution.

As such, is a CDO an example of how the skills and tools of designers can inspire not only teams and process managers, but also other top management functions? In this transfer of know-how, how can design enhance its practice, by bridging more clearly the designer's thinking potential, to board members?

4.2 Strategic Dialogues in Collaborative Models

This article has searched and argued the core competences of a design leader since the 1950s, suggesting that their natural evolution has been expressed by the character of a Chief Design Officer. On the other hand, in the historical search for these traits, it was concluded that the success of Sottsass, Rams and Ive as design leaders has always depended upon a dialogue of proximity with top management and on the continuous pursuit of partnerships, through collaborative models of management.

In fact, from AEG to Olivetti, from Braun to Johnson & Johnson, from Apple to Philips, in the course of history there is always a company that has proven that a design-driven attitude can contribute to a unique market placement through a straightforward dialogue between design leaders and the company's top management. This CEO-Designer partnership approach, places design at the heart of companies and enables the establishment of a strategic dialogue and an internal design culture. This is a dialogue about goals, aims, and resources, about needs and possibilities, about environment and constraints, about action and results, in which the designer acts as a facilitator.

Sottsass and Rams, are remarkable case studies on the historical path, whose intervention in companies are consistent with the responsibilities, competencies and thinking models presented by Dalrymple et al. (2020) concerning the CDO role. But they are above all, leaders, facilitators, and mediators who advocate the role of design in organizations and who justify the existence of the CDO position, voiced by Ive.

Every company has a mission and a strategic vision, but they are also complex human systems in which the designer's ability to observe, coordinate, visualize, simplify, and make something coherent are crucial. Understanding the assumptions of design within organizations allows design to be embedded as culture. As an organization recognizes itself as an integral player in the realm of design, the better it can experience design's full potential. It is under this branching philosophy of design value, thought, leadership and culture, that Sottsass, Rams, and Ive have illustrated the potential of the CDO in six decades of design management history.

References

- Apple.: Jony Ive to form independent design company with Apple as client, 28 June 2019. <https://www.apple.com/newsroom/2019/06/jony-ive-to-form-independent-design-company-with-apple-as-client/>
- Augustyn, A., et al.: Olivetti & C. SpA (2019). <https://www.britannica.com/topic/Olivetti-and-C-SpA>
- Badenhausen, K.: The World's most valuable brands 2019: Apple on top At \$206 billion. The Guardian (2019). <https://www.forbes.com/sites/kurtbadenhausen/2019/05/22/the-worlds-most-valuable-brands-2019-apple-on-top-at-206-billion/>
- BBC.: Apple design guru Jony Ive promoted. BBC (2015). <https://www.bbc.com/news/technology-32879802>
- Best, K.: Design Management: Managing Design Strategy, Process and Implementation. AVA Academia Publishing, London (2006)
- Beverland, M., Farrelly, F.J.: What does it mean to be design-led? Des. Manage. Rev. **18**(4), 10–17 (2007). <https://doi.org/10.1111/j.1948-7169.2007.tb00089.x>
- Brown, T.: Change by Design: How Design Thinking Transforms Organizations and Inspires Innovation. HarperCollins Publ, New York, NY (2009)
- Brown, T.J.: Strategic design or design strategy? Effectively positioning designers as strategists. Des. Manage. Rev. **30**(1), 38–45 (2019). <https://doi.org/10.1111/drev.12160>
- Buchanan, R.: Worlds in the making: design, management, and the reform of organizational culture. She Ji: J. Des., Econ., Innov. **1**(1), 5–21 (2015). <https://doi.org/10.1016/j.sheji.2015.09.003>
- Chin, A.: 3M's chief design officer eric quint details the firm's creative vision. Designboom (2015). <https://www.designboom.com/design/3m-chief-design-officer-eric-quint-interview-11-10-2015/>
- Chung, K.-won, Kim, Y.-J.: Changes in the role of designers in strategy. In: The Handbook of design management, pp. 260–275. Bloomsbury Academic, London (2011)
- Cooper, R., Junginger, S.: Design management - a reflection. In: The Handbook of Design Management, pp. 1–32. Bloomsbury Academic, Berg (2011)
- Dalrymple, M., Pickover, S., Sheppard, B.: Are you asking enough from your design leaders? McKinsey quarterly (2020). <https://www.mckinsey.com/business-functions/mckinsey-design/our-insights/are-you-asking-enough-from-your-design-leaders>
- Danish Design Centre and DI.: Design Delivers 2018 – How design accelerates your business. Danish Design Centre (2018), April 2019. https://danskdesigncenter.dk/sites/default/files/pdf/design_delivers_-_how_design_accelerates_your_business.pdf
- Davies, R.: Apple becomes world's first trillion-dollar company. The Guardian (2018). <https://www.theguardian.com/technology/2018/aug/02/apple-becomes-worlds-first-trillion-dollar-company>

- Design Council: Design delivers for business: a summary of evidence from the Design Council's Design Leadership Programme. Design Council, London (2012). <https://www.designcouncil.org.uk/sites/default/files/asset/document/DesignDelivers%20for%20Business%20briefing.pdf>
- Design Council.: Leading business by design: why and how business leaders invest in design. Design Council, UK (2014), April 2019. https://www.designcouncil.org.uk/sites/default/files/asset/document/dc_lbbd_report_08.11.13_FA_LORES.pdf
- DMI.: What is Design Management?, May 2020. https://www.dmi.org/page/What_is_Design_Manag
- Domus: Ettore Sottsass Jr.:Design is one way to discuss life (2019), May 2020. <https://www.domusweb.it/en/biographies/ettore-sottsass-jr.html>
- Domus: Dieter Rams (2020). <https://www.domusweb.it/en/biographies/dieter-rams.html>
- Dorst, K.: Frame Innovation: Create New Thinking by Design, 1st edn. The MIT Press, Cambridge, MA (2015)
- Dubberly, H.: What can Steve Jobs and Jonathan Ive teach us about designing? *Interactions* **19**(3), 82 (2012). <https://doi.org/10.1145/2168931.2168948>
- Dykes, T.H., Rodgers, P.A., Smyth, M.: Towards a new disciplinary framework for contemporary creative design practice. *CoDesign* **5**(2), 99–116 (2009). <https://doi.org/10.1080/15710880902910417>
- Electrolux: Electrolux appoints Stefano Marzano to the new role of Chief Design Officer (2012), April 2020. <https://www.electroluxgroup.com/en/electrolux-appoints-stefano-marzano-to-the-new-role-of-chief-design-officer-12658/>
- Fry, S.: When Stephen Fry met Jony Ive: the self-confessed tech geek talks to Apple's newly promoted chief design officer. *The Telegraph* (2015). <https://www.telegraph.co.uk/technology/apple/11628710/When-Stephen-Fry-met-Jony-Ive-the-self-confessed-fanboi-meets-Apples-newly-promoted-chief-design-officer.html>
- Gemser, G., Candi, M., Ende, J.: How design can improve firm performance. *Des. Manage. Rev.* **22**(2), 72–77 (2011). <https://doi.org/10.1111/j.1948-7169.2011.00128.x>
- Girling, R., Carney, S.: Q&A: Rob Girling Co-Founder & Co-CEO, Artefact Sean Carney Chief Design Officer, Royal Philips. *Des. Manage. Rev.*, 4–7 (2017). <https://doi.org/10.1111/drev.12094>
- Heracleous, L., Papachroni, A.: Strategic leadership and innovation at Apple Inc. In: *Practicing Strategy: Text and Cases*, 2nd Edition, pp. 168–191. Sage, UK (2016). <https://doi.org/10.4135/9781526446565>
- Hern, A.: Jony Ive promoted to chief design officer at Apple. *The Guardian* (2015). <https://www.theguardian.com/technology/2015/may/26/jony-ive-promoted-chief-design-officer-apple>
- Holland, R., Lam, B.: Managing strategic design. Palgrave, London (2014)
- Hope, K.: Better by design: how creatives can transform your business. *The Telegraph* (2018), February 2019. <https://www.telegraph.co.uk/connect/better-business/business-solutions/why-your-company-needs-a-chief-design-officer>
- Hustwit, G. (Produtor & Director).: Rams [Motion picture]. EUA: Films First Corp. (2018)
- Isaacson, W.: *Steve Jobs*, p. 346. Simon & Schuster, New York (2011)
- Junginger, S., Faust, J.: *Designing Business and Management*. Bloomsbury, Bloomsbury Academic, an imprint of Bloomsbury Publishing Plc, London (2016)
- Kicherer, S.: *Olivetti: A Study of the Corporate Management of Design*. Rizzoli, London (1990)
- Liedtka, J.: Perspective: linking design thinking with innovation outcomes through cognitive bias reduction. *J. Prod. Innov. Manag.* **32**(6), 925–938 (2014). <https://doi.org/10.1111/jpim.12163>
- Luchs, M., Swan, K., Creusen, M.: Perspective: a review of marketing research on product design with directions for future research. *J. Prod. Innov. Manag.* **33**(3), 320–341 (2016). <https://doi.org/10.1111/jpim.12276>
- McGarry, C.: What Jony Ive's new job means for Apple design. *Macworld* (2015). <https://www.macworld.com/article/2926556/what-jony-ives-new-job-means-for-apple-design.html>

- McKinsey Quarterly: The Business Value of Design. McKinsey Design (2018), June 2019. <https://www.mckinsey.com/~media/McKinsey/Business%20Functions/McKinsey%20Design/Our%20insights/The%20business%20value%20of%20design/The-business-value-of-design-vF.ashx>
- Metz, C.M.: Jony Ive, Designer Who Made Apple Look Like Apple, Is Leaving to Start a Firm. New York Times (2019). <https://www.nytimes.com/2019/06/27/technology/jony-ive-apple.html>
- Micheli, P., Jaina, J., Goffin, K., Lemke, F., Verganti, R.: Perceptions of industrial design: the "Means" and the "Ends." *J. Prod. Innov. Manag.* **29**(5), 687–704 (2012). <https://doi.org/10.1111/j.1540-5885.2012.00937.x>
- Micheli, P., Perks, H., Beverland, M.B.: Elevating design in the organization. *J. Prod. Innov. Manag.* **35**(4), 629–651 (2017). <https://doi.org/10.1111/jpim.12434>
- Michlewski, K.: Design attitude. Farnham, Gower (2015)
- MoMA: Olivetti, design in industry (1952). www.moma.org/calendar/exhibitions/2741
- Mozota, B.B., Wolff, F.: Forty years of research in design management: a review of literature and directions for the future. *Strateg. Des. Res. J.* **12**(1) (2019). <https://doi.org/10.4013/sdrj.2019.121.02>
- de Mozota, B.B.: Design management: using design to build brand value and corporate innovation. Allworth Press, New York (2003)
- Muratovski, G.: Paradigm shift: report on the new role of design in business and society. *She Ji: J. Des., Econ., Innov.* **1**(2), 118–139 (2015). <https://doi.org/10.1016/j.sheji.2015.11.002>
- Noble, C.H.: On elevating strategic design research. *J. Prod. Innov. Manag.* **28**(3), 389–393 (2011)
- Noble, C.H., Kumar, M.: Exploring the appeal of product design: a grounded, value-based model of key design elements and relationships. *J. Prod. Innov. Manag.* **27**(5), 640–657 (2010). <https://doi.org/10.1111/j.1540-5885.2010.00742.x>
- Nussbaum, B.: Designomics. *Des. Indaba* (2010). <https://www.designindaba.com/articles/design-indaba-news/designomics>
- Ostrom, A., Parasuraman, A., Bowen, D., Patrício, L., Voss, C.: Service research priorities in a rapidly changing context. *J. Serv. Res.* **18**(2), 127–159 (2015). <https://doi.org/10.1177/1094670515576315>
- Pallister, J.: The secrets of the Chief Design Officer. *Des. Eur.* (2015), April 2019. <http://designforeurope.eu/news-opinion/secrets-chief-design-officer>
- Pohl, E.B.: The Ulm School. *Domus* (2012). <https://www.domusweb.it/en/design/2012/02/13/the-ulm-school.html>
- Polster, B.: Braun - fifty years of design and innovation. Menges, Stuttgart (2010)
- Pulos, A.J.: Reviewed work: olivetti: a study of the corporate management of design by Sibylle Kicherer. *Technol. Cult.* **33**(2), 400 (1992). <https://doi.org/10.2307/3105898>
- Quinteros, E.: Q&a: Ernesto Quinteros, Chief Design Officer. Johnson & Johnson. *Des. Manage. Rev.* **29**(3), 4–6 (2018). <https://doi.org/10.1111/drev.12132>
- Rams, D.: The designers contribution to company success. *Mater. Des.* **4**(3), 771–775 (1983). [https://doi.org/10.1016/0261-3069\(83\)90201-7](https://doi.org/10.1016/0261-3069(83)90201-7)
- Rams, D.: Dieter Rams. Die Gestalten Verlag, Less But Better (2014)
- Schneider, P., Beuker, R.: Braun design: dream real products, make real products. *Des. Manage. J.* **12**(4), 15–23 (2001). <https://doi.org/10.1111/j.1948-7169.2001.tb00560.x>
- Shelley, C.: The nature of simplicity in Apple design. *Des. J.* **18**(3), 439–456 (2015). <https://doi.org/10.1080/14606925.2015.1059609>
- Stevens, J., Moultrie, J.: Aligning strategy and design perspectives: a framework of designs strategic contributions. *Des. J.* **14**(4), 475–500 (2011). <https://doi.org/10.2752/175630611x13091688930525>
- Stuhl, M.: What Is Behind The Rise Of The Chief Design Officer? Forbes (2014), April 2019. <https://www.forbes.com/sites/groupthink/2014/11/11/what-is-behind-the-rise-of-the-chief-design-officer/#1e7bbcbf33c2>

- Svengren, L.: Industrial design as a strategic resource a study of industrial design methods and approaches for companies strategic development. *Des. J.* **1**(sup1), 3–11 (1997). <https://doi.org/10.2752/146069297790219404>
- Toguchi, R.: The Winning Habits of Steve Jobs. iUniverse Inc., Bloomington (2017)
- Verganti, R.: Design-Driven Innovation: Changing the Rules of Competition by Radically Innovating What Things Mean. Harvard Business Press, Boston, MA (2009)
- Vries, J.: PepsiCo's Chief Design Officer on creating an Organization where design can thrive. *Harvard Bus. Rev.* (2015). <https://hbr.org/2015/08/pepsiocos-chief-design-officer-on-creating-an-organization-where-design-can-thrive>
- Werner, M.: In depth - Braun (2014), May 2020. <https://us.braun.com/assets/en-us/pdf/Braun-history.pdf>
- Wolff, F., Amaral, F.G.: Design Management competencies, process and strategy: a multidimensional approach to a Conceptual Model. *Strateg. Des. Res. J.* **9**(3) (2016). <https://doi.org/10.4013/sdrj.2016.93.02>
- Wrigley, C., Straker, K.: Designing innovative business models with a framework that promotes experimentation. *Strategy & Leadership* **44**(1), 11–19 (2016). <https://doi.org/10.1108/sl-06-2015-0048>



An Initial Research Work on the Evaluation of Professor's Digital Competencies: Metared Overview

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Abstract. This research work was developed withing the scope of the metared – Portugal framework which consisted in identifying and evaluating the level of proficiency of digital competencies of Higher Education professors. The study involved 701 participating professors from several Higher Education institutions and outlined five dimensions of evaluation in the scope of digital proficiency that served as the guiding parameters for the sample analysis.

Keywords: Digital competencies · Digital proficiency · Digital evaluation

1 Introduction

The fast shift and change of paradigm concerning the demand of educators having a strong and solid skillset of digital competencies, which allows for a more sophisticated and diverse learning approach for students, is still a continuous challenge for the majority of these professionals. Particularly, when it comes to teachers' digital literacy there is a need to develop a more pedagogic-didactic content for digital literacy in order to deal with the way in which new digital trends influence the underlying conditions for schools, pedagogy and subjects [1]. Today's students have a richer background when talking about the usage of Information and Communication Technologies (ICT) in such contexts like in a Higher Education. With this, educators can no longer depend on limited resources or just by implementing the same learning methodologies, since the students bring new technological challenges to the table that need to be properly addressed by their educators. Being only a basic or intermediate user when it comes to digital interaction is nearly not enough with the high demand for a more technical learning and, consequently, the teaching itself. Therefore, the biggest challenge lies in comprising both the quality of learning and the proficiency of the educator in understanding its own level of expertise with technologies. Specifically, when it comes to identifying how quickly can the educator adapt his previous teaching methodologies based on new ones, these being capable of tackling new and innovative ways of learning.

That said, the European Framework for the Digital Competence of Educators (DigComEdu) refers to a set of factors that are indispensable for a broader understanding of the concept of digital skills and its direct relationship with educators. In this case, six main areas were defined, which interrelate, and are responsible for identifying the various evaluation parameters within this theme [2]. The areas are designated by: a) Area 1 - Professional Engagement; b) Area 2 - Digital Resources; c) Area 3 - Teaching and Learning; d) Area 4 - Assessment; e) Area 5 - Empowering Learners; f) Area 6 - Facilitating Learners Digital Competence. Regarding this study, the focus is on areas 1, 2, 3, 4 and 5 since the objective is to identify the level of proficiency of digital skills of higher education teachers. In addition, this research work not only contributes as a tool for collecting and analyzing a particular phenomenon, being this, the perception of the level of proficiency regarding the digital skills of a specific target audience, but also broadens the spectrum that these strategies intend to implement as a solution.

Finally, this study arises from the purpose of MetaRed Portugal, which is an association of Portuguese public and private higher education institutions, also open to other entities of the public administration that develop relevant activity in the field of ICT and in its application in the field of higher education. It aims to be a “meeting point” for debate, reflection, and collaborative work on the use of ICTs (Information and Communication Technologies) in higher education, with high regards to the principle of the autonomy of institutions, respecting their individual freedom to make their own decisions, proposing recommendations, and promoting the sharing of experiences and good practices.

2 Study Overview: Methodology

The methodology used in this research study comes from a previously established knowledge basis. In other words, to implement a comprehensive method to assess the teachers' digital competence levels, the same evaluation parameters defined in the DigCompEdu framework (European framework for the digital competence of educators) were followed. This is due to this model being defined as a progressive practice and based on different levels of proficiency in which six scales of progression are identified. That said, this study adopted the same six different scales of progression, which are: A1-Newcomer; A2-Explorer; B1-Integrator; B2-Expert; C1-Leader and C2-Pioneer, which characterize the stage in which everyone evaluated is. Assuming these scales of progression, it remains to be noted that the stages vary between: (i) an A1 user, which represents a person who makes little use of digital technologies and tools in his training strategy; and (ii) a C2 user, which represents a person who feels totally capable of using digital technologies and tools in an autonomous and innovative way in his training strategy.

These progression scales are often used in several evaluation models due to their flexibility and dynamics as a methodological basis, since they allow defining a wide range of data interpretation, both qualitative and quantitative, resulting in a general analysis of a richer and more diverse study.

3 Main Findings Analysis and Data Interpretation of the Research Work

The results and main conclusions obtained through the study, and the respective questionnaire applied, revealed several data of a quantitative and qualitative nature that we will now analyze and interpret. To carry out a more structured and dynamic analysis of the collected data, these five dimensions of evaluation were defined: (i) Professional Involvement; (ii) Digital Technologies and Resources; (iii) Teaching and Learning; (iv) Evaluation; (v) Training of Students. These dimensions delimited the various parameters and indicators of the study and followed the progression model inspired by the DigComEdu framework.

3.1 Professors Professional Involvement Main Findings

The evaluation parameter: “Professional Involvement” consists of the following criteria: a) Organizational Communication; b) Professional collaboration; c) Reflective practice and d) Digital Training.

Regarding the criterion “1.1. Organizational Communication”, it is important to note that, of all the 701 teachers, 346 (49.4%) indicated that “systematically select, adjust, and combine different digital solutions for effective communication. Furthermore, 225 (32.1%) teachers stated that they only combine different communication channels, such as email, class blog or the institution’s website as means of organizational communication. Thus, it is possible to conclude that teachers have considerable diversity when it comes to using various digital communication channels in their work (Fig. 1).

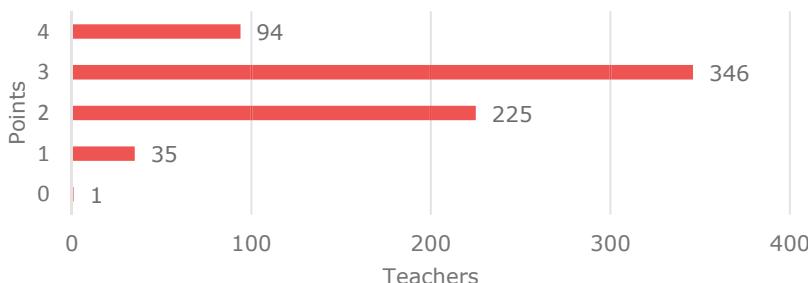


Fig. 1. Results from professional involvement section: organizational communication

Regarding the criterion “1.2. Professional collaboration” it is important to note that, from the 701 teachers, 296 (42.2%) reported that they “exchange ideas and materials, also with colleagues outside their institution, e.g., through a professional online network or in an online collaborative space. Still, 191 (27.2%) teachers indicated that they “co-work among colleagues, working together in collaborative environments or using shared folders/drives”. These numbers are particularly useful as they allow us to realize the importance of using digital channels such as social networks (such as LinkedIn) as a way of extending professional collaboration between teachers (Fig. 2).

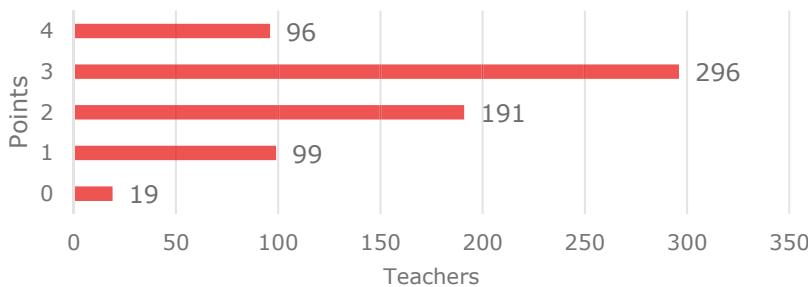


Fig. 2. Results from professional involvement section: professional collaboration

Regarding the criterion “1.3. Reflective Practice” it is possible to verify that, from the 701 teachers, 237 (33.8%) indicated that they “discuss with colleagues about how to use digital technologies to innovate and improve educational practice”. Still, 218 teachers (31.1%) refer that they “use a variety of resources to develop their digital teaching skills”. These results demonstrate that teachers use several ways to promote their reflective practice with the use of technologies, most significantly, through the diversity of use and discussion among peers (Fig. 3).

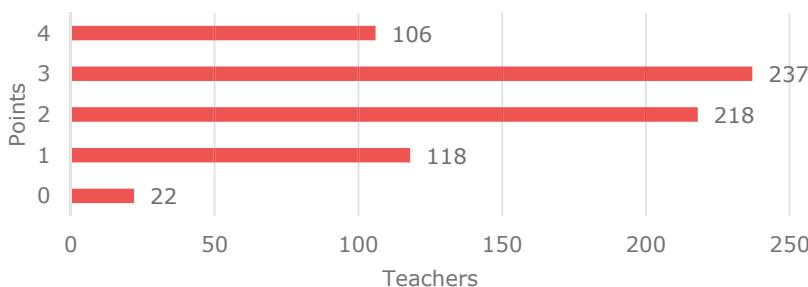


Fig. 3. Results from professional involvement section: reflective practice

Finally, about the criterion “1.4. Digital Training” we can see that, from the 701 teachers, 244 (34.8%) indicated that they “participate, frequently, in all types of online training. We can also verify that 207 from the 701 “took part in online training at least once or twice”. In this way, these data allow us to realize that the teachers have been increasing their level of awareness regarding their own training and training in Digital Literacy. This allows them to keep updated and respond to the most emerging learning challenges brought by students (Fig. 4).

In short, in the parameter “Professional Involvement” the average score of teachers was 10.5, with a maximum of 16 points. This means that the sample surveyed is above average. In addition, most teachers are in the levels of competence B1 and B2, respectively B1 - Integrator (33.5%) and B2 - Expert (36.2%).

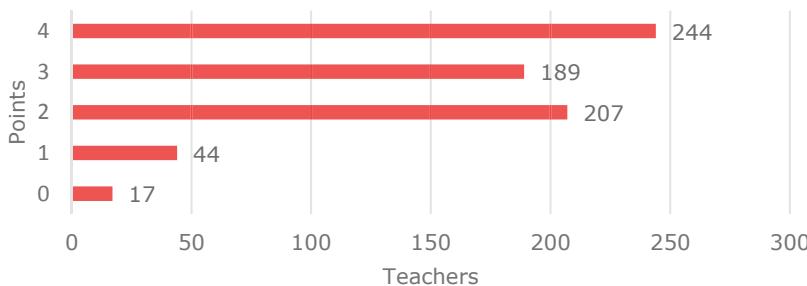


Fig. 4. Results from professional involvement section: digital training

3.2 Technologies and Digital Resources Main Findings

The next section to be analyzed, “Technologies and Digital Resources”, consists of three evaluation parameters: a) 2.1. Select Resources; b) 2.2. Create and modify resources; c) 2.3. Manage, protect, and share.

Regarding the first criterion, “Select Resources”, it was possible to verify that, of the 701 teachers, 248 (35.4%) indicated that they “compare resources using a series of relevant criteria, e.g., reliability, quality, adequacy, design, interactivity, attractiveness”. Still, 238 (33.9%) reported that they “evaluate and select resources based on their suitability for their group of students”. Thus, it is possible to conclude that teachers have been using two main methodologies in the selection of digital resources to be used in their classes. The main one, based on a richer comparison in terms of criteria such as quality, design, and interactivity, and the second one more focused on the needs of students (Fig. 5).

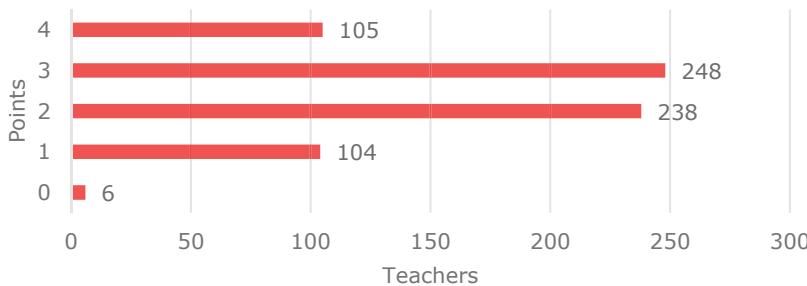


Fig. 5. Results from technologies and digital resources section: resource's selection

As for the next criterion “Create and modify resources”, it was found that, from the 701 teachers, 381 (54.4%) stated that they “create different types of resources”, and 197 (28.1%) indicated that they “create digital presentations and nothing much more”. You can conclude through these analyses the following: A considerable percentage remains faithful to the traditional digital presentation (ex. PowerPoint) but includes several digital resources and formats in its formative strategy (Fig. 6).

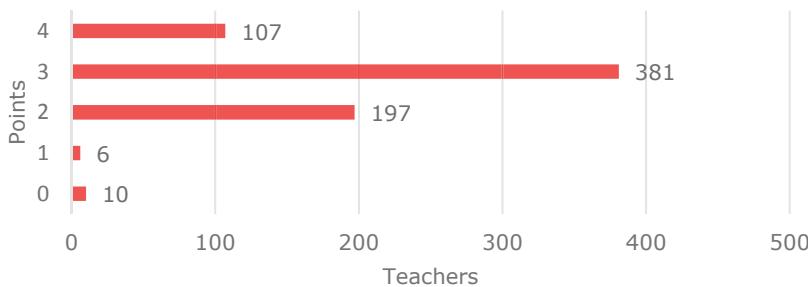


Fig. 6. Results from technologies and digital resources section: create and modify resources

Finally, about the criterion “Manage, protect and share” it was possible to notice that, from the 701 teachers, 241 (34.3%) indicated that they “only protect some personal data” while 181 of the teachers (25.8%) stated that they “protect files with personal data with a password”. Thus, it is possible to conclude that, regarding the protection of personal data in digital environments, teachers still have some aspects to improve in order to make their use of digital tools safer (Fig. 7).

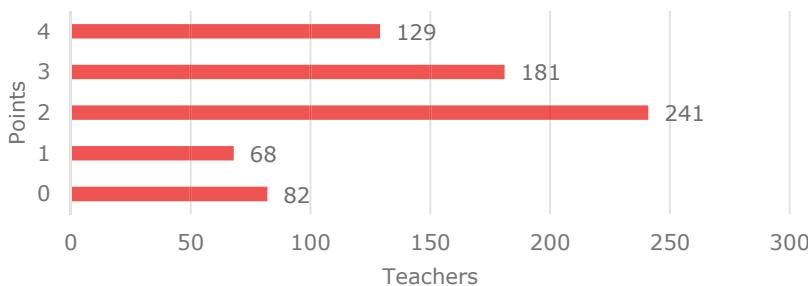


Fig. 7. Results from technologies and digital resources section: manage, protect and share

In summary, the “Digital Technologies and Resources” section had a score of 7.6 out of 12, which is 1.2 points above average, resulting in most levels of proficiency of teachers in B1. Integrator (27.8%) and B2. Expert (32.1%).

3.3 Teaching and Learning Main Findings

The section dedicated to “Teaching and Learning” presents three evaluation parameters. These are: “3.1. Teaching in the classroom”; “3.2. Guide (Supervise participation”); “3.3. Collaborative Learning”.

Regarding the evaluation parameter “3.1. Teaching in the classroom”, we found out that, from the 701 teachers, 231 (33.0%) “use a variety of digital resources and tools in their teaching”. While 228 (32.5%) stated “using digital tools to systematically improve their teaching”. With this, we conclude that the teachers are concerned with including a diversified range of digital tools in their training strategy for the improvement of

their teaching, thus, applying innovative pedagogical strategies using new technologies (Fig. 8).

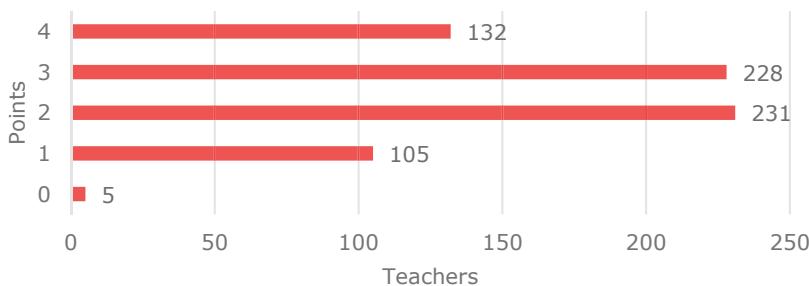


Fig. 8. Results from teaching and learning section: teaching in classroom

As for the parameter “3.2. Guide (Supervise and participate)” it was possible to infer that, from the 701 teachers, 218 (31.1%) admit that they “monitor and analyze the online activity of their students regularly”. Although, 193 (27.5%) indicate that they only “occasionally they check the students’ discussions”. Thus, we can see that, for the most part, teachers use strategies for monitoring and analyzing the various online activities of their students, and, in addition, try to apply these methods regularly. However, there is still a considerable margin of teachers who only occasionally check some of the students’ online discussions (Fig. 9).

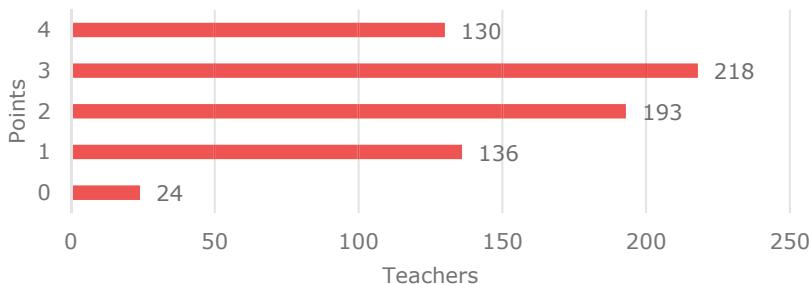


Fig. 9. Results from teaching and learning section: guiding (Supervising the participation)

Regarding the parameter “3.3. Collaborative Learning “we can conclude that, of the 701 teachers, 315 (44.9%) indicated that they “ask students to work in groups and use the internet to find information and present their results in digital format”. It should also be noted that 174 (24.8%) are limited to “encouraging students to work in groups to search for information online or present their results in a digital format”. This leads us to the conclusion that teachers are concerned with involving students in digital environments through individual or group assignments, promoting collaborative awareness and, at the same time, digital literacy skills to its students this way (Fig. 10).

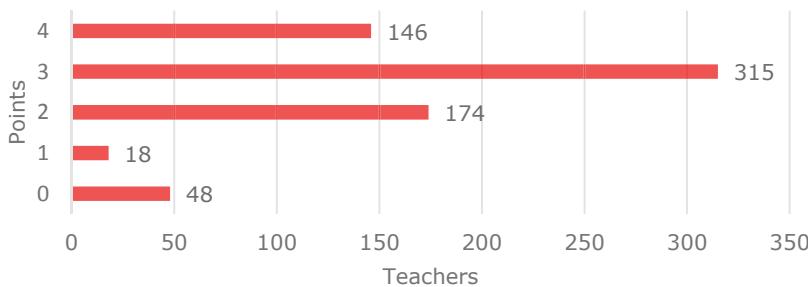


Fig. 10. Results from the teaching and learning section: collaborative learning

In short, in the “Teaching and Learning” section, there was a score of 9.8 out of 16. That is 1.8 points above the average and the most common proficiency levels were B1-Integrator (31.7%) and B2- Expert (27.4%).

3.4 Evaluation Dimension Main Findings

The “Evaluation” section presents three main parameters, which are: “4.1. Evaluation Strategies”; “4.2. Analyze evidence” and “4.3. Feedback and Planning”.

Regarding the parameter “4.1 Assessment Strategies”, it was possible to observe that, from the 701 teachers, 233 (33.2%) indicated that “sometimes they use a digital tool, e.g., a questionnaire to monitor progress of students”. It should also be noted that 200 (28.5%) teachers report that they “monitor progress regularly, but not through digital media”. That said, despite the high number of teachers who use at least one digital tool to monitor and assess student progress, there is still a considerable number of other teachers who use only more traditional methods to measure students’ progress without resorting to digital resources (Fig. 11).

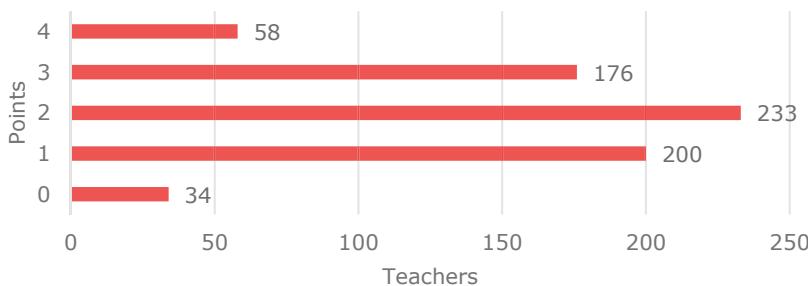


Fig. 11. Results from the evaluation section: evaluation strategies

As for the parameter “4.2. Analyzing Evidence” it was possible to observe that, from the 701 teachers, 244 (34.8%) indicated that they “take into account data on the activity and behavior of students, to identify those who need additional support”. Still, it was found that 222 (31.7%) refer “in part, only to analyze academically relevant data, e.g.,

performance and classifications. In this way, it is possible to notice that a large part of the teachers still does not dedicate a specific and adequate strategy to the analysis of evidence by the students. This can lead to a considerable increase in aspects such as lack of productivity or lack of interest. This is because, the intervention by the teacher is considered fundamental to maintaining a good progress in the learning process and in the teacher/student relationship (Fig. 12).

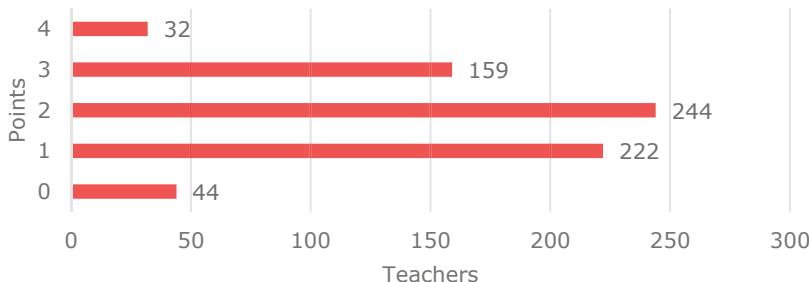


Fig. 12. Results from the evaluation section: analyze evidence

Regarding the last parameter of this evaluation dimension, “Feedback and Planning”, we found out that, from the 701 teachers, 232 (33.1%) answered that they sometimes “use digital ways to provide feedback, e.g., automatic scoring in online questionnaires or “likes” in digital environments”. On the other hand, only 198 (28.2%) of the teachers refer that “they provide feedback to students, but not in digital format”. That said, although there are a considerable number of teachers who occasionally use digital ways of giving feedback through scores, comments, likes, etc., the more traditional ways of giving feedback persist (Fig. 13).

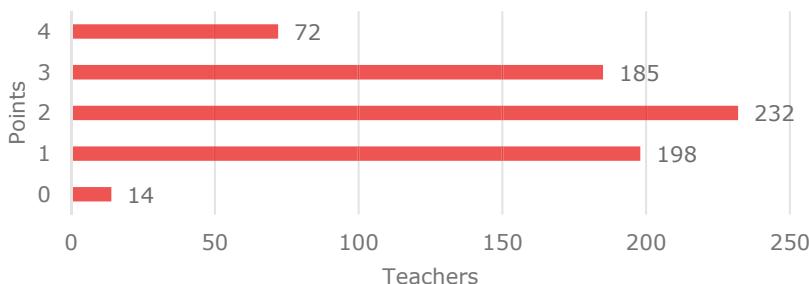


Fig. 13. Results from the evaluation dimension: feedback and planning

Finally, in this dimension, the average score was 6.1 out of 12, resulting in just 0.1 points above the average. Still, it was in this dimension where the worst results were seen in terms of levels of digital proficiency, these being A2-Explorer (27.4%) and B1-Integrator (29.7%).

3.5 Students Training Dimension Main Findings

The evaluation dimension “Student Training” included the following parameters: “5.1. Accessibility and inclusion”; “5.2. Differentiation and personalization” and “5.3. Active participation”.

Regarding the parameter “5.1. Accessibility and inclusion” it was possible to verify that, from the 701 teachers, 198 (28.2%) indicated that they “discuss possible obstacles with students and outline solutions”. On the other hand, only 190 (27.1%) refer to “adapting tasks to minimize difficulties”. In this way, the data obtained allowed us to realize that teachers try to adapt some of their digital materials to the various types of learning manifested by students. In fact, some still allow open discussions to define possible digital solutions tailored to each student (Fig. 14).

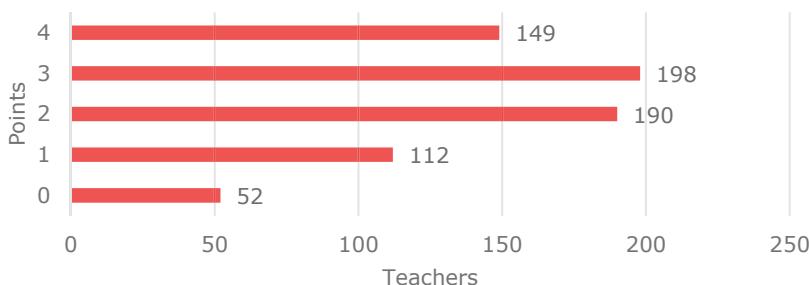


Fig. 14. Results from the students training dimension: accessibility and inclusion

As for the parameter “5.2. Differentiation and personalization” it was possible to notice that, from the 701 teachers, 254 (36.2%) reported that they “provide students with recommendations for additional resources”. On the other hand, 152 (21.7%) of the teachers stated that “whenever possible, they use digital technologies to offer differentiated learning opportunities”. In this sense, there is an effort on the part of teachers to implement some differentiation in their teaching through a fun range of digital resources and activities. Differentiation is considered to offer diversified experiences to students (Fig. 15).

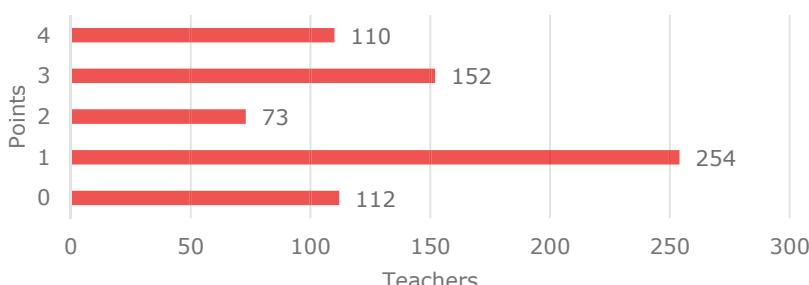


Fig. 15. Results from the students training dimension: differentiation and personalization

Regarding the parameter “5.3. Active participation”, it was found out that, from the 701 teachers, 297 (42.4%) said that “when they teach, they use stimuli, e.g., videos, animations”. It should also be noted that 159 (22.7%) of the teachers reported that “their students use technologies to investigate, discuss and create knowledge in a systematic way”. Thus, this criterion allowed us to realize that teachers use different digital components to keep their students interested and proactive. In addition, they foster the critical, active, and creative ability of students to use technologies at their discretion for the development of work (Fig. 16).

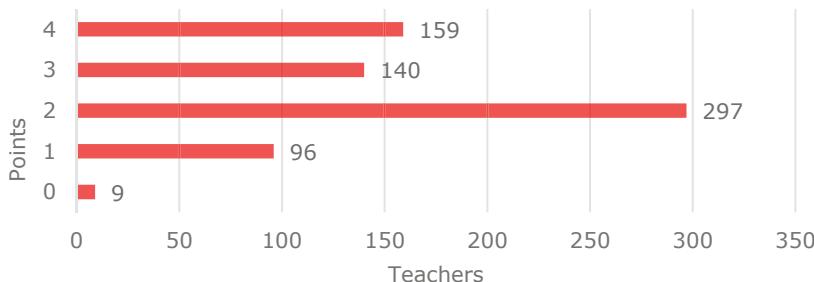


Fig. 16. Results from the students training dimension: active participation

In short, the average score for this dimension was 6.7 out of 12, which translates to 1.7 points above the average. It should be added that this dimension also presented the worst results in terms of the teachers’ digital proficiency levels, namely A2-Explorer (21.5%) and B1-Integrator (26.5%).

4 Conclusion

This initial research work on the evaluation of digital skills of higher education teachers in the context of the MetaRed Portugal network made it possible to reach some conclusive indicators. However, it is important to clarify that this study is still an active and recurrent investigation, permeable to many other agents of change, and may result in more complete and in-depth data when carrying out new questionnaires for a new sample. From this way, we can conclude that:

- From the 22 questions asked, each of which was worth a maximum of 4 points, resulted in a total of 88 points. Thus, the total average score of teachers in terms of the various parameters of digital proficiency was 51.3, which translates into 9.1 points above the average.
- Regarding the average score per question, teachers recorded a total of 2.3 out of 4 points, which translates into just 0.3 points above the average. This is since the dimensions “4. Evaluation” and “5. Training of Students” presents the lowest levels of competence in terms of results (A2 and B1).
- Regarding the levels of digital competence, the most common were B1-Integrator (32.2%) and B2-Expert (37.4%).

Finally, about the conclusions on the promotion of students' digital skills, which this study briefly addressed, it was found out that:

- In the “Information” topic, 28.1% of teachers stated that they discussed with their students how to verify the accuracy of the information.
- In the topic “Communication”, 48.1% of teachers reported that their students use communication and digital collaboration, especially among them.
- In the topic “Creation”, 43.2% of teachers indicated that their students create digital content as an integral part of their study.
- In the topic “Responsible Use”, 34.0% of teachers indicated that they inform their students that they need to be careful when sharing personal information online.

These data lead to a general understanding that teachers have been increasing their digital literacy skills. In addition, it is possible to check your demand for advanced training in this area, to achieve new pedagogical strategies that include your work and your students. However, there is still some work to be done regarding the modernization of the contents and programs to be used in class. Furthermore, this research work also concluded a direct relation with how digital competence might not benefit from being regarded as an isolated phenomena on the level of single actors. Rather, it can be regarded as an organizational task, influenced, and driven by several contextual factors embedded within and across a wider school organization [3].

References

1. Krumsvik, R.J.: Situated learning and teachers' digital competence. *Educ. Inf. Technol.* **13**(4), 279–290 (2008)
2. Redecker, C.: European framework for the digital competence of educators: DigCompEdu (No. JRC107466). Joint Research Centre (Seville site) (2017)
3. Pettersson, F.: On the issues of digital competence in educational contexts—a review of literature. *Educ. Inf. Technol.* **23**(3), 1005–1021 (2018)



Storytelling for Preschool Children in Sri Lanka: Social and Emotional Development Between Linear and Non-linear Storytelling Approaches

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Abstract. This study tests the effectiveness between linear storytelling (the story has only one direction) and non-linear storytelling (the story has many directions) approaches on the social and emotional development of pre-school children in Sri Lanka. Thirty-six (36) pre-school children aged between four to five (4–5) participated in the study. The non-linear storytelling and linear storytelling sessions were administered to the children and observed them during the activity time. Qualitative data were collected by using observational notes, interviews, and recorded videos during the storytelling session and activity time. The study showed that the social and emotional skills were remarkably different among linear storytelling and non-linear storytelling approach. The linear storytelling approach had a limited effect on the social and emotional development of the child while the non-linear storytelling approach had a continued effect.

Keywords: Storytelling · Pre-school education · Children · Social and emotional development

1 Introduction

Storytelling for preschool children is the most important teaching and learning method. Moreover, early childhood is the most sensitive and important stage of considering human life. 85 percent of brain development occurs by age five. (Human development unit South Asia region 2014). Important skills like cognitive, physical, social, emotional, computational thinking and linguistic skills are developed during this period. With the current pandemic, children are surrounded by more and more media-driven stories than ever before. Online education has gained more value in the world and children settle their experiences in modern digital screens (Bratitsis and Ziannas 2015). Therefore, we have to rethink the most suitable teaching and learning methods, which are more effective for developing children's social and emotional skills than earlier.

Recent research shows how storytelling is affected by early childhood development. A Child starts to create simple stories by the age around two. Storytelling has important value in developing narrative skills in a child and also, it is a fundamental skill for developing the cognitive and emotional skills of a child (Costa et al. 2011). A group of

researchers found that there is a connection between social and emotional development and the process of story development plus layers of the story involved in the final product (O'Byrne et al. 2018). Storytelling assists the child in gaining language (Peterson and Biggs 2001). Moreover, Storytelling is a community activity, there is usually one speaker and listeners, each one has a chance to take their turn and tell a story. All this emotional and language development makes for a better ability to live within the community. (Berkowitz 2011 cited by Erickson 2018).

Many years back, the situation of storytelling was quite different. The flow of the story is required to create a story, and also the narrative structure determines the order and direction of a story. Thus, the story was developed only in one direction from the point of view of the narrator. But people like Virginia Woolf, an English writer and so-called modernist author of the 20th century, broke the rules of writing and carefully developed multiple points of view in her books (Gordon 1984).

Likewise, a story out of narrator and consecutive order is not the only way to conduct a non-linear story (John 2019). There are also non-linear stories that use parallel and complex narratives too (Roettgers and Roettgers 2018). The non-linear storytelling approach takes different ideas and links them in order to integrate stories and to build different branches of a story (Chung Liu et al. 2010). Interactive storytelling is also a non-linear storytelling method (Kim and Kim 2016). Because of the difficulties to define interactivity, it became more problematic to define interactive storytelling. (Bostan and Marsh 2012). Interactive stories have given options to promote engagement, enjoyment, and fun. Furthermore, interactivity enhances the benefits of linear storytelling (Garzotto et al. 2010). Storytelling not only helps to develop socio-emotional skills but also helps to identify problems in discourse skills, literacy-related difficulties, and learning difficulties (McCabe and Rollins 1994).

According to Sri Lankan pre-school curriculum, social and emotional skills are a highly crucial area to develop within the child. Therefore, the government preschool guide book (punchi api ape lowai - Guide book of activities on early childhood education - Western Province) has recommended storytelling activity to develop 5 main objectives in social and emotional skills (The Ministry of Education - Sri Lanka 2015). However, the reports point out that parents ignore social skills and fail to recognize the importance of collaborative activities and socialization changes in the preschool environment (Human development unit South Asia region 2014). Although Sri Lanka has a long history and a culture of storytelling, there is a lack of using it, in an effective way to develop skills in a child (Wijetunge 2012). Thus, a special approach is required to integrate parents, teachers, and children and with the growing complex environment, even teachers must be guided to be productive (Kulawansa and Nanayakkara 2011). Yet, our Sri Lankan preschools do not much practice the non-linear storytelling approaches than the linear approaches. Pre-school guidebooks have shown that stories can enhance the social and emotional skills of the child. However, all the stories in the guidebook are in a linear approach instead of a non-linear approach (The Ministry of Education - Sri Lanka 2015).

We predict that non-linear storytelling practices are much more effective for the social and emotional development of preschool children in Sri Lanka. Because in the contemporary world, the non-linear storytelling approach has taken a special place because most non-linear storytelling techniques combined with technology and collaborative

workspaces create a direct path for a child to engage with peers and enhance their social and emotional skills by working together (Antle 2003). The purpose of this article is to examine how a non-linear storytelling approach affects social and emotional development more than a linear storytelling approach among preschoolers in Sri Lanka. To test this prediction, the research approach followed ethnographic methods; qualitative research methods have been used and sourced from primary data including observations, and interviews about teachers' perspectives on linear and non-linear storytelling approaches and data references gathered from preschool children and teachers. Secondary data were cited from existing literature like journal articles, previous researches, websites, and other reliable sources, which are specially related to storytelling practices, children's behaviors and their development, etc. (Nasir et al. 2012).

2 Method

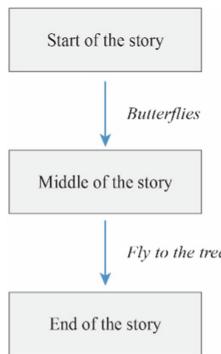
2.1 The Setting

Ethnographic research has been used and children's behaviour is studied in everyday context and data gathered from observations and interviews with the purposive sample of subjects (Hammersley 1991). The child participants in this study were 36 children between age 4–5, attending suburban preschools in Sri Lanka. The first days were allocated to be familiar with the preschool environment and children. After that, the data collection took place during the morning cycle (8:30 am–11:30 am). Children were grouped into two teams, *Team A* and *Team B*, and conducted storytelling sessions separately. One team was in the linear storytelling session while the other team was in the non-linear storytelling session. After the storytelling sessions, children's behaviours were observed separately, through the regular preschool group activity, under the preschool teachers' supervision. The team activity was about creating a collage of a butterfly and a bee (British Sociological Association 2017).

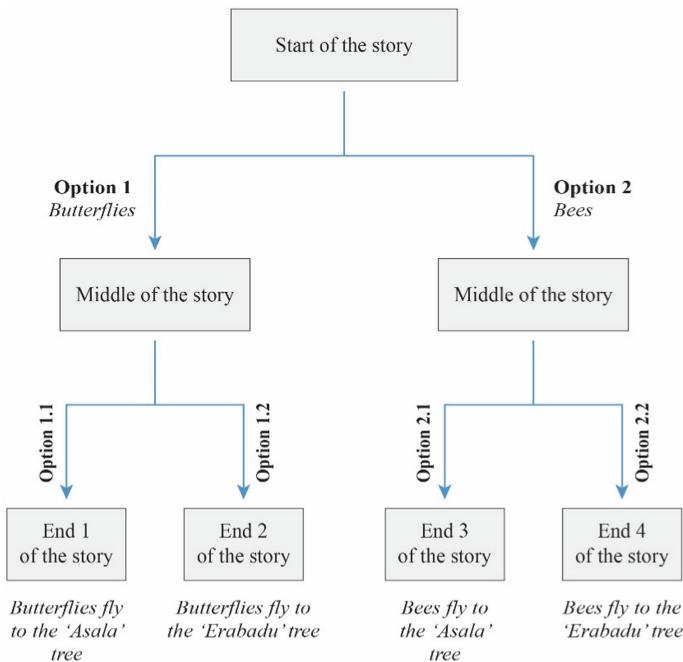
2.2 Sample Stories

Linear Storyline. A native 'Sinhala' language story, which is already in the pre-school guidebook (Appendix A) has been used for *team A* (see Fig. 1). This linear story is specially designed to enhance five social and emotional skills according to the pre-school guide book in Sri Lanka; Exchange ideas, Make friends, Collaborative working, Goal setting and task accomplishment, and Anger management (The Ministry of Education - Sri Lanka 2015).

Non-linear Storylines. Researchers and pre-school teachers re-create the same story which was in the guidebook into a non-linear story by adding options to the linear story as mentioned in Fig. 2 (Garzotto et al. 2010). There were final four-story directions by adding some options to the existing linear story (Appendix B). In the non-linear storytelling session, a child can choose any direction according to their preference and choice of options. *Team B* was constantly narrowed down according to their choices, and eventually, they were separated into 4 stories.

**Fig. 1.** Linear Storyline

The ends of both storytelling approaches, linear and non-linear, give the same motivation/summary of “respect others and accept others’ thoughts”. Data was taken as qualitative data in order to describe the effectiveness of the linear and non-linear storytelling approach.

**Fig. 2.** Non-linear storylines

2.3 Data Collection

The researcher asked children to join the group activity after the storytelling sessions in order to observe their instant development of social and emotional skills. According to Erickson these temporary social and emotional skills will be developed with time, by doing storytelling sessions daily (Erickson 2018). Social and emotional skills were scored either as verbal or as non-verbal: verbal elements included characteristics of voice, volume, and speech clarity; non-verbal elements such as gestures and body movements, interpersonal proximity, touching, eye contact, smiling, and facial expressions (Collins and Collins 1992). Data was collected by using observational notes, interviews, voice recordings, and videos during the day (Creswell 2003).

Then the remaining days were used to analyse and discuss research videos and voice recordings of children's behaviour with preschool teachers. Also, the teachers are a part of this study, and their data were gathered from observations and semi-structured interviews to see teachers' perspectives on storytelling approaches on social and emotional development. To compare the effectiveness of linear storytelling structure and non-linear storytelling structure on social and emotional skills, the following key points have been observed separately, during the research time (The Ministry of Education - Sri Lanka 2015).

1. Exchange ideas
2. Make friends
3. Collaborative working
4. Goal setting and task accomplishment
5. Anger management

3 Results and Findings

The purpose of this study was to investigate the effectiveness of non-linear storytelling structure and linear storytelling structure on social and emotional skills. Results and the conclusions of the findings are based on observational notes, videos, recordings of the children's behaviors in their natural environment, and semi-structured interviews with teachers. Research findings were analyzed by comparing and mixing with the qualitative data to support findings. The following Table 1 gives a summary of all findings.

3.1 Linear Storytelling

Teachers have found some basic social and emotional skills when a child enters the pre-school initially. Most basic skills are commonly visible from some children such as respect and love for parents. Other skills can be seen in the development of social and emotional interactions in a child, as an example if there are more family members and siblings, children are more socialized than a single child. Some parents are asking for help for some specific weakness of their child, such as not eating enough, oversleeping in the morning, disturbing elder siblings, being rude to younger siblings, etc. In that case, teachers create some specific stories according to that weakness and how to overcome

Table 1. Social and emotional skills on storytelling approaches

Social and emotional skills	Linear storytelling and Non-linear storytelling
Exchange ideas	<p>Team A: It is observed that children in linear storytelling sessions had no option other than just listening and they had no space to share their ideas and to question the story. Therefore, children may think of that as a barrier to talking and interfering with the storytelling session</p> <p>Team B: In the non-linear storytelling session, it seems children were free to exchange ideas and they were free to express their logic for selecting preferred options</p>
Make friends	<p>Team A: It appears that children are relaxed with their spaces and peers around them while listening to linear stories. But few children, who lost their attention to the story, expressed annoying behaviors</p> <p>Team B: Children maybe feel hopeless and insecure when close friends left them because of their selections in storylines. But also, it has been observed, that they had an opportunity to make new friends and become more social</p>
Collaborative working	<p>Team A: It seems that children in the linear storytelling session had no space to share their ideas with others during the session. Therefore, it made no remarkable effect among the children during the group activity</p> <p>Team B: It was observed that children were motivated to work together in the group activity in a non-linear storytelling session. After they got the chance to select a butterfly or bee in the story, children may tend to think of themselves as a butterfly or bee</p>
Goal setting and task accomplishment	<p>There seems to be no significant difference with the goal setting and task accomplishment skills between linear and non-linear storytelling groups according to the observations during the group activity. According to the interviews, pre-school teachers make a rush on children to complete and close their work no matter what. Children used to complete their work in previous activities as a practice, and the researcher was able to see that influence through this study</p>

(continued)

Table 1. (*continued*)

Social and emotional skills	Linear storytelling and Non-linear storytelling
Anger management	Maybe the children were able to control their anger because non-linear storytelling is quite a new experience for them. However, observations are not enough to come to a conclusion, because children are usually trained to control their anger even before these storytelling sessions and activities

that weakness and tell the whole class by not mentioning that child. However, the child is always aware of his or her weakness and gives attention to the story. According to the parent's statements, that is a great method that helps a child to develop certain lacking social skills. When we use the overall storytelling in a class, it has a positive impact on the social and emotional development of children, such as expanding the understanding, developing imagination, developing creativity, imitating characters, and developing leadership, self-development, and enhancing listening skills. It also helps to develop memory capacity.

Commonly, pre-schools are using linear storytelling methods. As an example, the teacher prepared the story of a large lake, full of lotuses. So, the teacher started the story. At the start, the teacher asked the children what flowers were in the lake? And the teacher hoped that they all will say the "lotuses". As the teacher expected, children were saying aloud together "lotuses!!!" The teacher was also happy and continued the story. But what will happen if there is this one child who thought that lake was full of "Lilies"? The teacher will re-correct him to "lotuses", not to "Lilly" and again, continue the story which she prepared before as a usual linear story.

With the above example, there are some negative points in linear storytelling, such as restricting children's imagination. Overall, some weaknesses are found in linear storytelling structure such as having to use simple terms or they will not be listening, hard to take attention from the children if there are too many, losing attention if the story is too long, it will be boring if not more effort is given to tell the story by acting and role-playing.

Example: Sometimes in the middle of the storytelling session, the teacher realized the story is boring for children. In that situation, the teacher tends to finish the story briefly without giving much effort.

Also, the teacher must create very new stories. Otherwise, children will be bored with common stories. Many stories are known by children and always they need a new experience and a new story. The teacher also needs to maintain her voice and tone. Sometimes the teacher has to pause the story to silent the class and start the story again, it will lose the attention of children. Once children lose attention to the story, they begin to annoy and act harshly to the child next to them. Therefore, teachers do not like when children lose their attention to the linear story.

Teacher: "Sometimes we had to stop the story and make children quiet and calm. Therefore, as a solution we asked them to be silent and cross their arms at the beginning."

(see Fig. 3). However, the difficulty of concentrating on a story may also have increased children's linguistic egocentrism (Eisenberg 1985).



Fig. 3. Children are listening to a linear story by crossing their arms.

3.2 Non-linear Storytelling

One or two teachers had heard about non-linear storytelling approaches. But they have never tried those structures in the classroom. By joining and observing a non-linear storytelling programme, teachers also learned about factors that directly affect a child's social and emotional development. According to the point of view of teachers, there were effects such as the development of self-confidence, ability to make independent decisions, creativity, understanding, listening skill, and curiosity. As an example, a child may tend to think about what will happen next, during this non-linear storytelling program. Children thought what would happen if they selected a butterfly rather than a bee?

Imagining is more influential in non-linear storytelling methods than linear storytelling structure. For example, one boy's choice was the "Asala" tree (Golden shower tree), and the teacher asked him the reason for his selection, and he showed his two fingers and replied that "I have two Asala trees at home". The teacher said that he is lying, but the point is that he imagined the trees at his house. Possibly, the non-linear story enhanced and reflect his imaginative skills.

In a non-linear storytelling structure, the social development of leadership/independence was noticeable. Example: One girl suggested to the others to choose a butterfly. Some children followed her guidance, but some were not.

There are strengths in the non-linear storytelling structure according to the teacher's perspective. Such as by letting children choose their story path, children had more confidence in themselves. In further, teachers can get to know the hidden personalities of children while children get to know who has the same tastes and dislikes.

Additionally, children may be curious as to what would have happened if they had chosen a bee instead of a butterfly. It will enhance their arguable and logical mind rather than being a typical follower of the linear story.

4 Discussion

Though the non-linear storytelling approach may seem like a good and new experience, there are still some issues with doing so, as it is not practical with the resources of a typical Sri Lankan preschool.

- The teacher needs a good plan, knowledge, and time to create complex storylines according to a non-linear storytelling approach.
- Pre-schools need more teachers/more human resources, time, and space to run the non-linear storytelling session.

However, the digital non-linear storytelling approach can be used as a solution to overcome these issues. Introducing digital storytelling that is well-supported for the preschools can be an extraordinary facilitator of a wide range of significant educational benefits (Di Blas et al. 2009). Schools around the world are currently closed due to COVID-19. As a result, education has changed imperatively and online education platforms are a more useful and effective way for education (Li and Lalani 2020). In a timely manner, the digital non-linear storytelling approach can make a significant contribution to the development of a child's social and emotional skills.

5 Conclusion

Successful childhood is the foundation of a successful life. It is not enough to focus only on academics, but also it is crucial to have rich social and emotional skills in a child to be a respected citizen of the country in the future. This study has compared and described the reactions between linear storytelling and non-linear storytelling approaches on the social and emotional development of pre-school children in Sri Lanka. When considering the child's perspective, he /she always experiences a single direction, even though it is non-linear storytelling. Therefore, in addition to the linear storytelling approach, more development of social and emotional skills can be observed through non-linear storytelling approaches, since it provides the freedom to a child to interact with the story. It seems like a non-linear storytelling session is more effective and had positive responses from children.

This research adds information by investigating the effectiveness of the non-linear storytelling method for preschoolers. However, the effectiveness should be studied in other non-linear storytelling aspects such as digital screens, books, games, story rooms, etc. Furthermore, suggest a mix of a quantitative and qualitative studies to check and claim these findings.

Children can imagine and create their own stories according to their preferences. This kind of intelligence exists in humans, but it is a challenge for artificial intelligence and machines to reach that level. The ultimate goal of this study is to spark a conversation about the future of automatically generated, customized, and personalized storylines through Artificial Imagination in order to benefit children's social and emotional development (Sassoon 2020).

6 Appendices

6.1 Appendix A: Linear Storyline

ඔන්න එක වත්තක මල් පිරුණු වියල ගහක් තිබුණා,මේ ගස් සමනල්පු ගොඩක් තිවියා,මෙයලා මේ මල් වල පැඹී බේ සංඛ්‍යා තිවියා,වික ද්‍රවයක් ගස් මල් නැතුව ගියා. ඉතින් සමනල්පු සේරම එකතු වෙලා මේ ගැන කනා කළා,දැන් ඉතින් අපිට කුම නැති වෙන්නයි යන්ගේ යන්ගේ,අපි දැන් මොකද කරන්නේ? "අපි ඇතට ගිහින් මල් ගස් භෞයමු." එක සමනලයක් කිවිවා."අනෝ එකට මම නන් බයයි." තව සමනලයක් කිවිවා.

සමනල්පු සේරම එකතු වි ඒ ගැන කනා කළා. අවායනයේ වැඩි දෙනගේ තීරණය වුමෙන් "මම ගස් නැවතුහාන් අපිට කුම නැතුව මැරෙන්නයි වෙන්නෙ,ටට වැඩිය ගොදයි අපි හැමෙර්ම පරිස්‍යමින් ගහන් ගට මාරු වෙමින් කැමෙල් ගොදට මල් නියෙන ගහකට යමු" කියලා,ටට වැඩි දෙනාගේ කැමුත්තාට හැමෙර්ම හටිම සංඛ්‍යා මල් පැඹී බොන්න පටන් ගන්නා.

එකමුතු වි තීරණ ගෙන වැඩි කළ තියා හැමෙර්ගෙම ජීවිත තීරුගන්ත පුදුවන් වුණා.

There was a big tree full of flowers in one garden. There were a lot of butterflies on this tree. They were happy to drink the nectar of these flowers. After a while, the flowers begin to be disappeared. So, the butterflies all got together and talked about this.

"Now we're going to run out of food. What do we do now?

"Let's go far and look for flowering trees." One butterfly said,

"Oh, I'm scared of that." Said another butterfly.

Butterflies all came together and talked about it. In the end, most butterflies decided, "If we stop, we'll have to live without food. We all should move from tree to tree safely and go to live in a tree with good flowers, in the forest. They flew and flew and found a tree with a lot of flowers! They said, "We are all safe because we work together, and we make decisions together!"

6.2 Appendix B: Non-linear Storyline

Option 1 and Option 1.1

ඔන්න එක වත්තක මල් පිරුණු වියල ගහක් තිබුණා,මේ ගස් "සමනල්පු" ගොඩක් තිවියා,මෙයලා මේ මල් වල පැඹී බේ සංඛ්‍යා තිවියා,වික ද්‍රවයක් ගස් මල් නැතුව ගියා. ඉතින් සමනල්පු සේරම එකතු වෙලා මේ ගැන කනා කළා,දැන් ඉතින් අපිට කුම නැති වෙන්නයි යන්ගේ,අපි දැන් මොකද කරන්නේ? "මම දැක්කා ලයෝන ඇයල ගහක් කැමෙල් මැද්ද තියනාවා, අපි ඇතට ගිහින් මල් ගස් ගොයමු." එක සමනලයක් කිවිවා."අනෝ එකට මම නන් බයයි." තව සමනලයක් කිවිවා. සමනල්පු සේරම එකතු වි ඒ ගැන කනා කළා,අවායනයේ වැඩි දෙනාගේ තීරණය වුමෙන් "මම ගස් නැවතුහාන් අපිට කුම නැතුව මැරෙන්නයි වෙන්නෙ,ටට වැඩිය ගොදයි අපි හැමෙර්ම හෙට පරිස්‍යමින් ගහන් ගට මාරු වෙමින් කැමෙල් ගොදට මල් නියෙන ගහකට යමු" කියලා,එන් එක සමනලයක් තිවියා, හටිම මුරුන්සුයි.කරිරුවන් කියන දේ අහන් නෑ. එය සිතුවා තනියම මල් ගැ ගොයන් යනවා කියලා,ඉතින් එයා තනියම ය වෙලා පිටත් වුනා. අනෝ එන් ලොකු ඩූලයක් ඇවිල්ල එයාව ගහගෙන ගියා.

There was a big tree full of flowers in one garden. There were a lot of **butterflies** on this tree. They were happy to drink the nectar of these flowers. After a while,

the flowers begin to be disappeared. So, the **butterflies** all got together and talked about this.

"Now we're going to run out of food. What do we do now?

I've seen a beautiful "**Asala tree**" (Golden shower tree) in the middle of the woods,

"Let's go far and find that tree." One **butterfly** said,

"Oh, I'm scared of that." Said another **butterfly**.

Butterflies all came together and talked about it. In the end, most **butterflies** decided, "If we stop, we'll have to live without food. We all should move from tree to tree safely and go to live in a tree with good flowers, in the forest. But there was one butterfly. Very stubborn. Doesn't listen to anyone. He thought he was looking for flowers alone, so he left alone at night.

Alas, a great wind blew and blew him away to another country, because he did not work and make decisions together.

Option 1 and Option 1.2

එන්න එක වත්තක මල් පිරුණු විශාල ගහක් තිබුණු. මේ ගහේ "සමනල්ලු" ගෙවික් කිවිය. මෙයලා මේ මල් වල පැහි මි සංඛ්‍යාන් තියිය. වික අවසක්න් ගහේ මල් නැඳුව යියා. ඉතින් සමනල්ලු යෝරුම එකතු වෙලා මේ ගැන කතා කළා. දැන් ඉතින් අපිට කැම නැති වෙන්නයි යන්නේ. අපි දැන් මොකද කරන්මත්?" මම දැක්කා ලජ්සන එරඩු ගහක් කැලේ මැදැඳ තියනවා. අපි ඇතට ගිහින් මල් ගස හොයමු." එක සමනලයෙක් / කිවිව." අන් ඒකට මම නත් බයයි." තව සමනලයෙක් කිවිවායමනල්ලු යෝරුම එකතු වී ඒ ගැන කතා කළා. අවසානයේ වැඩි දෙනගේ තීරණය වුණේ" මේ ගහේ නැවතනොත් අපිට කැම නැතුව මෙරන්නයි වෙන්න. රට වැඩිය හොඳයි අපි නැමෙම් පරිසයින් ගහෙන් ගහට මාරු වෙමින් කැලේ හොඳට මල් තියෙන ගහකට යුතු" කියලා. එවිට වැඩි දෙනාගේ කැමැජ්නට හැමෝම් එකග වී ඉගිලි යියා. පසුව මල් පිරුණු ගස් තිබෙන කැලේකට ගිහින් මේ හමෝම් ගරීම සංඛ්‍යාන් මල් පැහි බෙළනන පටන් ගෙත්තා.

එකමුතු එ තීරණ ගෙන වැඩ කළ තිසා භැංමෝගේ තීවිත තේරුනෙන පූලවන් වුණා.

There was a big tree full of flowers in one garden. There were a lot of **butterflies** on this tree. They were happy to drink the nectar of these flowers. After a while, the flowers begin to be disappeared. So, the **butterflies** all got together and talked about this.

"Now we're going to run out of food. What do we do now?

I've seen a beautiful "**Erabadu tree**" (Red flower tree) in the middle of the woods,

"Let's go far and find that tree." One **butterfly** said,

"Oh, I'm scared of that." Said another **butterfly**.

Butterflies all came together and talked about it. In the end, most **butterflies** decided, "If this tree stops, we'll have to live without food. We all should move from tree to tree safely and go to live in a tree with good flowers, in the forest.

They flew and flew and found an "**Erabadu tree**" (Red flower tree) tree with a lot of flowers! They said, "We are all safe because we work together, and we make decisions together!

Option 2 and Option 2.1

ඒන්න එක වත්තක මල් පිරුණු විශාල ගහක් තිබුණා.මේ ගහේ "ම් මැස්සො" ගොඩක් තිවියා.මෙයලා මේ මල් වල පැහැ බි යනුවින් තිවියා.වික දටයකින් ගහේ මල් නැතුව ගියා. ඉතින් ම් මැස්සො, සේරම එකතු වෙලා මේ ගැන කතා කලා.දැන් ඉතින් අපිට කුම නැති වෙන්නයි යන්නේ.අපි දැන් මොකද කරන්නේ? "මම දැක්කා ලස්ස ඇපුල ගහක් කැමෙල් මැදුරු තියනවා. අපි ඇතට හිනින් මල් ගස් හොයමු." එක ම් මැස්සොක් කිවිවා."අනේ එකට මම නන් බයයි." නව ම් මැස්සොක් කිවිවා. ම් මැස්සො සේරම එකතු වී ඒ ගැන කතා කලා.අවසානයේ වැඩි දෙනගේ තීරණය මුළුන් "මේ ගහේ නැවතුණෙන් අපිට කුම නැතුව මැරෙන්නයි වෙන්නේ.ටට වැඩි භෞදි අපි භාමෝම් පරිස්සයින් ගහන් ගහට මාරු වෙමින් කැමෙල් හොයට මල් තියෙන ගහකට යමු" කියලා. ඒත් එක ම් මැස්සොක් තිවියා. හටම මූර්න්ඩුයි.කිවිරුවත් කියන දද් අහන් නා. එය තිබුවා තනියම මල් ගහ හොයන් යනවා කියලා.ඉතින් එය තනියම ර වෙලා පිටත් මුනාඅනේ එන් ලොකු පුළුගක් ආවිල්ල එයට ගහගෙන ගියා.

එකමුතු වී තීරණ ගෙන වැඩ නොකළ තියා මුරණ්ඩු ම් මැස්සොවෙන රටකට ගහගෙන ගියා.

There was a big tree full of flowers in one garden. There were a lot of **bees** on this tree. They were happy to drink the nectar of these flowers. After a while, the flowers begin to be disappeared. So, the **bees** all got together and talked about this. "Now we're going to run out of food. What do we do now?

"I've seen a beautiful "**Asala tree**" (Golden shower tree) in the middle of the woods,

"Let's go far and find that tree." One **bee** said,

"Oh, I'm scared of that." Said another **bee**.

Bees all came together and talked about it. In the end, most bees decided, "If this tree stops, we'll have to die without food. We all should move from tree to tree safely and go to live in a tree with good flowers, in the forest. But there was one **bee**. Very stubborn. Doesn't listen to anyone. He thought he was looking for flowers alone, so he left alone at night.

Alas, a great wind blew and blew him away to another country, because he did not work and make decisions together.

Option 2 and Option 2.2

ඒන්න එක වත්තක මල් පිරුණු විශාල ගහක් තිබුණා.මේ ගහේ "ම් මැස්සො" ගොඩක් තිවියා.මෙයලා මේ මල් වල පැහැ බි යනුවින් තිවියා.වික දටයකින් ගහේ මල් නැතුව ගියා. ඉතින් ම් මැස්සො, සේරම එකතු වෙලා මේ ගැන කතා කලා.දැන් ඉතින් අපිට කුම නැති වෙන්නයි යන්නේ.අපි දැන් මොකද කරන්නේ? "මම දැක්කා ලස්ස එරඩු ගහක් කැමෙල් මැදුරු තියනවා. අපි ඇතට හිනින් මල් ගස් හොයමු." එක ම් මැස්සොක් කිවිවා."අනේ එකට මම නන් බයයි." නව ම් මැස්සොක් තිවිවා.

ම් මැස්සො සේරම එකතු වී ගැන කතා කලා.අවසානයේ වැඩි දෙනගේ තීරණය මුළුන් "මේ ගහේ නැවතුණෙන් අපිට කුම නැතුව මැරෙන්නයි වෙන්නේ.ටට වැඩි භෞදි අපි භාමෝම් පරිස්සයින් ගහන් ගහට මාරු වෙමින් කැමෙල් හොයට මල් තියෙන ගහකට යමු" කියලා.එමිට වැඩි දෙනාටේ කැමෙන්තට භාමෝම් එකග වී ඉදිලි ගියා. පසුව මල් පිරුණු ගස් තිබෙන කැලෙකට හිනින් මේ හමෝම් භරිම සැතුවින් මල් පැහැ මොන් පටන් ගන්නා.

එකමුතු වී තීරණ ගෙන වැඩ කළ තියා භැමෝම්ගෙම ජීවිත තීරාගන්න පුදුවන් මුණා.

There was a big tree full of flowers in one garden. There were a lot of **bees** on this tree. They were happy to drink the nectar of these flowers. After a while, the flowers begin to be disappeared. So, the **bees** all got together and talked about this.

"Now we're going to run out of food. What do we do now?

I've seen a beautiful "**Erabadu tree**" (Red flower tree) in the middle of the woods,

"Let's go far and find that tree." One **bee** said,

"Oh, I'm scared of that." Said another **bee**.

Bees all came together and talked about it. In the end, most **bees** decided, "If this tree stops, we'll have to live without food. We all should move from tree to tree safely and go to live in a tree with good flowers, in the forest.

They flew and flew and found an "**Erabadu tree**" (Red flower tree) tree with a lot of flowers! They said, "We are all safe because we work together, and we make decisions together!

References

- Antle, A.: Case study: the design of CBC4Kids' StoryBuilder (2003). <https://doi.org/10.1145/953536.953546>
- Bostan, B., Marsh, T.: Fundamentals of interactive storytelling (2012). <https://doi.org/10.5824/1309-1581.2012.3.002.x>
- Bratitsis, T., Ziannas, P.: From Early Childhood to Special Education: Interactive Digital Storytelling as a Coaching Approach for Fostering Social Empathy. Elsevier B.V. (2015). <https://doi.org/10.1016/j.procs.2015.09.267>
- British Sociological Association: Statement of Ethical Practice. BSA Publications (2017)
- Liu, C.C., Liu, K.P., Chen, G.D., Liu, B.J.: Children's collaborative storytelling with linear and nonlinear approaches (2010)
- Collins, J.W., Collins, M.: Social Skills Training and the Professional Helper. 1st edn. Wiley (1992)
- Costa, C., Mayora, O., Gabrielli, S.: I-Theatre: developing narratives skills in kindergarten children (2011)
- Creswell, J.W.: Research Design Qualitative, Quantitative, and Mixed Methods Approaches, 2nd edn. Sage Publications (2003)
- Di Blas, N., Garzotto, F., Paolini, P., Sabiescu, A.: Digital storytelling as a whole-class learning activity: lessons from a three-years project. In: Iurgel, I.A., Zagalo, N., Petta, P. (eds.) ICIDS 2009. LNCS, vol. 5915, pp. 14–25. Springer, Heidelberg (2009). https://doi.org/10.1007/978-3-642-10643-9_5
- Eisenberg, A.R.: Learning to describe past experiences in conversation (1985). <https://doi.org/10.1080/01638538509544613>
- Erickson, E.: Effects of storytelling on emotional development (2018)
- Garzotto, F., Paolini, P., Sabiescu, A.: Interactive storytelling for children, pp. 356–59 (2010)
- Gordon, P.: Narratology: the study of story structure (1984)
- Hammersley, M.: Reading Ethnographic Research a Critical Guide. Routledge (1991)
- Human development unit South Asia region: laying the foundation for early childhood education in Sri Lanka (2014)
- John: Exploring nonlinear narratives. The Art of Narrative (2019). <https://artofnarrative.com/2019/07/07/exploring-nonlinear-narratives/>. Accessed 26 May 2021

- Kim, S.-K., Kim, S.K.: Survey on the narrative structure of the interactive storytelling authoring system (2016)
- Kulawansa, D., Nanayakkara, M.: Agent based primary education supporting platform (2011)
- Li, C., Lalani, F.: The COVID-19 pandemic has changed education forever. This is how." World economic forum (2020). <https://www.weforum.org/agenda/2020/04/coronavirus-education-global-covid19-online-digital-learning/>. Accessed 27 May 2021
- McCabe, A., Rollins, P.: Assessment of preschool narrative skills (1994)
- Nasir, M.N.F., et al.: Non-Linear and Interactive Storytelling for Children Book (2012)
- O'Byrne, W.I., Houser, K., Stone, R., White, M.: Digital storytelling in early childhood: student illustrations shaping social interactions. *Front. Psychol.* **9**. (2018). <https://doi.org/10.3389/fpsyg.2018.01800>
- Peterson, C., Biggs, M.: 'I was really, really, really mad!' Children's use of evaluative devices in narratives about emotional events. *Sex Roles* **45**, 801–825 (2001). <https://doi.org/10.1023/A:1015692403932>
- Roettgers, J., Roettgers, J.: Netflix takes interactive storytelling to the next level with 'Black mirror: Bandersnatch.' *Variety* (2018). <https://variety.com/2018/digital/news/netflix-black-mirror-bandersnatch-interactive-1203096171/>. Accessed 18 July 2019
- Sassoon, J.: Storytelling and artificial intelligence|Research world (2020). <https://www.researchworld.com/storytelling-and-artificial-intelligence/>. Accessed 29 May 2021
- The Ministry of Education - Sri Lanka. punchi api ape lowai - Guide Book of Activities on Early Childhood Education. Western Province (2015)
- Wijetunge, P.: Organizational storytelling as a method of tacit knowledge transfer: case study from a Sri Lankan University (2012).



Information Visualization and Design Activism: An Emerging Relationship

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Abstract. Information Visualization is a practice of visual communication that aims to make visible and understandable phenomena whose invisibility, abstraction or complexity defy human perception and knowledge. It involves a visual codification of categories and quantities, relationships and processes, embodied in artefacts such as charts, thematic maps, infographics or interactive data visualizations. This kind of devices are designed in order to enable insights and new interpretations about different subject matters, taking advantage of human perceptual and cognitive faculties. In recent years, Information Visualization has become widespread in several fields of activity, from science to the arts, through journalism and has gained significant media coverage. This growth in the use of visualizations makes it necessary to have critical tools which may allow a better understanding of these visual devices – What do they communicate? Why? For what purpose? This paper presents a set of arguments which relates Information Visualization with Design Activism, a multidisciplinary approach to design that is identified by the ethical motivation of the designer, by the sense of public intervention that underlies it and its counter-narrative or disruptive discourse. Based on the literature review, we arrive at the assumption that it may be possible to characterize an emerging sub-domain that results from the intersection between Information Visualization and Activist Design. The validation of this assumption implies the development of this research in order to identify and characterize visualization projects in which the Motivation, Purpose and Discourse factors can be compatible with those that identify Design Activism.

Keywords: Information Visualization · Data visualization · Information design · Design activism · Visual communication

1 Visible World and Visualized Reality

The visible world encompasses the phenomena that are directly and naturally within the reach of the eye, but also the images that result from the use of instruments and technologies that allow to overcome the limits and expand the power of human vision. This means that vision is not only conditioned by the limits of the visual system (e.g. maximum and minimum achievable distance) but is also magnified by the use of tools and technologies, such as the microscope or telescope, photography or x-ray.

However, there are phenomena that are simultaneously outside the natural range of vision and the increased visual potential provided by these devices. For example, how to observe the evolution of inflation over a certain period of time? Or the distribution of unemployment across different regions? This type of phenomena, due to their invisible and abstract nature, require visual representations that make them perceptible and understandable (e.g. numerical tables, charts, maps). In parallel, there are other phenomena that, although partially or totally visible, challenge human perception due to their scale or complexity. Major sports events or accidents, the functioning of an organism or the manufacturing process of a product, exemplify another type of phenomenon whose understanding require a visual representation.

According to Costa [1], visible reality is only part of what is recognized through vision because the use of various technical instruments allows the generation of images that broaden the visibility spectrum beyond the natural limits of the human visual system. In this context, visual representation allows the generation of images that expand the perceptual spectrum to the scope of phenomena whose invisibility, abstraction or complexity defy the needs of human knowledge. This invisibility, abstraction and / or complexity, combined with the need to discover, understand or communicate information, are the factors that motivate the use of different forms of visual representation that are encompassed in a wide field of image production which allow us to envision information [2].

Semantically, the term ‘visualization’ has a duality that illustrates its potential in relation to human perception and information. In fact, it may refer to the generation of mental images of something or it may mean to represent something through the use of images [3]. Indeed, Ware [4] demonstrates that a substantial part of the brain is dedicated to the processing of visual information and that information acquired and processed using the human visual system surpasses that obtained by the combined use of the other four senses. This is the fundamental reason why in the field of visual communication the relationship between vision, representation and understanding is widely explored using diverse visual strategies and models which allow to observe and interpret different phenomena, to memorize certain information or to assist decision making. For this reason, Norman [5] argues that thinking depends, to a large extent, on the use of this sort of external aids. It is devices such as those, that we integrate in the broad field of Information Visualization, that make us smart.

2 Information Visualization as a Design Process

Information Visualization means representing categories and quantities, relationships and processes, in order to allow observations and interpretations about reality that take advantage of the faculties of the human visual and cognitive systems. It is a process of representation that aims to make visible and understandable phenomena whose invisibility, abstraction or complexity challenge human understanding needs [1, 2, 6, 7]. As such, this is a practice that emerges and applies in different contexts and that takes on different names depending on the disciplinary fields in which it is used (e.g. Data Visualization, Scientific Visualization, Infographics, etc.). Not rejecting these distinctions but recognizing the affinities inherent to all of them, Cairo [7] proposes a comprehensive

and inclusive understanding of this concept that encompasses several forms of visual representation (charts, thematic maps, infographics, interactive data visualizations or news applications) specifically designed to enable the exploration, analysis, discovery and communication of information about a particular subject. In this perspective, we may conclude that visualizing information is a design process whose result is materialized in visual instruments, that we may simply call visualizations. These visual artefacts have the essential purpose to allow the observation and understanding of a certain phenomenon, process or situation.

To support this idea, we call upon the *design as interface* approach proposed by Bonsiepe [8]. According to him, design is ontologically defined through the relationship between the user, the tool and an action with a specific purpose. In this context, the user is the agent who needs to perform a certain task, whether physical or cognitive. The tool refers to the artefact, material or immaterial, necessary to perform this task, and it encopasses both physical artefacts or semiotic devices. The purposeful action means the task assumed as the design's predetermined goal. The three entities are articulated through the concept of interface, understood here as the practical and utilitarian interaction that realizes the design itself. Thus, the London subway map drawn by Harry Beck (1902–1974) between 1931 and 1933 [9] can be considered both as a paradigmatic example of *design as interface* and a visualization.

Acknowledging that in an underground transport the exact position of lines and stations is not significant but what matters to the passenger is the relative position between them and their location vis-à-vis a geographical reference such as the river Thames, Beck visualized the metro network as a topological diagram, a schematic representation of the lines and stations inspired by the technical drawings [10]. Since then this map has become a navigation aid in the London metro system and its effectiveness is demonstrated both by maintaining its original configuration, even with a substantially larger metro network, and by its replication in the visualization of transport networks in several cities worldwide [11]. Considering the design as an interface model proposed by Bonsiepe, this map assumes itself as a visual tool whose purpose is to enable the passenger to efficiently navigate the London underground network and, thus, embodies the efficient articulation between a user, a tool and a purposeful action.

In a parallel perspective, we may approach another design definition. Like Bonsiepe, Providência [12, 13] also describes design through a triad. In this case, he proposes an articulation between author, program and technology. Thus, design is the dynamic relationship between the author(s), responsible for the idealization of the artefact, the constraints and objectives to which the design process will respond (program) and the technical and operational means necessary for its achievement (technology). Evoking the Aristotelian philosophy that segments the production of knowledge among *theoria*, *praxis* and *poiésis*, Providência distinguishes design as a poetic activity, exemplary of the artistic way of thinking and doing and their specific motivations and intentions. These can oscillate, according to the circumstances and the assumption of the authorship, between the demand for a response to a practical need or the desire to intervene publicly depending on the individual's view about a certain subject.

From the definitions of Bonsiepe [8] and Providência [12, 13] we can assume that design is defined, simultaneously, by the practical utility, by the potential of use, by the

efficiency of performance that the artefacts provide in the accomplishment of a task, but also, for the symbolic potential and the cultural value that objects generate in the context in which they are conceived and used. The interdependence between these two dimensions of design is, moreover, supported by Heskett [14], for whom utility and meaning are essential concepts to design. According to him, objects simultaneously have a utilitarian function, linked to practical utility, and a significant function to which symbolic and cultural values are associated. In this perspective, we can argue that the methodological approaches to Information Visualization as such ones proposed by Fry [15] or Stefaner [16] are, in their essence, design process models specifically conceived and applied to the ideation and implementation of visualizations which purpose is to provide the exploration, analysis and/or communication of content through visual representation and interaction. According to these models, and following the arguments of Bonsiepe [8] and Providência [12, 13], a visualization realizes, on the one hand, the practical utility of design by visually representing certain information and thus making it visible and understandable and, on the other hand, it invariably generates symbolic and cultural value which impact on the social and cultural spheres can be varied.

3 Visualization as a Multiple Function Tool

Seeking to characterize Information Visualization as a design practice oriented towards the production of visual tools, Masud, Valsecchi, Ciuccarelli, Ricci and Caviglia [17] propose a conceptual model in which this process corresponds to different ways of implementing the data – information – knowledge – wisdom continuum. This hierarchical continuum is recognized in different academic fields and makes it possible to problematize data collection, its transformation into information and the socio-cultural production of knowledge and the formation of wisdom at an individual level [18].

Following this model, Information Visualization corresponds to a design process in which data, information and/or knowledge are transformed into a visualization with the aim of generating knowledge in the user's mind. As such, the process focuses, first, on the producer who is in charge of the design process, and then on the user considering the perceptual interaction which is established with the information through the visualization. As such, this model defines Information Visualization as a design process, based on the data, information and/or knowledge that are at the origin of the process, on the user's acquisition of the information and on the essential objective of generating knowledge. In this sense, Information Visualization is the design of a visual device that configures and communicates specific informational content with the purpose of affecting, in different ways, the knowledge of those who see, interpret and use it.

Considering the importance that knowledge assumes as the final goal of this process, it is necessary to identify its different modalities. Polanyi [19] describes two primary knowledge categories. Tacit knowledge is that which is difficult or impossible to articulate and communicate (e.g. how to ride a bicycle) and explicit knowledge is that which can be articulated and communicated (e.g. a bicycle has two wheels). This conception is further developed by Nonaka [20] who argues that knowledge can be of individual origin, resulting from personal experience synthesized in the expression ‘learning-by-doing’, or it can be a socio-cultural construction resulting from collective actions of a group

of people. In parallel, knowledge can be classified according to its potential to answer different types of questions as declarative knowledge (answering the question “what?”), procedural knowledge (answering the question “how?”), causal knowledge (answering the question “why?”), locational knowledge (answering the question “where?”), conditional knowledge (answering the question “when?”) or relational knowledge (answering the questions “with what or with who?”).

Taking this segmentation into account, Masud et al. [17] distinguish three categories of visualizations according to their specific purpose: analytical, communicative and formative. This segmentation is determined, on the one hand, by the original materials used to perform the visualization (data, information or previously synthesized knowledge) and, on the other hand, by the knowledge formation that it allows to aim, namely declarative, procedural or conditional.

Analytical visualization converts data into visual information so that the user can extract information previously unknown about the addressed subject. This type of visualization is produced in contexts where it is necessary to infer meaning and obtain information from the exploration and analysis of data, such as scientific research or statistical analysis. As such, the designer can be both the producer and the consumer of the information visualized. This category of visualizations allows to obtain a declarative type of knowledge.

Communicative visualization is not limited to collecting and representing data, but also presents previously synthesized information or knowledge integrated by the visualization designer. This type of visualization seeks to tell a story and produce a specific message and meaning that allows the end user to understand what is at stake in relation to the addressed subject. In this domain, the designer operates as a communication mediator who seeks to adapt the complexity of the message to the conditions of reading and interpretation capabilities of the information user. This type of visualization allows to generate declarative and procedural knowledge, as it promotes the understanding of a certain subject and, through this way, supports a certain view and/or decision making regarding the addressed subject.

Formative visualization shares some of the purposes and characteristics of communicative visualization but differs from it by focusing on the transfer of knowledge in a specific context and for a specific audience. Its distinctive feature is that it approaches the user through a pedagogical or formative discourse. In effect, these visualizations are made for users who have specific roles within a group or organization, so that they are able to know how and when they should act in a given context. This type of visualization is not limited to explaining how to act (procedural knowledge), but also seeks to affect the user based on the specific knowledge that is conveyed and the context in which it should be used. In this sense, it results in the generation of procedural and conditional knowledge.

The segmentation proposed by Masud et al. [17] shows that Information Visualization is a process which may have different motives and purposes. This idea is also supported by Iliinsky and Steele [21] who distinguish between two types of visualization according to the two essential functions: exploring a dataset or explaining previously synthesized information.

Thus, an **exploratory visualization** serves to analyze and interpret a dataset in order to obtain new information. It is based on the need to discover new information and its purpose is to extract meaning from the data that is visualized. This type of visualization is used, for example, when a statistical analyst draws a scatter plot to look for a relationship between two different indicators or when a scientist draws a diagram that works as an aid to his own reasoning.

In turn, an **explanatory visualization** is a communication tool that aims to present information that may (or may not) result from a data analysis. This type of visualization is based on the need to display information previously synthesized and its purpose is to inform the user about a certain subject. Thus, this type of visualization can be exemplified by an infographic story published in a newspaper in which the reader can watch for a multidimensional view of a complex event.

Although the exploratory and explanatory functions can occur in parallel, the distinction proposed by Iliinsky et al. [21] has the virtue to distinguish between two primary objectives of the practice of Information Visualization: exploring and analyzing data to discover new information (exploratory visualization) or communicating previously synthesized information (explanatory visualization). In this sense, an explanatory visualization is a communication tool that can be also defined according to the specific relationships that are established between the three entities involved: data, designer and reader. Thus, according to the predominance of the relationship established between these three entities we may also identify three sub-categories of explanatory visualization: artistic, informative and persuasive.

Artistic visualization is based on a primordial relationship between the designer (e.g. artist) and the data. What distinguishes it is the fact that its creators recognize the potential of visualization as a means of artistic expression and as an instrument of aesthetic delight. In this context, a visualization does not necessarily aim at an immediate reading and an objective interpretation of a certain dataset such as that which is intended in a scientific or journalistic context. Alternatively, visualization aims to provide an aesthetic experience or to confront the reader with a challenging view on the addressed subject.

Informative visualization is based on the primary relationship between the reader and the dataset, seeking a clear and understandable presentation of the information. Its essential purpose is to present information in an accessible way, being the type of visualization that is expected to be found in the media, in working documents or in statistical services, communicating information in an clear and immediate way.

Persuasive visualization is based on the primordial relationship between the designer and the reader and, as such, it is a communication tool that seeks to influence the user's knowledge about a given subject. In this type of visualization, the data is selected and represented in order to convey specific messages and to construct a discourse which corresponds to a point of view that the designer wants to share with the user. The purpose of this type of visualization is to influence the user's opinion and attitude towards the addressed subject.

Therefore, the identification of communicative, formative [17] or persuasive [21] purposes associated with Information Visualization, on the one hand, confronts the presumed neutrality and objectivity that is common to be associated with this kind of visual

communication practice. On the other hand, supports the claim for critical instruments that can contribute to better understand the motives and purposes that determine the design and use of visualizations in different contexts [22, 23].

4 Information Visualization as Design Activism?

The use of visualizations as communication tools that expose or raise awareness about socially relevant causes is identified by Engelhardt [24] and exemplified with the work developed by two personalities recognized in the Information Visualization domain: Otto Neurath (1882–1945) and Hans Rosling (1948–2017).

Neurath is acknowledged as the creator of Isotype – International System of Typographic Picture Education – back in the 1920 decade. Conceived as a complement but not as an alternative to the alphabetic and numerical code, this method is based on the use of pictograms, simplified figurative representations of people, places, objects, actions. These are elementary significant units that, when combined and repeated, allow to represent categories and quantities or describe relationships and processes in an easily understandable way. As such, the Isotype pictography assumes itself as an objective communication tool that uses vision as a universal means of accessing information and is at the service of scientific progress and the international community, contributing to the distinction between facts and myths and to overcome national borders and language barriers. Thus, the essential purpose of the Isotype system is to visually synthesize relevant information and contribute to the socialization of knowledge [25, 26].

Rosling is the creator of Gapminder, a foundation dedicated to the collection and dissemination of information on statistical indicators related to health and global development, and gained notoriety through TED talks in which he used the Trendalyser application. This visualization tool allows to explore, compare and visually relate a variety of statistical indicators of the majority of world countries through dynamic and interactive charts. The development of this application was motivated by the difficulties in the distribution, access and understanding of statistical information in universities and had the collaboration of the United Nations Statistics Division [27]. The Gapminder mission *is to fight devastating ignorance with a fact-based worldview everyone can understand* [28] and its use of several visualization tools helps translate numerical and abstract values into understandable facts and reveal information about the state of the world.

The two referenced cases (Otto Neurath & Isotype; Hans Rosling & Gapminder) raise the possibility that the practice of Information Visualization may, in certain circumstances, be framed by motivations, purposes and discursive methods identified with Design Activism.

Although the term Design Activism has emerged in the last decade, its root can be found in the conceptual proposal of Critical Design developed by Dunne and Raby [29]. According to these authors, all design is based on an ideological matrix according to which the designer can position himself between two extreme poles. On the one hand, an affirmative design, in line with the status quo, which practice meets current technical, social, economic and cultural expectations and, on the other hand, a critical design that questions the current ‘state of things’ and which manifests itself through devices and

artefacts that embody alternative views of the technical, social, economic and cultural values installed.

Based on this same duality, Hester [30] analyzes the attitude and involvement of designers towards society. Acknowledging that all kinds of design has an activist potential, he segments designers on five levels according to the way they enrole in the social context: *happy naive*, *enlightened naive*, *servants*, *contextualists* and *catalysts*. The happy naive group includes professionals who ignore the broad context of their work and the social impacts of their activity. The enlightened naive, do not ignore the context, but prefer not to worry about the social impacts of their work. Hester maintains that most designers fall into the third category – the servants, who respond to customers and their needs, disconnecting their work from the social context for economic reasons. Thus, servants category draws a boundary between affirmative design and critical design. On the critical design side, we have contextual designers who, responding to clients demands, also seek to integrate social concerns into their work. Finally, there are catalysts designers who assume themselves as agents of social transformation. They see their professional work as a critical interpretation of the installed values and as stimulus for societal change.

Using a sociological approach, Thorpe [31] establishes a parallel between design and the repertoire of action typical of social movements. In this perspective, Design Activism may assume several expressions such as artifacts that reveal positive alternatives to the status quo, devices that reveal information and make it understandable, political initiatives and actions (petitions, legislative proposals, etc.), humanitarian aid services directed to needy groups, events and contests that promote social and cultural changes, protest artefacts that confront established values and challenge collective reflection.

DiSalvo [32] evokes the relationship between design, politics and democracy. For this, he refers to Mouffe [33] who make a distinction between the *design for politics* that is at the service of the political structures, institutions and processes (parliament, parties, elections) and a *political design*, involved in the ideological dissent and public debate considered essential to democratic life. This political design is visible in projects that are at the service of protest movements, that promote the revelation and understanding of relevant subjects or that feed the discussion around controversial themes.

Pointing out limitations to the views of Thorpe and DiSalvo, Markussen [34] suggests a framework for Design Activism based on the relationship between the political dimension and aesthetic experience and proposes a definition based on the concept of *disruptive aesthetics*. For this purpose, he quotes Rancière [35] for whom the aesthetic experience is identified with the design and distribution of objects that introduce new subjects and new ways of feeling in the field of collective socio-cultural perception. In this way, the aesthetic experience has the disruptive potential of questioning and challenging established ideas and visions and it manifests itself, for example, in the redefinition of the concept of public space that an urbanism or architecture design can advocate.

Fuad-Luke [36] also takes disruption as a factor for the definition of Design Activism, associating it with an idea of *beautiful strangeness* that imposes a new way of seeing the subjects approached by activist designers. In this perspective, Design Activism is a practice that promotes change through the aesthetic effect it provokes and the interpretation it imposes over the subjects it addresses. As such, Fuad-Luke proposes a specific

definition: *Design activism is design thinking, imagination and practice applied knowingly or unknowingly to create a counter-narrative aimed at generating and balancing positive social, institutional, environmental and/or economic change.* (p.27). This definition combines three conditions that enable the identification of certain projects with the practice of design in an activist mode:

- Design Activism is not a profession but an attitude, embodied in a transdisciplinary movement shared by all those who do it consciously or unconsciously. A project can be identified as an example of design activism coming from several disciplinary contexts (e.g. urbanism, architecture, fashion, communication) and even if it is not assumed as such by its own authors.
- The essential purpose of the activist designer is to promote or generate positive social, environmental, economic or institutional change. This means that these projects are motivated by a critical understanding of reality that leads to the identification of a cause (e.g. pollution, poverty, human rights) over which it is considered necessary to intervene through design in a transformational way.
- Design Activism pursues its objectives through the use of a counter-narrative or disruptive discourse that offers a critical, revealing and/or alternative view in face of what is socially accepted as the established knowledge on the subject addressed.

Based on these notions, we briefly describe and analyse an historical and a contemporary visualization cases.

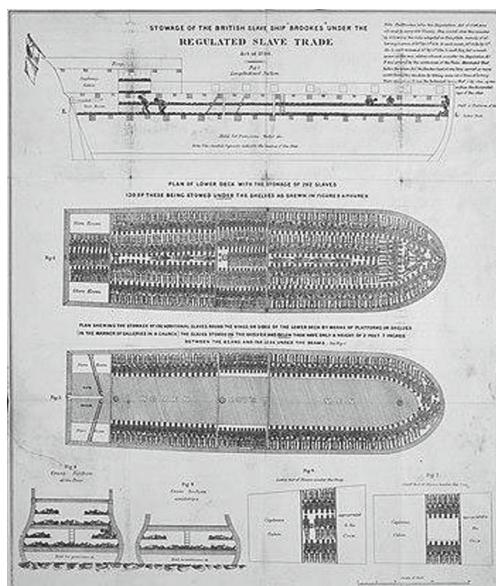


Fig. 1. Stowage of the British slave ship “Brookes” under the Regulated Slave Trade Act of 1788, Society for Effecting the Abolition of Slave Trade (Plymouth, 1788)

The ‘Brookes’ slave ship diagram (see Fig. 1) is probably one of the most powerful image used by abolitionist militants who fought to end slavery in the late 18th century [37, 38]. This image was originally published in 1788 by the Society for Effecting the Abolition of the Slave Trade in England and represents, visually, the conditions of transport of 400 human beings (men, women and children), compressed in the space of the holds of a ship. Published in newspapers, pamphlets, books and, above all, on posters exhibited in public places in Great Britain, France and the U.S., this image became a communication tool to reveal the cruelty of slavery. In effect, this visual representation had the power to overcome the limited informative scope of the testimonial reports and the texts that accompanied the public petitions promoted by the abolitionists. By communicating visually, the image generated an instant impression of horror and confronted society with this phenomenon. For this reason, the ‘Brookes’ diagram became an iconic communication tool of the British abolitionist movement.

Thus, the diagram of the ‘Brookes’ seems to identify with the characteristics of Design Activism. Indeed, the authors were motivated by an ethical position that determines their fight against the slave trade and slavery. In parallel, the design and dissemination of this diagram had the essential purpose of intervening in the public space with the aim of, first, changing the social perception of this subject and, ultimately, to demand the abolition of slavery. To achieve this goal, the authors used a visual representation of a revealing kind, making visible and understandable a situation that was far from the common eye but that unequivocally exemplifies the cruelty to which those human beings were subjected. In this way, they assumed a disruptive discourse that confronted and challenged the installed view on slavery.

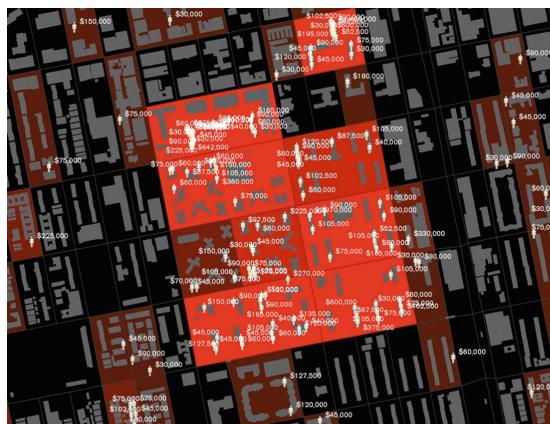


Fig. 2. Million Dollar Blocks map detail, (USA, 2006) © Center for Spatial Research, Columbia University

Similarly, the Architecture and Justice - Million Dollar Blocks [39] project (see Fig. 2), developed at the then-called Spatial Information Design Lab at Columbia University (USA, 2006), reveals a controversial facet of north american society. The diverse maps developed under this project represent statistical data from the U.S. prison system

but do not represent the occurrence and location of crimes as it is more usual in that country. Alternatively, they seek to identify the origin of those who are serving sentences in prisons. Carried out in collaboration with NGOs dedicated to the defense of human rights and social justice, the project presents flow maps, which reveal successive 'city-prison-city-prison' migrations of a large part of these people and location maps, which demonstrate how a large number of detainees are from the same neighborhoods, with authorities spending in excess of one million dollars a year to incarcerate residents of the same block. According to this fact, Million Dollar Blocks is the nickname for which this project has become known.

Developed in a multidisciplinary academic context centered on urbanism and architecture, the Million Dollar Blocks project assumes itself as a critique of the way in which the US law system overlaps other public institutions and challenge urban planners, architects and political authorities for the discussion and development of alternative policies that make it possible to change this situation. In other words, it is a project motivated by the identification of a critical issue that the designers considered relevant to reveal and address in order to raise a public discussion. In this way, the maps are a kind of disruptive counter-narrative, identifying not the places with the highest occurrence of crimes but plotting the areas where social interventions are needed to prevent social marginalization.

5 Results and Future Research

The arguments and the examples previously mentioned support the possibility that, through the meeting of certain conditions, Information Visualization could be a mode of expression of Design Activism. The validation of this supposition requires the combination of three conditions that distinguish the practice of Design Activism:

Motivation - Activist designer's motivation is based on the recognition of causes (e.g. human rights, environment, social justice, etc.) considered relevant to initiate a design process. In other words, it relates with an ethical foundation that determines a critical view on a subject and ignites the designer's will to visualize it.

Purpose - The designer assumes the aim of publicly intervene on the subject in question. In this context, design is an instrument which may promote the revelation, understanding and/or critical awareness about the phenomenon and the visualization is the device which contributes to the public debate on the subject that is addressed.

Discourse - Design Activism develops counter-narrative instruments that challenge established views on the subjects covered. In this sense, the discourse takes on a disruptive approach, which questions current interpretations and promotes alternative readings on the topics and subjects addressed.

Considering this assumptions, the future development of this research requires the identification of qualitative indicators that can simultaneously validate the specific relationships that define Design Activism and therefore classify visualization projects as such, namely:

- **Motivation - Ethical foundation**
- **Purpose - Public intervention**
- **Discourse - Counter-narrative and/or disruptive content**

The development of this research foresees the design of a conceptual model which may allow the validation of a design subdomain resulting from the intersection between Information Visualization and Design Activism. Such a model can contribute to the development of theoretical and critical tools that support a deeper analysis of the fundamentals, objectives and discursive content inherent to visualization devices. In a broader perspective, this model can open the possibility of classifying other design practices through the indicators which define Design Activism.

References

1. Costa, J.: *La esquemática – Visualizar la Información*. Ediciones Paidós Ibérica, Barcelona (1998)
2. Tufte, E.R.: *Envisioning Information*. Graphics Press, Cheshire (1990)
3. Cambridge Dictionary: <https://dictionary.cambridge.org/pt/dicionario/ingles/visualization>. Accessed 27 Aug 2021
4. Ware, C.: *Information visualization – Perception for Design*, 2nd edn. Morgan Kaufmann Publishers, San Francisco (2004)
5. Norman, D.: *Things that Make us Smart – Defending Human Attributes in the Age of the Machine*. Perseus Books, Cambridge (2003)
6. Cairo, A.: *The Functional Art – an Introduction to Information Graphics and Visualization*. New Riders, Berkley (2013)
7. Cairo, A.: *The Truthful Art – Data, Charts, and Maps for Communication*. New Riders, Berkley (2016)
8. Bonsiepe, G.: *Interface – An Approach to Design*. Jan van Eyck Akademie, Maastricht (1999)
9. Google Arts & Culture: Pocket Underground map, Harry Beck, 1933. <https://artsandculture.google.com/asset/pocket-underground-map-henry-c-beck/AQGrQlo9u07rQ>. Accessed 28 Aug 2021
10. Garland, K.: *Mr Beck's Underground Map*. Capital Transport, London (1994)
11. Ovenden, M.: *Transit Maps of the World*. Penguin, London (2015)
12. Providência, F.: Algo más que una hélice. In: Calvera, A. (ed.) *Arte – Diseño: Nuevos capítulos en una polémica que viene de lejos*. Gustavo Gili, Barcelona (2005)
13. Providência, F.: Poeta, ou aquele que faz: a poética como inovação em design. PhD Thesis. Departamento de Comunicação e Arte, Universidade de Aveiro (2012)
14. Heskett, J.: *Design – A very Short Introduction*. Oxford University Press, Oxford (2005)
15. Fry, B.: *Visualizing Data*. O'Reilly, Sebastopol (2003)
16. Stefaner, M.: Process and progress: a practitioner's perspective on the how, what and why of data visualization. In: Bihanic, D. (ed.) *New Challenges for Data Design*, pp. 391–404. Springer, London (2015). https://doi.org/10.1007/978-1-4471-6596-5_21
17. Masud, L., Valsecchi, F., Ciuccarelli, P., Ricci, D., Caviglia, G.: From data to knowledge – visualizations as transformation processes within the data-information-knowledge continuum. In: 14th International Conference Information Visualisation, pp. 445–449. IEEE (2010)
18. Kitchin, R.: *The Data Revolution – Big Data, Open data, Data Infrastructures & their Consequences*. Sage, London (2014)
19. Polanyi, M.: *The Tacit Dimension*. Routledge & Kegan Paul, London (1966)
20. Nonaka, I.: A dynamic theory of organizational knowledge creation. *Organ. Sci.* **5**(1), 14–37 (1994)
21. Iliinsky, N., Steele, J.: *Designing data visualizations – Representing informational Relationships*. O'Reilly, Sebastopol (2011)

22. Kosara, R.: Visualization criticism – the missing link between information visualization and art. In: 2007 11th International Conference Information Visualization (IV 2007), pp. 631–636. IEEE (2007)
23. Dörk, M., Feng, P., Collins, C., Carpendale, S.: Critical InfoVis: exploring the politics of visualization. In: CHI 2013 Extended Abstracts on Human Factors in Computing Systems, pp. 2189–2198. ACM (2013)
24. Engelhardt, Y.: Graphics with a cause, and universal principles for visualizing information. In: Oven P.C., Pozar, C. (eds.) On information design, pp. 17–34. The Museum of Architecture and Design, Ljubljana (2016)
25. Lupton, E.: Reading isotype In: Margolin, V.: Design Discourse: History, Theory, Criticism. University of Chicago Press, Chicago (1989)
26. Burke, C., Kindel, E., Walker, S.: Isotype. Design and contexts. 1925–1971. Hyphen Press. London (2013)
27. Rosling, H., Rosling, R.A., Rosling, O.: New software brings statistics beyond the eye. In: Statistics, Knowledge and Policy: Key Indicators to Inform Decision Making, pp. 522–530 OECD Publishing, Paris (2004)
28. GAPMINDER: <https://www.gapminder.org/about/>. Accessed 27 May 2021
29. Dunne, A., Raby, F.: Design Noir: the Secret life of Electronic Objects. Birkhäuser, Basel (2001)
30. Hester, R.T.: Design activism for whom? UC Berkley Environmental Design (2005): <https://frameworks.ced.berkeley.edu/2005/design-activism-for-whom/>. Accessed 27 May 2021
31. Thorpe, A.: Design as activism. a conceptual tool. In: Cipolla C., Peruccio, P. P. (eds.) Changing the change proceedings. Allemandi, Torino (2008).
32. DiSalvo, C.: Design, democracy and agonistic pluralism. In: Proceedings of the design research society conference, 2010 – Design & Complexity, pp. 366–371. Design Research Society (2010)
33. Mouffe, C.: On the Political. Routledge, London (2005)
34. Markussen, T.: The disruptive aesthetics of design activism: enacting design between art and politics. Des. Issues **29**(1), 38–50 (2013)
35. Rancière, J.: The Politics of Aesthetics. Continuum, New York (2004)
36. Fuad-Luke, A.: Design Activism: Beautiful Strangeness for a Sustainable World. Earthscan, London (2009)
37. Christianson, S.: 100 Diagrams that Changed the World. Pavilion Books, London (2014)
38. Radburn, N., Eltis, D.: Visualizing the middle passage: the brooks and the reality of ship crowding in the transatlantic slave trade. J. Interdisc. Hist. **49**(4), 533–565 (2019)
39. Million Dollar Blocks Project: <https://c4sr.columbia.edu/projects/million-dollar-blocks>. Accessed 27 May 2021



“Happiness Under Construction”: A Project in Opposition to the Problem of Obligatory Happiness

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Abstract. Happiness is the ultimate goal of living well and it is, at the same time, the principle of motivation that guides many people’s daily choices. However, there is currently an urgent need to be happy and, by taking advantage of this fragility, some companies and institutions have devalued the responsible exploration of this issue, and have made it a tradable and consumable asset. All of this has contributed to the evolution of happiness towards becoming a condition of belonging, giving rise to a way of living where this feeling must be mandatory and self-evident. It is in order to respond to this trend, and understanding that it is directly related to the lack of knowledge and deeper understanding of the theme, that the project “Happiness under Construction” emerged. It arose within the scope of an applied investigation, consisting of an interactive narrative in the form of a website, which presents itself as a proposal to act in opposition to the current model of obligatory happiness. The development of this project had two major methodological moments; one about the definition of the target audience, and another about the creation of the website—both of which got the collaboration of real people in order to support the project in a constructive way. Its result revealed that, through the intersection of the disciplines of positive psychology and positive design, the developed project contributed significantly to people’s wellbeing.

Keywords: Happiness · Wellbeing · Positive design · Positive psychology

1 Introduction

Happiness is one of the major themes in today’s society. However, the importance to which it is currently subjected has not always been recognized. Its value and power of influence have grown exponentially in recent years, and accompanied by this massive exploration in different areas, misconceptions about its construction have spread. Nowadays, happiness is interpreted as a condition of belonging instead of a natural construction, and even as a state in which emotions and less positive moments do not

fit – expressing itself as a feeling of constant contentment and euphoria, necessarily self-evident. At the same time, this trend has also enabled an economic exploitation of this fragility, in which the current urgency to be happy (or happier) is used to promote products and services with promises of providing happiness or enabling more favorable contexts for its achievement. Therefore, this reality marked by the ideology of consumable and tradable happiness, where the “purchase” of apparent happiness has been normalized, constitutes a problem. People consider happiness the only possible goal for living a meaningful life, and this current trend of making it mandatory, constant, and self-evident, is promoting a social pressure in which people feel lonely and guilty for not being able to correspond.

However, the identification of this problem reveals that, in part, this current way of living arises as a result of the lack of discernment about this theme. Happiness is so present in human experience that, many times, people do not actually question it. For this reason, they often end up following several models proposed by society without really thinking about them. This paper presents a project that addresses this problem by answering two research questions: “how can design contribute to the true happiness and wellbeing of the population?” and “how can a design project act in opposition to the current problem of obligatory happiness?” The project seeks to promote greater awareness and a critical sense of the theme, with a clear objective of promoting an improvement in habits and mentalities, through the presence of a narrative that deconstructs happiness in a natural and humane way.

2 Theoretical Background

This paper follows upon a master thesis project [1], where the theme of happiness was deeply studied. In order to have a good understanding of the theme and to develop a project capable of responding to the identified problem, this research focused on three different areas: happiness (the phenomenon where the problem was identified), positive psychology (the area that has been dedicated to the study of the positive side of human experience and that aims to improve the wellbeing of individuals and society) and positive design (the discipline that, through its procedures and methodologies, contributed to the practical realization of this project).

2.1 Happiness and Its Current Trend

Happiness, known as a feeling of wellbeing that combines cognitive and affective components, is currently assumed as a universal desire [2–4]. The beginning of its theorization happened among philosophers of ancient Greece and it was in this period that two divergent ideologies appeared [3]. The first one, *hedonia*, defines happiness as a sense of satisfaction with life, which results from the sum of positive emotions and the absence of negative ones. The second one, *eudaimonia*, features happiness as a profound long-term purpose, of which sacrifices during its construction take part [4, 5]. Although these two ideologies are based on opposite conceptions, they are also complementary, since human flourishing — a term that describes wellbeing in its fullness — must include not only elements of pleasure, but also of purpose [6].

Due to its practical implications for human wellbeing, happiness has always been a subject of interest and a theme of continuous study in different fields of knowledge. However, society's particular circumstances have, in recent years, promoted a greater focus in its research, because it was understood that most people reached a level of satisfaction of their basic needs that allowed them to dedicate themselves to their happiness in a different manner [3]. Thus, although there is still no consensus on what constitutes the good life, all areas that have a direct or indirect influence on it have been dedicated to the study of practical strategies for its promotion [5, 7]. However, along with the conscious measures that aim to make a positive contribution to its possibility, there has been a misuse of the current excessive interest in the topic. This led to a spread of erroneous and unethical ideas, that have been compromising people's wellbeing [8].

Happiness is currently one of the main topics that influence people's imaginary. The evolution of society's understanding of happiness is making it an imperative goal with an unclear purpose, which is triggering various obsessive behaviors for improvement [8, 9]. There is an obvious need for demonstrating happiness, and it is about this urgency to be and feel happy that several companies and institutions have sought to act, taking advantage of this current human fragility to generate profit [8]. In this way, these companies have turned this urgency into a tradable asset, inserted in a market that establishes a close association between the desire for insatiable happiness and constant consumerism. This superficial and deceptive exploration has contributed to a society that, motivated to seek happiness in several products available and failing to achieve it, begins to live under the pressure of this feeling [5, 8].

2.2 The Active Role of Positive Psychology

Positive psychology is a science dedicated to the study of positive aspects that take part of human experience [3]. It presents itself as a particular field of classical psychology that, through a focus of action at three distinct levels — subjective level, individual level, and group level — is characterized by an approach centered on human potential and by a promise of work in favor of improving the quality of society's life [10, 11]. In this way, it is distinguished by its dedication to the study of the “normal” functioning of people, in which it incorporates an appreciative perspective of human potentials and capacities [12], acting itself in a preventive way, through the education and awareness of society for its inner “me” [10].

Within the scope of the previous research carried out in this field, we understand that the determining factors of happiness are genetics (influencing it about 50%), circumstances (10%) and voluntary activities (40%) [13, 14]. Genetics is an immutable factor. Circumstances, due to the effect of hedonic adaptation to which they are subjected, have a very limiting role. This leads to the conclusion that voluntary activities and behaviors are the key element for a promotion of greater happiness [2, 14].

Ideally, everyone seeks a balance between regular experience of positive emotions and investment in aspects that enable long-term wellbeing [15]. However, the unidirectional interpretation that happiness is the ultimate end of the human experience often puts it in question. Daily decisions contradict this statement as it is believed that the present sacrifice will build future happiness [8]. In this way, positive psychologists have demonstrated that happiness is both a condition and a consequence [4]. They warn that

it should not be idealized as merely a future achievement, but also as something that should be part of the present, looking to sensitize people about the need for a balance between hedonic and eudemonic concepts in their lives [2, 4, 16]. Positive psychology relies its exercises and practical interventions on this premise [17, 18], demonstrating through the work it develops that it is one of the fundamental disciplines to take into consideration for the construction of strategies that aim to contribute to the eradication of this current trend.

2.3 The Intervention of Positive Design

In the context of practical interventions in positive psychology, design presents itself as an important vehicle for the promotion of happiness. Positive design, defined as a discipline that deliberately seeks to explore the effects of subjective wellbeing in individuals and society, focuses on the user's experience and is distinguished from other forms of design exactly by the existence of this explicit intention and its consequent process [19, 20].

Based on the principles of positive psychology, positive design seeks to develop projects that respond to the interests of people from its target audience [20, 21], and for that, more than creating products that please them, it states it is important to create experiences that challenge them. In this way, design must act as a mediator of its possibility and effectiveness [22], being able to operate in different ways [21]. However, the most important factor in building a project that aims to contribute to a long-term wellbeing is the ability to prolong the resulting experience over time. This happens due to the hedonic adaptation to which people are subject, in which there is an ease in overcoming various experiences and a subsequent need to experiment new ones [14]. For this reason, the implementation of strategies that aim for a better appreciation of the experience is essential for it to distinguish itself from others and, thus, have a greater probability of lasting [23]. Therefore, this appreciation must happen through the integration of particular moments in the experience that make people remember their past, reflect on their present, and anticipate their future, thus increasing their emotions in intensity and duration [24].

It is evident that the way in which the world is interpreted greatly influences the experiences that every person goes through. Therefore, when trying to promote pleasant experiences with a positive impact on people's lives, we should try to direct their attention to what they have and know as good, so that this feeling prevails and continues. Positive design seeks to allow people to be involved in experiences, in which they can identify and find some meaning [22, 23]. We recognize that this is a discipline with an active role in interventions that improve people's quality of life [22], which, in this case, will happen by integrating a strategy to promote a growth mindset [24].

3 Method

To start the development of the project "Happiness under Construction," two major moments of applied research were created. The first one focused on the definition and study of the target audience, and the second focused on the definition of the type of object and its construction process. In both moments, there was a theoretical study on

the aspects that make up each of these phases followed by a practical study with real users.

3.1 Definition of the Target Audience

The development of an object that aims to promote greater wellbeing among its users is a commitment that implies a particular responsibility. For this reason, throughout the construction of this project, it has become essential to adopt methods that aim for a more humanized process, in which the user experience occupies a central place. As a project with a preventive focus, we considered relevant to build for generations that, despite being mature enough to discern about happiness, were subject to a greater pressure from society to constantly demonstrate themselves as happy, being unable, many times, to truly understand what made them feel that way. Thus, we chose generation Y and older elements of generation Z as the target audience.

For a solid characterization of these groups, the research process began with a demographic study of the two generations. From this phase, theoretical premises about their personality traits and general behaviors were drawn. However, given the need to humanize the whole process, and in order to have real contact with people from the target audience, we adopted the Contextmapping method in a second contextualization phase. This is a participatory design method that uses generative techniques to explore perspectives, concerns, memories, sensations, desires, and experiences of participants in relation to a topic [25]. In order to fulfill the needs of this project, the Contextmapping method contained three phases. The first phase consisted on filling out a sensitizing booklet introducing the theme of happiness. The second phase consisted on a deeper reflection through an interview about the same theme. The third phase consisted of an online questionnaire on the consequent effects of the pandemic caused by Covid-19. This last moment aimed to promote greater knowledge about how the pandemic was influencing people's life and wellbeing, as well as their notions of present and future happiness. The data obtained through this method made it possible to create specific profiles with the types of behavior of future users — personas [26].

Sample. The sample of the Contextmapping method was composed of 15 people aged between 20 and 43 years old, members of generations Y and Z [27, 28]. Given our aim of making it as real as possible and, therefore, representative of the existing diversity within the target audience, the invited participants consisted of eight women and seven men, with academic backgrounds between the secondary education and doctorate. Among the participants, at that moment, three were still students and the remaining 12 were already employed, all stemming from different areas of expertise.

Results. After analyzing the information collected in these moments, it was possible to understand that the selected sample was, in general, informed. Almost all participants interpreted happiness as a long-term construction, of which aspects such as achievement, health and wellbeing, success and time are very important. However, it also became evident that positive relationships play a particular role in the construction of happiness, being one of its main influencing factors. Relationships are one of the most important variables and one of the biggest vulnerabilities for the happiness of this group, presenting

itself not only as one of the elements that greatly induce it, but also as one of the main reasons that can condition it. People recognize the positive meaning that interacting with others has in their lives, but they also perceive that a large part of the current perception about happiness is related to this need for control over what others think about them. This leads to behaviors of constant personal promotion and to a major difficulty with opening up about sensitive issues.

From the results, we could also conclude that people recognize the presence of the current trend about happiness in their daily lives. The sample recognized that this is a major problem and 93% managed to identify relatives who are being influenced by this negative trend. However, some participants (particularly from generation Y) showed little awareness of whether they were also being influenced by it. On the one hand, younger participants were generally more open to a better understanding of themselves and the topic — something that can be explained by the fact that they are more comfortable about looking for information and sharing ideas about these topics. On the other hand, older participants showed greater difficulty in recognizing these issues, since they debate this subject in a more individual and introspective way. This revealed that, for some people, there is still a prejudice about addressing the necessity of this topic —almost as if the search for information on this topic is not intended to everyone, but only to those who need some support. However, since everyone wants to be happier, an opening for experiencing the project was recognized, albeit through a short and interactive format.

In the context of the current pandemic, we noticed that the main change felt by the sample was related to the transition from a daily life in constant contact with the exterior to another mostly interior, compromising the need to socialize with others. We also concluded that, besides some negative impact already felt, the sample is aware that the biggest impact will be felt more sharply in the future, which has mainly promoted feelings of concern and anxiety. Nevertheless, the sample still showed motivation to work on their happiness and to overcome the difficulties that they acknowledge to exist. All participants seek wellbeing in the balance between the variables that are most important to them and strive to invest in meaningful and fulfilling aspects, only a few did not know how to start or continue this path. In this way, the present analysis allowed the identification of three user profiles – the personas – presented in Table 1.

Table 1. User profiles identified in the target audience definition.

Profile	Description/Portrait
The interested one	The user who is interested in the topic and who deliberately seeks answers to feel even better about himself
The one who feels pressured	The user who is going through a more delicate phase and who pretends to be all right so that everyone around him sees him/her as such, with the expectation that he/she will also start to feel that way
The curious one	The user who never stopped to think about the subject in depth and, therefore, does not consciously relate to it

3.2 Project Definition

After studying the target audience, we understood that, in general, people place much of the responsibility for the construction of happiness on the circumstances in which they find themselves and devalue the power of their active role in it. To counteract this thought, this project had the goal of acting on the 40% of the composition of happiness attributed to intentional activities and behaviors, positioning itself as an informative tool on the theme, and as an object capable of encouraging the public to establish a change in their way of thinking and acting. We then established that the project should enable personal growth [29], distinguishing itself from the existing tools, with the fact that it seeks to promote a bridge between disinformation and specialized information. Thus, to get the attention of a larger audience, we developed an interactive experience characterized for its short duration and introductory approach to the theme. In response to the tastes and trends of the generations in focus, the project was defined as a digital tool — a website — that integrates explanatory texts about the theme, interactive activities, and practical exercises from positive psychology interventions.

This is a project that aims, above all, to contribute to the wellbeing of its users through their awareness. However, despite appearing as part of a master's degree in design, the discipline of positive psychology is also very present in its conception. So, in order to respond to a limitation of knowledge on this second discipline, two proofs of concept (POC) were created with a group of experts in the field. The goal of these POCs was to validate the content of the website and to understand if the information provided there was correct and well applied. These tests took place in an online format and the prototypes of the website presented were still under development.

POC Sample. The sample of the two POCs consisted of eight female specialists aged between 21 and 62 years. All participants were from the field of psychology and positive psychology: at the time, two were still finishing their studies in the field, one was unemployed, and the rest had professional positions related to positive psychology.

Results. In order to achieve the goals proposed by the construction of the website, we considered relevant to focus specifically on five variables: purpose, emotions, relationships, gratitude, and anxiety. The decision to include the first four variables was because purpose and emotions have been identified as the two main components of happiness, relationships are seen as the key dimension for its possibility, and gratitude is interpreted as the aspect with greater capacity to increase it [2, 30]. The integration of a particular narrative about anxiety happened as a way of responding to the reality of uncertainty, which results from the pandemic period. The goals of these POCs were to test the quality of the various elements of the website and to analyze if together they had the capacity to motivate a reflection about the theme and a change of perspective and behavior of its users.

The main distinguishing element of this project is the integration of a narrative that, through different interactions used to deconstruct the variables of happiness, promotes a greater interest and involvement from the users. However, the ability of the interactions to deliver the intended messages should be tested with experts in the subject. For this purpose, in the first POC we requested an evaluation of each of the variables that make up the project. Through the acquired responses, we understood that their choice

was correct and that, in general, they were developed in a positive and balanced way. However, also through the results obtained, we concluded that there was still a margin for general progression. Therefore, the next phase was to improve the project and apply the suggestions presented.

For the second POC, we carried out a new validation of all the content and interactions that make up the website and here a significant evolution of its quality and consistency was evident. The results obtained revealed that the website was able to promote an informed reflection on the topic and a change in perspective and behavior in its users, presenting itself as a proposal with the potential to contribute positively to their wellbeing and happiness. In this way, despite the indication of a few last suggestions of improvement, the sample of experts considered that the project answered correctly to its purpose and that it presents itself as an interesting and successful measure to combat the current evolution of happiness.

4 The Project “Happiness Under Construction”

4.1 Creative Reasoning

After being informed by the literature review and the methodological phases, the final form of the project “Happiness under Construction” was defined. We understood that the best way to act in opposition to the presented trend would be through the promotion of knowledge about the subject. In the case of a subject whose knowledge is based mainly on the “I” of the equation, the developing project would have to act as a supporting object for personal evolution and growth [21]. Furthermore, it would have to promote an experience that made sense for different users. Accordingly, the website would have to have a narrative that aroused reflections and offered positive contexts that would enable particular memories of each person.

It was then, through the use of knowledge in design that the project gained another dimension and sought to distinguish itself from other approaches within the same theme [Fig. 1]. This website had a main narrative that, in a summarized way, led to a discernment about each of the chosen happiness variables — purpose, emotions, relationships and gratitude. In parallel, within the same kind of narrative, we created a particular one with the goal of deconstructing the theme of anxiety within a pandemic context, emerging as a way to help people in this particular moment and showing awareness about the reality lived and its audience’s concerns. These different reflections should take place in an interested and immersive way and, therefore, the different elements that make up the website — information architecture, interactions, colors, typography, and illustrations — were intended to accompany and reinforce the message of hope and resilience of the project and of creating dynamics where people could identify and relate in a more personal way.

The developed interactions intended to make users part of the action of the narrative and to illustrate the idea that, similarly to how happiness is built through choices, also in this experience they had to make decisions to see the results and continue through the narrative [Fig. 2]. The chosen colors intended, when combined, to convey feelings of motivation, tranquility, lightness, and comfort. The selected fonts intended to promote

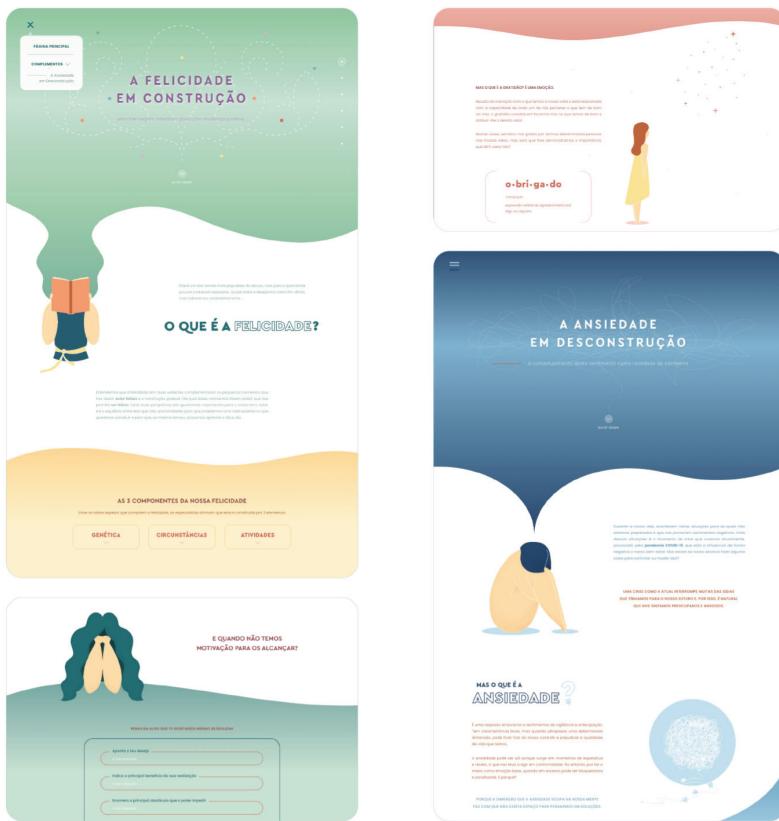


Fig. 1. Screens from different parts of the website.

a modern message and, at the same time, to allow an easy and comfortable reading. Finally, the drawn illustrations sought to create a greater identification of the audience with the content, making it the illustrated result of the decisions.

4.2 Final Validation

The entire project was developed according to an applied research, in which different samples were consulted at different stages of its construction. However, for an evaluation of the effectiveness of the project and the impact it has on its audience, we carried out a final validation with a new sample of the target audience. With this, we intended to create an opportunity for the public to contact directly with the project and to evaluate their involvement with it, having the possibility to discern in a concrete way about their emotional experience and about the visual and functional aspects that compose it. It was also possible for each participant to make a general evaluation of the project, its intentions, and its ability to fulfill the aspects it proposed. For this we presented a functional prototype of the website and the validation took place in an online format.



Fig. 2. Some of the interactions presented in the website.

Sample. For this validation, we consulted a sample of 91 people, aged between 20 and 45 years old, defined by 60 female and 31 male participants. Within this group, 25 were students and the remaining 66 were professionals from different areas.

Results. Stopping the current growing trend towards objectifying happiness is a complex initiative. However, according to the results obtained, we understand that the project “Happiness under Construction” was well received by its target audience, who considered it capable of awakening reflections about the theme and boosting a greater awareness of its components. In addition, according to the results obtained, we found that the project was able to promote a new perspective on the construction of happiness in its users and to encourage a change in their behaviors. The participants considered the website a relevant informative object, capable of responding to a theme that is increasingly important to them, and in which they often feel alone and misunderstood. Furthermore, from this validation, we found that the whole visual, microinteractions, and discourse adopted were fundamental for a greater clarity of the message, for a better identification of the public with the object, and for a greater involvement of the users in the experience. We also found that these elements were responsible for many of the emotions and positive memories triggered. Thus, despite the indication obtained of small aspects still to improve in the website, it was possible to conclude that the project “Happiness under Construction” fulfilled its main goals. It found an opportunity to act on an audience who is interested in getting to know more about the project and in enjoying the experience that results from it — which reveals that this project, once implemented, presents strong possibilities for success.

5 Contributions

“Happiness under Construction” emerged as a project with the main goal of responding to the current misconceptions about happiness and the negative trends associated. For that, it used the knowledge from positive psychology and positive design to answer the identified problem in a more humane way. The combination of these two disciplines allowed this project to act in an informative way and, through a more immersive approach, capture the attention of a larger number of people. However, the goal of the established narrative was not related to the attribution of concrete answers about what happiness is, but rather to awaken reflections and introducing new perspectives, making different people, within their different contexts, identify with it and able to find some meaning therein. It was through this explicit intention of making each person feel this experience as their own, that this project sought to distinguish itself from others. Through the particular deconstruction of the theme, this project sought to present a perspective of building a happy life through a gradual process, in which different emotions take part and are seen as natural and important. In this way, it aimed to raise in its users a greater awareness and critical sense about their own happiness.

However, despite the positive evaluation from this research, the project also has limitations. Because this is a project that, at the moment, is only materialized in the form of a prototype, there are still some restrictions in its functionality. However, there is an interest in continuing to work on these limitations and to implement it in the future, making it accessible to those who are interested.

This project is also mainly focused on the individual quality of happiness, since it is assumed as an object of introductory awareness and it was considered important to, firstly, motivate a reflection on the “I” of happiness. However, this project is aware of the dimension of the problem it addresses and, for this reason, it does not seek to be a final resolution to the problem itself, but rather an initiative that triggers a change in the way of thinking about the issues exposed here. Thus, we understand that this project represents the beginning of a research that, in the future, must be deepened to create firmer contributions to the evolution of design in this segment.

Collective happiness is also very important in today’s society and the lack of attention to which it is often subjected must be redefined. Therefore, in a future evolution of this project, the development of a second product is being considered, which will raise awareness in society, this time with a particular focus on group happiness.

6 Conclusion

“Happiness under Construction” presents itself as an interactive project that seeks to act in an informative way with the community, with the goal of countering the depreciative evolution to which happiness is currently subjected. In this way, this project is presented simultaneously as a contribution to the academic community and to the civil community. Its contribution to the academic community is due to the fact that it is a project developed in the area of positive design that sought, through its study and subsequent implementation, to invest in the evolution of this discipline. On the other hand, its contribution to the civil community arises from the premises that motivated it, for the care it integrated into the entire development process and for the construction it suggests.

Therefore, the website “Happiness under Construction” is a valuable proposition that, through the crossing of these two distinct areas, presents clear benefits in the short-term wellbeing of its users and also shows possibilities of acting positively in the community’s long-term wellbeing. Therefore, it is with a high degree of certainty about the initiative that motivates this project and about the benefits it presents to the community, that it is believed that, when implemented, it will be successful.

References

1. Nogueira, A.: *A Felicidade em Construção: um projeto incidente no design positivo, se oposição à ditadura da felicidade* [Master’s thesis, IADE – Arts, Technology and Design Faculty]. Repositório Comum (2021). <http://hdl.handle.net/10400.26/37374>
2. Lyubomirsky, S.: *The How of Happiness*. The Penguin Press, London (2008)
3. Boniwell, I.: *A ciência da felicidade: psicologia positiva em poucas palavras*. 4 Estações – Editora, Lda. (2016)
4. Gaziri, L.: *A ciência da felicidade: escolhas surpreendentes que garantem o seu sucesso*. Faro Editorial (2019)
5. Campos, J.: *Marca positiva: um olhar sobre as marcas, as pessoas e a felicidade*. Influência (2019)
6. VanderWeele, T.: On the promotion of human flourishing. *PNAS Early Edition* **114**(31), 8148–8156 (2017)
7. Ryan, R., Deci, E.: Self-regulation and the problem of human autonomy: does psychology need choice, self-determination, and will. *J. Pers.* **74**(6), 1557–1586 (2006)
8. Cabanas, E., Illouz, E.: *A ditadura da felicidade*. Temas e Debates (2019)
9. Freitas, D.: *The Happiness Effect: how Social Media is Driving a Generation to Appear Perfect at any Cost*. Oxford University Press, Oxford (2017)
10. Seligman, M., Csikszentmihalyi, M.: Positive psychology: an introduction. *Am. Psychol.* **55**(1), 5–14 (2000)
11. Sheldon, K.M., King, L.: Why positive psychology is necessary. *Am. Psychol.* **56**(3), 216–217 (2001)
12. Marujo, H., Neto, L., Segurado, L., Balancho, F.: Emergência, desenvolvimento e desafios da psicologia positiva: da experiência subjetiva à mudança social. *ECOS – Estudos Contemporâneos da Subjetividade* **3**(2), 181–201 (2013)
13. Seligman, M.: *Authentic happiness*. The Free Press, New York (2002)
14. Lyubomirsky, S., Sheldon, K., Schkade, D.: Pursuing happiness: the architecture of sustainable change. *Rev. Gen. Psychol.* **9**(2), 111–131 (2005)
15. Dolan, P.: *Projetar a felicidade*. Temas e Debates (2015)
16. Ryan, R., Deci, E.: On happiness and human potentials: a review of research on hedonic and eudaimonic wellbeing. *Annu. Rev. Psychol.* **52**, 141–166 (2001)
17. Biswas-Diener, R.: Applied positive psychology: progress and challenges. *Eur. Health Psychol.* **13**(2), 24–26 (2011)
18. Parks, A., Biswas-Diener, R.: Positive interventions: past, present, and future. In: Kashdan, T., Ciarrochi, J. (eds.) *Mindfulness, Acceptance, and Positive Psychology: the seven foundations of well-being*, pp. 140–165. New Harbinger Publications (2013)
19. Bjering, A.L.: Designing for happiness: how design can contribute to people’s subjective wellbeing. Norwegian University of Science and Technology (2014)
20. Desmet, P., Pohlmeier, A.: Positive design: an introduction to design for subjective well-being. *Int. J. Des.* **7**(3), 5–19 (2013)
21. Pohlmeier, A.: Design for happiness. *Interfaces* **92**, 8–11 (2012)

22. Pohlmeier, A., Desmet, P.: From good to the greater good. In: Chapman, J. (ed.) *The Routledge Handbook of Sustainable Product Design*, pp. 469-486. Routledge, Milton Park (2017)
23. Pohlmeier, A.: Enjoying joy: A process-based approach to design for prolonged pleasure. In: *Proceedings of the 8th Nordic Conference on Human-Computer Interaction: Fun, Fast, Foundational*, pp.871–876. ACM Press (2014)
24. Honey, M., Kanter, D.: *Design, Make, Play – Growing the Next Generation of Stem Innovators*. Routledge, Milton Park (2013)
25. Visser, F., Stappers, P., Van der Lugt, R.: Contextmapping: experiences from practice. *Int. J. Co-Creation Des. Arts* **1**(2), 1–30 (2005)
26. Martin, B., Hanington, B.: *Universal Methods of Design*. Rockport Publishers, Beverly (2012)
27. Evans, M., Jamal, A., Foxall, G.: *Consumer Behaviour*. Wiley, Hoboken (2006)
28. Ha, L., Angus, A.: Webinar: decoding generation Z (2019). <https://www.portal.euromonitor.com/portal>
29. Casais, M., Mugge, R., Desmet, P.M.A.: *Design with Symbolic Meaning for User Happiness Card Set (SIM)*. Delft University of Technology, Delft (2016)
30. Wiking, M.: *The Little Book of Hygge: the Danish way to Live Well*. Penguin Life, London (2016)



Interaction Design to Female Technological Collective Activism: Geek Girls Portugal Case Study

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Abstract. This work aims to reflect on the collective female activism in technology under the prism of human-computational interaction, the culture of participation and cyberfeminism from Geek Girls Portugal community (the first launched in the country) ethnographic case study. From the monitoring of the group's digital platforms, information was collected to configure an organizational and communicational system, as well as allowing reflection on the autonomy of members' decisions, using tools of non-discretionary use for the inclusion of women in technology in one of the domains in which patriarchy dominates. Conceptual paradoxes about the culture of participation and the emergence of digital platforms, from the launch of the Web in parallel to the beginning of cyberfeminism, will be presented. This article will also present preliminary results of doctoral research on how female technological communities play a catalytic role in the inclusion, education and activism of Brazilian and Portuguese women in technology.

Keywords: Human-computer interaction · Tech feminism · Online communities

1 Introduction

Over the past fifteen years, thousands of female tech communities were released around the world. Diverse and complex are the contexts in which these communities had developed, from the 1980s in the USA to the present; they aim to promote the female presence in technology. Online activism, like that practiced by women who intended to become Information Technology (IT) workers and researchers in the last decade, arises from contexts and characteristics of online communities' creation in the transition from the 20th to the 21st century.

The infinite connections and interactions made by people via the World Wide Web started to be established by new digital platforms (DP), capable of storing and transferring data between users. The design, the interface, the functionalities, the value, and the concept of the system of these media have increasingly become the result of the processing and use of content generated by the user. There are parallels and intersections of phenomena originating from the Web, but also from social, political, cultural, and historical orders, which had an impact on the creation and expansion of female activists

in Technology. The 2000s marked the era of Web 2.0 and a technological and communicational paradigm shift in which the status of “user-consumer” of content was changed to “user-producer”.

The computational programs, the hardware and new forms of interaction, starting in the 1980s, can be considered a crucial starting point in this study. Research and practices of Human-computer interaction (HCI) intensified to accommodate the domestic computer spread and Graphic User Interface paradigm. It is a specific area in computer science that incorporates cognitive science (especially Psychology), user behaviors and motivations, in human-computer interaction [15].

Civic participation, social inclusion, community engagement and feminism have become recent domains of HCI research and development. Through digital communities and platforms, feminism had reached new contours due to the wide and multifaceted interactions between women. Online feminism and the collective female activism in Technology emerged. [13, 23] The Internet has redefined notions, tools and strategies for resistance and female activism. Online feminism has made women's discourse more visible, public and representative through digital media. From the appropriation of digital platforms, these groups established a culture of participation with similar and particular characteristics.

Eleven years ago, the first Portuguese women in tech community was launched, Geek Girls Portugal (GGP). Initially founded under the nickname Portugal Girl Geek Dinners (inspired by the global Girl Geek Dinners movement), it has been developing IT training and educational activities in Braga, Coimbra, Leiria, Lisbon and Porto. Empowering young girls to enter the tech area, supporting students and young professionals and being a community for the growth of women with a passion for the technological area at various stages of their career are the main objectives of the collective.

Created by computer engineer Vânia Gonçalves, GGP brings together one of the largest online women in tech communities in Portugal. About 600 people had regular access to the organization's external and internal digital platforms, especially Slack application on 02 July 2019. There were 21 ambassadors, called Active Geeks, on the same date. Despite the interruption of the community activities in 2020 due to the covid-19 pandemic, the number of ambassadors increased to 25 women (30 August 2021). The women who represent the target audiences are called Geeks. The focus of GGP activities is geared towards Education: face-to-face meetings (meetups) that update issues related to the IT job market, instruction of young people in the transition from school to university.

Portugal was considered the country that gave women the most opportunities in technology in 2018 [14]. According to the OECD [16], 57% of Portuguese women study science, technology, engineering and mathematics. It is the highest percentage in the world: 17 points more than in the United States, more than double in Japan.

Technology is the medium and domain in which interactions and actions of empowerment, education and female inclusion are carried out, as well as scientific and professional final objectives to be conquered in terms of demands such as equal opportunities and pay. This work aims to relate the culture of participation, technology and interaction design to understand and study the collective technological female activism, based on Geek Girls Portugal case study. It will be presented how leaders and volunteers (Active

Geeks) develop strategies and employ tactics of interaction and appropriation of technologies on digital platforms, for public and private uses, to achieve their organizational and communicational purposes. This study objectives are:

- Map the relationship of Geek Girls Portugal with its internal and external digital platforms: interaction and use of inherent technologies, especially Slack.
- Assess the effectiveness of activist tactics modulated in the use and interaction of Digital Platforms (DPs) in the context of a participatory culture that values the construction and propagation of narratives (storytelling), and the achievement of the group's educational and training objectives.
- Analyze aspects of interaction and communication between leaders, volunteers and target audiences on digital platforms for internal and external use, in the light of concepts in the field of human-computational studies.
- Present preliminary results of doctoral research initiated in 2018 about technological feminist activism, in which it aims to point out solutions for the inclusion, empowerment and education of women in technology.

In this article we intend to present some of the research methods developed in the investigation, Geek Girls Portugal digital platforms (the relationship of the group and technology in the interaction with these DPs, the technological tactics used in social media), to point out theoretical contributions of HCI in the analysis of technological female communities, to debate the impact of Technology in the feminist cause in IT, to show preliminary results of the Slack study of Geek Girls Portugal, to make final considerations and to inform the bibliographical references.

2 Related Work

In a bibliographic survey, it was found the presence of few academic studies with intercession to this investigation in both countries. In Brazilian research, it was found that they analyze feminism in IT with an emphasis on the maker and hacker culture and free software, based on the theoretical relationship about cyberfeminism with feminist practices of technological inclusion in the labor market, in communities and the Academy [2, 21, 25]. In Portugal, Gender and Feminism academic works were found on the role of women in online games [22] and Gender and the Media [9].

Also, there is an emphasis on analyzing the configuration and developments of the fourth feminist wave, cyberfeminism under the Technological Feminism subject. The latter has yielded a vast existing production in the area of STS (Science and Technology Studies), which intertwines with Gender Studies [24]. STS investigates how political and cultural values influence technological advancement and scientific research and the reverse, scientific and technological influences on society. One of the main STS contributions has been to challenge the idea that science and technology are objective and neutral [11]. It is in cyberfeminism that one of the main concepts about technological feminism, technofeminism, emerges: “Technofeminism brings together a mutually shaping relationship between gender and technology, where the technology is the same time and the consequence of gender relations” [27].

In the last twenty years, studies have also emerged that relate feminism, and its technological aspect, with the scientific domains of Human-Computer Interaction (HCI). Feminist studies in technology had implications for the design of technology when sociologists applied theories in practice through ethnographic research of the people, places and systems that produce technology, at all different stages of development. Feminists began to demonstrate a new understanding of the male domain in science, medicine and technology, discovering specific socially situated practices for the production of knowledge, understanding how social practices of design, development and dissemination contribute to cultural trends in gender relations.

Feminist HCI would represent the integration of feminist theories and interactions in HCI practices [3]. Through digital communities and platforms, feminism has reached new contours due to the wide and multifaceted interactions between women. D'Ignazio and Klein [11] highlight that HCI's feminist design work included new topics, such as women makers and hacking spaces, maternity and postpartum, technologies and street harassment. The Feminist HCI relies on the feminist standpoint theory to explicitly value marginal perspectives. In Feminist HCI, researchers introduced design principles to draw attention to how knowledge resides in specific bodies, how power is distributed throughout the design process (empowerment, advocacy, ecology) and how to include more voices and perspectives in the design process (participation, pluralism, plurality).

Finally, another relevant concept in this emerging investigation is data feminism [12], which would be a way of thinking about data, related to direct experience and commitment to action and intersectional feminist thinking. The starting point for data feminism is something that is not recognized in data science: power is not distributed equally in the world. Those who exercise power are elite, heterosexual, white, healthy, cisgender men from the Global North. The work of data feminism is the first to tune into how standard practices in data science serve to reinforce these existing inequalities and to use data science to challenge and change the distribution of power.

3 Method

The ongoing doctoral research intends to develop communication studies on digital platforms of twenty Brazilian and Portuguese technology female groups (Facebook, Twitter, Instagram, Telegram, Whatsapp, YouTube, websites, Slack, etc.), monitoring with observant participation user behavior (community members and audiences).

Three communities among the twenty analyzed for a year were chosen as case studies with ethnographic methods (such as Geek Girls Portugal). Among the criteria of the choices is the possibility of access to at least one digital platform for exclusive internal use of the community, the need to deepen the ethnographic study from the profiles of different communities, the activities have been maintained without interruption in the organizations and the projection growing among target audiences. The digital platforms and events of these groups were monitored and evaluated using ethnographic methods for four years (2018, 2019, 2020, 2021). To profile these women in technology, 20 interviews were conducted with leaders of these communities and female role models in the Academy and IT job market). Part of the information collected in the fieldwork occurred via participant observation in more than 50 events held by these collectives

and related to the theme “women in technology”, such as WebSummit, Grace Hopper Celebration 2020 (the largest event for women in technology in the world); monthly meetups from these communities.

This research is part of the interpretive paradigm (qualitative nature), but will use quantitative data, such as statistics. It is also planned to carry out a conceptual analysis model and focus group with the female technological community and test the hypotheses launched. The investigation phases are (1) Follow and choose Portuguese and Brazilian ATF groups based on Digital Platforms; (2) Study Cases development; (3) Participative design; (4) Conceptual model of theoretical nature construction.

4 Organizational and Digital Platforms Ecosystem of Geek Girls Portugal in the Context of the Culture of Participation

There is no consensus in defining the concept of the Culture of Participation. For Jenkins [19], a participatory culture embraces values of diversity and democracy based on interactions between all of us and assumes that we are capable of making individual and collective decisions, as well as expressing ourselves through a wide range of forms and practices. In it, individuals participate in something, interact with something. Cultures also exercise their participation through technological means.

Carpentier [4] relates the participatory culture to the exercises of power, implicit and explicit. There are privileged and non-privileged actors “in formal or informal decision-making processes”. Partial participation would consist of “a process in which two or more parties influence each other’s decision-making, but only one part has the power over the final decision” [4].

The hierarchical participation between Active Geeks and the target audiences (Geeks) of Geek Girls Portugal is determined by explicit rules (on the group’s website, as well as on its digital platforms: profiles on Facebook, Twitter, Slack, LinkedIn) that define, clearly, the organization’s missions, objectives and characteristics. Social media posts and face-to-face events are open to comments and registration, almost unrestricted. However, for target audiences impacted and engaged with messages from leaders and volunteers to become Active Geeks, or access the internal communication application Slack, it is necessary to fill out a form on the GGP webpage. The parameters for evaluating and approving the entry and participation of new members are not explicit. The operational focus of GGP - education and training of young people and women in IT - is disclosed on these platforms. It is an objective considered voluntary and civic. Access and interaction are prerequisites for participation and engagement. The first two are determinants of how civic, democratic and social an online activist group can become in engaging with target audiences. Access implies acquiring presence and inclusion, while interaction presupposes contact and reciprocity [4].

Participation is key to involvement in social media and the creation of networks [20] however, the construction of the use and interaction between leaders and the impacted public is not equal due to the hierarchical status in the production, sharing and information reuse. Engagement refers to the creation and existence of a social bond between individuals, to protect them or strengthen ties [4]. The engagement of GGP Geeks can be gauged through the successful implementation of online and face-to-face actions carried out by the group, going beyond participation.

4.1 The Interaction and Use of Technologies in Geek Girls Portugal

An online community consists of a group of people who share the same purpose and are governed by rules and policies defined and implemented by its leaders and representatives of these leaders, through computer programs and common digital platforms. The factors that influence and impact the success of an online community are sociability and usability. Sociability is focused on social interactions, while usability focuses on evaluating interactions on human-computer interfaces [9].

Geek Girls Portugal has five digital external communication platforms (profiles on Facebook, LinkedIn, Twitter, website and Eventbrite profile) and two online internal communication platforms (Slack application profile and email group). The group did not create and implement any DP, web and mobile applications. The technological resources present in these DPs, such as applications, were also not implemented by members of the organization but chosen from the options offered by each DP. It can be said that the choice of digital GGP platforms and interaction, characteristics and ways in which information is shared with the target audiences, follow a pattern quite similar to Brazilian and Portuguese female activist groups in Technology. There are computer programs developers among leaders and volunteers, but their dedication to GGP is complementary to professional activities. Despite the need to support activities, and the existence of four ambassadors responsible for information dissemination, the organizational and communication model is centralized with Active Geeks.

In this section, the main characteristics of participation, the appropriation of resources and technologies of these media, interaction, production and sharing of content will be related to the fulfillment of objectives with the target audiences. The analysis (online audiences, number and characteristics of posts, associated applications, etc.) of these digital platforms was carried out on 02/07/2019 and 30/08/2021.

Website: <http://www.geekgirlsporugal.pt> is the main digital platform for external and public communication for Geek Girls Portugal. There is integration, via links, with the aforementioned social media, registration link for face-to-face events (meetups), in some Portuguese cities, through the Eventbrite application. There is a large and robust repository of institutional, operational (objective) information and activity schedule. We highlight the presence of a form, only on this digital platform, which must be filled out by aspiring Active Geeks, or target audiences (Geeks) interested in following GGP activities more closely. The form is the only way to access the Slack application and the Google Groups Mailing List. The evaluation criteria of the fields filled in and whom the evaluators are not exposed to the public. In other words, the public interaction and participation are controlled without the clarity of what are the criteria for access to these media. There are no interactions, rewards and gratuities for the target audiences, as well as educational actions planned for the digital platform. There are only announcements of lectures and meetups. Due to the covid pandemic, the events were paused between December 2019 and March 2021 (the same applies to the News link update).

LinkedIn: access to data on creation and usage performance is restricted to the administrators of the Geek Girls Portugal profile on LinkedIn (a Group Owner and a Group Manager). GGP is present in a group page and not in profile as a user on the digital platform: <https://www.linkedin.com/groups/2606315/>.

The analysis and visualization allowed on the timeline were obtained from November 2018 to February 2019 and consolidated on 30 August 2021. There were 10 posts, 457 members in the first period. The posts consisted of disclosing GGP redundant to the one present on Facebook and Twitter profiles. As in these platforms, there were no specific education activities for the target audiences and actions of gratification and rewards. Fifteen posts were published in 2020 and 79 during 2021; they consisted of tech job positions, events subscription and Geek and Active Geek members homage due to GGP 11 birthday celebration.

The participation of the target audience was manifested in two announcements of technology services by members of the group, a leader post of Portuguese Women in Tech (another Portuguese activist group of women in technology), a post about asking for help about software (unanswered), a thank you from being impacted and part of the community. It is a digital platform with minimal participation between Active Geeks and Geeks, without any use of applications and technologies inherent to it.

Facebook: Geek Girls Portugal fanpage <https://www.facebook.com/GeekGirlsPortugal/> was created in January 2010. There were 3,272 followers and 3,279 likes on 02/07/2019. The content analyzed on the timeline (between January 2018 to January 2019) was characterized by announcements and records of events carried out by GGP, dissemination of events in IT and women in IT by companies and organizations, posts from other NGOs “Competitors” in Portugal, job vacancies, workshops, reports, reports, statistics. It is also noted the absence of content, technologies and applications aimed at educational actions. There was little interaction activity by the target audiences, in sparse comments on posts. The leaders dedicated themselves to updating ads and news, did not use more interactive, specific to the platform. The organization performs sporadic updates of content. There were 3,789 likes and 3,955 followers on 30 August 2021. In 2021 61 posts were published, which content was very similar to LinkedIn posts; 47 posts were published in 2020, most of them consisted of forwarding tech events, job positions, press news from different sources. The first GGP online event was mentioned in a November post.

Twitter: the profile of Geek Girls Portugal <https://twitter.com/GeekGirlsPT> was created in December 2009. On 02/07/2019 the page was composed of 5,429 Tweets (posts), 1,132 Followers (followers) and 630 Following (profiles followed by GGP). There was an integration link with the group’s website and no use of associated Twitter applications or other platforms. The scarce appropriation of technological resources inherent to social media was similar to that observed on the Facebook fanpage.

The contents analyzed (from January 2018 to January 2019) had redundant characteristics with those of the Facebook profile, as well as few shares and public comments. Actions and resources for bonuses and rewards for target audiences did not exist in the profile. Interaction features like lives have not been observed. No specific educational activity for twitter was developed by the group. Public participation, in terms of publishing and sharing content (tweets), was also similar to Facebook profile.

On 30/08/2021 the page was composed of 5,489 Tweets (posts), 1,166 Followers (followers) and 647 Following (profiles followed by GGP).

Slack: the Slack application has been used by companies, private, governmental and public institutions with the main objective of organizing and optimizing the distribution and execution of tasks and projects among leaders and audiences in offline actions and events. Access to the GGP profile on Slack - geekgirlsporugal.slack.com - is allowed based on the analysis of the target audience data on a form published on the group's website. The identity of the person in charge of this analysis, as well as the permission criteria, is not exposed to the public. Participation is therefore restricted and monitored by Active Geeks. In the preview, held on February 7, 2019, there were 586 participants. This is the largest number of registrants in PD of Geek Girls Portugal. In the profile administration there was a primary owner; three owners; 11 Administrators (group ambassadors in the cities where meetups are held). The profile was created on 25/02/2016. The usage plan is free, which implies some restrictions on the participation of Active Geeks and Geeks: there are limitations of virtual space in the number of posts in the timelines (timelines) of the channels, in the volume of Direct Messages (DM) between members, in the choice of applications associated with the GGP profile, in the collection of data on the performance of the profile in the Analytics link.

There were four applications integrated into the profile of Geek Girls Portugal (Giphy, Google Drive, Simple Poll, Twitter), in a total of 10 that could be associated within the free plan, and 59,641 messages exchanged/posted in a total of 60 thousand allowed in the flat. The visualization on the timeline was carried out in the period between 02/25/2016 and 02/07/2019. There were 11 content channels open to all participants, created by the profile administrators: #random, #general, #porto, #lisboa, # job-offers, #braga, #coimbra, #leiria, #websummit, #faro. There were 892 members, the same channels, 66,502 messages sent, 10 Apps and Integrations Installed on 30 August 2021 (Doodle Bot, Giphy, Google Calendar, Google Drive, Monday.com, Outlook Calendar, RSS, Simple Poll, Slack for Gmail, Twitter).

According to Vânia Gonçalves, in an interview for this study, there are two exclusive and private channels to Active Geeks where plans, strategies and confidential content are shared. There is no access to the content of the Direct Messages exchanged between all members of the Geek Girls Portugal channel on Slack. However, the volume of these private messages is as significant as the number of posts present in the timelines of all channels. Considered a digital platform for internal, private use and prohibited to members accepted using a form, the GGP profile is the online media with the greatest participation and interaction between leaders and target audiences in sharing information, in the comments of posts and the direct contact between Geeks and Active Geeks. The

vast majority of information shared on social media previously analyzed is disclosed in the GGP Slack. Almost all of the published content and posts are not disclosed in the other group DPs. To investigate the interaction between members on Slack, five users out of a total of 40 identified as target audience were interviewed. The identities were preserved by initials. The interviewees are between 23 and 35 years old and work in Human Resources (S.D.), Project Management (M.T.), Mentoring of New Business for women (R.S.), Programmer (R.D.)/Computer Engineering student (L.A.) (Table 1).

Table 1. Geek Girls Portugal target audience interviews

	R.S.	R.D.	L.A.	M.T.	S.D.
How did you hear about GGP Slack?	Facebook asking to spread a job opportunity. They added me on Slack	I heard about GGP Slack through the GGP a mailing list	Through a friend interested in programming, since June 25, 2018	About a year ago, through research on the internet	Through GGP website and started accessing since May 2018
Do you think it is important to participate in the GGP Slack?	My initial goal of having programmers interested in working with me was not successful, the group is not important	It's important because it is a more complete tool than mailing list. Allows chat type, private messages, manages notifications. The most relevant information on Slack is events and meetings. Disclosure of job openings, exchange of ideas, article sharing are important	It's always extremely important to belong to networking as GGP. Slack is the best way to have direct contact with the group. The most relevant information is shared job offers	Yes, to support more women in tech. Learn about news and attend events	There is strong sharing of events, job offers, discussion of themes, sharing of situations that reinforce the sense of community

(continued)

Table 1. (*continued*)

	R.S.	R.D.	L.A.	M.T.	S.D.
How and why do you follow GGP work?	I admire GGP for women in technology cause. I'm a feminist, I study feminism. It matters for attracting more women to Tech	I've already participated in the organization, logistics of meetings because I want to do my part to increase the presence of women in these areas ("masculine"). I participate as a woman of technology, to show that women can be programmers	I've not been following the GGP work. I've limited myself to belonging to the group and seeing shared information. I aim to monitor the group's work soon	I have attended several events. They were interesting	I've found in GGP the support I needed to enter the technology. Meetups, sharing conferences, workshops, courses help me keep up to date

5 Tech Female Communities' Interaction

Human-computer interaction (HCI) studies the communication mediated between the end-user and the system designer, who must structure the system so that it can be understood by the user and so that the user can be guided by a sequence of actions to achieve results [8]. Social computing has become one of the fastest-growing areas in HCI. It is related to systems that support the collection, processing and dissemination of information distributed among social collectives [17]. Information is the main link between people, it mirrors and represents identities in common [10]. Social computing systems can generate value by integrating knowledge among participants, by carrying out tasks based on human skills and by producing legitimate results from a community.

Cyberfeminism is the result of the fourth feminist wave, marked by the emergence and expansion of the Web, the network society, the creation and democratization of access to new devices and computer programs, online communities and digital platforms for interaction and communication worldwide. It is a technological feminism aspect marked by optimism in the theoretical perspective about technology impact to empower women and transform gender relations. The information circulating on digital platforms was fundamental for women empowerment: objects and artifacts are no longer seen as separate from society, but as part of the social fabric that holds society together; they are never merely technical or social [28].

Manuel Castells (2002) [5] highlights the importance of IT and the emergence and expansion of the Web for women and minorities groups. Later, the sociologist delves into the issue, revealing new gains in power and female social representativeness, based

on interactions, connections and online activism. [6–8]. These networks represent the true producers and distributors of cultural codes. Not only through the network, but in its multiple forms of exchange and interaction.

In female technology communities, the choice of digital platforms and the way how information is shared among themselves, and the target audiences determine a specific model of interaction, demarcated by functionalities and usability characteristics. These platforms offer a set of free products and services, upon registration, in addition to being widely used by the public to be impacted and engaged. There is a paradox in the relationship of these women in technology. The features and algorithms of these digital platforms, invisible to members of these collectives, in addition to delimiting the exercise of their activities can lead to the sharing of information. “The Internet-based utopian marketplace would allow individuals to offer products or services ‘directly’ without having to rely on ‘offline’ intermediaries, whether state or corporate. In the early years of this development, some theorists touted the nascent growth of online platforms as the economic corollary of a ‘participatory culture’ that started with the emergence of social media networks and Web 2.0 in the early years of the millennium (Archibugi, Filippetti, Frenz 2013; Jenkins, Ford, Green 2013; Aigrain 2012; Botsman and Rogers 2010b; Bruns, 2008; Leadbeater 2009)” [26].

The platforms allowed tech female communities to start their development, which is crucial in the fulfillment of the activities in the pandemic of covid-19, but they can compromise the exercise of activism with monitored interaction and restricted to the scope of its creators. “The ‘platform society’ does not merely shift the focus from the economic to the social; the term also refers to a profound dispute about private gain versus public benefit in a society where most interactions are carried out via the Internet. While platforms allegedly enhance personalized benefits and economic gain, they simultaneously put pressure on collective means and public services” [26].

The study of the human-computational relationship cannot be dissociated from the dimension of the social sciences. It is possible to refer to Anthony Giddens, corroborating the thesis that no technology is innocent because it is made by humans for humans with undisclosed interests. According to the concept of Reflexivity, “individuals and society are defined not just by themselves, but also about each other. Therefore, they must both continually redefine themselves in reaction to others and new information” [18]. Reflexivity is shaped by the interaction and the incorporation of information imputed also in these social platforms by members of these collectives.

Despite a feeling of freedom due to the almost infinite sharing of information over the Web via digital platforms, it can be said that the structure of digital life follows the logic of face-to-face life. It is interesting to think about the relationship of women in technology in these communities in the light of the well-known theory of structuration, by Giddens. According to the author, “to understand society, one cannot look only at the actions of individuals or the social forces that maintain the society. Although people are not entirely free to choose their actions, and their knowledge is limited, they nonetheless are the agency that reproduces the social structure and leads to social change [18]. The collective objective is to change the status quo of the dominant patriarchy in Technology, which may suffer hidden influences on digital platforms by information architecture and

interaction design created in companies like Facebook / Instagram, still mostly formed by men.

6 Concluding Remarks

This work had an exploratory character, given the scarcity of scientific studies linked to the collective female activism in Technology and with this theme associated with interaction, social computing and the culture of participation. “Technology is more and more the means within which the activity takes place. (...) Technological systems are themselves inserted in a set of social and cultural practices that give them at the same time that they are constrained and transformed by them” [15]. From GGP case study the objectives previously mentioned and preliminary results of this PhD research are:

1. The GGP main goal is to educate and train young people and women in Technology, especially in the transition from school to university. However, except for sporadic lectures in schools, published on the group's digital platforms, in addition to the meetups, there is a predominance of content and interactions aimed at women already professionally inserted in IT (such as job vacancies, impressions about companies).
2. The main difference in the community's relationship with interfaces and interaction via technologies available in PD is the profile of Slack. The daily information flow, the spontaneous interactions between people who establish social bonds through the platform and the appropriation of the interface and resources points to the success of the application as an instrument of engagement, even without relation to the main objective of the group. GGP Slack is not a platform of an internal and private nature, but a forum for demands from leaders and the public. There is a centralization of interaction and access to Slack and the absence of a broader program of activities forbidden to Geeks.
3. The curation and sharing of narratives (storytelling) obtained in GGP Slack daily interaction, coming from the target audience, would allow greater assertiveness in decision making and, above all, in the loyalty and expansion of new members. A possible interpretation to justify the distance between the achievement of the group's objective and the fact that its strategies reflect, in the DPs, actions more focused on IT professionalization is the difference between “an imagined community (postulated and dreamed) and the community existing” [1].
4. The hypothesis is that GGP leaders may have projected a goal that has been lost until the present day, incorporated by new contingencies generated, such as the covid pandemic, including by the target audiences.

References

1. Allhutter, D.: Mind scripting: a method for deconstructive design. *Sci. Technol. Human Values* **37**(6), 684–707 (2012)
2. Araújo, D.: Feminismo e cultura hacker: intersecções entre política, gênero e tecnologia. Tese de doutoramento. Universidade Estadual de Campinas, Campinas (2018)

3. Bardzell, S., Bardzell, J.: Towards a feminist HCI methodology. In: Proceedings of the 2011 Annual Conference on Human Factors in Computing Systems - CHI 2011, pp. 675–684, Association for Computing Machinery, New York (2011)
4. Carpentier, N.: Além da escada da participação: Ferramentas analíticas para a análise crítica dos processos midiáticos participativos. Revista Mídia e Cotidiano **12**(3), 245–274 (2018)
5. Castells, M.: A sociedade em rede. Editora Paz e Terra, São Paulo (2002).
6. Castells, M.: Communication Power. Oxford University Press, Oxford (2013)
7. Castells, M.: Redes de indignação e esperança. Jorge Zahar Ed., Rio de Janeiro (2013)
8. Castells, M.: O poder da identidade. Kindle Version. Editora Paz e Terra, São Paulo (2018)
9. Cerqueira, C., Cabecinhas, R., Magalhães, S.: Gender in focus: (new) trends in media. Centro de Estudos de Comunicação e Sociedade, Braga (2016)
10. de Souza, C.S., Preece, J.: A framework for analyzing and understanding online communities. *Interact. Comput.* **16**(3), 579–610 (2004)
11. D'Ignazio, C., Klein, L.F.: Feminist data visualization. Workshop on Visualization for the Digital Humanities (VIS4DH), Baltimore. IEEE (2016)
12. D'Ignazio, C., Klein, L.: Data Feminism. MIT Press, Cambridge (2020)
13. Dimond, J.P.: Feminist HCI for real: designing technology in support of a social movement. Georgia Institute of Technology, Atlanta, Ga (2012)
14. Dinheiro Vivo Homepage. <https://www.dinheirovivo.pt/empresas/portugal-e-o-pais-com-mais-opportunidades-para-as-mulheres-na-tecnologia/>. Accessed 17 May 2021
15. Dourish, P.: Where the Action is: the Foundations of Embodied Interaction. MIT Press, Cambridge (2001)
16. El País Homepage. https://elpais.com/internacional/2018/05/08/mundo_global/1525801286_387567.html?id_externo_rsoc=FB_CC. Accessed 17 May 2021
17. Erickson, T.: Social Computing. In: Soegaard, Mads and Dam. The Encyclopedia of Human-Computer Interaction. Aarhus, Interaction-Design.org Foundation (2013)
18. Giddens, A., Sutton, P.W.: Sociology. Polity Press, Cambridge (2021)
19. Jenkins, H., Ito, M., Boyd, D.: Participatory Culture in a Networked Era: A Conversation on Youth, Learning, Commerce, and Politics. 1st edn. Cambridge, Polity Press (2016)
20. Ott, K.: Social media and feminist values: aligned or maligned? *Front. A.J. Women Stud.* **39**(1), 93–111 (2018)
21. Paz, M.: Mulheres e tecnologia: hackeando as relações de gênero na comunidade software livre do Brasil. Universidade Federal da Bahia, Salvador (2015)
22. Pereira, A.E.L.M.: O papel das mulheres nos jogos “online”. ISCTE-IUL, Lisboa (2017). <http://hdl.handle.net/10071/15365>. Accessed 11 Oct 2021
23. Riera, T.: Online Feminisms: Feminist Community Building and Activism in a Digital Age. Claremont Graduate University, Claremont (2015)
24. Rommes, E., Bath, C., Maaß, S.: Methods for intervention: gender analysis and feminist design of ICT. *Sci. Technol. Human Values* **37**(6), 653–662 (2012)
25. Santos, N.: Diferenças de gênero na apropriação das Tecnologias de Informação e Comunicação. Tese de doutoramento. UFRJ, Rio de Janeiro (2019)
26. van Dijck, J., Poell, T., Waal, M.: The Platform Society: Public Values in a Connective World. Oxford University Press, New York (2018)
27. Wajeman, J.: El tecnofeminismo. Ediciones Cátedra, Madrid (2006)
28. Wajeman, J.: Feminist theories of technology. *Camb. J. Econ.* **34**, 143–152 (2010)



Infusing Data Literacy in Design Education: Maturing a Distributed Design Observation Approach in Portugal

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Abstract. The production of data about design is important to create new knowledge about the discipline and support the development of better public policies. In Portugal, the DesignOBS project is developing these tasks, gathering information about the ecosystem. Databases are very important instruments to understand the discipline to systematically innovate. In this paper, we want to go further and address its literacy. Starting from the assumption that design is an activity of cultural mediation, its role in data interpretation could promote more participatory discussions about the discipline, and ultimately enrich the ecosystem; but data literacy in design is still at its infancy. To address this challenge, the present paper describes a hands-on approach to infuse data literacy in an educational design context, to support novice designers navigating a database about design companies. The study adopts a longitudinal case study approach and follows fifteen students from a design master course during the period of one semester. This research is an additional step for the maturation of the process to develop a design observatory in Portugal. It resulted in a set of data-focused infographics about design companies, richer datasets and levered the transformation of the student's perception of their potential role in the context of data. This study contributes to ongoing discussions at the intersection of data literacy and design, still in an early stage. Moreover, it advances design research by reflecting on the value of adopting designerly approaches to create new materials, diffuse information about the design ecosystem and promote more participatory reflections about the discipline.

Keywords: Design education · Design companies · Data literacy · Information design · Participatory approach

1 Introduction

As design is gaining traction globally, different approaches were developed to collect and map data about the design ecosystem [1]. Research from leading design centers, such as

the Design Council [2], the Danish Design Center [3] and more recently, the Barcelona Design Center [4] have developed a set of measures aimed at stimulating the growth of the discipline. In Portugal however, the lack of interface between the Portuguese national design ecosystem with the socio-economic and cultural fabric has jeopardized the promotion, visibility and thus representation of the discipline in the country [5] with few companies understanding the value of design at the strategic level [6].

To address this issue, the DesignOBS project (Towards a design Observatory in Portugal) was created to extract, systematize, interpret, and map information about design in the country. Based on existing European models such as “design ecosystem model” [7] we collected data regarding design offer, design demand and contextual design conditions (e.g. existing design policies, design schools, students, graduates, existing design companies). The first stage of the research process included a participatory approach with 34 national design schools, scattered around Portugal to support data collection and curation [8]. However, the activities developed so far can fall short if data owners and beneficiaries (design stakeholders) are not a part of the interpretation process. If data is a currency of power that can be used to support decisions of public importance [9], designers should be able to take a more active role in its analysis, interpretation and communication, especially when data is focused on the design discipline per se.

2 Background

According to Kapoor et al. [10], systems of innovation are based on an iterative loop between systems of records (collection, aggregation, cleaning, and filtering data repositories), systems of insights (analytic tools, algorithms, services) and systems of engagement (social and collaborative capabilities with user centered design that supports all the interactions in the ecosystem). Multiple projects have applied this conceptualization of innovation mostly to design new products and services in both public or private sectors, empowering citizens to use their own data and improving their quality of life e.g. [10, 11]. The DesignOBS project has been moving in this direction, creating processes that can leverage the participation of stakeholders in the different stages of the design research process [5]. For instance, based on a PhD citation analysis of design doctorates undertaken in Portugal the team identified very scattered to almost no connections between PhD theses [12]. One of the recommendations focused on improving the communicability of research doctorates via the implementation of a keyword system; and encouraging researchers to have clearer contributions for the design area either, by criticizing, building on, or disrupting existing results [12]. In this case, although the system of records (dataset with PhD citations) was developed with a participatory approach involving design schools, its interpretation was limited to a handful of researchers only. We argue that improvements can be two folded in this situation: on the one hand, many other interpretations and recommendations can be developed, via multiple combinations of the elements which constitute each database of the design ecosystem; on the other hand, bringing additional eyes, points of view and experiences can enrich the interpretative layers of the design landscape, providing more opportunities to improve/innovate the discipline. However, the process to make this happen still requires further research, especially because designers still do not see data as a design material [13].

2.1 Data Literacy in Design

Data literacy includes the ability to read, work with, analyze and argue with data as part of a broader process of inquiry into the world [9]. An increasing number of workshops introducing tools and practices are currently being developed to support the use of data for social change (for ex. see [9]) and create new product/service solutions [11], reaching publics beyond data experts.

In the design context, the Density Design lab approach, from the Polytechnic of Milan, has been working since 2004 on a program, with methods and tools, to explore data as material, create infographics, and new communication experiences [13, 14]. They developed a 6-months studio based learning program, exploring different topics focused on societal challenges (e.g. environment, migration, radicalization), involving experts and teachers throughout the process. This approach provides valuable lessons and guidelines to develop this type of activity. However, the learning process and approach is mostly focused on students with a strong graphic/communication design background, which may not suit students that have other valences.

Another study developed by De Götzen et al. [15] explores the role of data literacy in service design education with novice designers that do not have prior experience with data or specific knowledge about communication design. It aims to investigate how designers should be equipped to make sense of data to develop better service concepts. Although the study discusses the challenges faced by students, it does not bring forward the benefits of adopting designerly tools/methods in data interpretation.

These approaches are specific to empower designers with access to data, supporting them in their journey to acquire data skills that can be later applied in the co-creation of new product/service solutions [14] or materialize information that helps the general public to navigate for instance, through controversial social issues [16]. However, this ability has yet to be applied to interpret and communicate insights about the design discipline per se. Often, studies about design use methods/techniques from other disciplines such as social and/or economical sciences [17]. We argue that using additional methods/tools that are closer to the demands design practice, could enrich the research process by bringing forward new ways-of-seeing data, promote a more widespread diffusion of information about the discipline, and leverage participatory discussions.

Research Gap

Starting from the assumption that design is an activity of cultural mediation that results in the shaping of artefacts, devices and services [18], designers should have a more participatory role in the data mapping landscape, providing complementary interpretations/representations that could promote participatory discussion about the discipline; and ultimately, enrich the design ecosystem by taking guided actions. However, the process to make this happen is still at its infancy, especially because designers still see data as something far from their practice [13].

In this context, the present study aims to explore how infusing data literacy in design contexts can support the promotion of more participatory discussions about the ecosystem. Based on the extensive experience of two information designers and teachers, a learning-by-doing information design course was developed and ran for the period of one semester with students based in Portugal undertaking the design master course of

Universidade de Aveiro. The training was composed of three main parts: data awareness and preparation; data exploration and tinkering; and information representation. All these parts comprised different exercises connecting information with visualization and interpretation. The study uses the specific case of design companies in Portugal, a key vector of the design ecosystem [7] and constitutes an additional step for the maturation of a participatory observation and interpretation process for a design observatory in Portugal [5].

3 Methodology

To address the research questions mentioned above, this study adopts a longitudinal multiple case study approach focused on information design projects as a setting in which to observe the changes related to the student's awareness of data and technical capacity; results/materials produced, and the challenges faced. First, our study is exploratory and deals with current phenomena in a specific context, seeking an in-depth understanding of how and why questions, meaning that a multiple case study was a suitable methodological approach [19]. Second, the research design enabled us to explore the changes before, during and after the projects. The longitudinal approach allowed us to observe the changes in the process and materials produced; and study the level of data literacy embeddedness in all the students. The data for this study was collected in three stages (pre project preparation, during the project, after the project) during the span of one semester (5 months) so that the changes could be examined as they evolved. Multiple points of data collection increased robustness, while different types of data enabled triangulation [19]. Finally, 15 students of the design master of Aveiro University, undertaking the "representation of knowledge" course provided a rich context since all had different backgrounds related to arts and design, with no prior experience in data representation.

3.1 Approach

The course of Representation and Knowledge is part of the design master at Universidade de Aveiro, Portugal. The course usually occurs as a two-week intensive workshop plus a second phase of graphic representation process. However, this year's edition was fully taught online because of the pandemic context. This raised additional challenges for both teachers and students. To reach the goals of the course, the classes were distributed along the period of one semester (October 2020 to February 2021), with one class per week and in-between meetings with students.

Fifteen students from the first semester of the master participated in the course, working individually and in work groups of three people for the mid- and final projects. The course ran for 15 weeks and was designed as a hands-on learning activity to raise awareness about data, provide support and knowledge about interpretation skills and representation tools to students. It followed multiple stages of learning and interacting with different types of data (i.e. textual, numeric, visual). The learning process comprised three main stages with multiple activities (A):

Awareness and Preparation

A1: Students were invited to read, interpret, select and represent a one-page-only visualization based on the content of hand-picked articles/news about information design. This

weekly assignment was presented and discussed at the beginning of each session with colleagues and teachers, emphasizing the characteristics of the visualizations created (i.e. information selection and display, colors, elements etc.);

A2: Presentation of the main objective of the project, focused on exploring, tinkering and representing a database about design companies in Portugal. All the different elements (e.g. turnover, profits) of the database were explained and explored in online classes and tutorials;

A3: Presentation and training about two softwares to operate and represent the data: Microsoft Excel/Google Sheets, RaWgraph (online and open-source visualization program). AdobeSuite (namely illustrator, indesign and photoshop) was also used by the students who already had previous knowledge.

Data Exploration and Tinkering

A4: At each session, several features of the softwares were introduced and trained with students in tutorial sessions. The students developed new questions about the database (e.g. which district exports the most), and found ways of answering their own questions (e.g. creating new formulas, applying filters, tinkering data), presenting and discussing their thought process with colleagues. They added a new question each week;

A5: The database was tinkered and additional categories of data were also suggested by the students. They actively engaged in adding more information to support different types of analysis;

A6: a mid-semester presentation was undertaken, where students, already composed by groups of three people, had to develop a presentation with visualizations for the set of questions they had selected;

Data as Material and Representation

A7: a final poster, connecting all the previous stages (i.e. dataset, tools, questions) were transformed into a unique infographic image aimed to convey a message about design companies in Portugal.

3.2 Data

The dataset about design companies operating in Portugal was collected from SABI, Bureau Van Djik, a Moody's analytics company, with information coverage on over 800.000 Portuguese companies. The data selection process focused on companies with "design activity" (code 74.10), and updated information in the year 2018. The name of the company, brand, location (address, county, districts and NutsII), website (when available), phone number (when available), turnover (€), profit margin (%), number of employees, costs with employees, operating results, operational profits, and legal form was collected into a single excel file with 1.287 lines of information. Because of the socio-geographical characteristics of the country, the data was partially curated and tinkered with another layer of interpretation distinguishing between companies that are located in the coast, inland or islands, prior to providing the database to the students.

3.3 Sample

This study used targeted sampling based on specific case selection criteria in the interest of ensuring consistency, while providing a rich context for data collection [19]. First, selection criteria included students in the first year of the design master. The students have multiple backgrounds from design and arts fields, including industrial/product design, multimedia, arts, technologies, communication, and education. Two students had some experience with infographics in a previous course, half have never worked with spreadsheets, whilst some students already used Microsoft Excel to calculate budgets for product parts, also for a course. None of the students used to work with datasets, which provided a rich context to explore our research questions. The students undertook both individual and group work during the period of the study.

3.4 Data Collection and Analysis

Student teams were observed during the period of one semester. Their weekly debriefs and project documentation were collected in the different stages of their work during the entire semester. Moreover, to evaluate the approach used, interviews with all the students were undertaken, video and audio recorded, transcribed and analyzed in Nvivo software, following the guidelines proposed by Charmaz [20] a process which involves qualitative data analysis through thematic coding. Each interview was organized by work groups, via zoom, and had an average duration of 20 min each. The interviews followed a semi-structured guideline comprising eight main topics, namely academic background, previous experience and knowledge; interest and knowledge about design companies in Portugal; challenges faced in the course; thought/reflection process to design the materials; main conclusions reached and opportunities for improvements; data literacy and personal transformation; feedback about the design approach used in the course. Initial codes emerged from the data, and then shared and discussed amongst the co-authors during joint sessions, for alignment. After these sessions, the analysis was iterated to develop a more comprehensive understanding of the emerging themes and thematic descriptions.

4 Results

The longitudinal analysis enables an in-depth understanding of how the infusion of data literacy via a hands-on approach can transform the perspective of designers over their own roles in the data world. It also examines how the students found the course valuable, prospecting the use of the knowledge acquired for future projects. Finally, it demonstrates how different interpretative artifacts can enrich the landscape, adding or providing alternative ways-of-seeing data. This section follows the process described in the methodology section.

4.1 Awareness and Preparation - Muddling Through

The initial stage of the design process included multiple challenges regarding introduction of the database and its content; acquiring skills with the analytical and visual tools; and implementing an iterative process of questioning and representation.

First, students experienced uncertainty regarding the type of data available. Many did not know any of the concepts in the database: turnover, exports and profits were concepts characterized as belonging to the management/economic field. Despite containing information about design companies, students found that the information was difficult to relate to, at the initial stage. Moreover, the database was described as “very dense” and “complex”. Second, the tools and instruments provided (i.e. excel and raw graph) required a hands-on and demanding learning curve, which took several weeks to assimilate. Many students did not know how to create new formulas to obtain additional categories based on the already existing information available (ex. classify the size of the company based on EU standards: micro, small, big company). This task was undertaken during the class together with the teachers. Third, creating, selecting and answering relevant questions and elaborate strategic paths to get the answers was also very challenging for the students. Many found the information available based on quantitative data to be insufficient or restrictive in terms of creative thinking and output. Fourth, selecting and elaborating on relevant questions, and connecting those questions to visually appealing and understandable metaphors required many iterations that were sometimes difficult to make mainly due to the context within which the discipline was developed (fully online). Many emails, and short online meetings were undertaken with the teachers and team members, but this was characterized as “quite limitative”.

To address the challenges above mentioned, one unique physical class was promptly organized with all the students, where all their questions were answered together with the development of practical exercises. The “click” - as one student mentioned - occurred “when we managed to make shapes out of all those numbers, and after having those shapes, we managed to transform into other things even more interesting”. They also stated that “at that point, we needed a lot of motivation, the fact that we could come up with additional interesting questions was already quite good”.

4.2 Exploration and Tinkering - Taking the Leap

Results show that students were able to densify the data and critically analyze it, interplaying between analytical and visual tools (excel and RAW graph). They added additional layers of information such as the design area of the company (e.g. industrial design, communication/graphic design, fashion design etc.), verifying if they had a website or any online presence, and if they could list the outputs developed by the companies. This tinkering exercise, together with the iterative question-representation loop enabled students to find missing information or incoherent patterns in the dataset. For example, one student mentioned that “fashion design is not well represented here (...) Portugal has many successful companies operating in this area, but their online presence is poor, thus it seems that there are only just a few”.

Initial questions focused on identifying companies with “most exports”, “most employees” or “most turnover” slowly matured to “regions with most design companies”, “companies that invest the most in their employees” or “key design sectors in Portugal according to the region”. As the design process moved forward, their capacity to develop new sets of more sophisticated questions opened new doors of interpretation.

Additionally, the criteria for selecting data were identified by students as a “critical design factor”, influencing the message and output. Specifically, three groups decided

to represent companies with online presence and whose design area was identifiable on their website; two groups focused on companies with exports, eliminating from the analysis the others that did not; and another focused on companies within a specific geographical location only (i.e. Northern region). Having to make these choices was key to demonstrate how data selection and interpretation were deeply connected and bring awareness on representation biases: the choice of data, color, form, and shape are the result of a set of multiple choices made by the mediator of the message - that can distort or only partially represent a reality. Some students were insecure about the type of syntax, metaphor, or abstraction they should use to communicate an argument graphically: “we tried to add more and more questions to the graphical mix (...) however, it started to feel like... just something loaded with information that would hinder the reading; so, we had to choose the right equilibrium between question and answer”.

4.3 Materials and Representation - Using Design as Mediator

The students managed to densify the database and demonstrated critical capacity to curate the data, transforming it into visual elements. The application of the hands-on and iterative approach resulted in two materials, namely, a database with additional layers of information and five posters, with multiple metaphors and messages that represent parts of the design companies’ landscape in Portugal:

“Fish Design” (Fig. 1) features fishes of different sizes and shapes that allude to the constitution of the Portuguese design industry: a marine ecosystem where most companies are micro-sized (sardines). The “Panorama of design in Portugal” (Fig. 2) uses containers as metaphor to the percentages of exports by design sector, and the garbage in the ocean as losses suffered by these companies. “Export on wheels” (Fig. 3) uses the geographical disposition of the territory to represent exports by region, highlighting the importance of large urban centers for the area. “Design lemonade” (Fig. 4) uses the analogy of a Portuguese riddle to demonstrate that companies with good turnover do not necessarily generate more profits. Finally, “Conquering design” (Fig. 5) emphasizes the

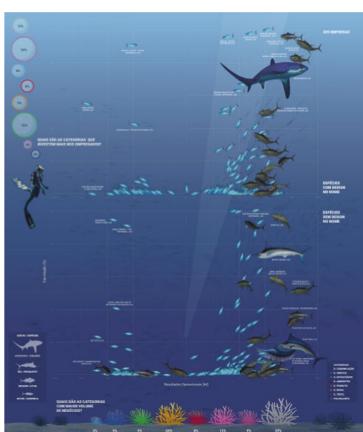


Fig. 1. “Design Panorama in Portugal”



Fig. 2. “Design Panorama in Portugal”

existence of “Trojan horses” in the arena – companies with design activities code (74.10) but whose products and services do not fit into this activity (ex. reprographic/printing companies).

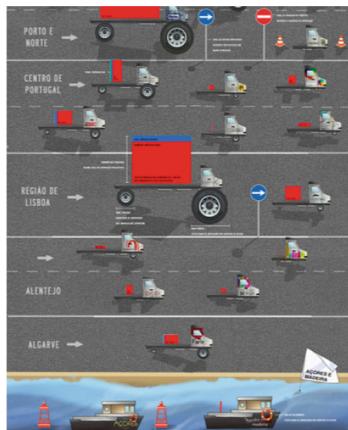


Fig. 3. “Design: exports on wheels”

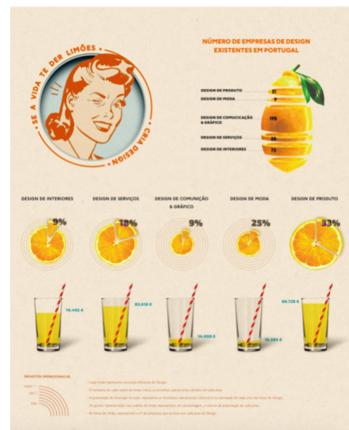


Fig. 4. “Design Lemonade”



Fig. 5. “To the conquest of design”

All students tested their visualizations, showing the evolution of their infographics to colleagues. By the end of the course, some were still not very satisfied with the selected metaphors and abstractions mentioning that “some parts have failed because readers were not able to interpret certain elements in the overall infographic”. They mentioned that some had too much detail, did not have a guided reading narrative, or were just too specific, temporally and/or culturally bound. For instance, having a “trojan horse” from the Greek mythology in the design companies’ arena (Fig. 5) can mean more to Europeans than other publics (“a poisoned present”); or using all-male soldiers (same figure) representing “employees” can also “freeze” a distorted view of the working people’s gender of that specific year (2018) in the design industry. In the fish ecosystem, the eye color of the fish also added more information that was not perceptible

for viewers. All these considerations were the object of discussion and much reflection in all the teams.

5 Discussion

Despite the initial barriers and challenges, students managed to change their perspective not only regarding data, seeing it as something useful and key in their practice, but also regarding their own roles as designers when dealing with data. The iterative process and familiarity with the database and the tools were important to raise self-esteem and critical capacity in reading the material provided about design companies and to develop new questions about the information present in their everyday lives. For example, one student mentioned that she started to pay more attention to infographics around her: TV, newspapers, internet and felt more prepared to understand the numbers, how they were presented and why. She mentioned the specific example of the “COVID quadrant” - an everyday graph displayed in Portuguese television to alert about the level of infection in the country - stating that “the information could have been curated in a thousand different better ways than how it is now”. Other students were curious about some companies presenting extremely high turnovers: whilst some choose to eliminate those from the analysis since they would “greatly distort the overall map of existing companies” others mentioned that “it would be interesting to understand who these giants are”, providing clues for future inquiry. Additionally, students were aware of the remaining potential of the data they have available, understanding its importance for their own future, after graduation: “that database still has a lot to uncover (...) I can use it in future work, or even to make decisions about the design area I will choose”. Another student mentioned that “we are designers but have no clear picture about the overall status quo of our area (...) this was important to acquire this capacity”. Students ended the course feeling more engaged, capable of dealing with data and understanding how important their role can be in communicating insights, not only about their own ecosystem, but in other areas as well. “Design is very important in data representation (...) it is a tool through which we can present huge amounts of information in a clean, intuitive way, that is appealing for other individuals which otherwise, wouldn’t know about that reality”. The databases as well as the infographics are available in www.designobs.pt, open to inspire other students and stakeholders, experimenting new “designerly” ways of communicating data about the vectors of the design ecosystem, and lever discussion about the discipline.

6 Conclusions

This study is an additional step in the maturation of a participatory and distributed observation and interpretation process for a design observatory in Portugal. Open databases containing information about the design ecosystem are not sufficient per se to innovate the discipline systematically. Despite its potential, data literacy in design is still at its infancy [13]. This study presents a longitudinal case study about the application of a one-semester long design approach to support novice design students with diverse backgrounds to interpret and graphically represent data about the Portuguese design

companies - a key vector of the design ecosystem [7]. In particular, the approach contributed to transforming students' position regarding data; creating richer datasets and new visual materials about the topic at hand which can be read, discussed, and criticized by the general public and design stakeholders, promoting participatory discussions that may advance the discipline. This longitudinal case study describes an approach that can be replicated in other settings.

This research also has some limitations that indicate directions for future research. The study was developed with a limited number of students and within a specific setting, focused on information design. Thus, it is hard to evaluate based solely on the results if the materials obtained can indeed leverage the emergence of new questions and research directions for the discipline. Future research could replicate the application of this approach to improve its robustness and explore other vectors of the design ecosystem, while also showcasing the emergent materials to other publics. Also, additional studies could focus on how to adapt the approach to generate other types of artifacts, that go beyond static infographics (ex. creating products based on data), developing various mediating artefacts, based on data, that can contribute to promote the discipline. The used of augmented reality is an example of such exploratory application [21].

References

1. Design for Europe. From Design for Europe to Europe by design: nine key learnings (2019)
2. Design Council. The Design Economy 2018: The state of design in the UK (2018)
3. Danish Design Center. Shaping the Next (2019)
4. Barcelona Design Center. Ecosistema del diseño español (2019)
5. Costa, N., et al.: Towards a Design Observatory: crafting a distributed approach. In: Cumulus (2020)
6. European Commission. Innobarometer 2016 - EU business innovation trends (2016)
7. Whicher, A.: Design ecosystems and innovation policy in Europe. Strateg. Des. Res. J. **10**(2), 117–125 (2017)
8. Borges, A., Silva, A.C., Modesto, A., Cunca, R., Costa, R.C., Branco, V.: REDE#01: Reunião de Escolas de Design. Aveiro, Portugal (2018)
9. D'Ignazio, C.: Creative data literacy. Inf. Des. J. **23**(1), 6–18 (2017)
10. Kapoor S., Mojsilovi, A., Strattnar, J.N., Varshney, K.R.: From open data ecosystems to systems of innovation : a journey to realize the promise of open data. In: Bloomberg Data Good Exchange Conference (2015)
11. Morelli, N., de Götzen, A., Simeone, L.: A system of innovation to activate practices on open data: the open4citizens project. In: Knoche, H., Popescu, E., Cartelli, A. (eds.) SLERD 2018 2018. SIST, vol. 95, pp. 99–109. Springer, Cham (2019). https://doi.org/10.1007/978-3-319-92022-1_9
12. Costa, N., et al.: Mapping the research thread of PhDs in design: a PhD citation analysis of the portuguese doctorates. In: Chakrabarti, A., Poovaiah, R., Bokil, P., Kant, V. (eds.) Design for Tomorrow—Volume 2: Proceedings of ICoRD 2021, pp. 203–216. Springer Singapore, Singapore (2021). https://doi.org/10.1007/978-981-16-0119-4_17
13. Mauri, M.: Introducing information visualization to design students. In: EDULEARN20 Proceedings, vol. 1, no. July, pp. 4442–4448 (2020)
14. Mauri, M., Colombo, G., Briones, M., Ciuccarelli, P.: Teaching the critical role of designers in the data society: the DensityDesign approach., no. March 2020 (2021)

15. De Götzen, A., Simeone, L., Morelli, N., Kun, P.: Making sense of data in a service design education. In: ServDes 2018 Service Design Proof Concept, no. June (2018)
16. Venturini, T., Ricci, D., Mauri, M., Kimbell, L., Meunier, A.: Designing controversies and their publics. *Des. Issues* **31**(3), 74–87 (2015)
17. Cash, P.J.: Developing theory-driven design research. *Des. Stud.* **56**, 84–119 (2018)
18. Branco, V., Providência, F.: Design as cultural mediation between matter and what matters. *Des. J.* **21**(1), 5–13 (2018)
19. Yin, R.K.: Case Study Research Design and Methods, 5th edn. Sage, Thousand Oaks (2014)
20. Charmaz, K.: Constructing Grounded Theory, 2nd edn. Sage Publications, London (2014)
21. Marques, A., Branco, V., Costa, R.: Minard revisited – exploring augmented reality in information design. In: Martins, N., Brandão, D. (eds.) *Advances in Design and Digital Communication: Proceedings of the 4th International Conference on Design and Digital Communication, Digicom 2020, November 5–7, 2020, Barcelos, Portugal*, pp. 79–89. Springer International Publishing, Cham (2021). https://doi.org/10.1007/978-3-030-61671-7_8



Design is in the House: Basic Concepts to Understand the Role of Design in the Creation of the Club Experience

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Abstract. The present paper reviews different sources from specialized literature regarding the role of Design in the construction of the club experience, focusing on clubs devoted to house and techno music. This review aims to explore Design not as the discipline in charge of the construction of objects – furniture, image, fashion, lighting devices – to be *inserted* within the physical space of the club, but as the discipline in charge of the creation of artificial environments capable of triggering emotions, organizing experiences, and challenging traditional notions of space. This paper reviews several works analyzing the case of the design of eight historic clubs and it is closed by a final section presenting eight Design strategies in the creation of the club experience. It also presents a critical comment and identifies some gaps in the literature. Hopefully, by sharing this literature review, other designers will be also inspired to look at clubs not only as spaces of leisure but also as a territory for design experimentation and design research.

Keywords: Clubs · Dance floor experience · Design · Experience design

1 Introduction

The early 1960s discotheque in the USA has been described by scholar Lawrence (2004; 2018) more as a business than as a space for social, technological, or artistic experimentation. Those were spaces with rudimentary sound and light system, where restrictive door policies were applied based on race, sexuality, and class, while *couple dancing* was encouraged. Since those early discotheques, the club has been a space for constant technological and design innovation. From the appearance of the mirror disco ball to the contemporary high-fidelity sound and lighting system, the nightclub has developed into a “*Gesamtkunstwerk* melting interior and furniture design, graphics and art, light and music, fashion and performance into a unique whole” (Kries 2018, p.10). Despite this, the specialized literature in Design and clubs has been mainly focused on art and graphic design applied to flyers, posters, murals, and music album covers: *Fly* (Ackland-Snow

et al. 1996); *Design After Dark* (Rose 1991); *Smiley Faces* (Twemlow 2018); *Club Culture and Contemporary Art* (Heiser 2018); and *Clubbed: a visual history of UK club culture* (Banks Ed. 2018).

This paper reviews different literature sources regarding the role of Design, not in the creation of what is *physically evident*, but in the use of buildings, objects, and technologies to create the intense clubbing experience. It explores concepts like *allatonce ness* (McLuhan 2001), *discotecture* (Munuera 2018), and *site-specific performance* (Biehl-Missal 2016) as strategies to *thicken* the atmosphere inside the dance floor, creating a superposition of media, sound, and lighting technologies. These technologies create a multiplicity of simultaneous narratives present inside the club, especially on the dance floor. These narratives are non-textual but embedded in such technologies.

Additionally, the present work reviews and challenge traditional notions of *space* and *underground*. The first defined as an *unstable* and *time-based* category, instead as a visual Cartesian category, and the second understood as a site-specific *sonic-architectonic-corporeal* dialogue, rather as a matter of *style*. Additionally, the role of the human body not only as a *receptor* but as a *generator* of aesthetic *knowledge* during the club experience is underlined.

The paper closes with some final critical thoughts about the information presented here and with a list of eight *design strategies* in the creation of the club experience. This will hopefully inspire other researchers to pay a closer look at clubs not only as social and technological spaces but also as spaces for design experimentation and design research. This paper results from a doctoral research project concluded early this year (Lugo-Elías 2021).

2 Allatonce ness (All-At-Once-Ness)

2.1 The Dom, NYC

Located in New York, the *Dom* restaurant was turned into a night-club by Andy Warhol while he was using his artist's name Andy Architect™ (Lavin 2009; Munuera 2018). The distribution of the space was like that of a theater or cabaret, with an elevated stage and a lower *house* with chairs and tables where the spectators could dance or simply sit. Within this space, Andy Architect™ held a series of *events* in which he used different technologies and media to create a "veritable sensory thunderstorm" (Heiser 2018, p. 184). These events were the *Exploding Plastic Inevitable* or *EPI*, in which Warhol used simultaneous slide projectors; strobe, spot and pistol lights; mirrors; loudspeakers blaring different records at once; and concurrent musical and dance performances completed with props (Joseph 2002, p. 81). By using all these technological devices, every *EPI* became a technology-based *space* – like the contemporary night-club. For Lavin (2009), the *EPI* was not conceptualized as *art* but as "architecture radicalized as medium" (p. 100). In this way Andy Architect™ was able to build a new type of architecture without constructing or even touching a single wall.

Warhol's *EPI* became the inspiration for Marshall McLuhan to coin the term *allatonce ness* (all-at-once-ness), which described Warhol's strategy to build a *semi-solid environment*, provoking an intense sensory stimulation in which the spectators became rapidly abducted. By using *allatonce ness*, the experience at the Dom became one of

constant *simultaneity* and *continuity* of events, narratives, time and space: “Our is a brand-new world of allatonceness. ‘Time’ has ceased, ‘space’ has vanished. We now live in a global village … a simultaneous happening” (McLuhan 2001, p. 63). In sum, every *EPI* squeezed out the empty space of the existing room and refill it with light and sound performance, making the building and its structure irrelevant (Lavin 2009, pp. 100–101). Allatonceness is still a present strategy observed in the contemporary night-club and festivals of electronic music, specifically house and techno, where DJ, sound, light, and media technologies are used to abduct the dancers into a continuous *allatonceness*, which can last for hours.

2.2 Space Electronic, Florence

In 1967, the *Dom* became the *Electric Circus*, a club visited by young Italian architect Fabrizio Fiumi, who once back in Italy, designed and administered the *Space Electronic* in 1969, together with other members of the *Gruppo 9999*¹ (Lavin 2009; Munuera 2018; Rossi 2018). The *Space Electronic* was placed in an old engine-repair shop, it was furnished with a parachute suspended from the ceiling, washing machine drums used as tables and chairs, and refrigerator casings. More than being defined by its architecture, this space was characterized by the different technologies applied there, like slide projectors, CCTV cameras; and by the eclectic events occurred inside which included recorded and live music, theater and artistic performances, a vegetable garden planted on the dance floor and an architecture school (Kries et al. 2018, p. 51). As Lavin (2009) points out, at the *Space Electronic*, *allatonceness* was implemented not only as a strategy to challenge architectural coherence via the superposition of media – acoustic and visual – creating an immersive environment and *thickening* the architecture with “layers of mediated matter” (p.105); additionally, the *Space Electronic* was used as a mean to reconfigure *allatonceness* “from a model of unity into a system of multiplication … replacing traditional publics with the collective social forms of popular and youth culture; and challenging architecture with the forms of duration and discontinuity developed in performance art” (p. 102). By doing so, the attendees or the social aspect of the club also became more integrated with the definition of the club itself, and the participation of the attendees at the events became more relevant.

Thus far, *allatonceness* has become a relevant strategy in the design of the club experience by creating and overlapping simultaneous media, technological and social narratives, meaning different stories being *told* at the same time within the same space. Later, in the 1980s, some aspects described here, like the use of second-hand furniture and economic means for furnishing the club, as well as using the club as a multiplication system for social reconfigurations, will be repeated in the house-music scene in the USA (s. Sect. 5 and 6). At the contemporary club, *allatonceness* still occurs where cutting edge sound, projection and lighting technologies continue thickening the club’s architecture, while the DJ overlaps different musical tracks while integrating the public responses and interactions, creating a continuous overlap of different narratives.

¹ Members of the *Gruppo 9999* were Carlo Caldini, Fabrizio Fiumi, Mario Pretu and Paolo Galli (Kries et al., 2018, p.51). The *Gruppo 9999* was part of the movement called *Architettura Radicale*, other collectives like *Archizoom*, and *Superstudio* – identified with the movement – created similar clubs in cities like Milan, Turin, and Florece (Rossi, 2018).

3 Discotecture

The *Palladium* in NYC is the venue analysed by Munuera (2018) to coin the term *discotecture* – the architecture of the disco – which describes the assemblage between architecture, media, and electronic technologies organized in the design of this club. The interior of the *Palladium* was designed by renowned architect Arata Isozaki² in 1985 in a movie theater originally built in 1926.

Isozaki intervened the interior space of the theater by installing a gigantic grid made of squares, but without affecting the original interior shell of the building. This was his solution to create a multidimensional space through technology, and with minimal architectonic intervention. As described by Munuera (2018, p. 126), the grid was a sixty-five feet high silver cubic framework, supporting different technologies like the two twenty-five-screen video arrays on which video was displayed, a complete theater lighting system and stage machinery, and a complex light system capable to illuminate the grid's surface creating a glow effect.

This grid was also able to merge the frontstage, backstage, and house – where the audience sits in the original theater – in a continuous space, a hybrid space where DJs and dancers performed the night event of *clubbing*. These are perhaps the most identifiable elements of *discotecture* understood as “a continuous performance and a collection of assemblages that render visible the construction of bodies, technologies, media and environmental ideas” (Munuera 2018, p. 119). Isozaki’s strategies implemented at the *Palladium* transformed the club from a simple *container* of events, into the event itself.

Isozaki’s grid served here as a bridge between stage and dance floor, allowing the interplay between technology, DJ, and attendees – aspects that became the protagonist during the event – exposing the disco as an assemblage of different architectural, social, and technological aspects.

4 Total Space

Built between 1955–56 by architect Vicenzo Carmenati, in Platja d’Aro, near Barcelona, the *Maddox* opened in 1967. Built based on a plan consisting of geometric circles and undulant lines with no hard angles, the architectural features of this club were already capable to trigger the notion of endlessness. In addition to this, the different technologies implemented in this space made it a perfect candidate for Esteves to write his essay *Total Space* (2018), where the author analyses the category of *space* in the context of clubs. Profusely documented by Esteves (2018), the *Maddox*, ca. twenty years before the *Palladium*, got a technological arsenal consisted of 200 lighting devices linked to a central system, lasers, and special projectors, custom-made machinery for *cloud and water effects*, and a projector capable of simulating the horizon.

While describing all these features, Esteves confronts the case of the *Maddox* with the work of Giedion, *Architecture and the Phenomena of Transition: The Three Space Conceptions in Architecture* (1971). By doing so, Esteves (2018) explains Giedion’s idea of dividing the history of architecture in three phases based on the corresponding notion

² In 2019, Isozaki became the recipient of The Pritzker Architecture Prize, considered the *Nobel* of Architecture.

of *space* predominant in each historical phase: until roman times, the exterior space was the predominant; the interior space and its connotation of prestige was of relevance in a second phase; until the modern movement, when space was defined by the continuity between the interior and exterior spaces (p. 142). Here, Esteves's main critique is focused on Giedion's notion of space as a stable category, and how it prioritizes *vision* as the only sense capable of perceiving the dimension, position, and volume of the *space*. "Space had become a stable category informing the discourse and practice of architecture. [Space] was commonly understood as measurable and Cartesian, two qualities that necessarily prioritized the visual sense" (p. 142). This notion of *space* as a category only perceptible through vision may be the result of the pervasive use of geometrical perspective to think, project and represent architecture. This notion is challenged in the club, where *space* is perceived not only through sight but even more predominantly through our haptic and auditory abilities.

Furthermore, for Esteves (2018), the *Maddox*, with its architectural features and technology, simply surpassed Giedion's interior-exterior paradigm by creating a continuous infinite *space* adding *time* to the equation. The *Maddox* set an "unprecedented phenomenological-spatial apparatus" (p. 132) where space is defined not only by vision but by a full corporeal time-based experience. Space became *unstable* and *temporal*, rather than *stable* and *perpetual*; "a time-based construct; a temporal dimension" (p. 144) merging time, place, and event into a *total space*.

5 Birthday Iconography

On February 14th, 1970, the *Loft* opened its doors in New York. This space was not a public club, but a *private party*,³ a sort of *semi-clandestine* leisure space run by David Mancuso. The *Loft*, together with the club scene in New York, has been the subject of much of Tim Lawrence's work (2004, 2018), who describe how Mancuso rented a loft and installed a high-efficiency stereo equipment along the wall facing the turntables to encourage attendees to dance with one another and under minimal light effects; also mirrors and taking photographs were forbidden to inhibit self-consciousness, while childhood vibes were triggered by *birthday iconography* – balloons and handmade designs made from crepe paper.

Like what had happened with the *Space Electronic*, at the *Loft*, the use of second-hand furniture and *lost and found* objects like cable spools – used as tables – evoked *counter cultural* vibes and a spirit of *reinvention*, reflected multiple times by a giant mirror ball in this reimagined world. All these design elements aimed to potentiate sociability on the dance floor, privileging social interaction over self-consciousness, and *hearing* over *seeing*.

³ To understand the *private* or *semi-private* nature of the *Loft*, it is necessary to contextualize it in the NYC in the decades of 1960s and 1970s. Lawrence (2018) and Munuera (2018) report three main factors involved in the appearance of such private events: first the rise of feminism, gay liberation and anti-war, and LSD movements, whose members needed private security spaces to gather; second, the need to avoid NYC's legislation on alcohol and opening times applied to public clubs, by not selling alcohol and therefore not needing any licence; and finally, the drop in rent prices of large spaces, especially in lower Manhattan, due economic crisis and urban decay in the 1970s.

6 The Unfinished, the Possible

The *Paradise Garage* and the *Warehouse* are two of the most influential venues in the history of contemporary clubbing (Fikentscher 2000; Lawrence 2018; Pratginestós 2002). If the sound system at the *Loft* was remarkable, that of the *Paradise Garage* was granted with legendary status and called the *Levan Horns*⁴ – after the influential DJ Larry Levan who played there. On the other side, the *Warehouse* is considered no less than the birthplace of the house music (Lles 2002).

Both venues opened in the late 1970s, and both shared features with other venues, like the *Loft*, creating a specific aesthetic that is even nowadays related with the *underground*. This aesthetic has components of what Munuera (2018) describes as the *provisional*, the *unfinished*, and the *emerging*, recognizable in the exposition of raw construction materials – like pipes, exposed bricks, and crumbling plaster (p. 118).

Additionally, the décor of these spaces was often sparse, nonexistent, or improvised with economic means such as dark curtains, and predominantly dark in terms of lighting⁵ (Fikentscher 2000, p. 70). These *unfinished* elements embedded in the architecture can be seen as part of an aesthetic narrative of the *possible*, in concordance with the narratives of gender and social equality carried by the Afro-American and Latino LGBT + population of these underground spaces.

All these elements – music, superb sound systems, darkness, sparseness, improvisation – worked as material *cues* orienting the attendees not in what they *must do* in a club, but what they *could possibly do*, letting the doors open for people to interact with the club and to participate in the design of the dance floor experience. These narratives of liberation, secrecy, and new possibilities are still fundamental parts of the ethos of underground clubbing, reproduced later in the rave movement and even in the contemporary techno scene dominated by big seasonal festivals hosted in large, sometimes remote, industrial parks.

7 Design as a Site-Specific Performance

Open in the late 1990s, in a large empty industrial space near the banks of the Spree River, in Berlin, the *Ostgut* was a space devoted to techno music. Given the large size of the venue, two more venues were hosted inside, the *Panorama Bar* for house music and the *Lab.oratory*, focused on sex and fetish parties for a predominantly male clientele. According to Wurnell (2016; 2017), this venue was closed and demolished in 2003 leaving the space free for the construction of the *O2 Arena*; but only two years later, in October 2004, the *Panorama Bar* reopened inside a different building, an old power plant. Later that year, the promoters of the *Panorama* opened the *Berghain* – which takes

⁴ Richard Long oversaw the design of this sound system which was characterised by an accurate and powerful bass (Lawrence, 2018). The system was so famous that it was duplicated in other venues, like the *Zanzibar* in Newmark, New Jersey, and later in London's renowned *Ministry of Sound* (Fikentscher, 2000, p.70).

⁵ As Arnold (2012) documents, the *Warehouse* was located inside a three-storey building with no signal on the façade and black painted windows producing darkness and evoking *secrecy*.

its name after the two neighborhoods flanking the club, the Kreuzberg and Friedrichshain – and only two years after, in 2005, the *Lab.oratory* re-opened in the same building.

This club has been subject of an impressive media coverage and enjoys worldwide renown⁶ for both the quality of the music played there, as well as for their infamous door policies. But despite this, the inclusion of this club in the present review is due the work of Biehl-Missal (2016), who using participatory observations, interviews a document analysis, explored the relationship between people's movement – especially dance – and the club's architectural design. In her work, the researcher explores the idea of the *sensual communication* between the architecture and the participants, embodied in the act of dancing: "the space influences the movements that people are likely to perform, and people's movements 'perform the space', generating an experience of the space that is perceived through the body" (Biehl-Missal 2016, p. 29).

This sensual communication is provided by the existence of *architectural, visual, or sonic hooks, or cues*, which are embedded in the space's organization, use of lights and the site-specific acoustic effects. In this way, the architecture of the *Berghain* – so Biehl-Missal – organizes the performance of the attendees through a series of transitional spaces, encouraging participation, interaction, and circulation; the use of light, or better say the lack of it, evokes a contradictory sense of intimacy and anonymity which derives in indulgent sexual, sensual and drug practices.

This *sensual communication* encircled the *sonic communication* between the sound coming from the speakers, impacting the walls of the architecture creating *walls of sound*, which could be not only audible but also haptically perceived by the dancers as the sound frequencies hit their skin: "with the body absorbing vibrations in space and reinforcing them through dance movements" (Biehl-Missal 2016, p. 9). Another element in the *sonic communication* is the effect of architectonic reverberation, which is explained by Snoman:

We already know that when something produces a sound, the resulting changes in air pressure emanate out in all directions, but only a proportion of this reaches our ears directly. The rest rebounds off nearby objects and walls before reaching our ears; thus, it makes common sense that these reflected waves would take longer to reach our ears than the direct sound itself.

This creates a series of discrete echoes that are all closely together and from this, our brains can decipher a staggering amount of information about the surroundings. This is because each time the sound is reflected from a surface, that surface also has a distinct frequency response and this means that different materials will absorb the sound's energy at different frequencies (Snoman 2004, pp. 109–110).

But not only the material nature of the space at the dance floor is responsible for reverberation, this effect can be enhanced by sound frequencies embedded in the music track by the producer "to attribute a sound with a sense of physical space" (Gadir 2014,

⁶ The Rolling Stone Magazine has considered the *Berghain* as one of the best techno clubs in the world: <https://www.rollingstone.com/culture/culture-news/berghain-the-secrective-sex-fueled-world-of-technos-coolest-club-111396/> (last accessed, March 24th, 2019); as well as by the British journal The Guardian: <https://www.theguardian.com/travel/2016/jul/15/berlin-clubs-nightlife-germany-techno> (last accessed, March 24th, 2019).

p. 20), or it can be provoked by the DJ through the equalization of music by using the mix table.

In sum, the wordless *sonic*, *sensual*, and *architectonic* communication occurred at any given night at the *Berghain* can be understood as *aesthetic knowledge*. “This knowledge may be (re)created through movement when people dance in a space and ‘take home with them’ an experience and a new understanding” (Biehl-Missal 2016, p. 28). The human body, and not the architecture, became then the repository of *what we know* from the clubbing experience. The human body carries the traces, sensations, and aesthetics acquired after the participation in the club experience. Therefore, is it possible to suggest that the Design of the club is not constrained to the material and technological context of the dance floor but that it is extended to the human body, which performs and embodies the dance floor experience.

8 Final Thoughts

The review of the various clubs presented here lead us to conclude that designing a club means more than to arrange its material context. Beyond the spatial architectonic distribution, construction materials or objects placed inside a club, to design a club means to produce a sensorial experience. This is possible by challenging the architectural coherence of the club while creating a *semi-solid* environment, designed, and thickened by the superposition of different layers of media, and technologies.

By challenging this notion of architectural coherence, clubs have been a space where the notion of *space* has also been challenged and it is not understood as a Cartesian visual category anymore, but as an *unstable* and *time-based* concept, intrinsically linked to the events occurred inside, transforming the club from a container of the event into the event itself. This adds another element to the design of the club, the social aspect, which must be potentiated and included in the design of the club.

Along this review, the club is presented as a hybrid *event-space*, where architecture, media and electronic technologies got assembled through different design strategies, from which the most important are:

1. *Allatonceous*, or the superposition of media and different narratives, achieved through the simultaneous use of different technologies. In the cases presented here, the most common technologies are those of sound, projection, and lighting, however allatonceousness is still relevant for other technologies like Virtual Reality, that could be applied in the future.
2. The use of the *unfinished* to evoke the *possible*. More common as part of the aesthetic of the *underground*, the use of secondhand furniture, lost and found objects, and the exposition of raw building materials evoke a narrative of what is *possible* rather than what is *finished*, *established*, and *perpetual* – this countercultural stance is in concordance with the narrative of underground clubs as spaces that challenge the social *status quo* through utopian *social* and *gender* equality.
3. Simultaneity of architectural narratives. Occurred when a club is installed in a previously existing building – i.e., the Palladium was installed inside a former theater

- and the *Berghain* is installed inside a former power plant – the club overtakes part of the building's history into the club's identity.⁷
4. The use of *hooks* and *cues*, not to define but to *suggest* different ways to use or embrace the space and to decide the activities to be carried on inside. An example of these hooks is the use of darkness to anonymise behaviors and provoke social disinhibition. Also, distance and emptiness are used to choreograph the rhythm of movement of individuals in transitional spaces like corridors and stairs.
 5. *Birthday iconography*. Balloons and handmade paper designs evoke childhood memories and avoid self-consciousness.
 6. The construction of *walls of sound*. Design can establish the conditions for the *sonic*, and *sensual* communication between sound, architecture, and people by enabling the construction of *walls of sound* within the dance floor, produced by the vast range of sound frequencies transmitted by the club's sound system. The design of the club can underline the sonic and haptic experiences as a predominant way to perceive the space.
 7. Design as a site-specific bodily performance. Here, the design of the club should consider the human body not only as a *receptor* but also as a *generator of aesthetic knowledge* – physical, visual, sonic, and haptic. This knowledge includes body movements and social interaction.
 8. The human body is also the only capable to blend the two categories of *space* and *event* during the participation in the club experience. The human body, and not the architectonic space, became the real container of what we know from the club experience, caring the traces, experiences and knowledge produced by the design of the intense aesthetic experience at the dance floor.

The present review also suggests that the category of *underground* can be understood not only as a *social* category or as matter of *style*, but as a site-specific *sonic-architectonic-corporeal* dialogue, an assemblage of human movement, musical rhythm, sound waves and frequencies, second-hand furniture, birthday iconography, and darkness.

From the different technologies presented in this review, the pharmacological technology is missing, this is intentional rather than accidental. Given the *design scope* of this paper, the use of drugs to produce different state of consciousness and perceptions has been left out, the main reasons are two: 1) to maintain the focus of this paper in what the discipline of Design can *do*, leaving the emotional and psychological effects of drugs for health related disciplines; and 2) to avoid contributing to the *academic fetishization* (Rief 2009, p. 5) of rave and club cultures, by giving excessive attention to drugs.

A critical comment should be also made to the texts reviewed in this article. Given the historical perspective that most of the works reviewed here have, they use data obtained mainly from secondary sources like historic interviews and document analysis – photographs and architectonic blueprints. And, despite the empiric work of Biehl-Missal (2016) there is still a lack of works using empirical evidence to support the theoretical

⁷ This is noticeable in historic clubs, such as the *Paradise Garage* and the *Warehouse*, which were installed in a parking garage and a warehouse respectively and took the characteristic of this spaces into the design of the dance floor and into the venue's name.

framing presented here. Another critical note should be made due to the lack of examples of clubs outside the US, UK and Europe existing in specialized literature.

The eight strategies presented in this section are related to the club experience – specifically house and techno clubs – but they have also potential to be applied to other spaces and events such as concert halls, open air music festivals, museum, galleries and in the design of experiences based in virtual reality. Also, future technologies can benefit from these strategies.

Finally, the present review should not be seen as the *last word*, but as a *starting point* for designers to better understand the concept of space and spatiality. Also, we hope designers can better understand the past role and future potential of the club as a space not only for social, music and technological experimentation but also for design exploration.

Acknowledgments. This work is financed by national funds through the FCT – Fundação para a Ciência e a Tecnologia, I.P., under the scope of the project UIDB/04057/2020.

References

- Ackland-Snow, N., Brett, N., Williams, S.: *Fly: The Art of the Club Flyer*. Thames & Hudson, London (1996)
- Arnold, J.: The Warehouse: The place house music got its name (2012). <https://www.residentadvisor.net/features/1597>, Accessed 25 Apr 2019
- Banks, R.: *Clubbed: A Visual History of UK Club Culture*. Face 37, Manchester (2018)
- Biehl-Missal, B.: Filling the ‘empty space’: site-specific dance in a techno club. *Cult. Organ.* **25**(1), 16–31 (2016). <https://doi.org/10.1080/14759551.2016.1206547>, Accessed 27 Apr 2019
- Esteves, P.: Total space. In: Kries, M., Eisenbrand, J., Rossi, C. (eds.) *Night Fever: Designing Club Culture, 1960-Today*, pp. 130–147. Vitra Design Museum, Weil am Rhein (2018)
- Fikentscher, K.: “You Better Work!”: Underground dance music in New York City. University Press of New England, Hanover (2000)
- Gadir, T.: Musical Meaning and Social Significance: Techno Triggers for Dancing. Doctoral thesis, University of Edinburgh, UK (2014). <https://www.era.lib.ed.ac.uk/bitstream/handle/1842/9478/Gadir2014.pdf?sequence=2&isAllowed=y>, Accessed 27 Apr 2019
- Heiser, J.: Club culture and contemporary art: a relationship. In: Kries, M., Eisenbrand, J., Rossi, C. (eds.) *Night Fever: Designing Club Culture, 1960-Today*, pp. 172–189. Vitra Design Museum, Weil am Rhein (2018)
- Joseph, B.W.: My mind split open”: andy warhol’s exploding plastic inevitable. *Grey Room* **8**(Summer, 2002), 81–107 (2002). <http://www.jstor.org/stable/1262609>, Accessed 27 Apr 2019
- Kries, M.: Foreword. In: Kries, M., Eisenbrand, J., Rossi, C. (eds.) *Night Fever: Designing Club Culture, 1960-today*, p.10. Vitra Design Museum, Weil am Rhein (2018)
- Lavin, S.: Andy Architect™—or a funny thing happened on the way to the disco. *Log* **15**(Winter 2009), 99–110 (2009). <http://www.jstor.org/stable/41765265>, Accessed 16 July 2018
- Lawrence, T.: *Love Saves the Day: A History of American Dance Music Culture, 1970–79*. Duke University Press, Durham (2004)
- Lawrence, T.: Dance floor transformation: counterculture, post-industrialism, and environmental design in New York City during the 1970s and early 1980s. In: Kries, M., Eisenbrand, J., Rossi, C. (eds.) *Night Fever: Designing Club Culture, 1960-Today*, pp. 88–97. Vitra Design Museum, Weil am Rhein (2018)

- Lles, L.: La casa de Jack: Ritmo y deseo. El primer imperio del house (1985–1995) [Jack's house: rhythm and desire: The first empire of house (1985–1995)]. In: Blánquez, J., Morera, O. (eds.) LOOPS: Una Historia de la Música Electrónica, pp. 230–260. Reservoir Books Mondadori, Barcelona (2002)
- Lugo-Elías, C.: Reassembling the Dance Floor: Exploring interactions at after-parties in spaces of consumption of electronic music in the city of Oporto in the years 2016–2018. Doctoral thesis, University of Porto, Portugal (2021).
- McLuhan, M.: The Medium is the Massage. Gingko Press, Corte Madera (2001)
- Munuera, L.: Discotecture: the bodily regime of archi-social exploration. In: Kries, M., Eisenbrand, J., Rossi, C. (eds.) Night Fever: Designing Club Culture, 1960-Today, pp. 116–129. Vitra Design Museum, Weil am Rhein (2018)
- Pratginestós, R.G.: Poderosamente real: la música disco, de The Loft al Paradise Garage (1970–1985) [Mighty real: disco music, from The Loft to the Paradise Garage (1970–1985)]. In: Blánquez, J., Morera, O. (eds.) LOOPS: Una Historia de la Música Electrónica, pp. 119–139. Reservoir Books Mondadori, Barcelona (2002)
- Rief, S.: Club Cultures: Boundaries, Identities, and Otherness. Routledge, New York (2009)
- Rose, C.: Design After Dark: The Story of Dancefloor Style. Thames & Hudson, London (1991)
- Rossi, C.: In the media: Italy's radical pipers in the 1960s and 1970s. In: Kries, M., Eisenbrand, J., Rossi, C. (eds.) Night Fever: Designing Club Culture, 1960-Today, pp. 25–39. Vitra Design Museum, Weil am Rhein (2018)
- Snoman, R.: The Dance Music Manual: Tools, Toys and Techniques. Focal Press, Oxford (2004)
- Twemlow, A.: Smiley faces: the graphic language of electronic dance music promotion. In: Kries, M., Eisenbrand, J., Rossi, C. (eds.) Night Fever: Designing Club Culture, 1960-Today, pp. 216–229. Vitra Design Museum, Weil am Rhein, Germany (2018)
- Wurnell, M.: The Berghain Backstory: Building Berlin's Most Legendary Nightclub (2016). <https://medium.com/cuepoint/the-berghain-backstory-building-berlins-most-legendary-nightclub-87ad2d901ee9>, Accessed 26 Apr 2019
- Wurnell, M.: Berghain: The World's Most Legendary Techno Club. [Kindle DX version] Telegram Journalism (2017)



An Interactive Product to Enhance Elderly People's Self-esteem: Results from the User Research Phase

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Abstract. This paper focuses on the user research phase of an ongoing MA project which aims to design and evaluate an interactive product to enhance elderly people's self-esteem. A structured questionnaire, carried out on people with 56+ years, was created to obtain data concerning their exercise routines, cognitive and gaming activities, and overall sense of self-esteem. After analyzing the responses, we conclude that most respondents do not practice the recommended amount of exercise nor carry out cognitive activities, which will ultimately have a negative impact on their health and self-esteem. Furthermore, most respondents do not play games (digital or non-digital) which calls into question the trend of resorting to gamified solutions as a means to increase the wellbeing of adults and elderly people. In conclusion, based on the respondents' habits, obstacles, preferences, and motivators, we argue the proposed solution should be digital but not based on gamification.

Keywords: Interactive product · Elderly · Self-Esteem · Gamification · User questionnaire

1 Introduction

This paper is a part of an ongoing MA project concerned with the design and evaluation of an interactive product to enhance the self-esteem of elderly people (henceforth the Elderly). Given that a Human-centered Design (HCD) approach is being followed, understanding the potential end users is a critical stage for the development of the ongoing project. Therefore, a two-pronged user research process was carried out which consisted of: (i) expert interviews; and (ii) user questionnaires. In the first phase, experts identified the target users' physical and psychological issues and their willingness (i.e., motivation) to improve their well-being. The experts also made recommendations regarding physical activity and how to motivate participants and, finally, gave their opinion on the potential benefits and adequacy of the Nintendo Wii fit platform to tackle those issues. In the second phase, a questionnaire was applied to obtain information about the Elderly's habits, preferences, knowledge of fitness products and, ultimately, to understand what

kind of solution would be better for them. This paper focuses on the second phase, which was done online due to the restrictions imposed by the Covid-19 pandemic.

Over the last decades, there has been a continuous increase in ageing population worldwide, and with it, an increase in people whose self-esteem, physical and cognitive capabilities deteriorate faster over time (Azevedo 2015; Soeiro 2010). Simultaneously, there has been a growing interest in the study of well-being. Several studies about the Elderly's overall well-being (e.g., Robins et al. 2002; Tresniewski et al. 2003; Chodzko-Zajko 2009; Orth et al. 2010; Becker 2013) have been conducted as well as some attempts to develop products that improve it (Liu et al. 2018). Research has been done to understand how the Elderly's well-being may be positively affected by self-esteem (e.g., Tresniewski et al. 2003), social contact (e.g., Denissen et al. 2008), physical stimuli (e.g., Becker 2013; Rodrigues 2015), cognitive stimuli (e.g., Pruessner 2009), video gaming (e.g., Ijsselsteijn 2007) and exergaming (e.g., Kappen et al. 2018). Furthermore, the so-called "active-ageing industry" which includes wellness and fitness technologies, is expected to grow substantially in the coming years (Halpert 2019). Consequently, there is ample space for research within this area.

Recent studies (e.g., Orth et al. 2010) on self-esteem suggest that the Elderly tend to have lower self-esteem compared to younger age groups, and that it is further diminished by the decline in their cognitive and physical abilities (França 2015). Other studies have been done to understand whether video games and exergames can improve their physical and cognitive abilities. Some of these studies suggest that video games can in fact enhance the Elderly's cognitive abilities. However, there is still a debate on whether the cognitive skills gained through video games actually transfer to everyday activities (Cardoso et al. 2017). Comparatively, several studies (e.g., Kappen et al. 2018; Chao et al. 2014; Willaert 2020) indicate that exergames (e.g., played on Nintendo's Wii platform) can have a positive cognitive and physical impact on the Elderly. Despite these positive outcomes, the percentage of Elderly playing them is still low (Loos 2017), mainly due to a lack of interest; however, almost no research has been carried out to understand how User Experience (UX) could address this specific issue.

Existing studies about the Elderly and their overall well-being have contributed to both their ageing process and the solutions that may appease the biological consequences of it. However, the needs and motivations of the Elderly are not always considered when proposing video games or exergames as solutions, and few studies (e.g., Loos 2017) consider the user experience when evaluating or designing such games. Therefore, following a Human Centered Design approach and by incorporating its methods (i.e., questionnaires), it is possible to obtain more detailed information about users and understand their needs better. In this sense, the objective of this paper is to show the results and analysis of the questionnaire.

2 Method

A structured questionnaire was used to gather in-depth information. It consisted of predefined, closed-end questions to obtain more detailed information about older adults and the Elderly.

2.1 Sample

The questionnaire was answered by 150 Portuguese citizens ($n = 150$, MOE = 0.08), 77 female, 72 male and 1 other, with an age equal or above 56 years old. The chosen age target comprised the age groups of older adults (56–64), youngest-old (65–74), middle old (75–84), and oldest-old (85+) Elderly, categorized by Sang et al. (2018).

2.2 Material

The questionnaire consisted of 7 sections with explanatory titles to make the change of topic easier to follow. At the beginning of the questionnaire, an introduction was provided to disclose information about the target and scope of the study. In total, 46 questions were asked which were divided into 7 sections: (1) Initial Data, 3 questions; (2) Physical and Cognitive Habits, 8 questions; (3) Game Habits, 2 questions; (4) Knowledge about physical products, 10 questions; (5) Final Thoughts, 9 questions; (6) About you, 9 questions; and (7) Demographic Information, 5 questions.

2.3 Procedure

The questionnaire was created on Google Forms. It was distributed by sending emails and posting on social platforms between December 2020 and January 2021. The response rate was continuously monitored. After reaching the number of responses that was aimed for, the questionnaire was closed to analyze the data.

Any person with an age equal or superior to 56 years old answered the questionnaire alone or with assistance, if needed.

2.4 Results

The data was analyzed on SPSS Statistics. Additionally, to obtain a visual description of the sample, a univariate analysis was performed, using frequency tables and graphic representations. Secondly, to better compare, visually, variables related to the same topic, box plots with several independent variables were created.

Section 1. Initial Data. 51.7% of the respondents said they prefer an activity that contributes to their physical health, 46.2% preferred an activity that contributes to their psychological health, and 43.3% preferred an activity that helps them develop as a person. These answers may be influenced by the social desirability bias (Grimm 2010), but it is still possible to conclude that they value activities that improve their overall health and well-being.

Section 2. Physical and Cognitive Habits. According to Traywick, n.d., the minimum recommended exercise time per week is 150 min (2 h 30 min). In general, the respondents practice less than 1 h per week, or do not practice exercise at all (Fig. 1). The dominant activity was low intensity exercise, which includes a casual walk and riding a bike at a slow pace. Medium intensity exercise includes jogging, cycling, swimming, and dancing. High intensity exercise includes circuit training and medium intensity exercises done at a faster pace, e.g., running and cycling faster (Downing 2021).

The results show that 70.7% of respondents never do high intensity exercise per week, 27.3% never do medium intensity exercise per week and 11.3% never do low intensity exercise per week.

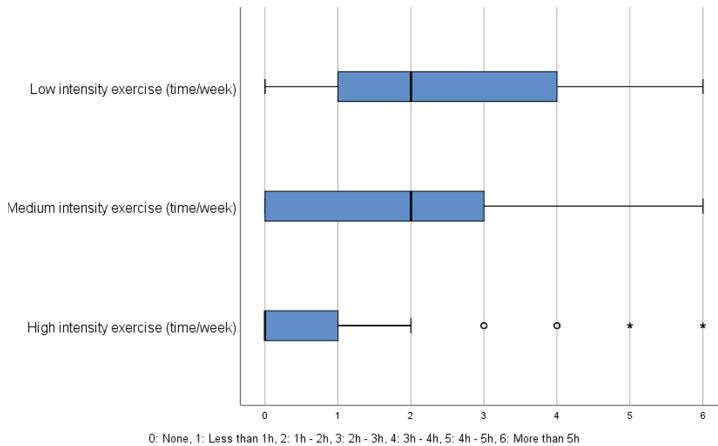


Fig. 1. Summary of physical exercise intensity performed per week.

Another question was whether respondents performed exercise with weights, which includes exercise using body weight or additional weights. This type of exercise can be of medium or high intensity depending on the weight, repetitions, and pace. The results showed that the exercise level with weights is quite low, as 49.3% never do it, as shown in Fig. 2. This shows that almost 50% of the respondents do not perform strength exercises, which are very important for one's health, even as an older individual. (McLeod et al. 2016).

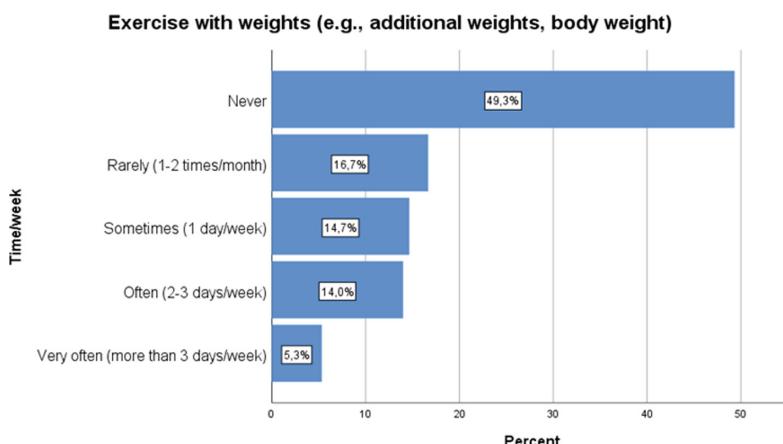


Fig. 2. Frequency of exercise with weights.

The respondents were also asked about their preferences on location and company when exercising. Most of the respondents (42.7%) prefer to exercise outdoors, 35.4% prefer indoors (i.e., homes, gym), and 18.7% chose both. Regarding company, most of them (45.3%) prefer sometimes alone and sometimes with company, 33.3% prefer only with company, and 15.3% prefer alone. This shows that the preferences regarding location and company to exercise are varied and may depend on the mood of the person, their location, and type of physical activity.

Additionally, the respondents were asked about their involvement in certain cognitive activities (i.e., reading, memory games, board games, sudoku, domino, crosswords, drama, dance, learning new things, and teaching) per week. Most of them (59.4%) do not practice any of these activities, and 18.1% do it for less than 1 h per week (Fig. 3). This can be due to lack of time, lack of interest or because they are unaware of the importance of cognitive training.

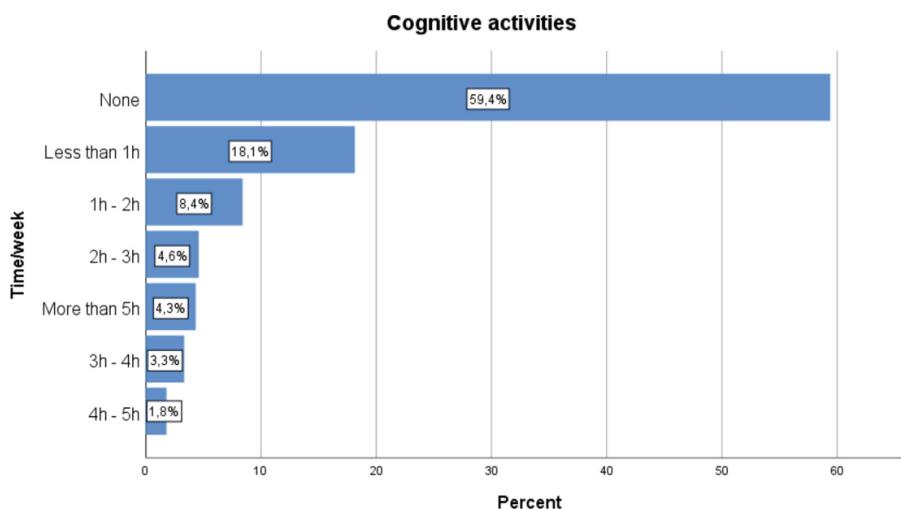


Fig. 3. Cognitive activities (time/week).

Physical exercise improves cognitive health (Kirk-Sanchez and McGough 2013) and, according to the results, most of the respondents are not performing the recommended exercise (Fig. 1 and Fig. 2) nor stimulating their cognitive performance (Fig. 3), which may lead to a faster cognitive decline and fall in self-esteem (Karlamangla 2009; Pruessner et al. 2009).

To better design a solution for the target users, it was also important to know what encourages them to take better care of their health (Fig. 4) and what their obstacles to exercising are (Fig. 5). The results show that the main motivation for most of the respondents is to feel better at a body and mind level (76.7%) followed by being healthier (60%). Their biggest obstacles to exercising are laziness (46.3%), lack of motivation (44.9%), and lack of time (27.9%).

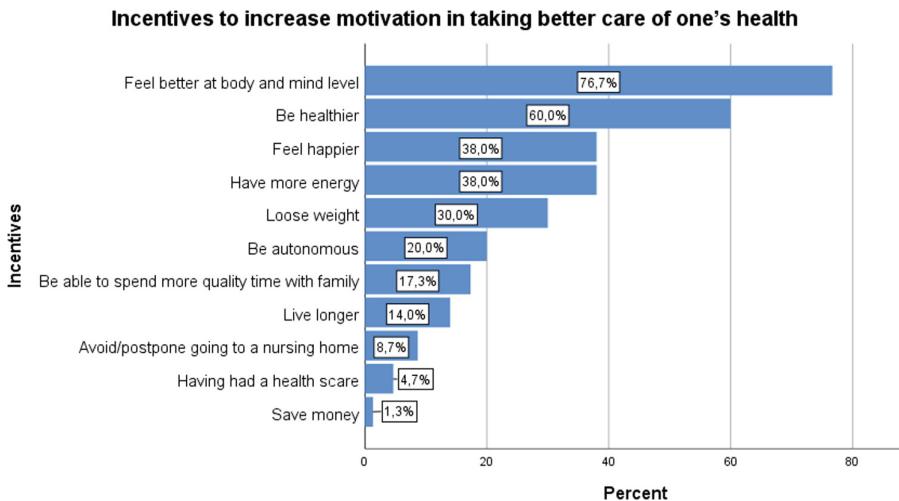


Fig. 4. Incentives to increase motivation.

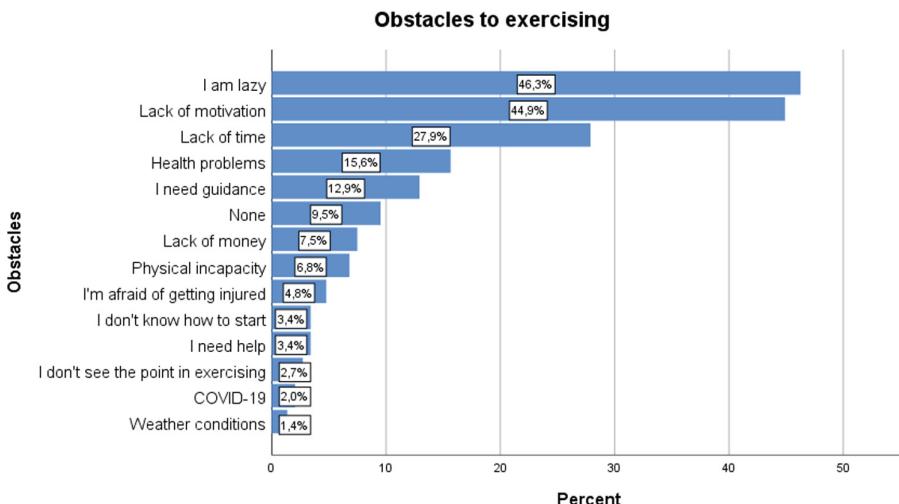


Fig. 5. Obstacles to exercising.

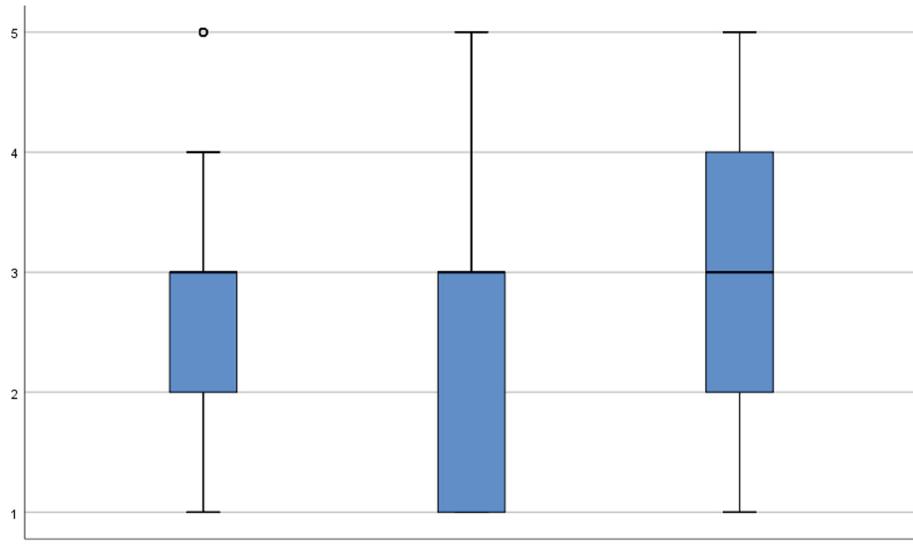
Section 3. Game Habits. Some studies (e.g., Loos 2017) have shown that older adults are not interested in exergames thus it was important to understand our users' gaming habits. 50.4% do not play any non-digital games and 46.3% do not play any digital games. The most played non-digital games are card games (31.9%) and a similar result is found for digital games (37.6%). The latter is followed by logic games, played by 30.9%. Even though approximately half of the respondents do not play any game, it is interesting to observe that the percentages of gameplay are higher for digital games. This may be due to several factors, e.g., higher adoption of technology which increases

access to digital games, and the fact that digital games do not require the presence of another person.

Section 4. Knowledge About Physical Products. Questions about their knowledge and use of certain fitness products were important to see what products they use and, especially, understand their knowledge and use of Wii Fit. This could help to prove that people in this age range are not adopters of Wii fit which is an exergame widely mentioned in literature about the Elderly (e.g., Kappen et al. 2018; Chao et al. 2014; Willaert et al. 2020). 58.7% know but do not use physical exercise products (e.g., dumbbells, mattress, stepper, exercise bike) even so, only 37.3% use them. 42.7% know but do not use fitness apps, only 13.3% do. Finally, only 28.7% know but do not play Wii fit, 54% do not know what it is, thus it is the least known option, and only 8% play it. The percentages of knowledge and use of physical exercise products may be higher due to their higher visibility in physical stores.

A specific question was asked to understand how different types of exercise products impact the target users' motivation to exercise (Fig. 6). Additionally, to understand which fitness products are more likely to be used by them, another question was asked regarding their willingness to use the products (Fig. 7). It was interesting to see the contrast in how the products affect their motivation to exercise (Fig. 6) and how much they agree they would use them (Fig. 7). In Fig. 6, similarly to exercise in a game format, fitness apps

Summary of the effect of different types of exercise products on motivation to exercise



1: Strongly disagree, 2: Disagree, 3: Undecided, 4: Agree, 5: Strongly agree

Fig. 6. Summary of the effect of different types of exercise products on motivation to exercise.

also rank low when it comes to motivating the user to exercise (75% answered “strongly disagree”, “disagree”, and “undecided”). However, in Fig. 7, respondents noted they would more likely use a fitness app than a product that offers exercise in a game format. Additionally, physical products have a bigger impact on motivation and are more likely to be used by the respondents.

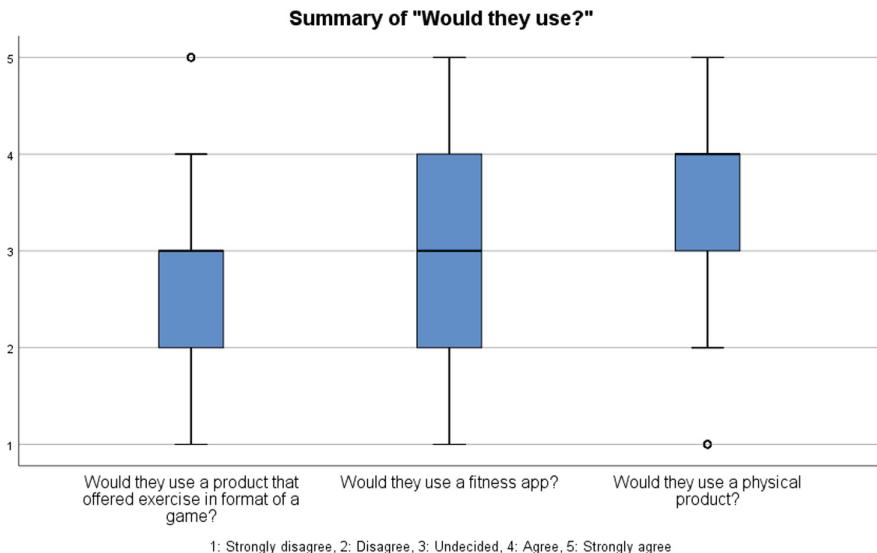


Fig. 7. Summary of “Would they use?” those fitness products.

Section 5. Final Thoughts. Respondents were asked how much they valued their autonomy (ability to perform daily tasks) and their level of motivation to maintain it. 85.3% strongly agree that they value autonomy and 60.7% strongly agree that they are motivated to adopt habits to help maintain autonomy.

The study also included questions designed to understand users’ preferences, their motivations and which exercise products they would use. Figure 8 summarizes the degree to which certain variables can affect the target user’s motivation to exercise. Their motivation would be further increased if they followed a plan made by professionals and exercised with friends or family. The “medium of exercise” (physical product, game format or app) rates lower.

Section 6. About You. It was important to assess the users’ familiarity with technology, as well as physical and emotional pains. Firstly, most users have none to few problems when using technology (55.3% have no problems, 32% have few problems). Secondly, most have no problems with mobility (77.3%) nor personal care tasks (92%). Regarding pain frequency however, the data is more spread out as 39.3% rarely feel pain, 32.7% feel pain sometimes, and 14.7% feel pain often. For most, the pain felt is soft (39.3%) or moderate (36.7%). Furthermore, the results show that 34.7% of respondents rarely

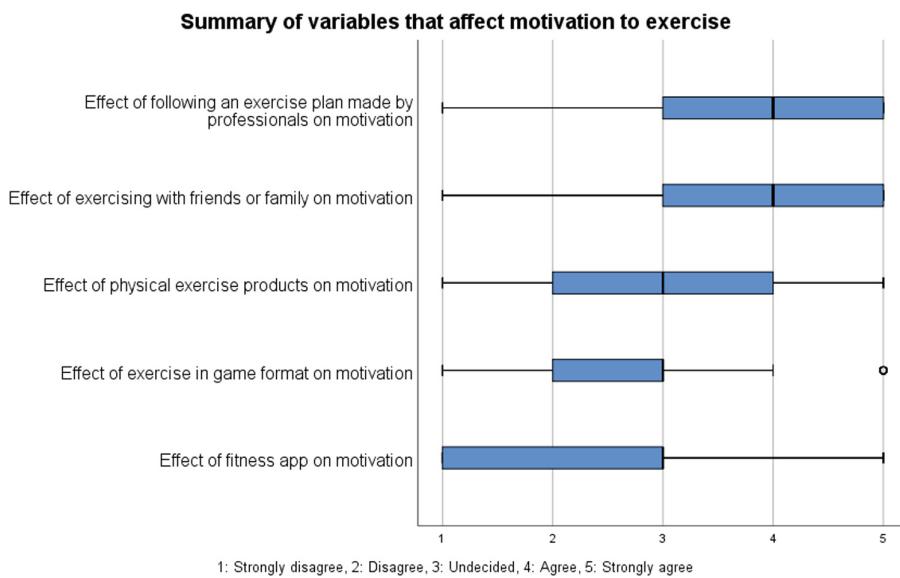


Fig. 8. Summary of variables that affect motivation to exercise.

feel anxiety, 32% feel it sometimes, and 13.3% feel it often. Additionally, 41.3% rarely feel depressive feelings, 25.3% never do, and 23.3% feel it sometimes. To be able to determine whether anxiety and depression increase with age, we need a bigger sample with a more balanced distribution in the age groups.

We can assume that, if the questionnaire had reached more people from the older age groups, the percentages regarding physical (Nakano et al. 2014) and emotional issues (Robins et al. 2002; Tresniewski 2003; Orth et al. 2010) would be higher.

Self-esteem (SE) was measured following the Rosenberg Self-Esteem Scale. Scores between 15 to 25 are considered average ("Rosenberg Self-Esteem Scale" 2014), which indicates that most respondents have an average level of SE (Fig. 9). SE tends to peak at 60 and then decline (Robins et al. 2002; Tresniewski 2003; Orth et al. 2010). As 66% of respondents are 56–64 years old and 26.7% are 65–74 years old, it supports that most SE values are not low. Furthermore, the respondents' demographic profile suggests a higher SE level since, most respondents are married, live with their spouse or partner, are educated, and do not live in isolated places (França 2015).

Regarding the relation between age and self-esteem, it is possible to see a tendency of decreasing SE with an increase in age (Fig. 10) which is supported by other studies (e.g., Robins et al. 2002; Tresniewski 2003; Orth et al. 2010). However, more data is needed to confirm these results (e.g., more respondents 75+, a wider range of demographic backgrounds).

Section 7. Demographic Information. There were a total of 150 respondents, 66% are 56–64 years-old and 26.7% are 65–74 years old, and 51.3% female. 48% have a degree pre-Bologna and 23.3% have a high school diploma or equivalent. A large number is

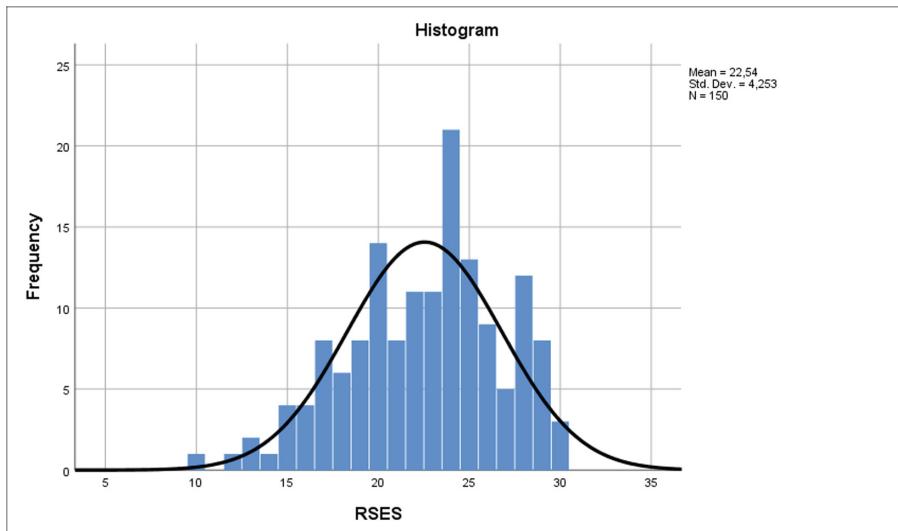


Fig. 9. RSES's histogram

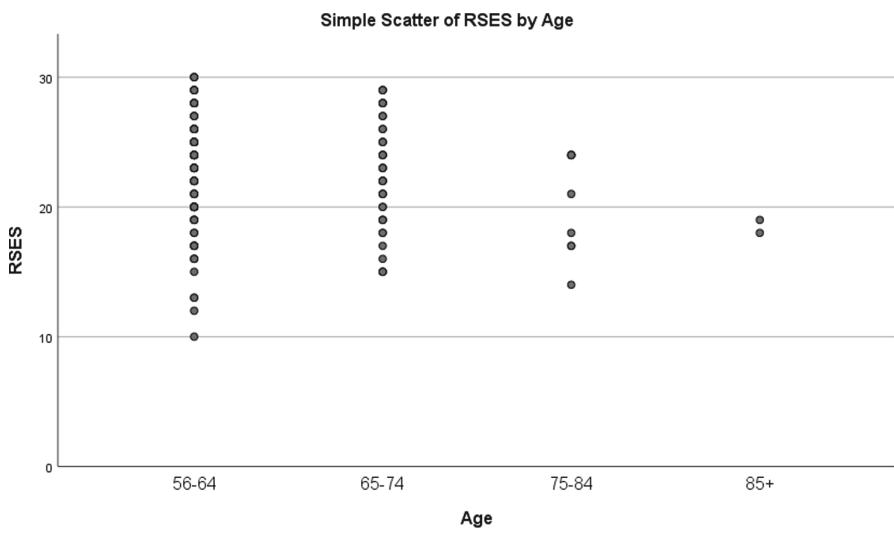


Fig. 10. RSES by age

still an active member of the workforce, 40.7% are working full-time, 14.7% are self-employed, and 34% are retired. 63.3% are married, 17.3% are divorced, and 73.3% live with their spouse/partner. Unfortunately, due to COVID-19, it was not possible to obtain answers from more people of the older age groups, 75–84 years old and 85+, that were supposed to be collected in a daycare center.

3 Conclusion

The user questionnaire showed that most respondents do not have an interest in game play. Most respondents do not know Wii-fit (54%) nor play it (only 8% play), most do not have the habit of playing games, whether they are non-digital or digital.

Furthermore, the majority of respondents did not agree that exercise in a game format would increase their motivation to exercise nor showed interest in using such a product. 75% answered “disagree” and “undecided” to exercise in a game format increasing their motivation to exercise and gave the same answers regarding if they would use such a product. This can show that many studies (e.g., Kappen et al. 2018; Chao et al. 2014; Willaert et al. 2020) focused on gamified solutions as a means to increase the wellbeing of older adults and elderly, do not reflect the target user’s point of view. Therefore, to increase the target users’ physical activity, a Human Centered Design approach is crucial to follow.

Moreover, when it comes to exercise in game format, fitness apps, or using physical products, the respondents are more likely to use physical products and then fitness apps. Additionally, considering what motivates them the most to exercise (following a plan made by professionals and being able to exercise with friends or family) and their main obstacles to do so (laziness, lack of motivations, and lack of time), it can be concluded that for a solution to succeed, from the target users’ point of view, it should: (i) be used in the house to save commuting time and Fig.ht laziness; (ii) allow for the user to exercise with friends or family (e.g., in person or in a remote way); (iii) allow the user to use physical products; (iv) offer training plans made by professionals. Considering these needs, to maximize the access, the solution should be digital. Furthermore, the questionnaire also helped to create the personas for the following phase which is ideation.

There are some limitations in this study. First, due to Covid-19, the study was not able to reach many people from the older age groups which makes it difficult to prove certain observations seen in literature.

(i.e., self-esteem declines with age, physical function declines with age). Second, since this study was conducted during the Covid-19 pandemic, some of the answers may differ from a “normal”, non-pandemic context (i.e., regularity of exercise, anxiety, depression).

This study may be relevant to designers as well as researchers, and medical and fitness professionals. We argue that, to suggest or design products as a means to increase the well-being of older adults and elderly, more user experience studies should be conducted to better understand their habits, needs, motivations, goals, preferences and struggles before, and while using such a product. This can be achieved by following a Human Centered Design approach focused on developing a positive user experience that genuinely satisfies Elderly needs and motivations.

The next steps of the ongoing project, that this paper takes part of, are to (i) define and develop the target users (i.e., personas, user journeys, customer segment table); (ii) ideate; (iii) develop a solution with a positive user experience that meets the users’ needs; (iv) test; and (v) iterate. The resulting digital solution can contribute to healthy ageing and well-being, as it will help to maintain or increase physical exercise, cognitive stimuli, and ultimately self-esteem.

Acknowledgement. The study was supported by UNIDCOM under a grant from the Fundação para a Ciência e Tecnologia (FCT) No. UIDB/00711/2020 attributed to UNIDCOM – Unidade de Investigação em Design e Comunicação, Lisbon, Portugal.

References

- Azevedo, M.A.: O envelhecimento ativo e a qualidade de vida: uma revisão integrativa (Master's thesis, Escola Superior de Enfermagem do Porto, Oporto, Portugal) (2015). <http://hdl.handle.net/10400.26/10776>
- Becker, A.: Exercício físico, qualidade de vida e autoestima global em idosos portugueses : um estudo exploratório do instrumento Whoqol-old (Master's thesis, Faculdade de Ciências do Desporto e Educação Física da Universidade de Coimbra, Coimbra, Portugal) (2013). <http://hdl.handle.net/10316/25068>
- Cardoso, N., Landenberger, T., Argimon, I.: Jogos Eletrônicos como Instrumentos de Intervenção no Declínio Cognitivo – Uma Revisão Sistemática. Revista De Psicologia Da IMED 9(1), 119 (2017). <https://doi.org/10.18256/2175-5027.2017.v9i1.1941>
- Chao, Y., Scherer, Y., Montgomery, C., Lucke, K., Wu, Y.: Exergames-based intervention for assisted living residents: a pilot study. J. Gerontol. Nurs. **40**(11), 36–43 (2014). <https://doi.org/10.3928/00989134-20140407-04>
- Chodzko-Zajko, W., et al.: Exercise and physical activity for older adults. Med. Sci. Sports Exerc. **41**(7), 1510–1530 (2009). <https://doi.org/10.1249/mss.0b013e3181a0c95c>
- Denissen, J., Penke, L., Schmitt, D., van Aken, M.: Self-esteem reactions to social interactions: evidence for sociometer mechanisms across days, people, and nations. J. Pers. Social Psychol. **95**(1), 181–196 (2008). <https://doi.org/10.1037/0022-3514.95.1.181>
- França Luís, T.: A Percepção da Autoestima e dos Sentimentos de Solidão em Idosos. Institucionalizados (Master's thesis, Instituto Superior Miguel Torga - Escola Superior De Altos Estudos, Coimbra, Portugal) (2015). <http://repositorio.ismt.pt/handle/123456789/485>
- Grimm, P.: Social Desirability Bias. Wiley International Encyclopedia of Marketing (2010). <https://doi.org/10.1002/9781444316568.wiem02057>
- Halpert, J.: 7 new tech devices for elder care that help seniors live happier, healthier lives. CNBC (2019). Accessed 15 Oct 2020, <https://www.cnbc.com/2019/09/12/7-new-tech-devices-for-that-help-seniors-live-happier-healthier-lives.html>
- Ijsselsteijn, W., Nap, H., de Kort, Y., Poels, K.: Digital game design for elderly users. In: Proceedings of the 2007 Conference On Future Play - Future Play '07, pp. 17–22 (2007). <https://doi.org/10.1145/1328202.1328206>
- Kappen, D., Mirza-Babaei, P., Nacke, L.: Older adults' physical activity and exergames: a systematic review. Int. J. Hum. Compu. Interact. **35**(2), 140–167 (2018). <https://doi.org/10.1080/10447318.2018.1441253>
- Karlamangla, A., Miller-Martinez, D., Aneshensel, C., Seeman, T., Wight, R., Chodosh, J.: Trajectories of cognitive function in late life in the united states: demographic and socioeconomic predictors. Am. J. Epidemiol. **170**(3), 331–342 (2009). <https://doi.org/10.1093/aje/kwp154>
- Kirk-Sanchez, N., McGough, E.: Physical exercise and cognitive performance in the elderly: current perspectives. Clin. Intervent. Aging **51** (2013). <https://doi.org/10.2147/cia.s39506>
- Liu, Y., Lund, H., Wu, L.: Playful cognitive training with physical interactive tiles for elderly. In: 2018 International Conference On Information And Communication Technology Robotics (ICT-ROBOT) (2018). <https://doi.org/10.1109/ict-robot.2018.8549898>
- Loos, E.: Exergaming: meaningful play for older adults? In: Zhou, J., Salvendy, G. (eds.) ITAP 2017. LNCS, vol. 10298, pp. 254–265. Springer, Cham (2017). https://doi.org/10.1007/978-3-319-58536-9_21

- McLeod, M., Breen, L., Hamilton, D.L., Philp, A.: Live strong and prosper: the importance of skeletal muscle strength for healthy ageing. *Biogerontology* **17**(3), 497–510 (2016). <https://doi.org/10.1007/s10522-015-9631-7>
- Nakano, M., Otonari, T., Takara, K., Carmo, C., Tanaka, C.: Physical performance, balance, mobility, and muscle strength decline at different rates in elderly people. *J. Phys. Ther. Sci.* **26**(4), 583–586 (2014). <https://doi.org/10.1589/jpts.26.583>
- Orth, U., Trzesniewski, K.H., Robins, R.W.: Self-esteem development from young adulthood to old age: a cohort-sequential longitudinal study. *J. Pers. Soc. Psychol.* **98**(4), 645–658 (2010). <https://doi.org/10.1037/a0018769>
- Pruessner, J., Lord, C., Meaney, M., Lupien, S.: Effects of self-esteem on age-related changes in cognition and the regulation of the hypothalamic-pituitary-adrenal axis. *Ann. New York Acad. Sci.* **1032**(1), 186–194 (2009). <https://doi.org/10.1196/annals.1314.017>
- Robins, R.W., Trzesniewski, K.H., Tracy, J.L., Gosling, S.D., Potter, J.: Global SE across the life span. *Psychol. Aging* **17**(3), 423–434 (2002). <https://doi.org/10.1037/0882-7974.17.3.423>
- Rodrigues, P.F.C.: Ansiedade, Autoestima E Qualidade De Vida: Estudo Comparativo Em Idosos Praticantes E Não Praticantes De Atividade Física (Master's thesis, Escola de Psicologia e Ciências da Vida - Universidade Lusófona de Humanidades e Tecnologias, Lisbon, Portugal) (2015). <https://core.ac.uk/download/pdf/48583885.pdf>
- Rosenberg Self-Esteem Scale. Shirley Ryan AbilityLab (2014). Accessed 31 May 2021, <https://www.sralab.org/rehabilitation-measures/rosenberg-self-esteem-scale>
- Sang, B., Oh, J., Park, H., Choi, S., Wee, J.: Differences in youngest-old, middle-old, and oldest-old patients who visit the emergency department. *Clin. Exp. Emerg. Med.* **5**(4) (2018). <https://doi.org/10.15441/ceem.17.261>
- Soeiro, M.S.: Envelhecimento Português Desafios Contemporâneos - Políticas e Programas Sociais - (Estudo De Caso) (Master's thesis, Faculdade de Ciências Sociais e Humanas - Faculdade Nova de Lisboa, Lisbon, Portugal) (2010). <http://hdl.handle.net/10362/5736>
- Tresniewski, K., Donnellan, M., Robins, R.: Stability of self-esteem across the life span. *J. Pers. Social Psychol.* (2003). <https://doi.org/10.1037//0022-3514.84.1.205>
- Willaert, J., De Vries, A., Tavernier, J., Van Dieen, J., Jonkers, I., Verschueren, S.: Does a novel exergame challenge balance and activate muscles more than existing off-the-shelf exergames? *J. Neuroeng. Rehabil.* **17**(6) (2020). <https://doi.org/10.1186/s12984-019-0628-3>



A Methodological Design Approach for Health Education: Indoor Radon Exposure Case Study

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Abstract. This study aims to analyze the contribution of a methodological design approach in health education, more specifically concerning indoor radon gas exposure. The work is implemented under the scope of the Project TECH - Technology, Environment, Creativity and Health and is part of a major research activity named RnHealthTech focused on the research of technologies for occupational health risk assessment in the Alto-Minho region, North of Portugal. The project is focused on communicating indoor radon gas exposure risks to young people through a design strategy where the dissemination of the results will be afterward assessed and validated. Accordingly, it is intended to investigate some specific solutions for the problem, through a literature review and on this basis to develop a method for the project implementation. The study seeks to highlight design as a human-centered methodology, to innovate solutions adopting the designer's mindset and approach the problem from the children's perspective, as well as the concept of how to create designs that evoke emotions that result in positive user experiences. It is expected to emphasize that employing design, and a visual communication strategy provides significant new benefits for children and young people in playfully and educationally environments, by using a human-centered approach.

Keywords: Design methodology · Radon risk exposure · Health education · Board games

1 Introduction

RnHealthTech is a Polytechnic Institute of Viana do Castelo, Viana do Castelo, Portugal research project that aims to reinforce the use of digital technologies for intelligent Indoor Air Quality (IAQ) monitoring in buildings, and therefore boost health education towards radon exposure. This investigation is strongly aligned with the purposes of

the 21st century, by promoting an integrated approach towards the societal challenges set out by the United Nations Sustainable Development Goals (SDGs), in particular as regards “*Goal 3: Ensure healthy lives and promote well-being for all at all ages*” [1], and contributing to solving local problems that institutions and community partners have previously identified. Under the scope of RnHealthTech, this research intends to design a straightforward methodology that focuses on developing a health education strategy towards indoor radon gas protection targeted at young children, aged between 6 and 9 years old.

The selected age group is mature enough to be provided with guidance concerning radon exposure, to be educated about radon risks, and be taught basic knowledge about environmental radiation so that they can make educated choices later in their lives.

To promote health and well-being, the designer’s role is broad and global, acting in an interdisciplinary way, by seeking new solutions aware of human behavior, social issues, and sensory factors. Based on that, the proposed methodology is beyond the design process and will help to understand the concepts of teaching-learning and communication strategies for health. By stimulating the act of playing in childhood, the RnHealthTech project is promoting children’s training on the risk of exposure to indoor radon gas, linking it to other scientific areas, such as design and health.

A Design project is always born from an unresolved problem. Much like other studies, the research started with a formulation of goals and objectives concerning the issue under investigation: Can Design, combined with Health Education methodologies, improve the effectiveness of risk communication concerning radon exposure among young children and adolescents? In this regard, both design methodologies and teaching-learning strategies, along with communication for health and playfulness to meet the project goals are extensively used.

To attain the proposed objectives, a design methodology will be applied not only to reach the outlined goals but also to contribute to the symbiosis of health communication and design thinking. Hence, this paper is organized as follows: Sect. 2 presents conceptual issues regarding radon gas exposure and its impact on human health. Section 3 describes the research methodology to be implemented. Following Sect. 3, Sect. 4 puts forward a discussion regarding design and communication strategies to be adopted, such as the health education strategy and the design path for the development of a board game for children.

Lastly, conclusions are undertaken with a special focus on risk communication to radon gas exposure, focused on children and adolescent populations, along with the impacts on the innovation of the products that the investigation will generate. The limitations of the research are also outlined.

2 Background

Radon gas arises from natural sources, is colorless, and is odorless. It is considered the largest source of natural ionizing radiation, formed by the radioactive decay of uranium in rocks and soil. This radioactive decay occurs when uranium becomes unstable and changes, forming new elements and releasing energy [2]. Radon concentration in the atmosphere is low, but in enclosed environments, such as housing, can reach worrying

levels. The highest values are found on lower floors, such as cellars, storerooms, and ground surfaces. The danger decreases with distance from the ground. Granite soil is the main source of radon, which infiltrates buildings through cracks and fissures in the pavement (for example, between the tiles) and on the walls, as well as in the joints of the pipes.

In winter, in less ventilated houses, the amount of this gas inside can be double that recorded in summer [3]. Living in a granite area is not synonymous with high levels: it all depends on the quality of construction, maintenance, and ventilation [4]. Because it is colorless and odorless, prolonged exposure to this gas indoors is not detected and can cause lung cancer, since its disintegration into radioactive particles can be trapped in the respiratory tract emitting radiation, and therefore contributing to lung cancer. In general, the room's surfaces covered with granite, such as walls and countertops, also release significant quantities of radon, especially if there are uninsulated fractured stones, for example, with varnish. Some brick and cement walls, in poorly ventilated rooms, can release radon if they contain sand from granite areas with a high content of radio and uranium.

The district of Viana do Castelo is located in the extreme north of the Portuguese national territory, in the region of Minho, between the river Minho and the river Neiva. It comprises ten municipalities, all with a high predominance of granitic soil (Fig. 1). This territory is very prone to indoor radon presence, therefore an extensive campaign to inform local people about the influence of this gas, which is often unknown to the population, is mandatory.



Fig. 1. Granitic soil map in the Minho Region. Source: Authors

According to the literature, the World Health Organization (WHO) [4] states that indoor radon gas is the second most relevant cause regarding lung cancer, after tobacco smoking, and is also responsible for a prominent incidence in cases of childhood leukemia. "When an individual spends time in an atmosphere that contains radon and its decay products, the part of the body that receives the highest dose of ionizing radiation is the lung tissue, although the extrathoracic respiratory tract and the skin can receive appreciable doses." [4]. Given this, it is necessary to create awareness among people concerning the risks of prolonged exposure to indoor radon gas, as well as the mechanisms to reduce its exposure.

3 Health Education: Board Games and children's Communication

According to the WHO (1998) [4], Health Education can be defined as a combination of learning experiences aimed at helping individuals and communities improve their health by increasing knowledge and influencing their attitudes. In this sense, it is important to teach children the best lifestyle habits to improve individual and collective health. However, providing comprehensible information to the public can be a challenge. It involves organizing and presenting the information in a way that is readable and understandable to the target audience. Human beings learn constantly and are born ready to learn. This process occurs in the brain and there may be more propitious periods, according to social interactions and depending on the individual's experiences, stimuli, challenges, and interactions [5]. Through play, children learn social norms of behavior, develop language, and explore their imaginations. Playing explores the child's thinking, which is modified through experience. In this sense, receiving health information playfully and activating the sensory receptors to explore colors, shapes, textures, smells, and sounds [6]. In this sense, we aim to develop a game to communicate the problem of radon exposure to children. A game can be considered as an activity that has easily agreed and compulsory rules. In any type of game, whether board or card games are integrated into the culture of playfulness [7]. Play is a great opportunity to educate, especially in health, which is so important for physical and emotional survival. We intend to create communicative support, a playful game to explore and contribute radon gas to the children's public, to instill knowledge and social responsibility of this invisible danger. For that purpose, it is necessary to encourage children to act, research, reflect, explore, through play and investigative conduct, they become more attentive, organized, able to act with more autonomy in decision-making when facing daily conflicts and obstacles [8]. This project-oriented study intends to apply Tim Brown's Design Thinking [9], a method

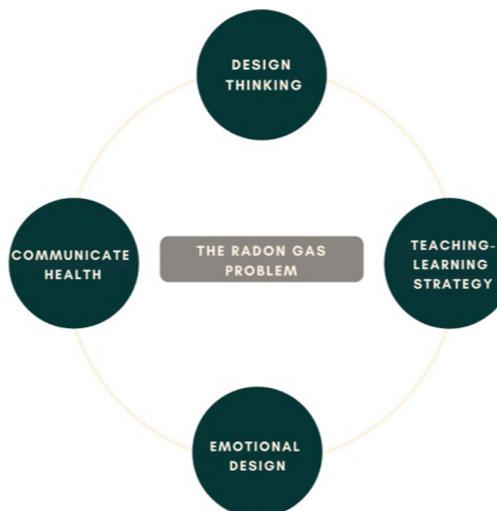


Fig. 2. Design as a multidisciplinary process. Source: Authors

to the problem, crossed with Donald Norman's Emotional Design [10], as depicted in Fig. 2.

Designers can collaborate in an interdisciplinary way, being able to think creatively and holistically and to solve the problem in the best way. Emotion Design plays a key role in the human thinking of the world and in dealing with novel situations. Objects contain a component that is appealing to the personal emotional side of each singular, activating good or bad recollections. Consequently, emotional design concerns the design of products and services that prompt a set of positive emotions in the consumer, leading to improved decision-making and problem-solving skills from designers [10].

It is also necessary to understand educational teaching strategies, and how they are applied in schools, as well as case studies of health issues for children and youth education so that the design can contribute to better communication. Learning strategies are procedures for education that facilitate and make possible the act of knowledge. These strategies can be changed through specific training to increase the effectiveness of learning a particular task [11].

Communication is inherent to the human being, being extremely necessary for the transmission of knowledge and understanding. In health, it would be no different, it is.

essential. In this context, design becomes a mediator in the process of communication in health. Communication does not only transmit information but at the same time imposes a behavior [12]. Thus, being a design communication project for the children's audience is of the most important for effective and well-done communication. Since the public is unaware of the risks associated with radon in indoor environments, it is recommended to formulate a special risk communication policy.

Also, radon risk communication should be focused on information for different audiences and recommendations for appropriate measures for radon reduction in indoor environments. Collaboration between technical experts and communication professionals is needed, to develop a range of specific messages [4]. The aim of this project is that knowledge about radon gas is measured before and after with the target audience, measuring the level of perceived knowledge on the subject.

4 Methodological Design Approach

Design is a multidisciplinary activity and an iterative process. The design needs a method to assist the problem-solving, which dictates the path of rational, explicit, and systematic procedures to successfully achieve the final goal of the project. In general, the method is the way to proceed, the way to act, a path to reach an end. It is the designation given to a set of rational, explicit, and systematic procedures put into practice to achieve statements and theoretical or concrete results.

The method is structured with the macro-level of the design process, and in a more specific field, determining the micro-level, such as the phases of research, intrinsic in the same design process. When we talk about methods, it is more appropriate to talk about attitudes, behaviors, and ways of acting. A method should not be confused with a recipe. A recipe is a formula, a pre-established model for achieving some results. The method corresponds to a series of operations, whose objective is to achieve the best result with the least effort. The difference between them is that a recipe can fail when faced with a

problematic situation, as it does not foresee the unexpected, and the design methodology precisely seeks and indicates the best way to overcome the unforeseen that can and will arise along the way.

The fact that there are rules does not inhibit creativity. The guidelines of the design method are made of objective values that become working tools in the hands of the creative designer, stimulating him/her to discover new things [10].

The creation of methodology increases the quantity and complexity of design problems. This meant that these problems were no longer dealt with intuitively or based only on the previous experience of the designer who managed the whole process [13]. Every problem-solving process uses research as a basis to find out information that can help to observe and understand the relevant events to achieve a certain objective. In this way, we were inspired by the methodologies of Design Thinking (T. Brown) linked to Emotional Design (D. Norman), as can be observed in Fig. 3.

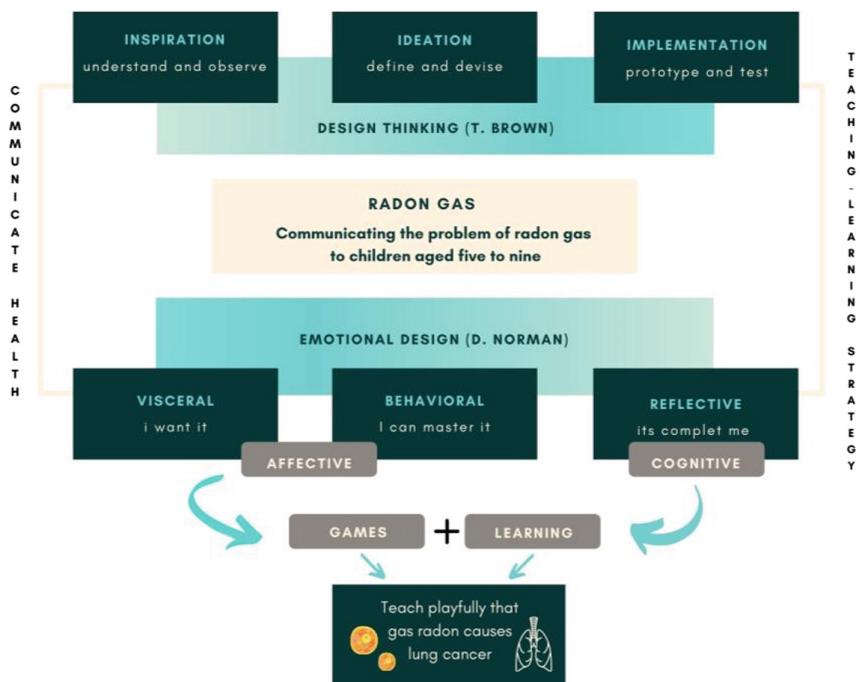


Fig. 3. Adopted design methodology Source: Authors

The practical questions that must be answered through the current investigation are the following: how can design contribute to children's health education? How to communicate in a straightforward way to a child audience to generate awareness not only with children but also among children's families? To answer the above-mentioned questions, the investigation tried not only to develop a strategy to communicate health hazards among children from 6 to 9 years old but also to emphasize the importance of Design as a process centered on the human being.

Design thinking has a human-centered principle and encourages the designer to focus on the people they are creating for, which indicates better products, services, and internal processes. There are many - but similar - variants of the Design Thinking process in use today, presenting from three to seven phases, stages, or modes. Design Thinking can be developed within a project context and dynamisms the articulation of a clear goal as a principle, creating deadlines naturally that impose discipline and allow us to review progress, make corrections along the way, and redirect future activities. This clarity, direction, and boundaries of a well-defined project are vital to sustaining a high level of creative energy.

There is not only one way to solve a problem, but in how many ways they are divided, they can have several stages. However, we focus on the three main stages: Inspiration, Ideation, and Implementation, as they include the whole method and directly relate to edutainment [9]. **Inspiration** is the stage of discovery, understanding the challenges, preparation of research, and define a clear problem statement. A good problem statement is human-centered, broad enough for creativity, yet specific enough to provide guidance and direction. The project briefing will begin to consider multiple perspectives: the problem of radon gas itself, through existing research such as surveys, studies of engineering professionals, as well as the problem in the indoor environment, soil mapping, to understand the concept of the problem involved, to then be able to develop the solution thought in the user's need: the youth audience. Also, health information needs to be clear, understandable, recallable, consistent, and personalized, and for that, it is extremely necessary to study the target audience and its peculiarities. This phase will guide the entire design process from here on out, giving you a fixed goal to focus on and helping to always keep the user in mind.

The **ideation** phase gets you thinking and exploring new angles. By focusing on the number of ideas rather than quality, you're more likely to free your mind and stumble upon innovation. During the ideation phase, you'll use a range of different ideation techniques such as brainstorming, promising ideas, and thinking about what is relevant to the target audience. Therefore, in this stage of development of the work, health education was considered an instrument for the construction of healthier societies through playful games as a tool.

The **Implementation** phase is the phase of prototyping and user testing. Having narrowed our ideas down to a select few, we will turn them into prototype versions of the product for can be tested on real users. This stage is crucial in maintaining a user-centric approach. The testing phase enables us to see where the prototype works well and where it needs improving. Based on user feedback, we can make changes and improvements before we spend time and money developing and/or implementing your solution.

On the other hand, Emotional design is based on the existence of three brain levels that require different stimuli in terms of design [10]. These are Visceral design, Behaviour design, and Reflexive design. The **Visceral level** is connected to appearance, characteristics that stimulate the senses. Relates to the products' first impact. The **Behavioral level** is connected to the effective use of the object, which addresses product use and experience. Also, comprises four components: function, specifying the activity the product is designed to perform, and understand the use. Finally, the **Reflexive level** relates to introspection and the meaning of the object [10] and addresses the meaning of

the products or their use, also the long-term relationships, culture, satisfaction to own, display or use, and the identity of the person concerning the product.

Emotion is assured a special place in the scope of design when someone is experiencing an emotion or a pleasant feeling that resonates in the increase of their creative potential and ability to solve technical problems. Differently, when the feeling is anxiety, it impacts attention and concentration, and in that case, the designer is required to make more effort to focus carefully on details. Hence, the role of emotion in design has been more important than has been recognized. Even if implicitly, design thinking has been considering the emotions and needs of its target public, since 'Design, at its most basic level is about rendering objects more desirable' [14] We currently live in a consumerist, hedonistic society, and this is one of the main avenues for the explicit introduction of the field of emotion in design thinking. The emotions are personal and each experiences different emotions when faced with the same product, also everyone may feel more than one emotion at the same time. Therefore, one may conclude that emotion is mutable, generated by a relatively short, immediate stimulus, and it is at this moment that it must be measured to obtain satisfactory results. Understanding the complex system of affective codes is essential for the designer to deeply understand the society in which it is inserted and realize how the emotions, attractions, and desires of the consumer emotions, attractions, and consumer desires [15].

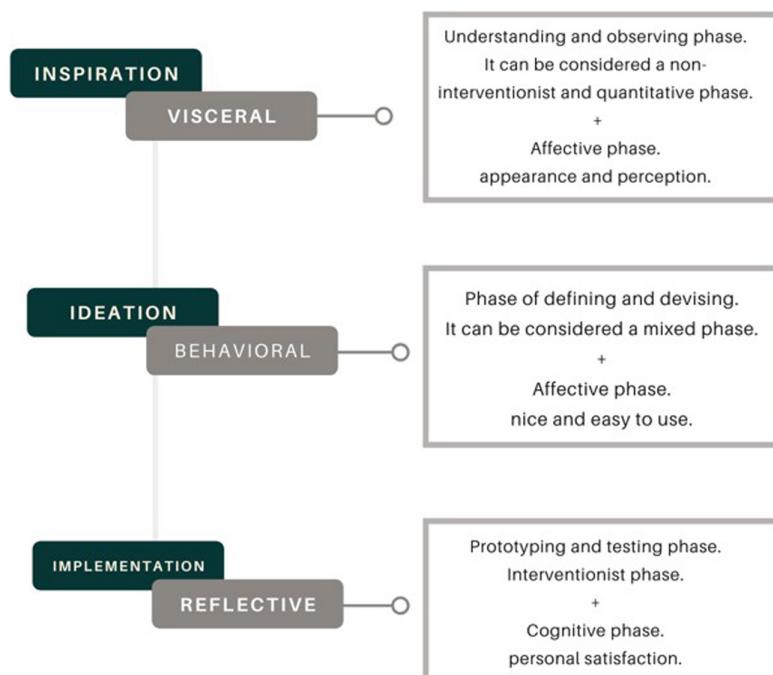


Fig. 4. Design Methodology process (Design thinking + emotional Design) Source: Authors

Emotions are a shared factor between humans and animals. However, emotions in humans have a special nature, in so far as they are interconnected with our actions, values, and judgments inherent to human life. The impact of emotions depends directly on the senses triggering such emotions. Feelings, on the other hand, allow emotions to affect the mind. With no emotions, we would not be able to take pleasure in life and to appreciate what surrounds us. Emotions give meaning and significance to things [16]. Attractive products work better; the more attractive they are, the more positive emotions they will trigger, which in turn will affect the mental process, making the individual more creative and more resilient to problems. The effect derives not only from the morphological qualities of the products but also from the shape of the type printed on the packaging, labels, bags, or even printed on the very objects.

Also, children can absorb all the information around them using their senses: smell, taste, touch, hearing, and sight. With health communication focused on children, they will develop and create new skills.

Figure 4, illustrates the proposed fusion design methodology. The proposed approach is a mix of two distinct methodologies: Design Thinking and Emotional Design. This mix aims to find better answers to this challenge. In this sense, this project seeks to communicate health education effectively to children through playful and fun alternatives, in a creative and focused way of solving problems. The literature review allowed us to reach different levels of valid knowledge and to verify distinct and relevant points of view. Within the Inspiration and Ideation stage, it will seek to reach the Visceral and Behavioral, which are effective, through better communication of health through playful games, aiming to reach the reflexive (cognitive) with better memorization of the content presented. It is possible to understand that design and health, not only can but should go hand in hand.

We believe in valuing the importance of health and well-being, focusing on prevention, rather than prioritizing the treatment of disease. The challenge of what and how to do design is to create exploration programs that aim to produce research results in semi-ready design, which are not focused on a specific project, but mainly intended to produce design knowledge that can be used according to the need [17]. Based on this statement it can be said that applied research has the function of generating knowledge and translating the information collected generically, in the terms and vision of design making them useful and usable for the solution of problems creatively and innovatively in the development process of a product project. The important thing is not to generate a specific knowledge that can only be applied in a certain moment or project, but that this knowledge is accumulating, enriching the designer's repertoire, making him/her more and more experienced and able to design new products in an increasingly creative way.

5 Conclusion

Design can be seen as a problem-solving process created to relate different aspects involved in the project execution. To that end, it is mandatory to adopt a systematized way of thinking not only to help create but also to plan and execute the project in various stages. From one hand, we have selected Design thinking because is a user-centric methodology, focusing on human first and foremost, seeking to understand people's needs and come up with effective solutions to meet those needs.

To complete this human-centered methodology we also include emotional aspects, as we are working with children and because we believe that emotions impact the decision-making process. In many cases, designers experience stimulating emotional responses in the external environment that influence their decisions on aspects of the design process which in turn will have an emotional outcome, e.g., in the arrangement of shapes or by opting for graphics or colors. All product aspects can evoke emotions; therefore, emotion-oriented design requires a holistic approach to the project in which the designer gives shape to a relationship between users and products, which in this specific case consisted of exploring emotions. Through sensory experiences, it allows cognitive development so that in this playful environment, the child can memorize the messages about health, exploring with curiosity, and experiencing the message transmitted.

The present research implies the connection and cooperation between two Design approaches, in the sense of developing a set of specific procedures that will be adopted in each stage of the work, whose development will be carried out in the future. Through this process, the designer, in addition to the final product development, may prioritize the development stages, focusing on the target users and needs. Implying the application of mixed process, the comparison and cooperation between methods will favor and influence the output of more thorough and representative results. The main goal of design methodology is to explain how designers think and develop methods that make the design process more efficient and effective.

Acknowledgments. This work is a result of the project TECH - Technology, Environment, Creativity and Health, Norte-01-0145-FEDER-000043, supported by Norte Portugal Regional Operational Program (NORTE 2020), under the PORTUGAL 2020 Partnership Agreement, through the European Regional Development Fund (ERDF). A.C. co-authored this work within the scope of the project proMetheus, Research Unit on Materials, Energy, and Environment for Sustainability, FCT Ref. UID/05975/2020, financed by national funds through the FCT/MCTES.

References

1. UN-ESC. Work on the review of progress towards the Sustainable Development Goals (2017). <https://unstats.un.org/unsd/statcom/48th-session/documents/2017-4-SDG-SG-E.pdf>
2. United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR). SOURCES AND EFFECTS OF IONIZING RADIATION; 2000 Report to the General Assembly, with Scientific Annexes; United Nations: New York, NY, USA, volume I: Sources (2000)
3. Curado, A., Lopes, S.I., Antão A.: On the relation of geology, natural ventilation and indoor radon concentration: the northern Portugal case study. Comunicações Geológicas (107), 31–41 (2021). ISSN: 0873–948X; e-ISSN: 1647–581X
4. World Health Organization (WHO). WHO Handbook on Indoor Radon: A Public Health Perspective; WHO: Geneva, Switzerland (2018)
5. Boita, C.: O brincar na aprendizagem infantil: do cuidar ao direito de aprender. SIEDUCA, Vol. 5, no. 1 (2020)
6. Munari, B.: Das Coisas Nascem Coisas. Edições 70, Lisboa (1981)
7. Vasconcellos, M.S., Carvalho, F.G., Araujo, I.S.: O jogo como prática de saúde [livro eletrônico]. Editora Fiocruz, Rio de Janeiro (2018)

8. Kebach, P.F.C.: O desenvolvimento da inteligência na primeira infância e as possibilidades de atuação construtivista e interacionista na educação infantil. *Revista Eletrônica de Psicologia e Epistemologia Genética* 10(2), 104–126 (2018)
9. Brown, T.: *Design Thinking* [recurso eletrônico] Uma metodologia poderosa para decretar o fim das velhas ideias (tradução Cristina Yamagami). Alta books, Rio de Janeiro (2020)
10. Norman, D.: *Emotional Design: Why We Love (or hate) Everyday Things*. Basic Books, New York (2004)
11. Zerbini, T., Abbad, G.: Estratégias de aprendizagem em curso a distância: validação de uma escala SciELO – Scientific Electronic Library Online, São Paulo (2008). <https://doi.org/10.1590/S1413-82712008000200005>
12. Watzlawick, P., Beavin, J., Jackson, D.: Pragmática da comunicação humana: um estudo dos padrões, patologias e paradoxos da interação. Cultrix, São Paulo (2002)
13. Bürdek, B.E.: *Design. História, Teoria e Prática do Design de Produtos*. Blücher, São Paulo (2006)
14. Greenhalgh, P.: *Quotations and Source on Design and the Decorative Arts*. Manchester University Press, Manchester (1993)
15. Desmet, P.: *Designing emotions*. delft, netherlands:technische universiteit, Delft. Des. J. Int. J. Aspects Des. 6(2), 60–62 (2002)
16. Gross, J.: Emotions and emotion regulation. In: *Handbook of Personality: Theory and Research*, pp. 525–552. Guilford Press, New York (1999)
17. Calvera, A.: Treinando pesquisadores para o design: algumas considerações e muitas preocupações acadêmicas. In: *Revista Design em Foco*, vol. III, no. 1, pp. 97–120. Salvador (2006)



Development of the Business Model and User Experience for a Pill Dispenser: A Designer Perspective

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Abstract. The elderly population has been significantly increasing all over the world, causing an emerging need to create products that facilitate the day-to-day life of this population and that prolong their independence in a domestic environment. This article focuses on the first phase of an investigation project which aims at creating a device that stores and dispenses pills automatically with the integration of a virtual assistant. In this first phase it was intended to define the user experience and business model for the product based on the state of the art, that addresses topics such as the problems resulting from aging, ambient assisted living, and current solutions available in the market for domestic environments, such as virtual assistants and pill dispensers. As a result, it was possible to determine that the product will have three type of user experiences, namely in the domestic environment, in hospitals and nursing homes/day centers/continuous care units and these experiences allowed it to define the business model much more clearly. In conclusion, this article will allow to proceed to the next phase of the project.

Keywords: Pill dispenser · Virtual assistant · Elderly · Design · Ambient assisted living

1 Introduction

In recent years, there has been a dramatic increase in the elderly population, that can be explained by the low birth rate and the increase in average life expectancy, resulting from developments in medicine and the improvement of health care [1]. In developed countries elderly are usually defined as people with over 65 years old [2]. Aging is the gradual accumulation of molecular and cellular damage that leads to physiological decline, chronic diseases, and a general decline in the individual's capacity [3] and as consequence, a greater prescription of medications is needed to control the worsening of the problems which can make medication regimens more complex. A study estimated that 45% of elders have difficulty managing their medication regime, making mistakes

like missed doses and/or overdosing, which can put their health at risk [4]. With the increase in health problems, performing daily tasks can be more challenging, so usually elderly people need help and supervision from caregivers to perform these tasks [5].

This project intends to target the issues in taking complex medication regimes and in the supervision of elders, through the development of a device that automatically stores and dispenses pills with the integration of a virtual assistant. This device, will make it possible to assist the elderly daily, improving medication adherence and improving communication with caregivers but also with health professionals like nurses and doctors. This device will be used in a domestic environment, hospitals, adult day care centers and continuing care units. For its development, the intention is to create a user experience that is intuitive for the elderly, applying all the principals of user-friendly approach. This article aims to define the business model and the user experience of the product.

2 State of the Art

2.1 Physical and Cognitive Characteristics of the Elderly

Physiological decrease caused by aging is a process that affects all organisms however, it is not possible to date the exact beginning due to biological, psychological, and social differences between individuals [8]. At the anthropometric level, there is a decrease in muscle mass, body water and bone mass, that when associated with low physical exercise and excessive caloric intake, leads to an increase in fat mass [9]. There are changes in height, on average, the body decreases 2 to 4 cm throughout life due to arthritis, inflammation of spinal joints, herniated discs, and kyphosis that causes spinal deformities [10, 11]. Difficulties arise in awareness of posture, balance and movement due to loss of sensitivity in the body's limbs [12–14]. In vision, there are losses in central and peripheral vision due to pathologies such as cataracts, glaucoma and macular degeneration [15, 16] and presbyopia, which makes it difficult to focus on close objects and adapt to low-light environments [17, 18]. In hearing, losses are suffered due to exposure to noisy environments throughout life [19–21]. In the sense of touch, difficulties arise in the perception of temperatures, vibrations, textures, among others [17, 22]. In the olfactory sensation, there is greater difficulty identifying and distinguishing between smells [23, 24] which combined with the decrease in taste sensitivity, generates a lack of appetite due to the loss of flavor in food [25–27]. One of the major cognitive problems caused by aging occurs in various aspects of memory [28, 29] such as, in prospective memory, which consists of the ability to retain information to perform a task [30], in short-term memory, responsible for information processing, linguistic comprehension, problem solving and learning [31, 32], in the episodic memory, which deals with the storage of information about experiences and personal events [32–35] and in semantic memory, responsible for the retention of knowledge, such as the meaning of words and symbols, but also general culture (music, geography, etc.) where lexical access becomes slower [34]. To tackle these cognitive and physical problems, greater attention will be paid to the development of device interfaces.

2.2 Ambient Assisted Living

The increase of the elderly population and the desire to grow old in the comfort of the home environment has been reflected in the growth of research in the topics such as aging at home, health, and technology [36]. Due to the improvement and emergence of new technologies, the “Ambient Assisted Living” was created, which aims at the conception of a home environment that provides automated assistance, responding and executing commands, but acting independently when needed [37]. This environment is supported by products that can transmit data and information to each other through wireless communication, such as body sensors, virtual assistants, among others [38]. These products can enhance communication between patient, doctor and caregivers, enabling the supervision of their clinical status, through the collection of data (e.g., measurement of blood pressure and diabetes), later sent and stored on servers, for access by the caregivers and the physician, who will provide feedback and new guidelines to the elderly, thus creating a continuous process of supervision [38]. The adoption of technological products by the elderly occurs mainly when they are influenced by their social group, as they provide assistance and help in their adaptation [39].

Virtual Assistants. There are currently various virtual assistants in the market, such as Google Assistant, Microsoft Cortana, Apple Siri, and Amazon Alexa. These devices work in a very similar way as all of them can be activated through voice commands, performing a series of tasks, such as sending and reading messages, responding to basic requests for information (“How is the weather today?”), set alarm clocks, reminders, media playback and control of smart home devices [40]. Google and Amazon have some interesting smart-home products that use their virtual assistants, the most interesting ones being smart-displays (Fig. 1), namely the Google Nest Hub and Amazon Echo Show 10 because in addition to the virtual assistant, they have a camera and a touch screen with an interface to control smart home products and to make video calls and play videos. The only difference between them is that the Amazon device rotates 360°, following the user when making video calls.



Fig. 1. Smart-displays - google nest hub and amazon echo show 10 (left to right)

Automatic Pill Dispensers. Currently on the market, there are several types of automatic dispensers (Fig. 2) such as GMS, MedaCube, MedMinder, Hero and Pria who have in common the ability to dispense medication automatically at the time pre-defined by the user. These devices target the needs of the elderly, but also the need of supervision by caregivers.



Fig. 2. Automatic pill dispensers - MedaCube, MedMinder, Hero e Pria (left to right)

A comparison was made based on 6 points, design, refilling of pills, services provided, sound and light alerts (degree of complexity), security and at last supervision features. In terms of design, the Pria and the Hero stand out by their minimalist design, however the Pria only has a touch screen, which can make it difficult to interact with the interface for elderly people and the Hero has physical buttons, but it has a smaller screen that makes viewing information difficult for seniors with vision problems. The MedaCube and Hero have a straightforward refilling process, the medication plan is inserted in MedaCube through the device screen and in the Hero through a smartphone app (which also allows for a remote change of the medication regimen) after that the device helps the user in the refilling process by saying what medicine to fill in each compartment. Because refilling is one of the main constraints of these devices, some have services provided by pharmacies that simplify this process. MedMinder sends trays for replacement weekly or monthly, whereas Hero only sends the missing medications, and the refill must be done by users. Regarding **alerts**, Pria and Hero are the most efficient as they have more complete sound and light signals, but they also have some differences. Pria notifies users through a female voice, while Hero only has a buzzer-style beep, both illuminating the base of the cup and asking users to confirm if the dosage is correct. Still, they do not have the possibility to customize the audible warnings with the voice of caregivers, such as MedMinder and MedaCube, which could be quite useful to familiarize the elderly to the use of this type of products. In terms of supervision, Pria stands out when compared to its competitors, as in addition to having a mobile application that alerts to the occurrence of missed doses and need of refilling, it also allows caregivers to establish contact with the elderly by sending messages or making video calls. The devices with greater security are the MedaCube and Hero, as they block access to the tablet's compartments, in addition to blocking access of the digital interface (via Pin or Password) to prevent access from inexperienced users. One of the features that these do not include, only found in the Pria device is the unlocking by facial recognition, which ensures that the intake is made by the elderly and not by other users.

3 Methods

In a first phase, a state of the art was carried out, addressing topics such as health problems that affect the elderly, ambient assisted living, and devices available on the market

like automatic pill dispensers and virtual assistants. Based on the acquired knowledge, the user experience was defined using the sequential model of Beyer and Holtzblatt [6], in which it was concluded that there would be three types of user experiences, namely in domestic environment, hospitals and nursing homes/adult day care centers/continuing care units. Based on these sequence models it was possible to define the business model for the product though a canvas structured by Osterwalder and Pigneur [7], which divides business models in nine building blocks: customer segments, value propositions, channels, customer relationships, revenue streams, key resources, key activities, key partnerships, and cost structure.

4 User Experience

To define the user experience, a meeting was held with the team formed by mechanical, electronics, and informatics engineers and with industrial designers. It was concluded that there would be three types of experiences for the product, namely in the domestic environment, in a hospital environment and another in nursing homes/day centers/continuous care units. The device should also be able to support the use by various users (multiple profiles). For the definition of these three user experiences, a sequence model was used [6].

4.1 Domestic User Experience

At the time of taking the pills the elder will be alerted by the device through a soothing voice and some flashing LEDs and will receive a notification through the smartphone APP. This app can be used by the elder but also the caregiver who can supervise the medication regimen and contact the elder through phone calls or videocalls.

The dosage is dispensed into a cup after recognizing the user's face and the user is asked to check if pill dosage is correct (showing a screen message with the number of pills that the cup should have). After confirmation, the user takes the pills and is notified by a message on the screen to place the cup in the right place, while the cup location is being illuminated by a LED.

The replacement of the cartridge is scheduled by phone call or video call, in which a technical assistant collects the empty cartridge and replaces it, in addition to carrying out a maintenance to the device if necessary. Afterwards, the empty cartridges are taken to the company, in a first stage they are sterilized, and then forwarded to the filling site, where a pharmaceutical technician accesses the elderly's files to check the medication regimen, selecting and separating the medications to refill the cartridge. After refilling he proceeds to labeling the cartridge with the user ID (name and address). Lastly, the cartridge is sent to the company shipping area, to be sent back to the patient.

The sale of the product is guaranteed by a specialized department, responsible for contacting and selling the bundles, namely bundles A and B, the two ensure the replacement of the cartridge 2 times a month and assistance for device maintenance. After every sale made by the commercial employee, the administrator (1) asks the user for all the necessary information and for the medication regimen just to be able to give a pre-budget to the buyer, later he contacts the family doctor to obtain the medication accurately and

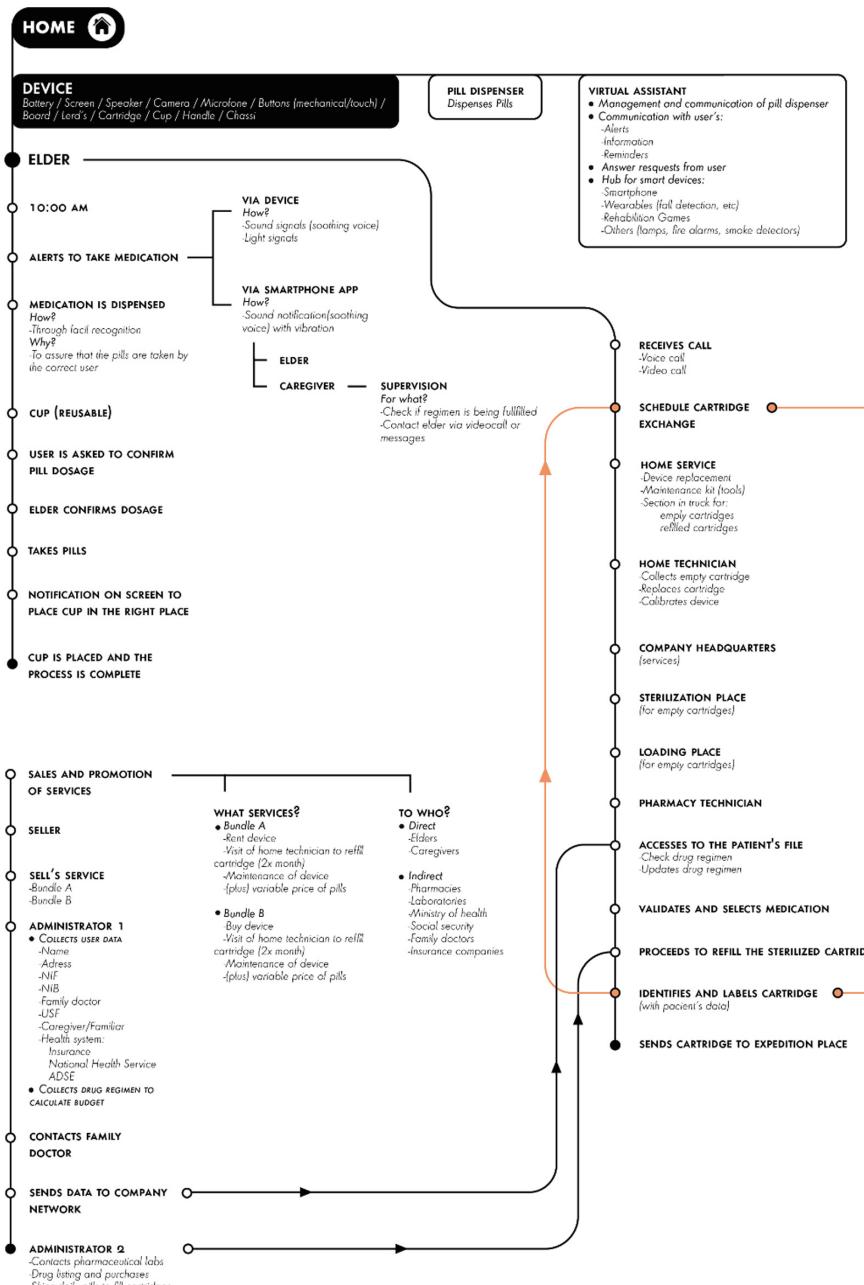


Fig. 3. Sequence model of the user experience in domestic environment

saves these data in the company's servers, based on these data, the administrator (2) is responsible for contacting the labs and ordering the necessary medication and forwarding them to the refill site. The Fig. 3 shows the sequence of the user experience in a domestic scenario.

4.2 Hospital User Experience

When it is time to take the pills, the device alerts the pharmacist through sound and some flashing LED's. The pills are dispensed automatically for a (disposable) medicine cup and the device asks the pharmacist to confirm if the pill dosage is correct (showing a screen message with the number of pills that the cup should have), after confirmation, the pills are dispensed, and the device shows a screen message to replace the cup. At the same time, the nurse who oversees the patient is notified (through the computer monitor on the patient's room and though a smartphone app) to pick up the pills from the pharmacy room. At last, the nurse gives the pills to the patient.

For hospitals, the department of sales and promotions (responsible for contacting and selling the bundles) has available two bundles, namely bundle C and D. These two

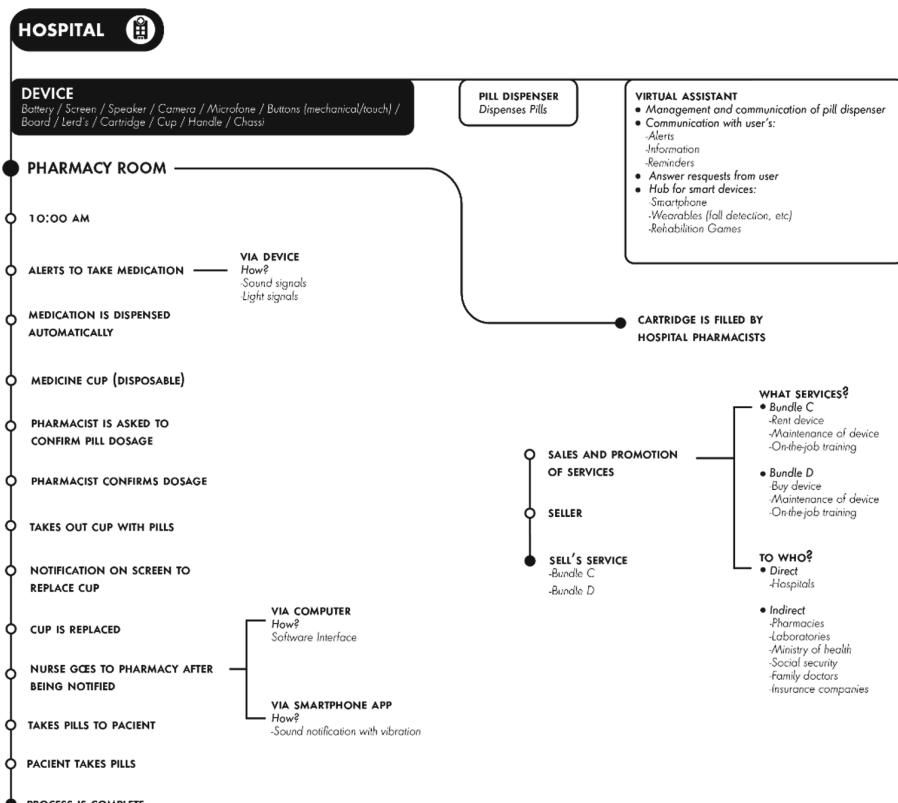


Fig. 4. Sequence model of the user experience in hospitals

ensure the device maintenance and on the job training, to teach pharmacists and nurses how to use the devices. These bundles do not include the refilling of cartridges because this process is assured by the hospital pharmacy. The Fig. 4 shows the sequence of the user experience in a hospital scenario.

4.3 Nursing Home/Adult Day Care Centers/Continuing Care Units User Experience

When it is time to take the pills, the nurses are alerted via device (sound and some flashing LED's), smartphone app and computer monitor. The pills are dispensed automatically for a (disposable) medicine cup and the device asks the nurse to confirm if the pill dosage is correct (showing a screen message with the number of pills that the cup should have). After confirmation, the pills are dispensed, and the device shows a screen message to replace the cup. At last, the nurse gives the pills to the patient room.

The department of sales and promotions (responsible for contacting and selling the bundles) has available the same type of bundles offered to hospitals, namely bundle C and D. These two ensure the device maintenance and on the job training, to teach healthcare assistants and nurses how to use the devices. These bundles do not include the refilling of cartridges because this process is assured by the nurses responsible for

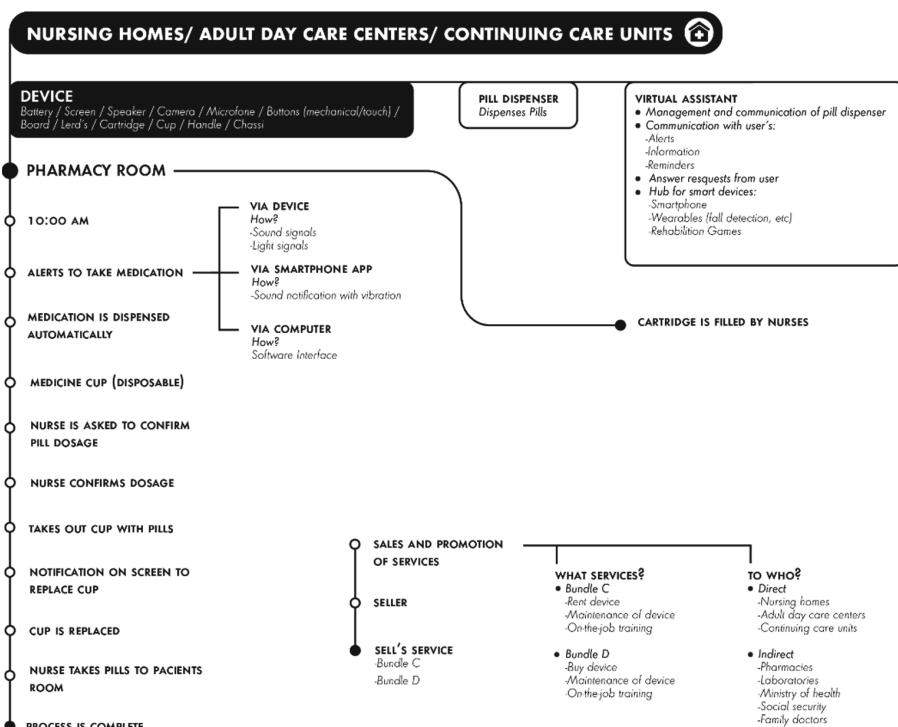
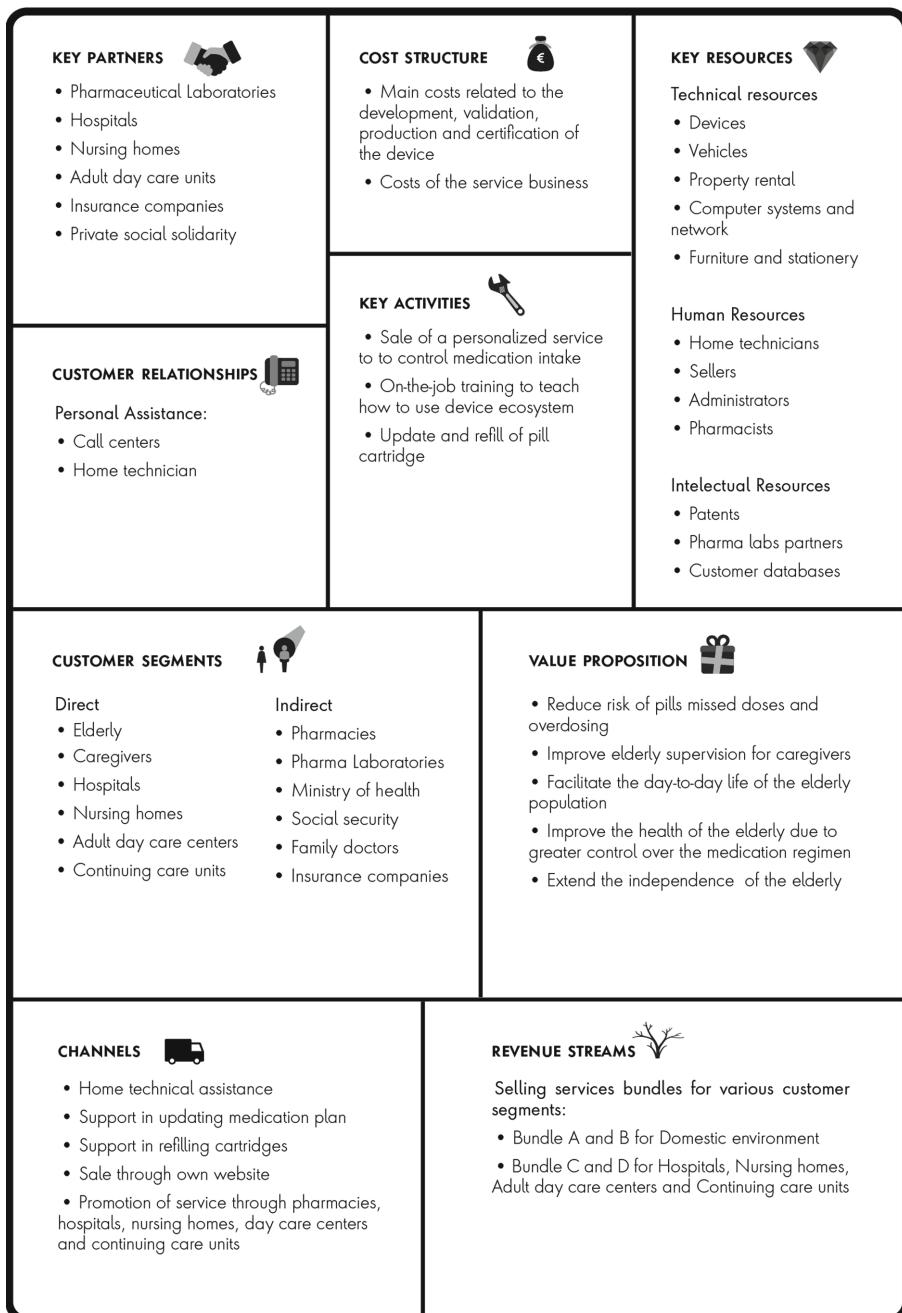


Fig. 5. Sequence model of the user experience in nursing homes, adult day care centers and continuing care units

medication. The Fig. 5 shows the sequence of the user experience in nursing homes, day-care centers, and continuing care units.

5 Business Model

With the user experience done, it was possible to define the business model for the product. For this purpose, it was used a structure developed by Osterwalder and Pigneur [7], which consists in a canvas divided into nine business model building blocks. The Key Partners, which involves all crucial suppliers and partners for the operation of the business, in this case the main ones are pharmaceutical laboratories, hospitals, nursing homes, adult day care centers, insurance companies, private social solidarity institutions and national health services. The Key Activities incorporates all essential actions to the business, more specifically the sale of a personalized service to control medication intake, on-the-job training to teach how to use the device ecosystem and the refill of cartridge pills. The Key Resources refers to all essential assets in a company, in this case there are, technical resources, which includes devices, vehicles, the property rental, computer and network systems, furniture and stationery material, Human resources, like home technicians, sellers, administrators and pharmacists, and at last Intellectual property, which includes patents, the pharmaceutical laboratories partners and customer databases. The Customer Segments describes the group of people that a business aims to reach, in this case there is direct customers, like elders, caregivers, hospitals, nursing homes, adult day care centers and continuing care units, and indirect ones like pharmacies, pharmaceutical laboratories, ministry of health, social security, family doctors and insurance company. The Cost Structure represents all costs necessary to operate a business, and the mainly ones are costs related with the development, validation, production, and certification of the device and costs inherent in providing the service. The Customer Relationships describes the types of relations a company establishes with its customers, as for this one, the core one is providing personal assistance, via voice call or through home assistance. The Value Proposition refers to products and services that create value for the Customer Segment, the primarily objectives are to reduce the risk of pill missed dosages and overdosages, improve the elderly supervision for caregivers, facilitate the day-to-day life of the elderly population, give more control over the medication regimen to improve their health and prolong their independence. The Channels describes how a company connects and reaches its customer to deliver a value proposition, as for this one, the company will promote their services via pharmacies, hospitals, nursing homes, adult day care center and continuing care units, and the sale of the services will be possible through their own website, providing customers support, including home technical assistance, update of the medication plan and refilling of cartridges. The Revenue Streams comes from the selling of different types of service bundles, such as bundle A and B for domestic environment, which includes the refill service, and bundle C and D, oriented to hospitals, nursing homes, adult day care centers and continuing care units, which offers training to health care professionals but does not include the refill services, as they usually do that in-house (Fig. 6).

**Fig. 6.** Business Model Canvas for the product

6 Conclusion

The initial research on topics, such as, problems caused by aging and the analysis of products, namely dispensers and virtual assistants, made it possible to recognize the main ideas to be implemented in the future device. The meeting to define the experience of use allowed to realize that the operation of the device will be built on a service aimed at various types of consumers, such as elders, caregivers, hospitals, nursing homes and continuing care units. The device will be maximized in a home environment because it will take advantage of all the features, namely the automatic dispensing, virtual assistance, and the home service that replaces the cartridges, while in other environments, such as hospitals, nursing homes and continuing care units, the use of the device will be based more on the automatic dispensing of pills. Based on the user experiences encountered, it was possible to define the business model with all the main resources for the operation of the product, involving customers, infrastructure, offers, and financial viability of the service.

These previous discoveries will allow to move forward in the development of the project, moving on to the design of the architecture and requirements for the product, to proceed to the conception and development of the device.

Acknowledgments. This work was funded by the projects “NORTE-01-0145-FEDER-000045”, supported by Northern Portugal Regional Operational Programme (Norte2020), under the Portugal 2020 Partnership Agreement, through the European Regional Development Fund (FEDER).

References

1. Gonçalves, C., Carrilho, M.L.: Ageing – an increasing phenomenon with geographical differences. *Revista de Estudos Demográficos* **40**, 21–37 (2006)
2. Orimo, H., Ito, H., Suzuki, T., Araki, A., Hosoi, T., Sawabe, M.: Reviewing the definition of “elderly.” *Geriatr. Gerontol. Int.* **6**(3), 149–158 (2006). <https://doi.org/10.1111/j.1447-0594.2006.00341.x>
3. World Health Organization. *World report And Ageing on Health* (2015)
4. Advinha, A.M.M.: Avaliação da Capacidade Funcional da População Idosa na Gestão da Sua Medicação (2017)
5. Reinhard, S.C., Given, B., Petlick, N.H., Bemis, A.: Supporting family caregivers in providing care. patient safety and quality: an evidence-based handbook for nurses (2008)
6. Benyon, D., Turner, P., Turner, S.: *Designing Interactive Systems*. Addison Wesley, Boston (2005)
7. Osterwalder, A., Pigneur, Y.: *Business Model Generation*. John Wiley & Sons, Hoboken (2010)
8. Ferreira, L., Filho, D.E.B., Janeiro, R.I.O.D.E.: O processo de envelhecimento. *Psicologia, Licenciatura*, pp. 1–15. Ficha no. 27 (2008)
9. Nogueira, A.R.C., Oliveira, B., Afonso, C.: Referências antropométricas para a população adulta e idosa Portuguesa. *Faculdade de Ciencias Da Nutrição e Alimentação Da Universidade Do Porto. Tese de Mestrado* (2016)
10. Fernihough, A., McGovern, M.E.: Physical stature decline and the health status of the elderly population in England. *Econ Hum Biol.* (2015). <https://doi.org/10.1016/j.ehb.2013.12.010>. *Physical*

11. Wei, H., Lei, X., Ridder, G., Strauss, J., Zhao, Y.: Health, height, height shrinkage, and SES at older ages: evidence from China. *Am. Econ. J.* (2013). <https://doi.org/10.1257/app.5.2.86>. *Health*
12. Drummond, A., dos Paz, C.C.S. C., deMenezes, R. L.: Proprioceptive activities to postural balance of the elderly - systematic review. *Fisioterapia Em Movimento* **31**, 1–13 (2018). <https://doi.org/10.1590/1980-5918.031.ao35>
13. Lord, S.R., Clark, R.D., Webster, I.W.: Postural stability and associated physiological factors in a population of aged persons. *J. Gerontol.* **46**(3), M69–M76 (1991). <https://doi.org/10.1093/geronj/46.3.M69>
14. Lord, S.R., Ward, J.A.: Age-associated differences in sensori-motor function and balance in community dwelling women. *Age Ageing* **23**(6), 452–460 (1994). <https://doi.org/10.1093/ageing/23.6.452>
15. Resnikoff, S., et al.: Global data on visual impairment in the year 2002. *Bull. World Health Organ.* **82**(11), 844–851 (2004). <https://doi.org/S0042-96862004001100009>
16. World Health Organization. World report on vision. In World health Organization, vol. 214, no. 14 (2019)
17. Czaja, S., Boot, W., Charness, N., Rogers, W.: Designing for Older Adults: Principles and Creative Human Factors Approaches. CRC Press (2019). <https://doi.org/10.1201/b22189>
18. Owsley, C.: Aging and vision. *51*(13), 1610–1622 (2012). <https://doi.org/10.1016/j.visres.2010.10.020>. *Aging*
19. Gopinath, B., Rochtchina, E., Wang, J., Schneider, J., Leeder, S., Mitchell, P.: Prevalence of age-related hearing loss in older adults: blue mountains study. *Arch. Internal Med.* **169**(4), 415 (2009). <https://doi.org/10.1001/archinternmed.2008.597>
20. Cruickshanks, K.J., Wiley, T.L., Tweed, T.S., Klein, B.E.K., Klein, R., Mares-Perlman, J.A., Nondahl, D.M.: Prevalence of hearing loss in older adults in beaver dam, wisconsin: the epidemiology of hearing loss study. *Am. J. Epidemiol.* **148**(9), 879–886 (1998). <https://doi.org/10.1093/oxfordjournals.aje.a009713>
21. Lin, F.R., Thorpe, R., Gordon-Salant, S., Ferrucci, L.: Hearing loss prevalence and risk factors among older adults in the United States. *J. Gerontol. Ser. A Biol. Sci. Med. Sci.* **66A**(5), 582–590 (2011). <https://doi.org/10.1093/gerona/glr002>
22. Norman, J.F., Adkins, O.C., Hoyng, S.C., Dowell, C.J., Pedersen, L.E., Gilliam, A.N.: Aging and the haptic perception of material properties. *Perception* **45**(12), 1387–1398 (2016). <https://doi.org/10.1177/0301006616659073>
23. Boyce, J.M.: Effects of ageing on smell and taste. *Postgraduate Med. J.* **82**(966), 239–241 (2006). <https://doi.org/10.1136/pgmj.2005.039453>
24. Doty, R., Shaman, P., Applebaum, S., Giberson, R., Siksorski, L., Rosenberg, L.: Smell identification ability: changes with age. *Science* **226**(4681), 1441–1443 (1984). <https://doi.org/10.1126/science.6505700>
25. Neumann, L., Schauren, B.C., Adami, F.S.: Sensibilidade gustativa de adultos e idosos. *Revista Brasileira de Geriatria e Gerontologia* **19**(5), 797–808 (2016)
26. Paula, R.S., Colares, F.C.J., Toledo, J.O., Nóbrega, O.T.: Alterações gustativas no envelhecimento. *Kairós Gerontologia*, **11**(1), 217–235 (2008). <https://doi.org/10.23925/2176-901X.2008v11i1p>
27. Schiffman, S., Zervakis, J.: Taste and smell perception in the elderly: effect of medications and disease. In: *Advances in Food and Nutrition Research*, vol. 44, no. February (2002). [https://doi.org/10.1016/S1043-4526\(02\)44006-5](https://doi.org/10.1016/S1043-4526(02)44006-5)
28. Nilsson, Lars-Göran.: Memory function in normal aging: Memory function in normal aging. *Acta Neurologica Scandinavica* **107**, 7–13 (2003). <https://doi.org/10.1034/j.1600-0404.107.s179.5.x>
29. Tulving, E.: How many memory systems are there? *Am. Psychol.* **40**(4), 385–398 (1985). <https://doi.org/10.1037/0003-066X.40.4.385>

30. Zimmermann, T., Meier, B.: The rise and decline of prospective memory performance across the lifespan. *Q. J. Exp. Psychol.* **59**(12), 2040–2046 (2018). <https://doi.org/10.1080/17470210600917835>
31. Cowan, N.: Working memory underpins cognitive development, learning, and education. *Educ. Psychol. Rev.* **26**(2), 197–223 (2013). <https://doi.org/10.1007/s10648-013-9246-y>
32. Nyberg, L., Lövdén, M., Riklund, K., Lindenberger, U., Bäckman, L.: Memory aging and brain maintenance. *Trends Cogn. Sci.* **16**(5), 292–305 (2012). <https://doi.org/10.1016/j.tics.2012.04.005>
33. Mitchell, D., Brown, A., Murphy, D.: Dissociations between procedural and episodic memory: Effects of time and aging. *Psychol. Aging* **5**(2), 264–276 (1990). <https://doi.org/10.1037//0882-7974.5.2.264>
34. Nyberg, L., Maitland, S., Rönnlund, M., Bäckman, L., Dixon, R., Wahlin, Åke., Nilsson, Lars-Göran.: Selective adult age differences in an age-invariant multifactor model of declarative memory. *Psychol. Aging* **18**(1), 149–160 (2003). <https://doi.org/10.1037/0882-7974.18.1.149>
35. Verhaeghen, P., Salthouse, T.: Meta-analyses of age-cognition relations in adulthood: estimates of linear and nonlinear age effects and structural models. *Psychol. Bull.* **122**(3), 231–249 (1997). <https://doi.org/10.1037//0033-295X.122.3.231>
36. Vasunilashorn, S., Steinman, B., Liebig, P., Pynoos, J.: Aging in place: evolution of a research topic whose time has come. *J. Aging Res.* **2012**, 1–6 (2012). <https://doi.org/10.1155/2012/120952>
37. Do, H., Pham, M., Sheng, W., Yang, D., Liu, M.: RiSH: a robot-integrated smart home for elderly care. *Rob. Auton. Syst.* **101**, 74–92 (2018). <https://doi.org/10.1016/j.robot.2017.12.008>
38. Dohr, A., Modre-Osprian, R., Drobics, M., Hayn, D., Schreier, G.: The internet of things for ambient assisted living. In: ITNG2010 - 7th International Conference on Information Technology: New Generations, pp. 804–809 (2010). <https://doi.org/10.1109/ITNG.2010.104>
39. Peek, S., Luijkx, K., Rijnjaard, M., Nieboer, M., van der Voort, C., Aarts, S., van Hoof, J., Vrijhoef, H., Wouters, E.: Older adults' reasons for using technology while aging in place. *Gerontology* **62**(2), 226–237 (2016). <https://doi.org/10.1159/000430949>
40. Hoy, M.: Alexa, siri, cortana, and more: an introduction to voice assistants. *Med. Ref. Serv. Q.* **37**(1), 81–88 (2018). <https://doi.org/10.1080/02763869.2018.1404391>



Playful Spaces

Versatility, Appropriation end Emotion in Jewellery Design

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Abstract. Our research derives from the interaction between product scale and architecture. We are interested in exploring organic concepts dominated by asymmetric and modular geometrical shapes. A jewel can convey different appropriations and emotions such as architecture composed of poetic and intangible spaces. Our design methodology corresponds to an experimental process frequently based on drawings, cardboard models, 3D drawings, or prototypes, focusing on main principles such as spatiality, versatility, mutability. We had explored the relationship between shadow and light, scale variations, the opposition between empty and full spaces, the chromatic or texture contrast. Line dominates these modular structures, linking heterogeneous volumes and surfaces. In the same way, we can rehabilitate instead of constructing, we can approach the assemblage and folding techniques from pre-existing materials in the jewellery field. From wastes or mass-produced materials that are no longer useful crossed with traditional metals like silver, we proceed to the production of limited series pieces suitable for a public who values jewels by their unique design regardless of the value of its material and, at the same time, progressively conscious of negative impact derived of the extraction of raw materials and from the manufacture of the jewels themselves.

Keywords: Jewellery design · Modularity · Versatility

1 Jewellery as an Extension of Ourselves

How do we look at jewelry in the present? If in backward times, jewellery could play a role of protection or communication of power and social status, nowadays it gradually assumes its place as a particular and unique territory with which we can establish a relationship with different contours and meanings according to our context.

The object, the artifact, the accessory in this case only makes sense in a context. Heidegger in his book “The origin of the artwork” uses a specific example, a pair of peasant shoes, demonstrating the instrumental character of the object itself. The author gives the example of a pair of shoes seen through a pictorial representation of Van Gogh who would have painted this theme several times. In the first look from Van

Gogh's painting, it is not possible to perceive the environment of the shoes: "There is nothing surrounding this pair of peasant shoes to which and within which they could belong; only an undefined space" [1]. It is a pair of shoes without marks of the field, of the soil, something that denounces its use but "In the crudely solid heaviness of the shoes accumulates the tenacity of the slow trudge through the far-stretching and ever-uniform furrows of the field swept by a raw wind. (...) This equipment belongs to the earth and finds protection in the world of the peasant woman. From out of this protected belonging the equipment itself rises to its resting-within-itself." [2]. The deeper meanings, the essence of that pair of shoes was simply communicated by an artwork that could otherwise be described from the point of view of its manufacturing process or by observing its functionality, dimensions, constructive solution, and so on, fundamental aspects but which are not sufficient. Heidegger, at the same time, confirms that an object, in the face of a deeper look, can denounce more than a utilitarian function sharing with us a narrative. In architecture, the same happens if we analyze it from a non-merely functional and simplistic perspective. This creative field reflects the invaluable socio-cultural framework of the so-called place of "genius loci" paraphrasing Norberg Schulz: "A place is, therefore, a qualitative, "total" phenomenon, which we cannot reduce to any of its properties, such as spatial relationships, without losing its concrete nature out of sight. Everyday experience moreover tells us that different actions need different environments to take place in a satisfactory way. As consequence towns and houses consist of a multitude of particular places. (...) "Taking place" is usually understood in a quantitative, "functional" sense, with implications such as spatial distribution and dimensioning. But are not "functions" interhuman and similar everywhere? Evidently not" [3].

Even the pieces of jewelry consist of multiple and private "places" conditioned by the way of seeing the world and experiences of those who idealize them in a project and also execute them chasing an idea that is not exhausted in the concern with functionality: "The functional approach, therefore, left out the place as a concrete "here" having its particular identity" [3]. In this field of research of contemporary jewellery we are particularly moved by the desire to rethink the relation between the object and the body, either by the direct relationship that is staggered from the moment we become bearers of a jewel or by the contemplative relationship that we can establish with it if we think about jewelry as an autonomous work of art. As John Lau observes "the accessories are extensions of the body, put and take elements that are used to protect, hide or for ostentatious purposes. They are symbols that identify and distinguish their users; however, when they are not in use, they become isolated objects that only with a powerful presence can seduce" [4]. A piece of jewellery plays a non-utilitarian but symbolic, cultural, and aesthetic function. It can function like an asymmetry in the way we dress, becoming a part of our identity just like a house that reflects the same way its owner personality. At last, not only a jewel is an extension of our selves just like architecture, assuming changes in everyday life according to our mood but also can contribute to important goals related to sustainability breaking with the traditional connection established between jewellery field and precious gems.

2 Concept and Creative Process

The Playful Spaces collection #2 marks the conclusion of a post-doctorate in Design at Lisbon School of Architecture, under the supervision of Professor Moreira da Silva. Architecture and design as a process of searching for new concepts in response to the needs and aspirations of human beings would be transposed to the scale of jewellery design and translated into a research project. In the context of this research, we have opted for methods inherent in design research, namely literary criticism, experimental methods relating to research in the context of a design project, but also observational research methods. The exploratory interview as a way of understanding the contextualization of the field of jewelry in Portugal, but also as a way of understanding the perspective of users, functioned as a complementary method of qualitative character and validation of the objectives achieved. We have chosen to integrate design practice into our methodology. Fernando Moreira da Silva considers four distinct ways of relating research with the practice of design, each one associated with different contexts: research through design, design study, typological research in design, design study [5]. Research through design focuses essentially on the description and analysis, often comparative, of design projects of other designers, as well as the tools used, which always happens concerning the geographical, social, cultural, historical, technical, ecological, and economic context, among other factors [2]. The study of design is part of the practice in workshops or companies, considering several conditions: location, social and material restrictions, the nature of the project, a program. As the same author points out, this research is an integral part of the design process itself that usually integrates a cycle of analysis, synthesis (simulation), and evaluation [2]. Typological research in design focuses on the search for constancy of the object in a variable context, and may correspond to the simulation of a model that allows interpreting its effects in a specific context, focusing on projecting something new considering the precedents: "This focus can vary from descriptive and exploratory and testing from empirical and descriptive to normative and prescriptive" [2].¹ At last, Design study consists of the development of knowledge through the practice of Design. Several solutions are studied, and their implications and impact are applied in an exploratory process that can determine or not adaptations and reformulations [2]. In this research project based on the design project, we manage from the beginning a dichotomy between intuition and rationalization, between experimentalism and analysis: "Design usually begins with intuition (discovery) and ends with a reason (justification)" [2].² In the course of this process, we have crossed above all the last two types of research, in the sense that we are creating something new, and the fundamental precedents for this project are eminently exploratory, which involves analysis, synthesis, and testing of solutions, in this case empirical. If some jeweler artists sometimes leave for a production process without thinking in detail about the piece, others such as Kukas, an important jewellery designer, for instance, develop a process closer to that of Design, constituting a reference for this methodology: "Kukas, as a designer,

¹ "Esse foco pode variar de descritivo e explorativo e o testar desde empírico e descritivo a normativo e prescritivo". Free translation.

² "O design geralmente começa com a intuição (descoberta) e termina com a razão (justificação)". Free translation.

always designed her pieces, made models and commended the realization of traditional goldsmiths. She approached sometimes to Bruno Munari's creative process presented in his book "Things Are Born Things", because, as Kukas points out, his jewels represent multiple forms, for example, "a cloud that collapses in the rain" phrase that symbolically gave its name to her retrospective exhibition.³

In the first moment, visionary drawings made without a compromise or a brief allowed us to freely rethink the territory and the way we act on it, so we would also question jewellery field and the way we act on it. We have sketched possible "shells" that allow human beings to feel realized within their habitat which is actually an extension of the landscape. We have systematized some functional and fluid design solutions and standardized even the organic and irregular shapes present in the volumes, roofs, fixed furniture solutions, and wide carpets that define spaces with different vocations (Fig. 1). But the functions performed by a house are not simply utilitarian. There is light but also shadow and this alternation gives us the warm silence we need to reflect, read, draw, write, contemplate the colourful nature and music that merge with many voices on a sunny day. These houses of ephemeral appearance are not anonymous cellular because were imagined in the function of a "genius loci" through the creation of intimate spaces that incorporate the topographic and natural characteristics of the place and bring them closer to us. What led us to this type of exercise was not the construction of the objects themselves, but the manipulation of ideas, and when the imagined space is transfigured into jewelry, a common purpose to architecture is fulfilled: "CONSTRUCTION is HOW to materialize those ideas" [6]⁴.

We start from space and nature in its poetic dimension, to the development of free experiments, translated into the production of unique jewellery pieces or in limited series. Oblique surfaces and ceilings would be translated into a set of irregular contour surfaces that integrate the modular shapes of hand-scale pieces and principles such as the exploitation of vast transparencies, the fluid relation between outside and inside, the decomposition of the interiors into volumes that define a boundary between public and private, the contrasts between full and empty, the opposition between warm, cold and neutral colors. In this transposition from imagined "places" to jewellery objects, we wanted, at the same time, to explore modular shapes created through new media and bring some joinery solutions and other experiences from the product design area to the jewellery field, although some of these intentions are not new. In the 1960s, American and European jewellery designers decided to embrace industrial metals such as aluminium, stainless steel or acrylics, namely lucite and perperv instead of metal and precious gems. These new production methods were adequately to the new shapes that could either reflect the influence of Pop Art or the so-called Space-age [7]. As Alba Cappellieri refers to the important role of Roland Barthes "that remind us that we are still a bourgeois

³ "A Kukas, como designer, desenhou sempre as suas peças, fazia maquetas e encomendava a realização a ourives tradicionais. Aproximava-se por vezes do processo criativo de Bruno Munari apresentado no seu livro "Das Coisas Nascem Coisas", pois, como Kukas refere, as suas jóias representam múltiplas formas, por exemplo "uma nuvem que desaba em chuva" frase que simbolicamente deu nome à sua exposição retrospectiva." Free translation. Interview to Cristina Filipe, 16/6/2020.

⁴ "A CONSTRUÇÃO é COMO materializar aquelas ideias". Free translation.

society that mystifies its own transience by transforming insignificant everyday objects into scintillating everyday myths” [8]. It was a time marked by the closest connection between art, fashion, product design, and jewellery “provoking interesting questions on jewellery in relation to status; replacing an emphasis on intrinsic value with one that placed an importance on the value of ideas” [7]. Gijs Bakker (1942), for instance, was trained as a jewelry and industrial designer at the Gerrit Rietveld Academie in Amsterdam and the Konstfackskolan in Stockholm and questioned not only traditional materials and techniques but also the scale of the jewel and the way it interacts with the wearer.

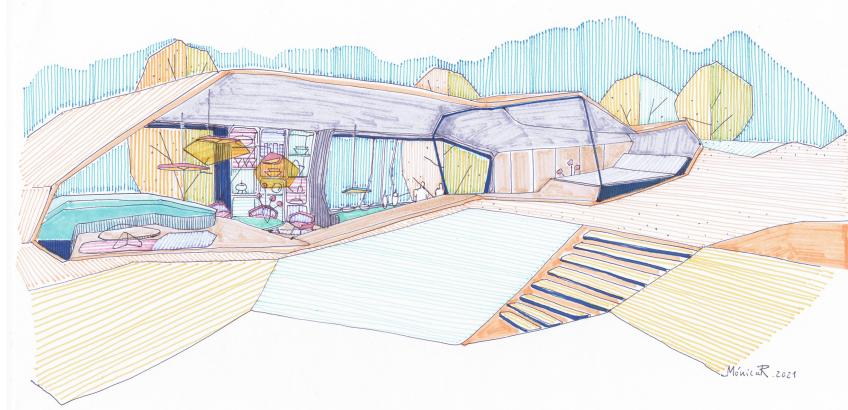


Fig. 1. Example of experimental drawings that were in the genesis of the Jewellery project. 2021. Mónica Romãozinho.

Even in Portuguese context, the jeweler and sculptor Alberto Gordillo (1943) worked in 1967 with *Fábrica Cartene* from Carlos Carvalho, in Oporto, designing pieces to be produced in series and distributed in stores such as *Porfírios*, *Papelaria Progresso*, *Loja das Meias* or *Ayer* [9]. However, our research had distinct phases, and our concern about developing more sustainable creative practices grew up. We are concerned about applying principles of Design for Environment to creative and production processes since the beginning of the project when we approach the product concept. Regardless of whether it is a project that fits in high jewelry, author jewellery, fashion jewelry, or contemporary or artistic jewelry, a transversal development is given to ideas and concepts, selection of materials, and planning of the form of production whether it is more handmade or more industrialized [10]. The same author shows that we can adopt a methodology that we have learned or we can include a series of questions regarding the impact we will provoke with our production, a personal decision of each creator or designer: “Sustainability is a road that must be built on a firm conviction based on personal concerns and values” [10]⁵.

The jewellery industry relates, on the one hand, to social problems, on the other hand to the most aggressive environmental impacts on the planet and this issue stems both from

⁵ “La sostenibilidad es un camino que hay que emprender con convicción propia basada en las inquietudes y valores personales”. Free translation.

the extraction of raw materials and from the manufacture of the jewels themselves. The industrial extraction of large-scale mines, whether of metals or gems, is carried out in the opencast mines or underground mines and its impact is soon felt in the deforestation and morphologic changes of the land. The process of separation of impurities involves the use of chemicals often used in large numbers in the case of illegal extraction and shedding into the waters, which happens in the process of separating gold from other sediments. Soils and rivers are contaminated and mercury eventually turns into methylmercury, organic mercury that causes contamination of algae from which the microscopic fauna feeds, affecting fishes even of a larger scale that integrate our food chain feed. Along with this project it was fundamental to minimize resources and processes [11]: minimizing the material content and that's the reason why we restrict the materials and to facilitate their separation, using recycled or recyclable materials and that's the reason why we chose polypropylene wastes, a frequent attitude between jewellery designers since the 60 decade from last century; designing for maintenance so we thought about modular products that easily allow its components substitution; minimize packaging solution so we promoted solutions that fit in a thin box or envelope and can be assembled by the user; minimize consumption energy considering that the main processes involved such as cutting by laser and drilling holes. At last, some of these strategies applied to product design can include final plan end-of-life which means the piece was also designed to be easily reused or recycled [2], an aspect particularly pertinent for packaging Design and less for the jewellery fiels because we understand the jewel as a less ephemeral object and able to create a strong connection with our personality being part of our identity when we dress every day. Although sustainability is an important goal for us, it must integrate a global intention for our creation, a strong concept because we don't think about a jewel as an ephemeral object, at the same time there was interest in exploring its ephemeral appearance and a light structure that communicates for some instances with our body but namely with our personality, just like its main source of reference, architecture.

The influence that certain contemporary authors exerted on this 2nd phase of “Playful Spaces” was particularly decisive, derived from an architecture and design framework. For instance, the Bouroullec brothers created two versatile solutions for the Danish company Kvadrat. “North Tiles” corresponds to a system of textile mosaics that allows coating and dividing spaces, providing the space with color, texture, and soundproofing. Another solution, the “Clouds” series, is composed of mixed modules in fabric and semi-rigid sponge that can coat walls, be suspended from ceilings or structures, or even divide spaces. At the same time, it allows the composition of organic surfaces: “Clouds spring from the idea of a symbolic reaction to the geometry of common architectural space, the aim being to put up a softly organic opposition to orthogonal space, created by the direct action of those using it and without the mediation of architectural design” [12]. It is inscribed in the same line of investigation as the previous series, corresponding to an evolutionary moment of the process because each m² of the previous modules implied an expenditure of 4m² of fabric, and “Clouds” presents a lower density and greater lightness. The modules are cleft, asymmetric, then subdivided into triangles through folding. They can be connected in different combinations that allow you to redraw spaces over and over again. These are strategies that we can apply to jewellery field and

due to their modularity, they facilitate a more sustainable production. When we started to design the necklace solution, we were thinking about giving to the wearer the chance of transforming the piece replacing the surfaces with other with different colours, although it was soon exceeded because the parts would be subject to rapid wear in their fitting areas and this conclusion derives from tests developed at the level of a first prototype. However, in the context of the necklace and also the bracelet, the intended fitting system was therefore considered for rapid replacement in case any parts are repaired. This solution allowed us not to apply glue, only the weld in the case of earrings. The idea of maintenance is also clear in Salcedo contribution called *Moda Ética para um futuro sustentável* that defend a perspective of design oriented to recycling referring to the possible addition or removal of components through mechanisms such as zippers or clasps [13] or by a fitting system explored since the first experiences of this post-doctoral research. On the other hand, options like these can Optimize product life which means avoiding solutions that can conduct the wearers to simply discard a product, such as the product degradation, its ephemeral technology or aesthetics, and cultural values [11]: Design for reliability (safety) recurring to ergonomic and safe solutions, allow the maintenance and repair through a jewellery modular project, facilitate reuse because separate components according to its different materials, designing for the appropriate duration which implies to get a connection between users and jewellery pieces.

In this first piece, we planned each geometric surface and incorporated folding flaps that fit into grooves operated in the next plane (Fig. 2). The modules integrate a geometric vocabulary revisited along with our research project that included more series than this. The same folds were marked and a gap was provided between them and the plans to which they are linked. Within the scope of this part and all the others that follow, we used prototypes in cardboard and polypropylene to test the joints. However, we wanted to explore a more dramatic volumetry, so we started to play with these modules through the process of folding. Our solutions derive from our architectural imaginary drawings that were a strong reference for these experiments since the beginning. Inside the same habitats, these irregular shapes were present in the modular elevations, in the carpets that define distinct interior areas and functions or hanging wall modules, sometimes also present in a furniture piece like a daybed.

This connection between space and jewel has also determined the next object which consists of a ring (Fig. 3) that has been one of the most complex objects, resulting not only from cardboard models experiences but also from a prototype executed in copper that allowed us to evaluate the impact of the piece on the hand, its scale, and especially its ergonomics. It is a versatile piece, adaptable to different diameters that wraps and overlaps the lateral fingers. It was born from an initially planned drawing that when being modeled introduces an asymmetry factor. In one of the modular shapes that integrates the same design, we chose to overlap a first colored surface of identical metric whose fixation to the base derives from the insertion of the next container blade of a flap that will fit into the intended tear. In the end, these two organic surfaces, namely the second one with its oblique position suggested the poetic movement of petals to the taste of the wind and fragilely linked to a stem symbolized by the silver structure.



Fig. 2. “Playful spaces” collection. Necklace. Polypropylene (reuse) and silver wire. $225 \times 276 \times 1$. 2021. Designl Photo: Mónica Romãozinho.



Fig. 3. “Playful spaces” collection. Mutable ring ($62 \times 31.5 \times 19$) and earrings ($40 \times 50 \times 1.5$). Silver and Polypropylene (reuse). 2020. Designl Photos: Mónica Romãozinho.

As we said before, it was fundamental to restrict the materials only to reused polypropylene and silver and to facilitate their separation. The modular and non-orthogonal shapes are translated again into the polypropylene blades corresponding to four colors that can be fitted to the post of earrings executed in silver and can be freely changed. There are no fitting details, so it's very intuitive to transform this pair of

earrings. We can opt for a surface added to each of the earrings (Fig. 3), or the overlap of two units, preferably with different contours, which causes a greater tension between shapes, colors, and also contrast between transparency and opacity. Asymmetry can be dramatized just by wearing a simple earring in contrast to another that contains the blades or, finally, we just wear the silver modules.

In the case of the bracelet (Fig. 4), we would have to equate a more closed and ergonomic curvature and we decided to reverse the joint system since the effect of projecting folds in contact with the arm could be aggressive. We designed folding components that are born from the extension of the modular shapes themselves. On the other hand, the surfaces are intersected without their contour being deformed. The 2nd polypropylene prototype led us to equate the introduction of tears parallels between them in the most extensive module, for position adjustment according to the width of each specific pulse. In the last prototype, we opted for the reuse of white polypropylene, since the folding of surfaces of another color and greater thickness implied creasing in advance with x-act to avoid being marked by a whitish end while weakening the resistance of the folds. This is one of the most inclusive types of jewellery pieces at the level of this disciplinary domain.

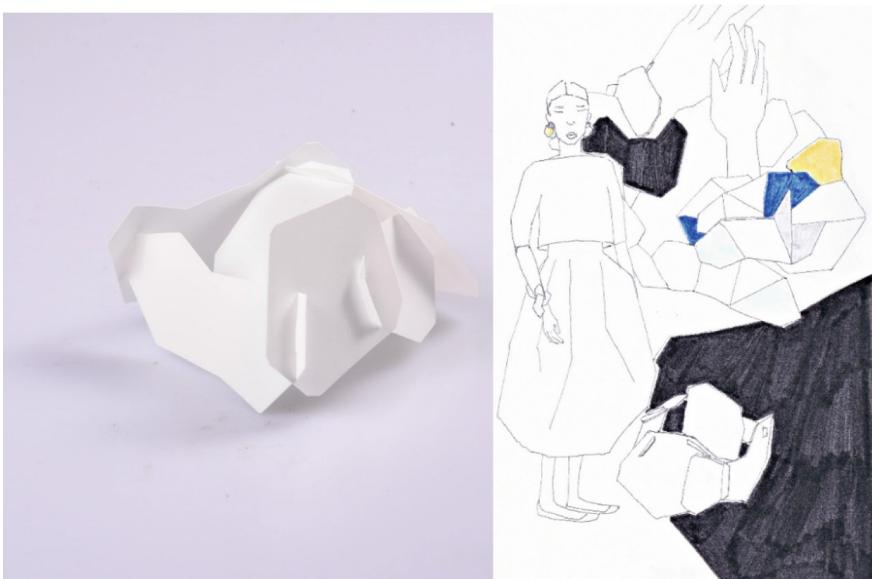


Fig. 4. “Playful spaces” collection. Bracelet. Polypropylene (reuse). 90 × 80 × 40. 2021. Design: Mónica Romãozinho. Photo: Rafael Seguro | Fábrica da Criatividade.

The last piece does not depend on the body in its physical dimension, as witnessed by the work of Puig Cuyàs: “I am not interested in the body but in the person, the psychology of the person. Eternity-durability, memory or not, and fears are the basic feelings of humans. That’s why I make only brooches because they don’t have contact with the body. I am interested in sharing something with the medium of the piece” [14]. Due to

its freedom and lightness, we found that two brooches could be used simultaneously forming a seemingly continuous and definitely more scenic and impactful structure. It reinforces the evolutionary meaning of a possible exercise of creating evolutionary structures work that can be adapted from object to object. We pursue the simplicity, elegance, and clarity of surfaces or volumes, premises that direct us to specific references from the fashion universe that are particularly present at this particular creation process, namely from a perspective assumedly closer to designers such as Rei Kawakubo, Yoshi Yamamoto and Issey Miyake who opened, for the first time, doors to postmodernist interpretation, playing with the barriers that seam the East from the West, between fashion and anti-fashion, between modern and anti-modern [15]. We are talking about authors who do not produce mere consumable objects. The Bao Bao Bag (2002) for instance, designed by Issey Miyake, before becoming a brand in 2010, borns from a sequence of triangular surfaces that turn three-dimensional, thus suscitating a flexible structure. At the same time, Miyake's designs provoke surprise and communicate the idea of game, fun, lightness, bringing poetry to our daily life.

The modeling of modular surfaces through folding processes was the dominant concept for the last piece project which consists of a brooch (Fig. 5). Unlike the other ones created throughout the investigation process, the version presented is even lighter, and it is easier to play with a distinct positioning and to raise different relationships with the body. The modular surfaces belong to a lexical common to the rest of the line but the way they were folded dramatized the volumetric effect of the whole composition. The fastening pin is identical to that adopted in another collection untitled “Geometric spaces”, but we have considered two distinct zones for double drilling, one that allows more vertical positioning of the piece, another a more horizontal insertion. Following the



Fig. 5. “Playful spaces” collection. Brooch. Polypropylene (reuse). $15 \times 10 \times 3$. 2021. Design: Mónica Romãozinho. Photo: Rafael Seguro | Fábrica da Criatividade.

construction of the final prototypes of the necklace and brooch, we registered the final molds, recurring to drawing and manual cutting that will be translated into the technical design in CAD, enabling future copies or variants of the same solutions, regardless of the chromatic options to be considered. In this way, the project can be implemented using industrial methods, such as laser cutting and the use of a folding and creasing machine. The necklace, the bracelet, and the brooch can be assembled by each wearer and being contained in a plain package with an instruction manual and our next aim is to extend this philosophy to other pieces.

At last, the owner can also be involved since the beginning in the choice of colors and finishes allowing personalization of the jewel and even its assembly (Fig.6). As Frank Lloyd Wright once said: “There should be as many kinds (styles) of houses as there are kinds (styles) of people and as many differentiations as there are different individuals. A man who has individuality (and what man lacks it?) has a right to its expression in his own environment.” [16]. We produce unique pieces or limited series to preserve the sense of identity of each piece and at the same time promoting a sustainable attitude.



Fig. 6. “Playful spaces” collection. Brooch. Polypropylene (reuse). 15 × 10 × 3. 2021. Design: Mónica Romãozinho. Photo: Rafael Seguro | Fábrica da Criatividade.

3 Conclusive summary

We conclude that jewellery moves in the absolutely hybrid territory. It can respond to society’s needs and aspirations such as design or architecture. Finally, we use it as with a garment, it remains in contact with our body, communicates something about our personality and identity, acquires a symbolic value. We see it as a platform of our

individuality, as well as a home, intimate space. The explored concept allows almost unlimited variations in chromatic composition and even the replacement of modules giving the possibility of creating new solutions according to these principles. It reaffirms a concern with the monetization of residual materials, an attitude that has been reflected in the work that we continue to develop in the present. Our postdoctoral project ended with the brooch project, an object physically independent of the body, soon free of constraints. We are interested in sharing a narrative, a set of experiences and meanings with someone even if abstract and imagined because the owner of the jewelry is often anonymous: "When I work, I have a person in my mind, and I say that I hope we meet one day and share something through my work. Share the experience lived through my working process, of all that I've found, discovered, and made visible. That is my work's central aim. And, to suggest to the wearer that the simple gesture of putting on a piece of jewelry can on itself also become a metaphor" [17].

References

1. Heidegger, M.: *The origin of the work of art*. In: *Poetry, Language, Thought*, p. 33. Harper Perennial, New York (2001)
2. *Ibidem*
3. Norberg-Schulz, C.: *Genius Loci: Towards a Phenomenology of Architecture*, p. 7. Rizzoli, New York (1976)
4. Lau, J.: *Manuales de Diseño de Accesorios*, p. 9. Editorial Gustavo Gili, Barcelona (2013)
5. Moreira da Silva, F.: *Investigar em design versus investigar pela prática do design – Um novo desafio científico*. In: 5º CIPED. Bauru, Brasil (2009). http://ciaud.fa.utl.pt/images/investigadores/design/efectivos/Fernando_Moreira_da_Silva/anexo_40c/Investigar_em_design_ver_sus.pdf, Accessed 7 Julu 2020
6. Baeza, A.: *A ideia construída*, p. 41. 4ª ed. Caleidoscópio, Casal de Cambra (2011)
7. Galton, E.: *Jewellery Design: From Fashion to Fine Jewellery*, p. 23. Bloomsbury, London (2012)
8. Cappellieri, A.: *Brilliant! I futuri del gioiello italiano*. In: XXI Esposizione Internazionale della Triennale di Milano. Mantova: Corraini Edizioni (2016)
9. Filipe, C.: *Joalharia contemporânea em Portugal: Das vanguardas de 1960 ao início do século XXI*, p. 35. MUDE, Lisboa (2019)
10. Fettolini, J.: *Principios y procesos éticos en el diseño y la creación de joyas*, p. 16. Promopress, Barcelona (2018)
11. Fernandes, P., Júnior, O.: *Sustainable product design: the development of a conceptual model*. In: *Applied Mechanics and Material*, vol. 518, no. 339 (2014). <https://www.researchgate.net/publication/260105948>, Accessed 24 Oct 2020
12. Monaco, S.: *Clouds*. In: *Domus: Contemporary Architecture, Interiors, Design, Art*, no. 922, p. 27 (2009)
13. Salcedo, E.: *Moda Ética para um futuro sustentável*, p. 48. Editorial Gustavo Gili, Barcelona (2014)
14. Kontogianni, M.: *The Review of Ramon Puig Cuyàs' Retrospective exhibition and the lecture* (2018). <https://klimt02.net/forum/articles/review-ramon-puig-cuyas-retrospective-exhibition-and-lecture-marietta-kontogianni>, Accessed 9 Apr 2018

15. Kayamura, Y.: *La révolution japonaise dans la mode parisienne*. In: XXIème CIELE: Mode in Japan. 5 continents Editions, Milan, p. 47 (2003)
16. Wright, F.L.: In the cause of architecture. In: Architectural Record, vol. 23, pp.155–221 (1908)
17. Kontogianni, M.: The Review of Ramon Puig Cuyàs' Retrospective Exhibition and the Lecture (2018). <https://klimt02.net/forum/articles/review-ramon-puig-cuyas-retrospective-exhibition-and-lecture-marietta-kontogianni>, Accessed 9 Sept 2018



Comparative Analysis of CGM Digital Solutions for Children and Young People with Diabetes Type 1

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Abstract. The presented study is part of a research that consists of evaluating and creating a new model of dashboards used in continuous glucose monitoring (CGM), at the user interface (UI) and user experience (UX) level. The main objective is to design a solution that guarantees efficient interpretation of data glucose by users, children, youth people, their family and healthcare professionals, with mobile applications in a Portuguese context. The graphic representation in dashboards will help type 1 diabetes patients to prevent hyperglycemia or hypoglycemia that could put their health at risk, and to identify the reason for these events. This article focuses on the first phase of the study, which consisted of collecting quantitative data through two digital surveys made for parents of diabetic children. The UX benchmarking was made based on the survey's results, which gave concrete information about the particular needs of each user. The main objective was to identify the method of recording glycemic data, electronic devices used, applications most used, and collecting information about functionalities and their importance. This analysis has the purpose of identifying and evaluating the main solutions used for these patients in order to analyze relevant solutions that contribute to this study.

Keywords: Dashboards · Digital design · Health design · Type 1 Diabetes

1 Introduction

The project consists of the study of graphic representation of dada glucose in digital dashboards, intending to improve efficiency at the user interface (UI) and user experience (UX) level. The study is user centered on children, youth people with Type 1 diabetes and their caregivers that use Continuous Glucose Monitoring to manage health.

Type 1 diabetes is a chronic disease that is more prevalent in pediatric age, 90 to 95% of cases under the age of 16 years (Dias 2018). People with type 1 diabetes depend on daily insulin administration to control blood glucose levels. Therefore, they need to monitor their blood sugar several times a day. There are three types of monitorization:

1- Ambulatory monitoring of capillary glucose (AMGC) –A traditional and invasive method that requires puncturing a finger to obtain a blood sample (Dias 2018) (Fig. 1).

2- Flash Glucose Monitoring (FGM) –This method uses two components: a sensor usually implanted in the arm of the user, and a device that shows the level of the glucose in a dashboard with an 8-h register. A device just can read the sugar values when it is in contact with the sensor. (see Fig. 2).

3- Continuous glucose monitoring (CGM) – This system consists of a sensor, as in FGM, implanted on the skin that can be connected with a mobile phone through the Bluetooth system, allowing remote data sharing with another user. The glycemic data is recorded on digital dashboards that can be viewed on a device such as a mobile phone, smartwatch, and computer. CGM is the focus of the study (see Fig. 3).



Fig. 1. AMGC device



Fig. 2. FGM device and sensor



Fig. 3. CGM sensor and mobile phone

(Freestyle Abbott website, accessed 26/07/2021)

Below, a comparative table with the advantages and disadvantages of the 3 methods used in the management of type 1 diabetes. (see Table 1).

Table 1. Table of advantages and disadvantages of glucose measuring methods.

	AMGC	FGM	CGM
Advantages	<ul style="list-style-type: none"> - Precise data read - Sample usability - Method that does not depend of other methods 	<ul style="list-style-type: none"> - Shows the tendency curve: it indicates if glucose is rising or falling - No need to prick the finger frequently - Motivates users to frequently monitor, it is not painful - Shows a dashboard with an 8-hour registration - The same devices of FGM allows to measure AMGC method 	<ul style="list-style-type: none"> - Remote monitorization - It alerts when there are glycemic irregularities - Automatic recording of glycemic data every 5 min - Glucose data in real-time - Shows the tendency curve - Allows connection with insulin bomb - It alerts when the life-time of the sensor is finishing - Configuration of alert

(continued)

Table 1. (continued)

	AMGC	FGM	CGM
Disadvantages	<ul style="list-style-type: none"> - Pack of devices: reader, puncture device and test strips - Provokes pain: puncture a finger - It does not show the tendency curve - It only shows the current glycemic value 	<ul style="list-style-type: none"> - It does not alert the user when about glucose irregularities - Glycemic data is only visualized when the user approaches the device to the sensor - Uncertain data: a method that depends on AMGC - One specific device is necessary to read the results 	<ul style="list-style-type: none"> - Lag time between 10 to 15 - This method depends on AMGC to confirm results - It requires calibration whenever a new sensor is implanted - The wrong alerts configuration can cause discomfort and stress to users

1.1 Technological Development and Study Proposal

Initially, the management of type 1 diabetes was made through AMGC and the patients were making the registration handwriting on paper, a process that complicates the medical treatment and counselling as glycemic data was lost or the registration was not done regularly by patients. Since 2018, Freestyle Libre from Abbott, has had devices with a financial contribution of the Portuguese State in 85%, a crucial moment that gives to diabetics the opportunity to use a less invasive method in their routines, using FGM and CGM devices for a lower price ([Infarmed 2018](#)).

Technological development has proved to be an asset in the digital health management of Type 1 Diabetics by providing easier ways of monitoring the disease with CGM and FGM. However, dashboards of glycemic levels appear in a scientific and complex language ([Amaral 2018](#)) which has shown to be an obstacle to the interpretation of information by the age group under study (8–18 years) leading to the consequent demotivation of the disease control and management.

Healthcare digitization has brought clear benefits such as portability, constant updating of information, efficiency, and reduction of geographical barriers. Digital health devices allow adaptability to the needs of each patient or specific disease, by collecting information for a more accurate analysis of data, reducing high risks of disease control through prevention, and consequently reducing financial costs on health. In Type 1 Diabetes, most of the monitoring is made out from medical supervision, during the patient's daily life. Clinical follow-up has a limited time, so the patient must self-manage the illness. Research has demonstrated that there are improvements in the results of diabetes when patients use technological devices such as mobile phones, smartwatches, text messages automated and mobile devices. ([King et al. 2012](#)).

The creation of a new dashboard model aims to present a solution adjusted to the current reality, adapted to the target audience of the study without neglecting the particular needs of these users and their caregivers. It is intended that the new interface model positively contributes to the process of self-management of the disease of these patients, responding to the following problems:

- **Hierarchical information:** representation of information according to its importance, leading the user to immediately identify what is important.
- **Intuitive reading:** the new interface design will allow fast reading of glycemic data in real time, having an easy identification of hypoglycemia or hyperglycemia.
- **Hierarchization of functionalities:** all functionalities are essential but with different importance; Therefore targeting functionalities becomes essential.
- **Data history:** dashboard with daily data log allows visual analysis by comparing among days, making it possible to identify external causes that may have triggered hyperglycemia or hypoglycemia.
- **Two viewing modes:** 1st viewing mode: For children and young people, it should only contain essential information in a clear, intuitive, and motivational language; 2nd viewing mode: All the configuration features and scientific representations aimed at parents and caregivers, which allows that none of the essential functionalities are not overlooked.
- **Colours:** Associate colors with glycemic events
- **Positive communication:** Motivational communication, focused on the individual goal of each patient, with words of encouragement.
- **Feedback:** Keep the users informed about what is happening and how users should proceed to complete their objectives.

2 Methodology

A double diamond methodology by the Design Council was adopted for the development of this study. The methodology is composed of two diamonds: First diamond, Discover and Define; Secund diamond, Develop and Deliver. This study concentrates on secondary and primary research (Discover and Define), bellowing to the Fist diamond (Council 2019).

In the secondary research, information was collected on investigations, reports and publications that already existed on the theme and the target audience of the project, with the aim of identifying the design problem in general. Subsequently, the primary research focuses on the user and intends to collect concrete data that defines user specific problems, giving room for sharing personal needs. This phase of the project was developed through the quantitative method, which allows the collection of statistical information.

In order to have answers to the above-mentioned issues, two questionnaires have been made. The first one with the goal of having general answers concerning the diabetes procedures and the second one to define the essential digital functions of mobile apps. Based on these results a benchmarking analysis comparing direct with indirect competitors was made.

3 Digital Health

3.1 Children and Young People with Diabetes Type 1

Adolescence is a difficult evolutionary phase that involves physical and emotional changes related to puberty. According to the study published by the Journal of Adolescent Health (Ingerski et al. 2010) although the transition age for self-management of

the disease begins at age 13, young people only gain majority responsibility at age 17. The responsibility assumed by young people in the management of the disease negatively affects the monitoring of glycemic indexes. However, when these tasks are divided until later between the family and the young person, monitoring is more frequent, justifying that the continuous involvement of caregivers brings more positive results (Ingerski et al. 2010).

For many teenagers, checking glycemic indexes in public causes constraint and sometimes even shame. There is also a fear of measuring glycemic indexes and the results are not positive (Jaser et al. 2020). Relationships with colleagues are very important, considering that this disease involves self-care throughout the day carried out in the context of school or extracurricular activities that count on the presence of more people. It is essential to understand the perspectives of young people regarding their relationship with diabetes and the results they expect to obtain, to make them feel that their goals are attainable, and will have impact in their future life. Encouraging good management practices for Type 1 Diabetes is an extremely important factor, emitting signals that contribute to the well-being of diabetics and remind them of the impact that monitoring brings in the medium and long term.

3.2 Dashboards

In CGM, line graphs are the most usual mode of data representation that show values changing over time, rise and fall of glucose. Timelines enable patients and clinicians to perceive relationships between symptoms, treatments and life events, and see small bits of data as parts of a larger whole. Graphic representations allow a more effectively, accurately and faster communication than text communication. Data visualizations, also do more than making information easier to understand, they reveal patterns and connections that might otherwise go unnoticed. This allows health professionals and diabetics to identify the reason of glucose irregularities and prevent new abnormal events. Dashboards display devices (mobile and smartwatch) are limited in visual area, which requires information to be concise, clear and intuitive.

4 Quantitative Research

The quantitative research data was chosen as a simple method of collecting concrete data focusing on the particularities of each user (Assis 2008). On primary research, were made two digital surveys shared on private group created by Type 1 Diabetics on a social media platform Facebook. The surveys were structured for being answers by parents of young people with diabetes type 1. The digital process was the simplest way of obtaining result in a pandemic context when the research was developed. The obtained information was processed in an excel file, thus allowed to compare the answers of the same respondent and validate or not if it was credible.

The first survey aimed to understand the credibility of the project containing questions related to: the method of recording glycemic data, electronic devices used, operating system and applications most used on mobile devices. The second survey was focused

on collecting information about functionalities and their importance, providing free space for users to add not mentioned functionalities.

First Survey

Regarding the way respondents read the glycemic indexes, patterns of behavior were analyzed, combining the three methods: AMGC, FGM and CGM. These three measurement modes can be used alone or combined. The first survey revealed that the three largest volumes of people use two or three combined methods. The combinations of the AMGC with FGM (28.3%), the three methods combined (26.1%) and the CGM combination with FGM (17.4%) are the most used (see Fig. 4).

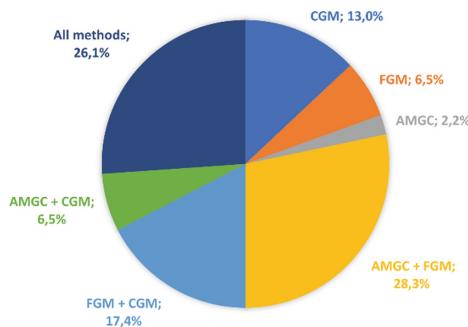


Fig. 4. Measurement methods used by diabetic people. Valid responses: 46. Null or unanswered responses:0

Of the 46 responses considered valid, 54% answered that they use digital applications mentioning four apps: xDrip + (72%), Tomato (20%), MySugr (4%) and Dexcom (4%). Proceeded to next question if users know the Happy Bob application, and if they use it in their routine, 100% answered that they have never heard about it and never used it.

Second Survey

The respondent could evaluate the suggested functionalities on a scale between 0 (not relevant) to 10 (very relevant). The most relevant identified functionalities were: the customization of alerts (9.2), the exportation of data (9.1), the individual customization of alerts (8.8) and the sending reports by email (8, 8) (see Fig. 5). However, none of the functionalities mentioned was identified as irrelevant, so none of them should be discarded.

Capillary registration, the expiration date of sensors, demonstration of glycemic value in real time, the time of action of insulins and the estimative curve of glycemic evolution are functionalities that are not in the survey but were mentioned by respondents as relevant.

Analysis of the Results

On the first survey, it was concluded that the use of applications on mobile devices is present in two of these most used combinations, which reveals that these patients turn to

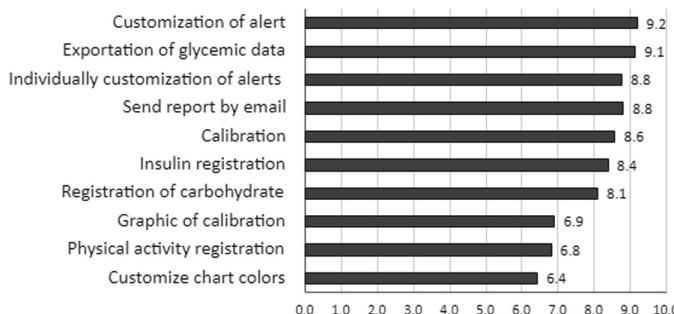


Fig. 5. Functionalities of Digital CGM applications. Valid responses: 21. Null or unanswered responses: 0.

CGM for auto-management of the disease. The reason that can justify the use of multiples methods is that each measurement method can have different values in the same time event, this factor reveals that the 3 methods are used simultaneously as a way to detect false glycemic values. The users identified four applications, xDrip +, Tomato, MySugr and Dexcom. However the Happy Bob was mentioned as unfamiliar because it is not compatible with sensos used in Portugal. The question about the Happy Bob application was made because it was designed for children, although it does not replace the daily use of another application. Happy Bob does not have all essential functionalities, it only can be used as a complementary application.

On the second survey, it was analyzed that the personalization of alerts is identified as the most important feature, confirming that sometimes the exaggeration of notifications and alerts that are issued by the devices, disturb the normal routine of these patients who are constantly alert, and may lead to the abandonment of monitorization (Mastrototaro et al. 2010).

Surveys results help to validate the importance of eHealth devices in a diabetic context, and to define direct and indirect competitors.

5 UX Benchmarking Analysis

The comparative benchmarking was made based on the quantitative results, that identified the preferences of the users, adding Happy Bob digital application on the analysis, whereas it is designed for children and young people with type 1 diabetes. The competitors are divided into two fragments:

The direct competitors – these competitors are those who solve the same design problem that we intent to resolve, that is, all application of CGM that allows connections with financed sensors in Portugal. Direct competitors: Xdrip + and Tomato.

The indirect competitors – are those who offer the same digital product but for different target, and all digital solutions that do not allow connections with free style sensor. Indirect competitors: Dexcom and Happy Bob.

A comparative table with direct and indirect competitors analyze the essential functionalities, according to uses responses. This process helps to understand what makes those competitors a choice of this target, and help to identify what can this project do better (Table 2).

Table 2. Competitive analysis

Functionalities	Direct competitors		Indirect competitors	
	xDrip+	Tomato	Happy bob	Dexcom
Customization of alerts				
Exportation of glycemic data				
Individually customization of alerts				
Send report by email				
Calibration				
Insulin registration				
Registration of carbohydrates				
Graphic of calibration				
Physical activity registration				
Customize chart colors				
Diverse Languages				
Operating system	Android	Android/IOS	Android/IOS	Android/IOS
Expiration date of sensor				
Connection with more users				
Connection with different devices				
Glycemic value in real time				
Time of action of insulins				
Estimative curve of glycemic evolution				

Direct Competitors: CGM Applications Compatible with Freestyle Libre Sensors
Common characteristics of CGM digital applications are: automatically registration in a frequency of 5 min; notify the user when the life-time of sensor is finishing, allows the user to make zoom in or zoom out on the dashboard to analyze de labels in detail or in

general; personalization of alerts; enable multiple users to connect remotely. It is made below an objective description of the unique characteristics of each one competitors.

xDrip+

- Data levels are represented by colour points on a dashboard view.
- Color personalization that helps to customize data representation.
- Supports connection with insulin pump and insulin pen.
- Calculate the necessary insulin and identify the time of action of the insulin.
- Graphic representation on the screen shows the last 12 h of glucose levels.
- Remote connection without a limited number for uses (Fig. 6).



Fig. 6. xDrip + application (Miaomiao website, accessed 22/06/2021)

Tomato

- Use of iconography as a fast way of interpreting data.
- Simple and clean dashboards: different colours for high or low glycose levels.
- Battery of sensors: remembering users that they need to change it, however it still continues registering in a maxim of 12 h after expiration, just for security.
- It is necessary to use the internet.
- Include individual daily graphic representations.
- The remote connection with a limited number of 3 persons.
- For followers, it is not possible to silence or configure alerts.
- Shows alerts list with a detail description (Fig. 7).

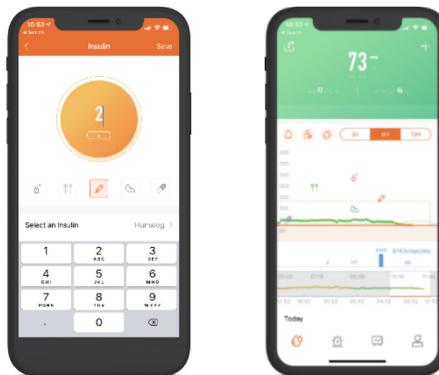


Fig. 7. Tomato application (*Tomato website*, accessed 23/06/2021)

Indirect Competitors: CGM Applications Compatible with Dexcom Sensors Happy Bob

- Developed for young people and children.
- Flux of glycemic levels is represented by stars that user can collect and make points, a representation that make the moment of check numbers more relaxed and funnier.
- Happy bob is a persona that gives life to this application that represents high and low levels with a happy or sad face.
- Each of emotional faces has his own colour.
- Does not replace the daily use of another application: it does not ensure that glycemic values are correct (Fig. 8).

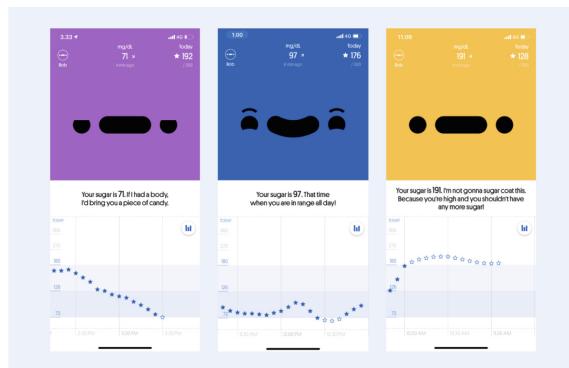


Fig. 8. Happy bob application (*Happy Bob website*, accessed 26/07/2021)

Dexcom

- Remotely connection is limited to a maximum of 5 persons.
- It is necessary internet for to make the registration.
- Allows following to personalize alerts.
- The main dashboard shows only the last 3 h of registration.
- It contains a secondary dashboard with a registration of all events that happen during the last 24 h.
- Complex representation of glucose level of the moment, it is difficult to understand when the value is increasing or decreasing (Fig. 9).



Fig. 9. Dexcom application (*Dexcom* website, accessed 28/06/2021)

The results of this analysis showed that some project objectives are partially resolved by other digital applications, thus allows to make decisions based on previous knowledge and experience. A combination of characteristics and features that should be implemented in the development of the project was identified. Regarding the methods of recording glycemic data, it is understood that diabetics use more than one method combined as a guarantee that glycemic values are correct. The survey results showed that CGM digital applications are one of the most used method for auto-management of the disease. The respondent's identified xDrip+ as their preferred digital application. Benchmarking analysis allowed to understand that the functionalities identified as the most important, are almost all present on that application.

The hierarchization of functionalities, according results of surveys, helped to understood the importance of each one, thus helping to create a product responding to those preferences. The customization of alert for users and followers was the most important functionality, differentiating characteristics of the other applications, mentioned by the respondents, that xDrip+ has.

The next phase of the study, according to the double diamond methodology, consist of the development of information architecture, wireframes, low fidelity mockups and

prototyping based on the data collected in this study. In the last stage, usability tests from a functional prototype will be made with the objective of understanding the effectiveness of the decisions taken, identifying possible improvements.

References

- De Amaral, P.R.Q.: Um app feito pra mim: desenvolvimento de tecnologia móvel para crianças com diabetes mellitus tipo 1 e suas famílias. Universidade de São Paulo (2018)
- Assis, M.C.D.E.: Metodologia Do Trabalho Científico Maria Cristina De Assis (2008)
- Council, D.: (2019). <https://www.designcouncil.org.uk/news-opinion/what-framework-innovation-design-councils-evolved-double-diamond>. Design Council. <https://www.designcouncil.org.uk/news-opinion/what-framework-innovation-design-councils-evolved-double-diamond>
- Dexcom. <https://www.dexcom.com/apps>
- Dias, P.A.A.: Aplicação da Casa da Qualidade no Desenvolvimento e Aperfeiçoamento de Dispositivos de Monitorização de Glicose em Jovens Adultos com Diabetes tipo 1 [Instituto Politécnico de Lisboa] (2018). <https://repositorio.ipl.pt/bitstream/10400.21/10836/1/Aplicaçãodacasadqualidadedenoveloamentoaperfeiçoamentodedispositivosemonitorizaçãodeglicoseemjovensadultoscomdiabetestipo1.pdf>
- Freestyle abbott. <https://www.freestyle.abbott/ca-en/home/blood-glucose-meters/freestyle-lite.html>
- Happy Bob. <https://happybob.app/>
- Infarmed. Relatório de avaliação do pedido de participação de dispositivo médico (2018). <https://www.infarmed.pt/documents/15786/2548205/Relatório+de+avaliação+Freestyle+Libre/a1a568c4-92c5-4eed-b781-9c1876fcb569>
- Ingerski, L.M., Anderson, B.J., Dolan, L.M., Hood, K.K.: Blood glucose monitoring and glycemic control in adolescence: contribution of diabetes-specific responsibility and family conflict. *J. Adolesc. Health* **47**(2), 191–197 (2010). <https://doi.org/10.1016/j.jadohealth.2010.01.012>
- Jaser, S.S., et al.: THRIVE! Positive psychology intervention to treat diabetes distress in teens with type 1 diabetes: rationale and trial design. *Contemp. Clin. Trials* **96**(March), 106086 (2020). <https://doi.org/10.1016/j.cct.2020.106086>
- King, D.K., et al.: What patients want: relevant health information technology for diabetes self-management. *Heal. Technol.* **2**(3), 147–157 (2012). <https://doi.org/10.1007/s12553-012-0022-7>
- Mastrototaro, J., Welsh, J.B., Lee, S.: Practical considerations in the use of real-time continuous glucose monitoring alerts. *J. Diabetes Sci. Technol.* **4**(3), 733–739 (2010). <https://doi.org/10.1177/193229681000400329>
- Miaomiao. Accessed 22 June 2021, <https://miaomiao.eu/how-to-use-miaomiao-reader-with-xdrip/>
- Tomato. Accessed 23 June 2021. <http://tomato.cool/>



Multisensory Museum Models for Knowledge Transfer

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Abstract. The paper reports the critical-analytical investigation on topics concerning knowledge accessibility in the cultural spaces of the Information Society, with a focus on enjoyment and use within museum itineraries.

Current society is characterized by a continuous flow of information that stimulate the user to moments of reflection and assimilation of knowledge. Therefore, nowadays there is an increasing need to find alternative ways for sharing knowledge in an accessible and inclusive manner to a diversified target.

On-field experimentation and collaboration with museums and archaeological sites has enabled the identification of some fundamental features for designing an accessible and inclusive space. Adaptive interaction, augmented narration, inclusive fruition, and multisensory perception are aspects that have guided the definition of a dynamic and adaptive model of museum itinerary for transferring knowledge to a wide audience with the aim of becoming a reference point for future designs.

Keywords: Multisensorial accessibility · Interactive experience · Engaging storytelling

1 Cultural Space between Physical and Digital

The paper investigates the cultural dimension of inclusive fruition among physical and digital space, the ways and problems connected to accessibility of spaces and knowledge, and it deals with narration as a strategy for inclusion. The museum transforms into a sensitive organism [1] that changes the relationship user-artifact [2] by investigating new models of interaction, alternative languages and experimentations that multiply the levels of the narrative and introduce unprecedented temporal dimensions and new exhibition paradigms.

This user-artifact relationship leads designers to explore new sensory forms of interaction between space, collections [3], and users, able to encourage immersive and engaging learning experiences through the activation of all senses.

In this direction, the paper reports the critical-analytical investigation on topics concerning knowledge accessibility in the cultural spaces of the Information Society, with a focus on enjoyment and use within museum itineraries. On-field experimentation and

collaboration with museums and archaeological sites have enabled the identification of some fundamental features for designing an accessible, usable space. This has enabled the configuration of a new inclusive and adaptive model for the enjoyment and use of museum itineraries intended to share knowledge to a wide audience with the aim of becoming a reference point for future designs (see Fig. 1).

«The integration of digital technologies within the physical museum space offers new ways of visualisation, engagement, interpretation and meaning-making» [3, 4]. The constantly evolving technologies are currently an integral part of the complex communication system and of the dissemination of itineraries aiming to share emotional experiences, provide and guarantee inclusivity, increase visitors' interest and upsurge audience.

Thus it is possible to emphasise multiple ways of “reading” the objects and their “histories” and it contributes to altering the relationship with time and space, influencing individual and collective behaviours, and deeply changing the mediation, perception and use of cultural data [5].

The cultural space becomes a space for co-participation [6] and co-creation, it enables processes of engagement and accessibility capable of getting the audience closer and of diminishing the distance with the local communities by following the principles of the Faro Convention [7].

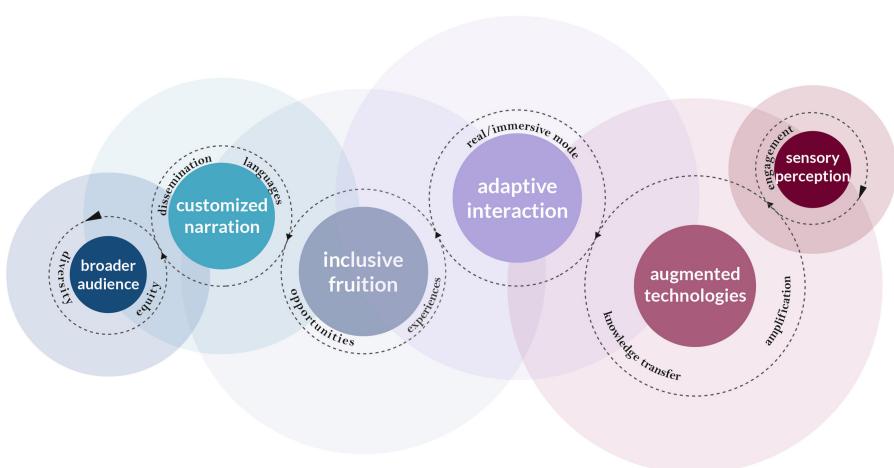


Fig. 1. The steps of a multisensory fruition itinerary.

2 Knowledge Accessible to All

As a place of opportunities and sharing, the museum fosters the visitor's active engagement in the knowledge process. In this context, accessibility – with its multiple facets – represents one of the main objectives to be pursued.

“Leave no one behind” is the core principle of the “2030 Agenda for Sustainable Development” [8], which engages all European countries in facing discrimination and disparities that undermine the personal rights, including those of people with disabilities.

Many European publications have highlighted the close connection between cultural heritage, accessibility, engagement, and audience inclusion. One of the five Pillars of the “European framework for action on cultural heritage”, is «cultural heritage for an inclusive Europe: participation and access for all», which acknowledges the potential of cultural heritage in positively influencing the people and the society through social inclusion. It «also fosters a sense of belonging to a European community, based on common cultural legacies, historical experiences, and shared values. To make the most of this potential, the widest possible access to cultural heritage, in all its forms, must be ensured for all people» [9].

These objectives have been encouraged by some European projects such as the recent “COME-IN!”, aiming to make small and medium museums accessible to a broader audience. The COME-IN! guidelines become a practical tool to design and organize accessible exhibits for people with different abilities and to evaluate the accessibility level of the entire chain of museum services [10].

This proves that a debate on this topic has already been initiated time ago. Even so, accessibility to cultural tangible and intangible heritage is still a considerably unexplored field and there are many physical, sensorial, and cultural barriers that come in the way of users’ access to information.

In order to open up cultural spaces, especially museums, to a broader audience, it is necessary to understand people’s different abilities and to identify flexible and adaptive forms of knowledge transfer that should not exclude any user. The International Classification of Functioning, Disability and Health (ICF) model [11] identifies the users’ different abilities, the individual features of differently abled people and the barriers that hinder their full and effective participation to the cultural and social life. Thus, the importance of analysing disabilities with reference to the multiple features that see it as a universal human experience, is emphasised. The model proposes an innovative and multidisciplinary approach to the able-bodied individual and to the differently abled person that proves to be useful for guiding the design of inclusive cultural experiences.

This means that design should be intended for the largest possible number of people without the need to adapt, thus allowing the use with simplicity, without difficulties and efficiently by people with different characteristics, abilities, preferences or needs [12]. The principles, found in the Universal Design methodology, can be transferred to the cultural spaces, developing experiences and adaptive contents able to ensure the transversal and integrated access to knowledge through the use of customizable methods for sharing and transferring information.

It becomes compulsory to count on diversified solutions and strategies in order to ensure accessibility/usability in its multiple facets, as physical, functional and perceptual-sensorial and therefore provide equal opportunities for participation and engagement. In the specific case of museums, it is necessary for the physical space to adapt to the user from the beginning of the visiting tour, successively activating – at different levels – interactive and sensory spaces through the use of technologies.

An interesting approach is represented by the sensory maps used by MoMa [13], the MET [14] and the British Museum [15]. They prepare the user to the museum visit, introducing a first level of fruition – orientation (*or*) – through a series of indications regarding the space layout and the salient features (low/bright lights, unexpected sounds, silent spaces, small or crowded spaces, perfumes, sudden air movements, etc.). Such indications are important to guide some categories of users in the museum-exhibition itinerary, like children (*ch*) and people with cognitive difficulties (*cd*). In some cases, the sensory maps report the haptic, interactive, and multisensory stations placed along the exhibition tour for an autonomous use by the visitors, without the support of accompanying persons. In the future, multisensory augmented maps can be configured (*tm*) in order to guide a wide audience in exploring the museum space. It is necessary to introduce new ways for accessing cultural contents in the entire museum space and to highlight the specific characteristics of each approach connected to the knowledge, aesthetic, and emotional areas.

It is important to provide each user with a key for accessing contents inside the physical and digital space of the museum, like the realization of physical replicas and the use of technologies such as digital touch or touch sensors (*ts*), that enable accessibility to the artifact also for people with visual difficulties (*vd*). At the same time, each tactile nuance can also enhance knowledge for all visitors (*ab*, *div*, *hd*).

With the aim of making cultural contents accessible to an increasingly wide audience, it is necessary to design by taking into consideration the users' possible different abilities since the beginning, through an inclusive design [16] and without creating separate itineraries (see Fig. 2).

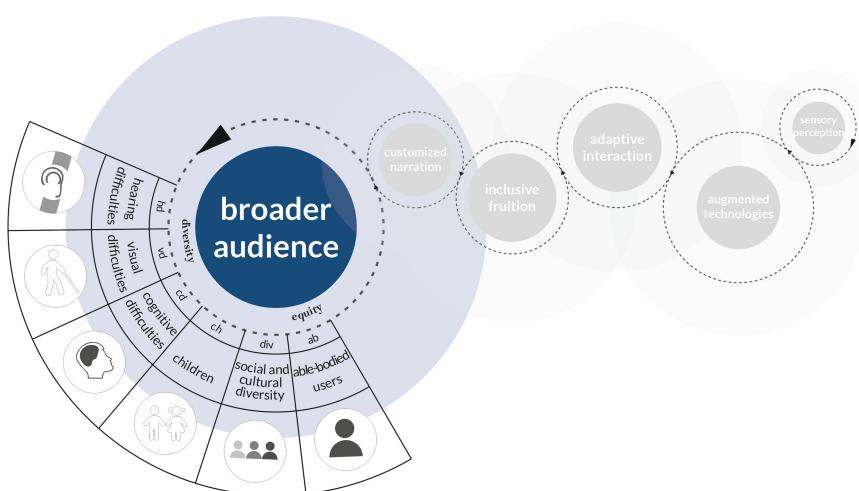


Fig. 2. Multisensory fruition model – focus on broader audience.

3 Narration as a Strategy for Inclusion

In a perspective of lifelong learning, accessibility, inclusion and direct participation of the museum audiences, storytelling has a unique and irreplaceable role [17]. It is used in multiple fields and it is nowadays recognized as the best tool able to ensure a successful engaging experience and to guarantee the right combination between interests, empathy, and imagination [18], with a relevant role in building knowledge, in learning, in intercultural dialogue and in the definition of individual and community identities.

Giving back the past through the narration of facts, events, people, is something that exists since forever and that nowadays not only sweeps through a wide variety of transmission and communication channels [19], but it has also spread across any discipline as a communicational practice to the point of making one talk about a Narrative Age [20, 21].

From the multiple single stories that rotate around the object, there are multiple possible narrations, that users make their own and re-elaborate based on experience. Through storytelling, it is necessary to make comprehensible the communicational vocation that exists within each cultural artifact, one or more among the infinite stories that the cultural asset encloses [22].

The narrative practices in the museum engage narrators and audiences in an empathic relationship that stimulates the creation of new stories, contents, and cultural forms. An efficient narration activates an emotional engagement of the user and guides him, almost unconsciously, in a process of knowledge transfer. This experience is identified by Sturm [23] as the “storytelling trance experience”, an experience of high educational and communicational value. The experience is mediated by the stories, which are physical, produce tangible effects, travel through physical media. Each story has sensory elements and moves through tangible means. This infers that the way in which one enjoys and uses a story is fundamental for inducing the trance and therefore the story is involving based on how much physical engagement it produces [24].

The process of the narrative trance includes a contact phase through one or more senses, followed by a phase of familiarity with the object and the narrative context and one of immersion in the story, culminating with the identification in some of the story’s elements that intertwine with personal experiences. Emersion initiates the reverse process, that of returning to reality by taking distance and transforming, which enable the interiorization of a new way to see and perceive objects. Emotions and engagement determined by the narrative during the trance experience allow the transfer of knowledge, values, information.

Thus, the narrative becomes an inclusive tool, simultaneously engaging heterogeneous audiences.

For museum design, it is therefore about tracing new “narrative geographies” and stimulating the visitor’s imagination. This is possible by structuring a complex, articulated space usable by parts, assuming that the fruition experience enables the creation of itineraries, disarticulating/extrapolating information and suggestions, sharing knowledge and interacting [25].

Nowadays the solutions adopted to ensure accessibility and inclusion envisage a different narrative for each type of audience. It would instead be useful to define the requirements of undifferentiated accessible storytelling, destined to all and that at the same

time can be declined in different languages and formats through digital communication technologies capable of augmenting transparency [26].

Based on the technology used, on the content production process, on the final product and the fruition methods, several variations of narration forms are identified [21]. These sweep from the traditional oral (*on*) and written (*wn*) narratives, to the multimedia mobile narrative (*mn*), the cross-medial (*cs*) and transmedial narrative (*ts*) as pieces that are about to form a unique puzzle or clues widely disseminated, even requiring interaction from the user, therefore making narration synchronous [21]. Linking the development of the Information Society to that of technologies, various steps are highlighted concerning the evolution of the storytelling types that are still nowadays present in various fields. Among them there is video storytelling (*vs*), the narration through static or dynamic images, namely visual (*vn*) and animated (*an*) narratives until the user's interaction with the narrative itself (*is*). Museums have introduced immersion as a narrative way (*in*), bringing the user to identify himself with the story until becoming a protagonist. The use of digital media has also increased the possibilities of co-creation of narrative contents, thus defining the participatory (*pn*) and generative (*gn*) narratives, while the development of tracking and localization technologies have brought to the development of geo-storytelling (*gs*).

The challenge of the museum is to configure multi-layered narrative strategies able to recount the cultural object through techniques, languages, diverse and adaptive ways for all target users with the aim of making cultural space really inclusive, also with the support of interaction and engagement of senses.

4 Adaptive Fruition and Interaction within Museum Itineraries

The new concept of museum requires ways of interaction with the visitors under various forms of participation, from the narrative practices to direct experimentation of the museum research. Inside the exhibition space, digital instruments can reinforce the relationship between cultural objects and users [27]. The articulation of the exhibition has the potential to enhance this relationship, alternating to a layered system of zoomed narration, a spatial, performative model that beseeches the visitor's participation through action and sharing [1].

Within the tour, the visitor becomes an observer (*ob*) and he/she explores the exhibits through the various systems for transferring information. In order to enhance fruition and make it accessible to all, it is necessary for such systems to be made available in various forms, from written descriptions and Braille texts (*br*) to the use of images, maps, audio speakers (*sp*), descriptions through the use of devices enabled with T-coil systems (*tc*), video (*vi*) etc. Thus, the visitor obtains access to information (*ai*) and is given the opportunity to explore the artifacts (*ex*), to be guided through itineraries where he/she can live a participatory experience (*pa*) or share the experience with other users (*sh*). Some of the contemporary museums also enable first person experience through interaction with the objects (*exp*) until the creation (*cr*) of customized elements as a result of the visiting experience.

To this purpose, there are some interesting ways of enjoyment and use for the visitor-exhibition system mediated by objects such as "The Pen" experience at the Cooper Hewitt

Smithsonian Design Museum [28], which has reinvented the way how visitors interact with artworks. The project uses a traditional object (the pen) and transforms it, through the use of technology, into a mediation tool between visitor and exhibition. Inside the museum, the interactive tables invite users to experience a series of uses of the pen with tools for the exploration and creation of contents starting from the exhibited objects. The experiences of the interactive tables are engaging, the functioning of the technological tools is intuitive, and the proposed activities augment the shared experience. “The Pen” represents a hybrid analogical-digital tool that provides the visitor with an alternative way for exploring both the physical collection and the virtual database of the museum. The exhibition space becomes an extension of the virtual collection and vice versa [29].

The examples of interaction with the museum space – through devices of mediation or through users’ direct actions – enable a wider reflection on the transformation of the museum field and on the potential of an interactive dimension, more personal and representative for the identity of the museum project. The museum moves its axis from a strictly collection-oriented dimension to a more narrative one.

The design of experiences able to expand the user - cultural object - space relationship crosses different levels of interaction (see Fig. 3). The user takes contact with the physical space (*ups*) by exploring the characteristics of the exhibition and the architectural specificities such as the physical-dimensional, chromatic, illumination features. The interaction with the physical object (*upo*) generally happens in an indirect way, since even today many museums adopt – for reasons that mainly concern the protection and conservation of artworks – the politics of “do not touch” [30]. With the aim of overcoming such barriers and ensuring that the user directly relates with the physical objects, some museums are experiencing new ways of interaction through the use of technologies or through replicas made in three-dimensional print (*3d*) that can be touched and manipulated as substitutes of the originals. Such modalities introduce possibilities of alternative and engaging interaction for the visitors, who gain the opportunity to experience the artifacts and therefore to acquire information through the use of senses different from the sight.

It is however necessary to underline a fundamental aspect concerning the current museum dimension, specifically the intertwining between physical and digital. To the spatial model, where new technologies surprise and perform space and the relationship between subject and cultural artifact, adds the virtual model that opens up experiential fruition to new dimensions [1]. The physical space intercepts *digital space* (*uds*) to amplify information and to transfer them through the creative experience.

The visitor gets immersed in the digital space due to the use of advanced technologies such as videomapping (*vm*), interactive floors (*if*), or the various “alternative” realities (*ar*), namely virtual, augmented or mixed, that amplify the relationship between user and digital object (*udo*). Interaction can take place through a virtual reproduction of the original museum exhibits that enables the user to “zoom” until perceiving otherwise invisible details, or to augment the levels of information through mobile apps (*ma*), qr code (*qr*), holograms (*ho*) etc.

The fact that the visitor can influence a communication flow with his/her own behaviour calls into question some fundamental features of the narrative structures and techniques and determines the development of new ones, with specific characteristics

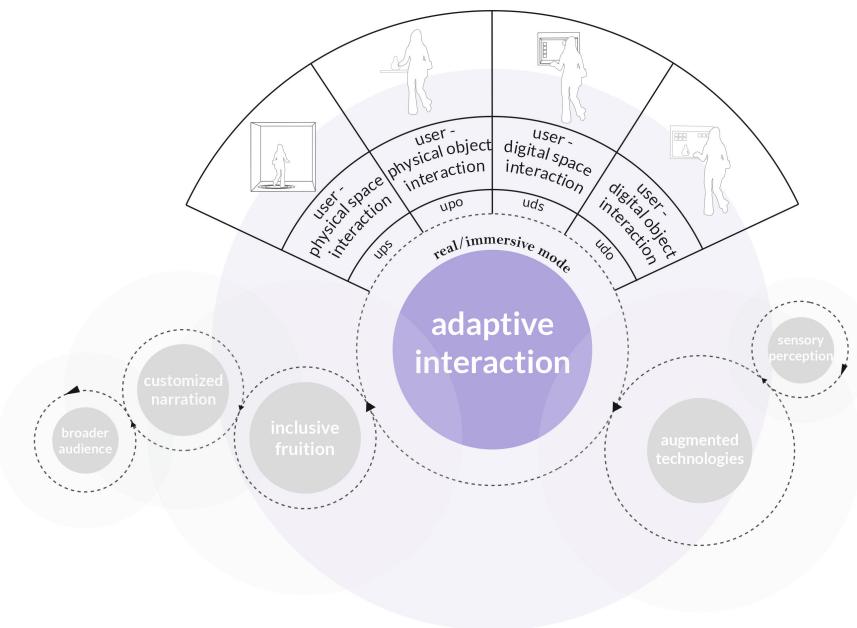


Fig. 3. Multisensory fruition model – focus on adaptive interaction.

such as experience multilinearity and cyclicity. While in a traditional perspective the visitor used to live an experience composed from a precise and immutable sequence of events, now he can choose from different, more or less “alternative” routes. Their possible combinations will all be predicted and made with care. The visitor’s interactivity transforms him from a passive user of information into a subject that autonomously searches his explanatory itinerary [31]. As a consequence, the design of new tools for the fruition of digital culture should be modelled on the variability of the user’s objectives, on his level of previous knowledge but also and especially on the level of engagement and on the availability for interaction and active participation [32]. This occurs since there is not only one type of museum or only one way of visiting museums; it all acquires significance when the purpose is not transferring culture from above but engaging in an experience [33].

In this context, the design practices are called into question to face a differently shaped exhibition space, where new forms for the generation of value of the cultural assets need to be supported according to alternative itineraries that multiply the real spaces. This should be done by using an instrumental context that allows to overcome the traditional museographic approach which has always been oriented more towards “seeing” and less towards “interacting”. The expansion of descriptive materials of the exhibits is encouraged, while the contact with the users is shaped respecting the differences in needs and expectations that a multi-shaped audience requires [34].

Such ways of interaction have the purpose to guide towards an inclusive and accessible design of the cultural space based on knowledge processes that cross through the users’ actions. In order to be configured in an adaptive way, the methods, instruments,

and technologies will need to be shaped by taking into consideration the characteristics of the cultural spaces and objects and to enhance inclusive contents through storytelling and multisensory experience.

5 The Multisensory Dimension of Museums

The key to make cultural places accessible and to overcome the physical, cognitive, cultural, and sensory barriers for the inclusion of an audience with different abilities, is therefore a correct multisensory perception of objects and of the museum space.

Despite the scientifically documented belief that sight is the dominant sense, its natural interaction with other senses should not be undervalued, since ignoring such aspect leads to a much reduced experience of the surrounding world and a misunderstanding of the complexity and hybridization, of the plasticity of the perceptual system [35]. Some current neurosciences theories claim that the separation between the areas of the brain (visual, hearing, tactile) should not be considered anymore. Instead, these areas should all be considered as multisensory even if each of them favours a specific sense [36].

In the field of cultural exhibits, a first requirement highlighted by the Smithsonian Guidelines for Accessible Design concerns the accessibility to contents at multiple intellectual levels and the presentation of such contents through more than one sensory channel [37]. The simultaneous activation of more sensory channels within an immersive experience is one of the most efficient tools for narrating objects and cultural collections and – paying attention to avoid overstimulation – it can constitute a primarily important factor that impacts memory [36]. Interacting within a museum space through senses means living an emotional and learning experience, making knowledge accessible to different targets of users that can interact with the exhibition by activating one or more privileged sensory channels for the transfer of information.

Within a museum tour, various senses can be stimulated through installations disseminated in the physical space that envisage multisensory interactions between visitor, objects, and spaces. In this case, digital strategies allow to work on the multiplication of the story levels for the object (through narration) giving space to a sensory stratification that enables major knowledge and enhances the visit emphasising the experiential dimension [1].

The use of different sensory channels (see Fig. 4) - sight (*si*), touch (*t*), hearing (*h*), and also taste (*ta*) and smell (*s*) – will bring to an increase in the communication and mediation efficiency, thus capable to successfully transfer concepts, information, emotions. The sense of smell for example, having a direct cognitive connection to areas of the brain which are engaged in dealing with emotions and memories (differently from sight or other senses), has the potential to become a concrete design tool within exhibition routes that stimulate the visitor into hardly “forgettable” experiences. In this direction, some experimentations have been recently started at the Mauritshuis museum in the Netherlands, with the aim of enabling users to experience perfumes evoked by the exhibited artworks. The “Smell the Art: Fleeting–Scents in Colour” exhibition includes smell dispensers (*sd*) activated by the visitors to immerse themselves in atmospheres of different times and to explore art in an “alternative” way [38].

Digital tools can transform cultural spaces into multisensory experiences that flip the sensory perception and enable to “see” images through touch and hearing, or to hear

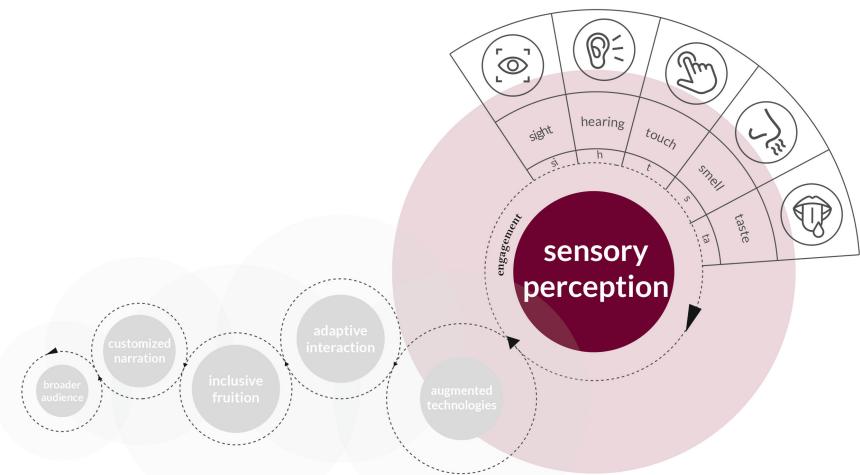


Fig. 4. Multisensory fruition model – focus on sensory perception.

sound through tactile experiences, as part of a totally new exploratory, perceptual-sensory knowledge process.

A further method is represented by the creation of an immersive and emotional space that engages all senses with the support of advanced technologies. The user immerses himself completely in the sensory experience and can actively interact with objects, images, colours, sounds, materials, and contents, through movement, gestures, actions, voice, touch. In this direction, the digital approach to arts and the cultural field moves towards an increasingly immersive and multisensory fruition, with interesting results in terms of museum-visitors interaction. Within immersive experiences, the technological language, intended as a human-context relationship, can become a metaphor/medium/media capable of transporting and transforming the experience. Specifically, it is precisely by means of these new languages that the museum gets configured as a “museum of bits of information”. Digital information, summed to the information at the basis of the ways of experiencing museum itself, is transforming cultural spaces into immersive places, where it is possible to live “synaesthetic and sympathetic experiences” [39].

An interesting approach to the relationship between multisensoriality and accessibility is the exhibition “Dialogue in the Dark” [40], where visitors get immersed into a totally dark space that recalls common places in London through the use of sounds, air movements, textures, temperature, guided by people with visual difficulties. Such type of interaction supports the visitor into getting to know and experience daily life through multisensoriality by generating awareness on the need for an inclusive approach in society.

6 Inclusive Models for Designing Adaptive Museum Itineraries

In the current context, the user is no longer a mere consumer of cultural products but an increasingly active subject in the production and circulation of contents. In this transition, digital innovation provides the infrastructure that multiplies the opportunities of exchange, accessibility, and participation. Therefore, it has been necessary to configure a new dynamic and adaptive model for the design of museum itineraries (see Fig. 5). Starting from the identification of the target audience as fundamental for understanding the diversity and satisfying the needs, the narration, inclusive fruition and adaptive interaction are connected through the use of technologies that augment the levels of information until tracing the user experience (*fr*, *ts*, *ba*, *be*) to customize the visit.

During the entire process, the engagement and integration of senses has a fundamental role in transporting the visitor into an immersive experience and contributing to the efficient transfer of information. The model is based on the critical-analytical study of the various layers and enables flexible approaches which take into consideration the diversity of the audience aiming to support designers towards the definition of inclusive multisensory museum tours for knowledge transfer. An essential aspect is the opportunity to shape the visitor experience and the interaction with knowledge through deep features that vary and modify based on the audience definition. An intelligent approach oriented towards the User Experience does not only take into consideration the technological characteristics, but also those elements of the interaction that deal with individual differences. Personality, emotions, cognitive strategies used by people to access information and make decisions, are all aspects that can influence the overall interaction [41].

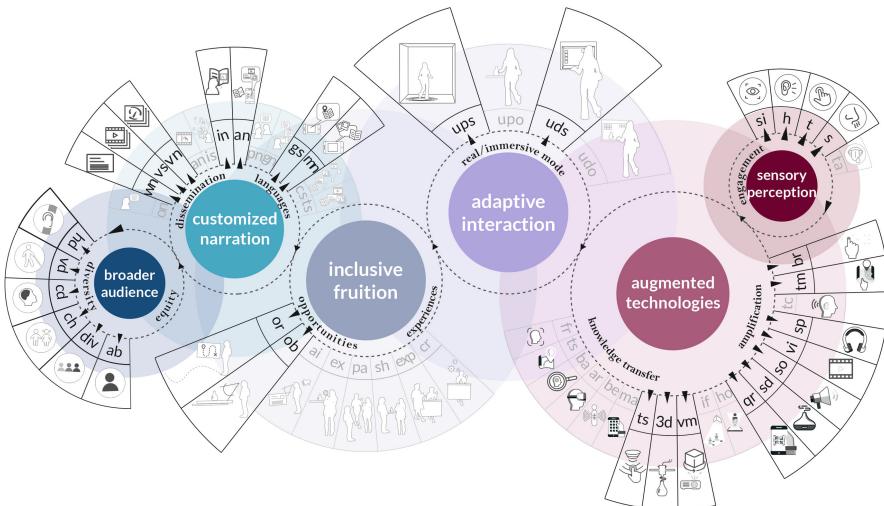


Fig. 5. Dynamic and adaptive model of multisensory museum itinerary.

7 Conclusions

Inclusive design, storytelling and multisensoriality represent a valid corollary of fruition ways that are able to foster a major audience engagement, while the digital tools are a valid means of communication to activate the sensory channels and make the museum tours accessible to different users.

In order to ensure accessibility and inclusivity, it is important to create spaces for participation and occasions of exchange through the engagement of field-specific associations from the initial phases of design for a shared construction of contexts and for the creation of really accessible cultural contents. Respecting the principles of accessibility of a cultural space means taking the place of the user, envisioning his/her difficulties, and trying to overcome them in order to transfer knowledge in an inclusive way.

The museum of the future in the Information Society is a space of knowledge, open and reachable, that ensures access as much as possible to heritage in all of its forms. The future of the museum resides in its capacity to tell stories through the senses and engage audiences through inclusive languages.

References

1. Spallazzo, D., Trocchianesi, R., Spagnoli, A.: Il museo come organismo sensibile, Tecnologie, linguaggi, fruizione verso una trasformazione designed - oriented. In: Congresso Nazionale AICA, Associazione Italiana Informatica e Calcolo Automatico, Un nuovo “made in Italy” per lo sviluppo del Paese. ICT per la valorizzazione dei beni e delle attività culturali (Roma, 4–6 Novembre), vol. 6 (2009). <http://designforculturalheritage.wordpress.com/2009/11/10/paper-aica>, Accessed 30 May 2020
2. Navarrete, T., Mackenzie Owen, J.: The museum as information space. Metadata and Documentation. In: Borowiecki, K., Forbes, N., Fresa, A. (eds.) Cultural Heritage in a Changing World, pp. 111–123. Springer, Cham. (2016) https://doi.org/10.1007/978-3-319-29544-2_7, Accessed 21 Apr 2021
3. Lopes, R.O.: Museum curation in the digital age. In: Hearn, G. (ed.) The Future of Creative Work, pp. 124–140. Edward Elgar Publishing, Cheltenam (2020)
4. Falk, J.H., Dierking, L.D.: Enhancing visitor interaction and learning with mobile technologies. In: Tallon, L., Walker, K. (eds.) Digital technologies and the museum experience: Handheld guides and other media, pp. 19–34. Altamira Press, Lanham (2008)
5. Brouillard, J., Loucopoulos, C., Dierickx, B.: Digital storytelling and cultural heritage: Stakes and opportunities. In: AthenaPlus WP5 (ed.) Creative applications for the reuse of cultural resources. Belgium (2015). <https://www.athenaplus.eu/index.php?en/207/digital-storytelling-and-cultural-heritage>, Accessed 30 May 2020
6. Simon, N.: The participatory museum. Museum 2.0. Santa Cruz (2010)
7. Colazzo, S.: Museo quale dispositivo educativo comunitario. In: Del Gobbo, G., Galeotti, G., Pica, V., Zucchi, V. (eds.) Museum & Society. Sguardi interdisciplinari sul museo, pp. 65–76. Pacini Editore, Pisa (2019)
8. United Nations: Transforming our World: The 2030 Agenda for Sustainable Development. United Nations, New York (2015)
9. European Commission: European framework for action on cultural heritage, European Commission (2019). <https://op.europa.eu/en/publication-detail/-/publication/5a9c3144-80f1-11e9-9f05-01aa75ed71a1>, Accessed 31 May 2021
10. Interreg Central Europe COME-IN!: COME-IN! Linee Guida. Interreg Central Europe (2019)

11. World Health Organization, Disability. <https://www.who.int/health-topics/disability>, Accessed 18 Apr 2021
12. NC State University, The Center for Universal Design: The principles of universal design (1997). https://projects.ncsu.edu/ncsu/design/cud/about_ud/udprinciplestext.htm, Accessed 28 May 2021
13. MoMA Accessibility, <https://www.moma.org/visit/accessibility/>, Accessed 18 May 2021
14. MET Resources for Visitors, <https://www.metmuseum.org/events/programs/access/visitors-with-developmental-and-learning-disabilities/for-visitors-with-autism-spectrum-disorders>, Accessed 04 Sept 2021
15. British Museum Sensory Map. <https://www.britishmuseum.org/sites/default/files/2019-11/British-Museum-Sensory-Map-PDF-Download.pdf>, Accessed 18 May 2021
16. Corey Timpson, Homepage, <https://coreytimpson.com/>, Accessed 29 May 2021
17. Falchetti, E., Da Milano, C., Guida, M.F.: La narrazione digitale come strategia per l'accessibilità e l'inclusione culturale in museo. In: Capasso, L., Monza, F., Di Fabrizio, A., Falchetti, E. (eds.) L'accessibilità nei musei. Limiti, risorse e strategie, Chieti, 23–25 ottobre 2019, Atti del XXIX Congresso ANMS, Museologia scientifica, vol. 14, no. 21/2020, pp. 193–197 (2020)
18. Roussou, M., Ripanti, F., Servi, K.: Engaging visitors of archaeological sites through ‘emotive’ storytelling experiences: a pilot at the Ancient Agora of Athens. In: Garagnani, S., Gaucci, A. (eds.) Proceedings of the KAINUA 2017, International Conference in Honour of Professor Giuseppe Sassatelli’s 70th Birthday, Bologna 18–21 April 2017, Archeologia e Calcolatori, vol. 28, no. 2, pp. 405–420 (2017)
19. Valenti, M.: Ricostruire e Narrare. L’esperienza dei Musei archeologici all’aperto. Edipuglia, Bari (2019)
20. Salmon, C.: Storytelling. La fabbrica delle storie. Fazi Editore, Roma (2008)
21. Bonacini, E.: I musei e le forme dello storytelling digitale. Aracne Editrice, Canterano (2020)
22. Trocchianesi, R.: Design e narrazioni per il patrimonio culturale. Maggioli Editore, Santarcangelo di Romagna (2014)
23. Sturm, B.: The “storylistening” trance experience. J. Am. folklore **113**(449), 287–304 (2000)
24. Fontana, A.: Story selling. Strategie del racconto per vendere sé stessi, i propri prodotti, la propria azienda. Rizzoli Etas, Parma (2010)
25. Trocchianesi, R.: L’Archivio Digitale degli Allestimenti Temporanei: contesto culturale, motivazioni, questioni aperte / The Digital Archive of Temporary Exhibitions: cultural context, motivations, open questions. In: Lupo, E., Trocchianesi, R. (eds.) design & cultural heritage. Progetto e memoria del temporaneo, III, pp. 93–99/100–106. Mondadori Electa S.p.A, Milano (2013)
26. Rocco, E., De Apollonia, G., Cavallo, R.: Un linguaggio per tutti: le sfide dello storytelling accessibile. In: Dal Maso, C. (ed.) Racconti da museo. Storytelling d’autore per il museo 4.0, pp. 85–103. Edipuglia, Bari (2018)
27. Vermeeren, A., et al.: Future museum experience design: crowds, ecosystems and novel technologies. In: Vermeeren, A., Calvi, L., Sabiescu, A. (eds.) Museum experience design. SSCC, pp. 1–16. Springer, Cham (2018). https://doi.org/10.1007/978-3-319-58550-5_1, Accessed 12 Oct 2021
28. Smithsonian Design Museum: Designing the Pen. <https://www.cooperhewitt.org/new-experience/designing-pen/>, Accessed 27 May 2021
29. Geismar, H.: Museum Object Lessons for the Digital Age. UCL Press, London (2018)
30. Bacci, F., Pavani, F.: ‘First Hand’, not ‘First Eye’ knowledge: bodily experience in museums. In: Levent, N., Pascual-Leone, A. (eds.), The Multisensory Museum. Cross-Disciplinary Perspectives on Touch, Sound, Smell, Memory, and Space, pp. 17–28. Rowman & Littlefield, United States of America (2014)

31. Palombini, A.: Narrazione e virtualità: possibili prospettive per la comunicazione museale. *DigiItalia* 1, 9–22 (2012)
32. Spagnoli, A.: Istituzioni culturali e Digital Cultural Heritage. Nuovi paradigmi di acquisizione, conservazione e valorizzazione nel contesto della cultura digitale/Cultural institutions and Digital Cultural Heritage. New paradigms for acquisition, preservation and value enhancement in the context of digital culture. In: Lupo, E., Trocchianesi, R. (eds.), *design & cultural heritage. Progetto e memoria del temporaneo*, III, pp. 27–32/33–38. Mondadori Electa S.p.A., Milano (2013)
33. Balboni Brizza, M.T.: Il museo come forma complessa. In: *La nuova museologia*, vol. 3, pp. 18–20 (2001)
34. Gambaro, P., Rosa, E.: Dinamiche open nel progetto per il Cultural Heritage digitalizzato Open dynamics in digital Cultural Heritage Design. In: Irace, F. (ed.), *Design & Cultural Heritage. Immateriale. Virtuale. Interattivo*, I, pp. 221–228. Mondadori Electa S.p.A., Milano (2013)
35. Pallasmaa, J.: *The Eyes of the Skin: Architecture and the Senses*. John Wiley and Sons Ltd., Chichester (2005)
36. Ward, J.: Multisensory memories. In: Levent, N., Pascual-Leone, A. (eds.) *The Multisensory Museum. Cross-Disciplinary Perspectives on Touch, Sound, Smell, Memory, and Space*, pp. 273–284. Rowman & Littlefield, United States of America (2014)
37. Smithsonian Museum: Smithsonian Guidelines for Accessible Exhibition Design. Smithsonian Accessibility Program. National Museum of American History, Washington D.C. (2010). <https://access.si.edu/museum-professionals>, Accessed 29 May 2021
38. Mauritshuis, Smell the Art - Fleeting Scents in Colour. <https://www.mauritshuis.nl/en/discover/exhibitions/vervlogen-in-geuren-en-kleuren/>, Accessed 30 May 2021
39. Riva, M.: Il sound design come “materiale” di progetto di nuovi linguaggi e modelli di fruizione del patrimonio culturale. In: Irace, F. (ed.), *Design & Cultural Heritage. Immateriale. Virtuale. Interattivo*, I, pp. 209–215. Mondadori Electa S.p.A., Milano (2013)
40. Dialogue in the Dark Homepage. <https://www.dialogue-se.com/what-we-do/dialogue-in-the-dark/>, Accessed 30 May 2021
41. Triberti, S., Brivio, E.: *User Experience. Psicologia degli Oggetti, degli Utenti e dei Contesti d’Uso*. Maggioli Editore, Santarcangelo di Romagna (2016)



Approaches About Emotions and Feelings in Research with Wheelchair Users: A Review

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Abstract. The present review sought to raise discussions about how emotions and feelings are addressed in research with users of manual wheelchairs. Although there is a small amount of specialized research in this field, it was possible to list 6 aspects to be discussed: main emotions and feelings, perception of emotions and feelings by the user, social and family influences, influences from rehabilitation and leisure programs, protocols and methods reported, relationship with the wheelchair and with their disabilities. As a conclusion of this discussion: there was an influence of external and internal factors on emotions and feelings, the time of using the wheelchair, the age and gender of the users of the technology. Indirectly, it was concluded that more robust studies are still needed on the emotions and feelings involved in the relationship between user, artifact and daily activities in the field of product design, with the aim of improving interaction with the technological physical interfaces.

Keywords: Assistive technology · Emotions · Wheelchair users

1 Introduction

According to the Assistive Technology Industry Association [1], Assistive Technology (AT) can be considered as any equipment, system or product used to increase, maintain or improve the functional capacity of people with disabilities. Such technologies assume a relevant role for their users, enabling them to perform simple tasks that may have been compromised [2], relating to other perceptions involved in the daily lives of users, such as self-efficacy, quality of life and social participation.

To improve the performance of daily activities and access to environments, people with limited mobility or impairment in the lower limbs can make use of a well-known AT: the wheelchair. Some research in health and engineering is available in the scope of biomechanical influences of the use of this equipment and how to improve its performance, but studies on users' emotions and feelings about this AT are still little explored.

When it comes to AT design, the designer needs to know the dynamics between individual and artifact, as this interaction directly influences the activities of the user's

daily life, their feelings and emotions. However, the definition of emotion is a notorious problem in scientific research [3]. In the design field Norman [4] states that the user interprets emotional experiences at many levels. For the author, there are three sequential levels of interaction with artifacts: visceral, behavioral and reflective. Only at the last level, consciousness reaches high levels of feeling, emotions and cognition. The reflective is the most vulnerable to variability through culture, experience, education and individual differences.

Observing individuals who use their wheelchair as the main means of mobility, we can say that the relationship between the user and the artifact takes place at reflective levels. Thus, it suffers the influences mentioned by Norman [4]: culture, experience, education level and individual differences. Therefore, it is believed that the relationship with this artifact at a reflective level can be complex and be present in various scenarios of the user's daily life, without necessarily being directly cited.

This study was aimed at reviewing the available literature on the emotions and/or feelings of manual wheelchair users. More specifically, we discuss how these issues have been addressed in investigations in the field of assistive technologies.

2 Methodology

The means of collection was through a literature review. For filtering, we sought to answer the question: How are emotions addressed in research with manual wheelchair users that use their wheelchair as the main mobility technology?

The present study had its procedures for the definition of descriptors and filtering of articles based on those used by the PRISMA method [5], but generating at the end only a scope review, due to a difficulty in performing a meta-analysis of the studies, which are very diverse between them.

The search strategy was built using the following terms: wheelchair * AND emotions * in the PubMed, Web of Science and Scopus databases, including original articles in English, from scientific journals and annals of events, between 2000 and 2021, with the inclusion criteria were: original articles, in English, scientific journals and annals of events, studies addressing the emotional theme, approaches that individuals who use wheelchair as the main means of their mobility. And the exclusion criteria were: studies that did not contemplate the research question, that did not deal exclusively with wheelchairs or most of the AT were motorized wheelchairs, reviews, duplicates, expanded abstracts, thesis and dissertation.

At the end, 13 articles were selected for discussion and, after reading and thoroughly analyzing the material, notes were made related to the approach to emotions in research on the use of wheelchairs, which are more relevant between Design and AT. The exposed process flow is summarized in Fig. 1.

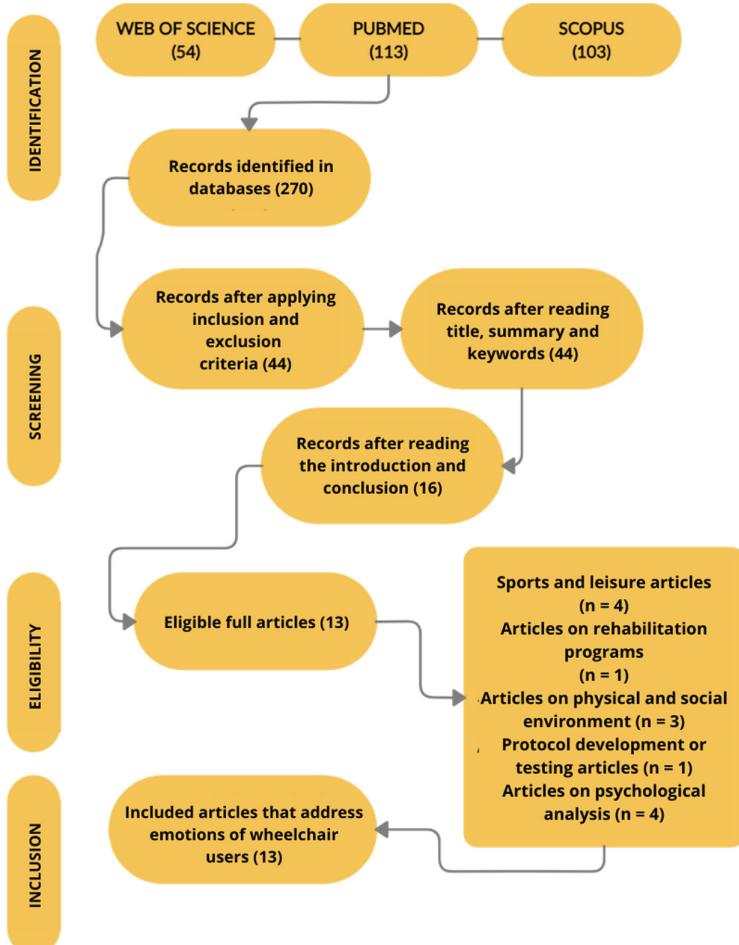


Fig. 1. Flowchart of the article filtering process.

3 Results

As a result of the reading of the final material, it was possible to segment the information collected into six topics frequently brought into the discussions and results of studies as related to emotions of being a wheelchair user (Fig. 2), namely: 1 - the main emotions and feelings cited regardless of the source of the report, including: users, family, friends and hospital support; 2 - the perception of emotions and feelings exclusively pointed out by users; 3 - the social and family influences of these emotions mentioned in the products; 4 - the influences resulting from rehabilitation, leisure and sport programs; 5 - the methods and protocols gathered to collect or analyze these emotions; 6 - the expresses emotions and feelings related specifically to the wheelchair, without considering other interferences.

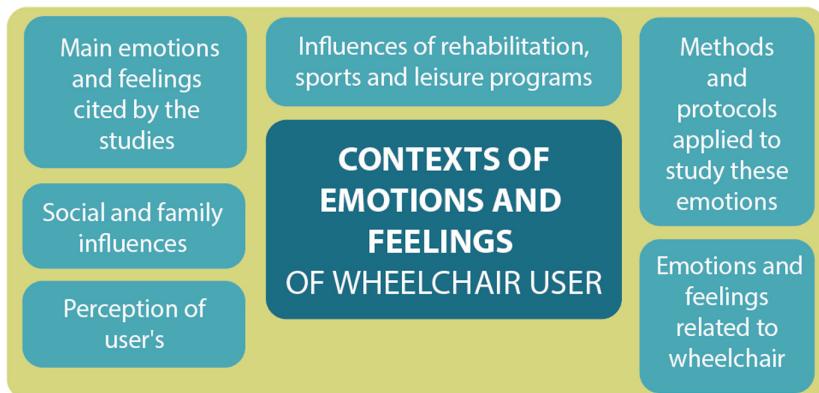


Fig. 2. Contexts found in the scope review that influence the collection and analysis of emotions of wheelchair users.

4 Discussion

4.1 Main Emotions and Feelings Cited by Studies

It is said by MURAKI et al. [7] that individuals with spinal cord injury who are wheelchair users are more prone to psychological problems such as anxiety and depression. When investigating wheelchair users' related emotions, Mokdad et al. [6] in their study report that this user audience expresses predominantly negative emotional responses, such as anger. It is possible to perceive negative feelings even before the individual becomes totally dependent on his wheelchair [8], feelings that are intertwined with the feelings related to the beginning of the contact with their disability.

It was also observed how the dependence on wheelchairs can present emotional aspects such as intrusive thoughts and denial [8]. One study indicated emotional responses of the users regarding their wheelchair were predominantly negative in the female audience compared to the male audience [6], raising questions about the influence of gender on this perception.

In the research by AHO et al. [9] it is presented that the diagnosis of some disease related to the use of wheelchairs can be difficult to understand and generate shock to the individuals and their parents on a multitude of levels and feelings. Another feeling resulting from the adaptation process of this AT may be the relative shame of physical limitations and mental blocks in performing tasks that were previously automatic, some avoid doing as activities because of these sensations [9]. In parallel, there is a fear that the health situation gets worse [9].

It is important to note that all this adaptation process described has an influence both on the diagnosis and on the use of an AT device, at different times these two spheres overlap in the interpretation of the studies.

The study of Aho et al. [9] states that, at the end of the adaptation process in relation to disability, the wheelchair starts to bring a sense of freedom to its user. However, a negative feeling that endures is that of stigmatization, characterized by the social reduction of a

person's personality due to his disability [9]. This shows that society generally wrongly believes that there are assumptions based on prejudice [9].

In a study on children's dance in wheelchairs, it is reported about this activity to generate in the participants an expression of themselves, in parallel with emotions of personal connection, freedom and belonging [10]. Parents reported their children's sense of pride [10]. The parents also commented that they felt the fun of the children, and the sense of accomplishment on the part of them [10].

The study approach in children's dance debate that the dance brings a greater feeling of wheelchair control and gain of the feeling of independence [10], an important feeling discussed by RICE et al. [11] in a study on the existence of fear of falling among wheelchair users, in which the feeling of independence can help to reduce fear of falling. The lack of a feeling of independence can be related to the fear of falling or being hurt. This fear may be the result of negative feelings attributed to the moment of falling [11]. When wheelchair users fall in public places, they experience fear and insecurity [9]. This can interfere with the performance of activities, for fear of falling again, causing limitations on real independence [11].

The lack of a feeling of independence can also be related to a frustration of daily dependence on other people [9]. This feeling is also associated [13] with adapting to the daily use of a wheelchair. In parallel to the feeling of independence, a scientific search for evaluating the feeling of confidence in the use of wheelchairs was noted, such as: the Wheelchair Use Confidence Protocol Scale (WheelCon-M) [12].

It is noticeable a change in the feelings involved in the use of a wheelchair during the time of contact with this AT, suffering from the influence of internal and external factors to the user [13]. The diagram below encompasses the emotions and feelings perceived with the reading and analysis of the materials.

Considering the moment when the user was during the studies carried out, a change in emotions and feelings can be seen (Fig. 3), in which the feelings tend to become more positive with the increase in the time of relationship with wheelchair and less influenced by extrinsic factors, such as hospital support and more by intrinsic factors such as age or education.

4.2 Perception of User's

One of the many important perceptions reported was that after a while of having the worst fall with a wheelchair, participants report fear of its recurrence [11]. The participants also reported difficulty in expressing symptoms and feelings of shame, but according to them, talking to health professionals is a way to reduce this difficulty, maturing a feeling of belonging with the disability, which reflects being part of the individual's personality and history [9]. This feeling of shame reported by users is related to some moments when they tried to escape from using a wheelchair and hide their deficiency, in parallel to the feeling of not needing this technology [9].

Users comment that they sometimes feel that people are afraid to talk to them because of their wheelchair, they comment on the stigma and dependence on other people being very influential factors in their perception [9]. It may be the result of a reported change in how they feel when viewed by others [13].

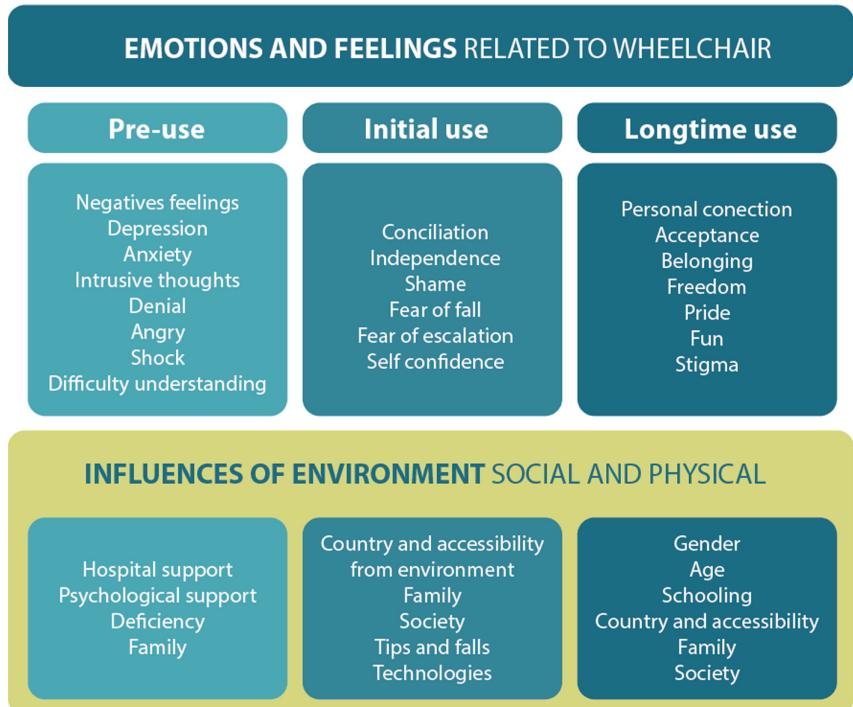


Fig. 3. Emotions and feelings related to the time of interaction with a wheelchair according to articles read.

It was noticed that leisure programs influence the user's perception of emotions, bringing experiences of group acceptance, sense of belonging, freedom of expression, pride, which are sometimes not provided in other environments [10]. A perception of improvement in the relationship with their wheelchair was pointed out with the participation in a children's dance program [10]. In general, over the long term, an improvement in the user's relationship with their AT is reported, bringing more security along with a feeling of freedom [13].

4.3 Social and Family Influences

A change was noted in how some of the participants felt when seen by others. It is possible to find influences from society in the study by Mokdad et al. [6], in which the authors argue about the reported emotions of their participants as a result of the country where they live. When talking about the existence or not of accessibility resources for the use of wheelchairs in social environments, there is an influence of the environment to be adapted to the feelings of well-being [9]. It is possible to find a negative influence in the study by Gaete-Reyes, in which its participants reported several moments where the situation of public transport further accentuates their disability [14].

Events such as the inability to access basic services such as the bus or taxi due to their disability, or the transport is not ready for the reception of the user and their wheelchairs

[14]. This lack of accessibility due to public transport can take away the feeling of being a citizen [14].

In Gaete-Reyes' research, feelings of anger and frustration from one of the participants were also observed due to the neglect that they perceive coming from the society where they live [14]. The study participants also talk about the social influence in their wheelchairs in the sense of perception, that is, society has a wrong view of this AT, seeing it as something pejorative or inferior [14].

Physical activities, such as sports, both in patients with paraplegia and quadriplegia, have a positive effect on psychological aspects, which may decrease levels of depression and anxiety [7]. In leisure settings, such as in children's dance, it has been reported that these practices encourage contact with public presentations, consequently influencing the social trust of the user with the use of their wheelchair [10]. The recovery of confidence to perform the activities needs to be worked through educational means and with interventions, through the transmission of appropriate techniques for handling the device [11].

In the family context, parents comment that there was a difficulty in accepting outside help and talking to other family members about the situation of their children in diagnosis of wheelchair use, as opposed to a concern to prevent their children from being isolated [13]. The family's support for exchanging thoughts and feelings was linked to a sense of self-confidence and strength [9].

There is an influence of the attitude of others on the well-being of these people, both for parents and for them [11]. An example given is the feelings involved in the reaction of people to the fall of wheelchair users, if they fall in public places, they end up feeling fear and insecurity [11].

4.4 Influences of Rehabilitation, Sports and Leisure Programs

Sports can be seen as a good influence on the routine of wheelchair users. According to the study by Mokdad [6], the practice of sport brought participants greater opportunities for socialization, improving their mental health, their relationship with disabilities, independence and confidence. The same point is highlighted by Machida [15], who, in his study, sport enabled a better development of confidence for some of the participants.

The positive benefits resulting from the influence of sport on people with disabilities were also highlighted by Moss et al. (2019), who observed benefits resulting from the practice of wheelchair basketball to its users, pointing out that the majority of their participants waited with good expectation for the matches.

Basketball has also promoted users to improve their social interactions, making new friends, and having positive interactions with other players, making wheelchair users feel welcome [16]. A study about a dance program for children using wheelchairs, establishes that although the program has particularities, resulting from the public, it still resembles in some aspects to non-user programs [10]. The study's research sought to give voice to children and their guardians and showed that the program brought the opportunity to express individuality and group expression [10].

The important role of occupational therapy is highlighted to promote better opportunities for the participation of people with disabilities in these sports and practices [16]. In China, there are rehabilitation programs for people with spinal cord injuries, but there

is a training gap and training ramifications when talking about family and social integration of these people [17]. As part of the program, group discussions, demonstrations and role-playing are used to improve participants' self-confidence and social adaptation.

Seeking to psychologically analyze the participants, before and after the program, the participants' emotional skills were assessed, interpersonal communication, problem solving and emotional control were verified. As a result, there were changes between the two periods between the participants' cognition and emotion scores, showing the effectiveness of this type of program [17].

The report about the influence of dance showed the participants' documentation in which the child's body and disability end up being analyzed by professionals separately from their conscience, generating a duality, but for the participants this aspect does not exist or is not relevant [10].

According to the parents' view of children's dance participants, contrary to the common view of society, they commented that the program reflects the children's abilities instead of emphasizing their deficiencies [10]. Even though it looks like other dance programs, this program has unique results in the particular context of wheelchair use, as it considers the potentials and limitations of the body according to the deficiencies and the participants [10].

An active life in society seems to be essential for the well-being of wheelchair users, influencing the perception of disability [11]. After a period of acceptance of the disease, it is perceived that there is an importance in not feeling ashamed of oneself and an improvement in the relationship with daily life and with the wheelchair [9]. Differences were perceived in the forms of emotional benefits of sport between quadriplegics and paraplegics, but still: sport benefits both audiences [7]. Apparently, the deficiency influences the model of the mobility AT [13] and this can be a factor of influence in the relationship with this technology.

4.5 Methods and Protocols Applied to Study These Emotions

Most of the studies approached a qualitative method, of interviews, questionnaires or reports [9–11, 13, 14, 16], it is believed that this is the best way to collect more detailed perceptions of emotions in the sample. In Rice [11], the quantitative method was used only for the initial selection of the sample. Focus groups, diary requests and visual documentation of the participants were also reported, with the same objective [10].

In a study with a child audience, an adaptation of the approach was observed, such as methods for designing experiences, to facilitate expression [10]. Depending on the focus of some interviews, parents and caregivers were involved [9, 10].

Some of the protocols found in the studies were: Community participation indicators (CPI) and Heinemann et al. [11]; Zung self-rating depression scale, 26 a State-Trait Anxiety Inventory, Profile of Mood States and Borg Scale [7]; Functional Independence Measurement scale, based on Question, Persuade, Refer, Suicide Prevention Gatekeeper Training Program, Social Learning Theory and The mini version of the Chinese Happiness Inventory (CHI-mini) edited by Lu et al. (2010) [17]; Geneva Emotional Wheel [6]; Richardson and colleagues' Resiliency Model [15]; Visual analog scale (VAS), Hospital Anxiety and Depression Scale (HADS), Impact of Event Scale (IES) [8].

It was noted with this survey that many of the protocols approached to support discussions on feelings and emotions of wheelchair users are in the health area. However, no material was found that crossed these data with technological aspects.

An important feeling, but until the study by RUSHTON et al. [12] there was no validated tool to measure self-confidence in wheelchair users. The confidence measure was developed especially for this study, it was called the Wheelchair Use Confidence Scale (WheelCon-M). This method is different from the others because it does not measure the capacity with the use of a wheelchair, but rather the belief, the feeling of possibility, in relation to the scenarios of the everyday environment [12].

4.6 Emotions and Feelings Related to Wheelchair

The time before and after using a wheelchair can be a psychologically stressful process, mainly due to the mental difficulty involved in learning to use this AT, in parallel with possible complications of the disability that alter the relationship with this technology [9].

Returning to the fall context mentioned in other topics, the actions most related to the fall are associated with the propulsion and transfer of the wheelchairs [11], fear generated by these situations influenced the relationship with this technology [11]. But after the initial adaptation process, the wheelchair starts to bring freedom to its users, some comment that there is a reconciliation with their AT [9], becoming a form of expression, and not just a means of locomotion [10].

In the study by RUSHTON et al. [12], the elaborated protocol sought to map the moments when confidence is challenged in the use of wheelchairs, to move it in new environments, when trying new skills, and in stressful situations. Managing emotions can play an important role in the development of new skills of wheelchair users and the widespread use of these skills in new environments and activities [12]. For example, if a person using a wheelchair is not able to control anxiety related to learning to climb a curb, they are unlikely to do so consistently, possibly resulting in a limitation on the independent use of this AT in the community [12].

5 Final Considerations

The present review article proposed to analyse the studies on emotion perceived by users of manual wheelchairs, verifying how the use of this product influences the emotional condition of the users.

Although several studies with wheelchair users mention the concepts of emotion and feeling, it was noticed that there is little research focused specifically on these concepts. The main source of perceptions on this topic is still qualitative research with few participants. Although little is known about the interaction between users and this artefact, it can be concluded that there are internal and external influences on how they relate over time, reflecting on their emotions and feelings. The conclusions corroborate with Norman [4] concepts that the user interprets experiences at many levels and at the reflective level, consciousness reaches high levels of feeling, emotions and cognition.

And it is seen that it is also the most vulnerable to variability through culture, experience, education and individual differences.

There was an almost inseparable connection between the emergence of feelings and emotions in the relationship of the individual's disability and their wheelchair. Additionally, it is perceived that there is a need to stimulate the positive emotions of the public through the use of adequate AT, the usage of physical environments with increased accessibility, and social environments with stronger integrations, such as sports and leisure programs. Therefore, the wheelchair users' can increase their feelings of belonging and independence.

Discussions in this review intend to stimulate the production of more studies on emotions and wheelchair users, so that researchers and other design professionals can have scientific material and, consequently, develop products and services that better understand the emotions and feelings of this public. The improvement of these projects can result in more positive feelings and improvements in the individual's relationship with technologies.

Acknowledgment. The present study was supported by the Coordination for the Improvement of Higher Level Personnel (CAPES - Process 88887.597667/2021-00); and National Council for Scientific and Technological Development (CNPq - Process 310661/2017-0 and Process 304619/2018-3).

References

1. ATIA, Assistive Technology Industry Association.: What is AT. ATIA website (2021). <https://cutt.ly/Yjk8qNu>, Accessed 11 Jan 2021
2. Sebold, W., Pedrosa, S.: Tecnologia Assistiva: uma introdução. Revista Educação e Cultura Contemporânea **17**(51). PPGE/Unesp. Rio de Janeiro (2020)
3. Scherer, K: What are emotions? and how can they be measured? Social Sci. Inf. **44**(4) (2012). <https://bitly.com/dwCIQ>, Accessed 11 Jan 2021
4. Norman, D.: Design emocional. Rocco, Rio de Janeiro (2008)
5. Moher, D., Liberati, A., Tetzlaff, J., Altman, D.: Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. PLoS medicine **6**(7), e1000097 (2009)
6. Mokdad, M., Mebarki, B., Bouabdellah, L, Mokdad, I.: Emotional responses of the disabled towards wheelchairs. Adv. Intell. Syst. Comput. **17**(21). 86–96 (2017). <https://bitly.com/48OSF>, Accessed 13 Jan 2021
7. Muraki, S; Tsunawake, N; Hiramatsu, S; Yamasaki, M.: The effect of frequency and mode of sports activity on the psychological status in tetraplegics and paraplegics. Spinal Cord **38**(5), 309–314 (2000). <https://bitly.com/dmBcp>, Accessed 11 Jan 2021
8. Janssens, A, et al.: Perception of prognostic risk in patients with multiple sclerosis: the relationship with anxiety, depression, and disease-related distress. J. Clin. Epidemiol. **57**(2), 180–186 (2004). <https://bitly.com/nTgLC>, Accessed 11 Jan 2021
9. Aho, A., Hultsjö, S., Hjelm, K.: Perceptions of the transition from receiving the diagnosis recessive limb-girdle muscular dystrophy to becoming in need of human support and using a wheelchair: an interview study. Disabil. Rehabil. **41**(19), 2289–2298 (2018). <https://bitly.com/an7m6>, Accessed 11 Jan 2021
10. Goodwin, D., Krohn, J., Kuhnle, A.: Beyond the wheelchair: the experience of dance. Adapt. Phys. Activity Q. **21**(3), 229–247 (2004). <https://bitly.com/bvSvm>, Accessed 11 Jan 2021

11. Rice, L., Peters, J., Sung, J., Bartlo, W., Sosnoff, J.: Perceptions of fall circumstances, recovery methods, and community participation in manual wheelchair users. *Am. J. Phys. Med. Rehabil.* **98**(8), 649–656 (2019). <https://bitlyli.com/94mvX>, Accessed 11 Jan 2021
12. Rushton, P., Miller, W., Lee Kirby, R., Eng, J., Yip, J.: Development and content validation of the wheelchair use confidence scale: a mixed-methods study. *Disabil. Rehabil. Assist. Technol.* **6**(1), 57–66 (2011). <https://bitlyli.com/tJu8X>, Accessed 13 Jan 2021
13. Rousseau-Harrison, K., Rochette, A., Routhier, F., Dessureault, D., Thibault, F., Cote, O.: Perceived impacts of a first wheelchair on social participation. *Disabil. Rehabil. Assist. Technol.* **7**(1), 37–44 (2011). <https://bitlyli.com/9rx6P>, Accessed 13 Jan 2021
14. Gaete-Reyes, M.: Citizenship and the embodied practice of wheelchair use. *Geoforum* **64**, 351–361 (2015). <https://bitlyli.com/0Y7DV>, Accessed 13 Jan 2021
15. Machida, M., Irwin, B., Feltz, D.: Resilience in competitive athletes with spinal cord injury: the role of sport participation. *Qual. Health Res.* (2013). <https://bitlyli.com/QVR0Y>, Accessed 13 May 2021
16. Moss, P., Lim, K., Prunty, M., Norris, M.: Children and young people's perspectives and experiences of a community wheelchair basketball club and its impact on daily life. *Brit. J. Occup. Therapy* **83**(2), 118–128 (2019). <http://shorturl.at/lnDV9>, Accessed 11 Jan 2021
17. Chiang, Y., Lee, C., Hsueh, S.: Happiness or hopelessness in late life: a cluster RCT of the 3L-mind-training programme among the institutionalized older people. *J. Adv. Nurs.* (2020). <https://bitlyli.com/vzsb6>, Accessed 13 May 2021

Graphic Design and Branding



Analyzing Local Identity Through Outdoor Advertising in the Cities of Kyoto, Osaka and Tokyo

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Abstract. The present study envisions a potential solution, through outdoor advertising, for the growing homogenization of the concept of *place* amid the dissemination of a global advertising culture, reinforced by the globalization of the market and the technologies of the digital age. As suggested by McClay and McAllister, the events mentioned above allow for an easy fraternization of people, products, and ideas thus, sometimes, making the world appear *placeless*. Nowadays, especially regarding communication in public spaces, the constant dispute between brands causes a lack in the support of a city's identity. From the perspective discussed here, brands could adopt idiosyncratic elements of the local culture in their campaigns and – through a cooperation between brands and cities – disseminate the intrinsic characteristics that incorporate its identity. This approach is substantiated through applied research, carried out in three Japanese cities (Kyoto, Osaka and Tokyo), where sociological, cultural and aesthetic aspects were analyzed. Through a field study based on visual research, different samples were constituted for each city, composed of 180 objects each, and examined in three sequential phases: descriptive analysis, content analysis and interpretive analysis. The results corroborate the hypotheses raised regarding the existence of divergent cultural preferences in outdoor advertising in each of these three cities. It was concluded that the introduction of advertising adapted to the society and culture of different regions may bring benefits for the local identity, as well as for the brands that will thus establish a more relevant communication with a city's inhabitants.

Keywords: Local identity · Outdoor advertising · Cultural preferences · Aesthetic preferences

1 Introduction

The coming of the digital age has enabled the dissemination of a global culture, where mobility and economic progress is emphasized over “place” [1]. In a similar way, the constant dispute between brands has damaged local identity, where massive outdoor advertising has led to a growing trivialization of the cities’ landscape [2].

Nevertheless, the importance of “place” and local identity is increasingly debated, with the cities striving to proclaim their differences and emphasize the aspects that make them unique and that, traditionally, result in better tourism rates.

In the case of Kyoto, since the period of state of war in Japan, (the *Muromachi* period (1336–1573)), the landscape of the city has been designated a scenic place, containing aesthetic appreciations [3]. The modernization of the city, together with massive, uncontrolled advertising practices, has transformed this landscape over the years [4] and the fear of losing its cultural heritage in the near future caused the Kyoto government to establish a series of restrictions on outdoor advertising in order to maintain harmony in relation to local characteristics [4] and promote quality ads [5].

It is intended to demonstrate with this study that outdoor advertising is an integral part of the urban landscape, capable of adapting and recognizing different socio-cultural contexts and thus contributing to reinforce the local identity and a sense of place.

Hence, the existence of different cultural patterns within Japanese society is highlighted from a social and historical context, exposing the determining factors for the adaptation of outdoor advertising to the variations in Kyoto, Osaka and Tokyo, and proposing a basis for a better understanding of the Japanese Market and Culture to update a western interpretation that is, at times, too stereotypical.

This investigation explores the adaptation of outdoor advertising based on the possibility of its consideration – in its various languages – of the local identity. In this sense, we aim to reveal if outdoor advertising presents different preferences within the advertising universe of Kyoto, Osaka and Tokyo.

Considering the restrictions imposed on advertising by the Kyoto government [5], it is also intended to verify whether they are beneficial to local identity, i.e., if there is a greater recognition of this local identity in comparison to the other cities in the study.

To ensue this investigation, first, the theoretical framework needed to support the study based on visual research was developed, which deals with the analysis and interpretation of images. Once fine-tuned the literature review and established the research hypothesizes, the methodology gave rise to quantitative results and qualitative assessments. The set of scientific knowledge and subjective interpretations generated a reasoned discussion that resulted in guidelines capable of envisioning a potential solution.

2 Literature Review

The input presented here is part of a master's dissertation where an extensive and thorough literature review was produced, analyzing four major areas: the Japanese society and sociological variations over time; cultural variations in popular culture; aesthetic variations inherent to Japanese culture; and the history of advertising in Japan. For the purposes of contextualization for this paper, only the most relevant findings are related.

2.1 The Japanese Society

When we reflect on the Japanese society, we are used to consider a unique and homogeneous society, constantly echoed by the *nihonjinhon* (theories of “japaneness”) [6]. The lifestyles and values of middle class, with greater access to mass media, acquiring a disproportionately high level of visibility in relation to the rest of the population.

Japan should, instead, be observed as a conglomerate of different provinces, divided into regional blocs, where people have different lifestyles and mentalities depending on the region they live, called *kenmin-sei* (the provincial character) [6].

Kyoto. Once the capital of the country and place of residence of the emperor, Kyoto is known for being a traditional city. The development of the local economy through the manufacture of various luxury products, caused its inhabitants to identify with the elegance and refinement consistent with the imperial court [7].

Osaka. After the establishment of the government in *Edo* (present-day Tokyo), Osaka transformed from a place of resistance against the *shōgun* regime [8] to the center of the commercial activities. The dissemination of art and culture beyond the elite within the city caused Osaka's popular culture to be appreciated throughout the country. Currently, its inhabitants maintain a merchant lifestyle, focusing on practicality and informality [6].

Tokyo. During Edo period (1603–1867), the city was the seat of the *Tokugawa* shogunate, thus considered the capital. The collision of different classes and traditions within Edo, brought by people who were attracted to the city by job opportunities and its growing economy, gave rise to a unique culture [7]. Currently, Tokyo residents demonstrate the marks of formality and hierarchy of the *samurai* regime [6]. Similarly, “*Edo Style*” can describe present-day Tokyo, where antagonistic concepts coexist in harmony [7].

Cultural Variations. Within Japanese popular culture, three major categories are identified: folk culture, alternative culture, and mass culture [6]. Although different regions may have greater appreciation for one of these categories, each person and, consequently, each city will incorporate all three, despite divergent degrees of prevalence.

Folk Culture. Folk culture is described as the type of popular culture that is established in the day-to-day life of the population, having great dependence on people's historical memory of their own regions [6]. It is the reason for regionally diverse behaviors and traditions such as festivals, folk songs, local dances, etc.

Alternative Culture. Alternative culture is characterized by the forms of mass dissent in relation to the instituted order [6], reflecting the discontent of parts of society and the desire to rebel and challenge the cultural status quo.

Mass Culture. Elements of popular culture, e.g., *anime* shows, J-dramas, J-pop groups, and fashion trends, that are spread through mass communication with the intent of being mass consumed. Its proliferation is deeply dependent on its current market value [6].

Aesthetic Variations. Traditionally, nine Japanese aesthetic principles are identified, these being: *wabi-sabi*; *shibui*; *yūgen*; *iki*; *miyabi*; *geidō*; *ensō*; *jo-ha-kyu*; and *kawaii*.

Wabi-sabi. It gives value to everything that is imperfect, where patina makes objects more pleasant [9]. Thus, the impermanence of objects alludes to a depth and meaning that transcends physical aspects.

Shibui. It expresses a discreet beauty, well crafted, but not too captivating [10]. *Shibui* blends elegance with rustic, where simplicity and restraint are appreciated.

Iki. It consists of three moments: *bitai* (flirtatiousness), *ikiji* (pride and honor), and *akirame* (resignation) [12]. *Iki* can be observed in the affairs and interactions between Japanese celebrities and their fans, defined by an affective but limited connection.

Yūgen. It may mean “mystery” or “subtlety”, used to refer to beauty hidden beneath the surface or to something that is only suggested, but which is absent in visual terms [11].

Miyabi. It attends to what is refined, eliminating the vulgar to give way to the grace and politeness of appearance and good manners [10].

Geidō. It incorporates discipline and ethics in traditional arts, valuing the process over the work, without the work itself being depreciated.

Ensō. A hand-drawn circle constructed through a single brush stroke. It is a representative teaching of an artist’s experience when reaching the “absolute void”.

Jo-Ha-Kyu. It describes a rhythm inherent to the human being translated into actions that start slowly, gain speed and end quickly. Although constant in traditional Japanese arts, the *jo-ha-kyu* rhythm can also be found in modern culture [13], being a frequent pace in advertising.

Kawaii. It incorporates three basic features: *itawashii* (pitiable); *aisubeki* (lovable); and *chiisakute utsukushii* (small and beautiful) [14], referring to every object or person that retains characteristics and/or childish behaviors, capable of triggering a protective and affective response in people.

3 Methodology

A research plan was established according to two stages: the first, observational, where all the study material was gathered; and a second, confirmational, based on the visual research process [15]. In its integrity, the investigation is organized according to an empirical methodological proposal of case study applied to the Japanese cities of Kyoto, Osaka and Tokyo. Three hypotheses were identified:

- H1: Outdoor advertising in Kyoto frequently presents elements of traditional culture.
- H2: Outdoor advertising in Osaka frequently presents elements of contemporary culture.
- H3: Outdoor advertising in Tokyo frequently presents elements of popular culture absorbed by mass culture, where the elements hold market value over cultural value.

3.1 Characterization of Research

Sample Characterization. Through an external quantitative research method, extensive study material was collected, *in loco*, relating to the cities of Kyoto, Osaka, and Tokyo during the period from October 2018 to March 2019. A first collection of research material was carried out during this observational phase from where the final samples were taken for each city, thus classified as non-probabilistic samples for convenience (Table 1).

Table 1. Profile of the samples

City	Number of brands analyzed	Number of advertising objects analyzed
Kyoto	67	180
Osaka	53	180
Tokyo	58	180
Total	178	540

Procedures. After the selection of samples, a coding sheet was created with 13 variables (attributes of advertising interventions) divided into 70 sublevels (variations of these attributes) to categorically describe the study objects – classified according to the most representative component of each variable. A second evaluator, whose profile was compatible with the specificity of this investigation, proceeded to analyze the advertising objects of one of the samples using the created coding, allowing to uncover discrepancies. The subsequent calculation of Cohen's kappa showed excellent results in the level of agreement between evaluators, with $k > .800$ and $p < .001$ in all weighted variables. Once refined this coding sheet, the results were accounted for. The results of this confirmational phase were presented through the most appropriate tables for this purpose, and all quantitative data obtained using the SPSS tool. In the third and final phase of this study, the results were interpreted, where the quantitative results were reinforced by qualitative data – interpretation of the results in the sociocultural context.

Results. The data of the variables that express results relevant to the investigation were examined below. In order to meet the predictions of the three hypotheses raised, the frequencies for each sample within the variable “Visual Elements” were recorded, which can be observed in Table 2.

Table 2. Visual Elements used in each sample.

Visual elements	Kyoto	Osaka	Tokyo
Japanese characters	38.3% (69)	17.8% (32)	20.6% (37)
Latin characters	18.9% (34)	11.7% (21)	12.2% (22)
Japanese and Latin characters	10.6% (19)	12.2% (22)	6.1% (11)
Product	8.3% (15)	7.2% (13)	8.3% (15)
Celebrity	2.2% (4)	4.4% (8)	12.2% (22)
Celebrity and Product	–	3.3% (6)	9.4% (17)
Manga/Anime	0.6% (1)	15.6% (28)	5.6% (10)

(continued)

Table 2. (*continued*)

Visual elements	Kyoto	Osaka	Tokyo
Mascot	2.2% (4)	8.9% (16)	2.8% (5)
Traditional elements	16.7% (30)	0.6% (1)	1.7% (3)
Contemporary elements	—	11.1% (20)	10.6% (19)
Traditional and Contemporary elements	1.1% (2)	1.7% (3)	6.1% (11)
Model	1.1% (2)	5.6% (10)	4.4% (8)
Total	100% (180)	100% (180)	100% (180)

It is shown that “Traditional elements” are more characteristic of the Kyoto sample (16.7%), than of Osaka (0.6%) and Tokyo (1.7%) samples. The bilateral proportion analysis demonstrates that the difference between these proportions is significant ($z_{obs} 5.36 > z_c 2,576$), supporting hypothesis H1. In relation to the elements of contemporary culture, “Manga/Anime”, “Mascot” and “Contemporary elements”, the sample of Osaka (35.6%) presents higher frequencies than the samples of Kyoto (2.8%) and Tokyo (19.0%). Once again, the analysis of the bilateral proportion demonstrates that this difference is significant ($z_{obs} 5.72 > z_c 2,576$), thus supporting hypothesis H2. Finally, it turns out that elements with greater market value, “Celebrity”, “Celebrity and Product” and “Traditional and Contemporary elements”, are more characteristic of the Tokyo sample (27.7%), than of the Kyoto (3.3%) and Osaka (9.4%) samples. The bilateral proportion analysis demonstrates that the difference between proportions is significant ($z_{obs} 6.1 > z_c 2,576$), supporting hypothesis H3. This study revealed additional results that contributed to the understanding of other regional preferences reproduced in the samples. When analyzing the variable “Type of Technique” (Table 3) it was found that the sublevel “Calligraphy”, a sublevel less valued in Osaka (6.7%) and Tokyo (3.3%) samples, appears as the second most frequent sublevel in the Kyoto sample (25.6%).

Table 3. Type of Technique used in each sample.

Type of technique	Kyoto	Osaka	Tokyo
Realistic photography	10.0% (18)	10.6% (19)	20.6% (37)
Illustration	14.4% (26)	28.3% (51)	17.2% (31)
Montage	7.2% (13)	16.1% (29)	22.2% (40)
Calligraphy	25.6% (46)	6.7% (12)	3.3% (6)
Typography	37.2% (67)	29.4% (53)	33.3% (60)
Calligraphy and typography	3.9% (7)	1.7% (3)	0.6% (1)
Sculpture	1.7% (3)	7.2% (13)	2.8% (5)
Total	100% (180)	100% (180)	100% (180)

The analysis of the variable “Dominant Palette” (Table 4) demonstrates a significant divergence between the Kyoto sample and the Osaka and Tokyo samples, where the former favors a color palette that tends to blend in rather than stand out.

Table 4. Dominant Palette used in each sample.

Dominant palette	Kyoto	Osaka	Tokyo
Bright colors	23.9% (43)	66.7% (120)	62.8% (113)
Sober colors	31.1% (56)	7.2% (13)	12.2% (22)
Pastel colors	13.9% (25)	14.4% (26)	16.7% (30)
Black and White	31.1% (56)	11.7% (21)	8.3% (15)
Total	100% (180)	100% (180)	100% (180)

The variable “Approach” also separates the Kyoto sample from the other two samples, where Kyoto presents very high values for the sublevel “Rational” (92.8%), while Osaka (58.3%) and Tokyo (56.7%) samples show more balanced results (Table 5).

Table 5. Approach used in each sample.

Approach	Kyoto	Osaka	Tokyo
Emotional	7.2% (13)	41.7% (75)	43.3% (78)
Rational	92.8% (167)	58.3% (105)	56.7% (102)
Total	100% (180)	100% (180)	100% (180)

In the variable “Material” (Table 6), it can be seen that among the most frequent sublevels the Kyoto sample values the sublevels “Wood” and “Fabric” (20.0%), the same sublevels being of little noticed in Osaka (6.7%) and Tokyo (5.5%) samples.

Table 6. Material used in each sample.

Material	Kyoto	Osaka	Tokyo
Paper	23,9% (43)	26,1% (47)	25,0% (45)
Acrylic	35,0% (63)	27,8% (50)	20,0% (36)
Fabric	9,4% (17)	5,0% (9)	1,1% (2)
Wood	10,6% (19)	1,7% (3)	4,4% (8)
Vinyl	9,4% (17)	15,0% (27)	18,3% (33)
Canvas	6,7% (12)	11,7% (21)	17,8% (32)

(continued)

Table 6. (*continued*)

Material	Kyoto	Osaka	Tokyo
LED lights	1,1% (2)	8,3% (15)	10,6% (19)
Other	3,9% (7)	4,4% (8)	2,8% (5)
Total	100% (180)	100% (180)	100% (180)

The former variable is related to the variable “Communication Channel” (Table 7) which demonstrates divergences between all samples. In the Kyoto sample, there is an appreciation for the traditional communication channels (Poster, Lantern, Curtains/Cloths, Store Name Sign (S.N.S.)). Likewise, the appreciation of the “Easel” sub-level among the most observed in the Osaka sample demonstrates a greater tendency for the usage of secondary communication channels (Easel, Totem, Banners) in this sample. Finally, the Tokyo sample is distinguished by a greater use of fixed urban structures for advertising (MUPI, Electronic screen, Billboards and Windows/Storefronts).

Table 7. Communication Channel used in each sample.

Communication channel	Kyoto	Osaka	Tokyo
Poster	16,7% (30)	5,0% (9)	7,8% (14)
MUPI	5,0% (9)	6,1% (11)	8,9% (18)
Electronic screen	1,1% (2)	4,4% (8)	6,7% (12)
Billboard	6,7% (12)	15,0% (27)	18,9% (34)
Gable	0,6% (1)	3,9% (7)	1,1% (2)
Windows/Storefronts	5,0% (9)	6,1% (11)	12,8% (23)
Lantern	4,4% (8)	1,7% (3)	2,2% (4)
Curtains/Cloths	8,3% (15)	2,8% (5)	1,1% (2)
Store name sign	17,8% (32)	2,8% (5)	5,6% (10)
Self-luminous S.N.S	15,0% (27)	13,9% (25)	12,8% (23)
Lateral S.N.S	11,7% (21)	13,3% (24)	8,3% (15)
Totem	2,8% (5)	8,3% (15)	3,9% (7)
Easel	3,3% (6)	10,6% (19)	4,4% (8)
Banners	–	5,0% (9)	–
Other	1,7% (3)	1,1% (2)	5,6% (10)
Total	100,0% (180)	100,0% (180)	100,0% (180)

3.2 Qualitative Assessments

After completing the frequency analysis, the quantitative data generated was interpreted with the help of exhaustive theoretical mapping, carried out with the objective of forming the necessary basis for the understanding of the results within the socio-cultural context of each city.

Adapting Outdoor Advertising to a Regional Culture. This investigation revealed that the three samples analyzed in this study had greater affinity in representing different elements of Japanese culture in advertising. An international brand that seems to understand regional differences and make use of them to communicate effectively is the non-alcoholic beverages manufacturer, The Coca-Cola Company, whose bottles of the *Region-limited Bottles campaign* support unique regional designs (Fig. 1). This type of regional campaign highlights the cultural differences within Japanese society and the advantages that adaptation – of advertising to the regions – can bring both to the proliferation of the cities' identity and to the acceptance of a brand within the environment in which it operates.



Fig. 1. Region-limited bottles, The Coca-Cola Company Japan, 2019. Photos by Ana Seixosa.

Aesthetic Preferences of Outdoor Advertising in Kyoto. Because of the results obtained in the variable “Dominant Palette” there are several instances in which *shibui* aesthetics manifests itself in the Kyoto sample. Several brands make similar adaptations to that observed for the brand McDonalds (Fig. 2), altering their usual colors and elements for more unobtrusive counterparts. Such restraint is characteristic of *shibui* [11]. Ultimately, adapting advertising in Kyoto considering the characteristics of *kyo-machiya* [5] implies such attributes, naturally associated with *shibui* elegance.



Fig. 2. McDonalds' Lateral S.N.S., Kyoto (left), Osaka (center) and Tokyo (right), 2019. Photos by Ana Seixosa.

We can also find influences of *geidō* aesthetics in the sample by connecting the results obtained for the sublevels “Black and White”, in the variable “Dominant Palette”, and “Calligraphy”, in the variable “Type of Technique”. In the sublevel “Lateral S.N.S” (variable Communication Channel) a dominance of “Black and White” was observed, as well as a greater usage of “Calligraphy” (Fig. 3). This type of design alludes to the Japanese calligraphic art (*shodō*), which naturally conveys *geidō* aesthetic [16] and can be observed in Fig. 4.

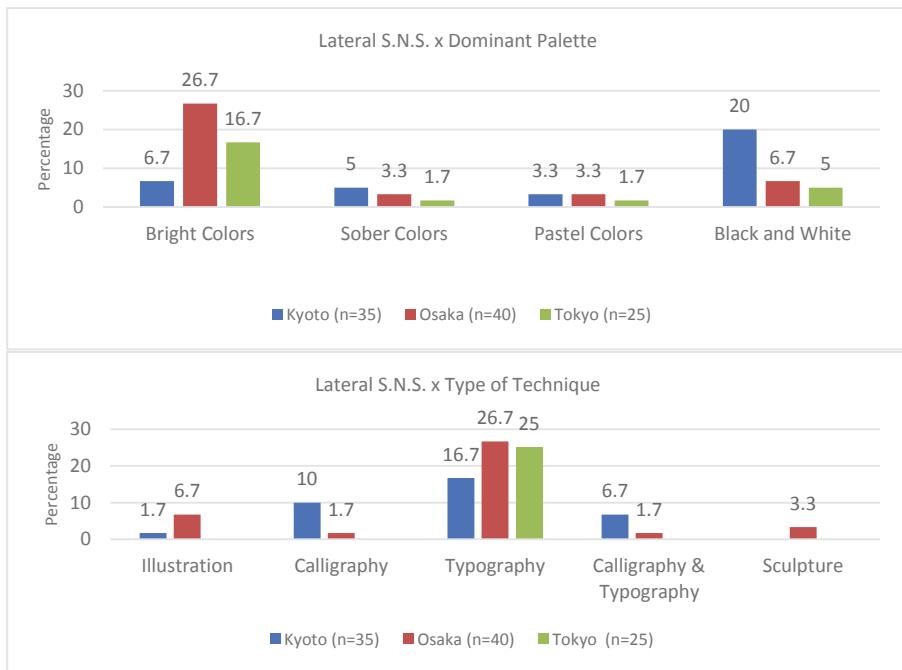


Fig. 3. Connection between Lateral S.N.S. and Dominant Palette (above) and Lateral S.N.S. and Type of Technique (below) for each sample.



Fig. 4. Lateral S.N.S. in Kyoto, 2019. Photos by Ana Seixosa.

Regarding the variable “Material” this investigation pointed out a higher frequency in the use of natural materials within the Kyoto sample. This, combined with the use of the “Poster” and “Store Name Sign” as the most frequent communication channels, has allowed for a noticeable presence of *wabi-sabi* aesthetic in the sample, where these channels will easily experience – and welcome – deterioration. Figure 5 illustrates one such cases, where the store *Okamoto Orimono Honten* maintains its original wooden sign, although it has completely lost its readability over the years. Here, time has stripped the sign of its initial advertising purpose, welcoming the wear that added a higher value to the store – demonstrating its history and traditional character.



Fig. 5. Patina in the sign for Okamoto Orimono Honten, Kyoto, 2019. Photo by Ana Seixosa.

Aesthetic Preferences of Outdoor Advertising in Osaka and Tokyo. Regarding the determination of frequencies that could reveal different aesthetic preferences to the cities of Osaka and Tokyo, the analysis of the variables “Dominant Palette”, “Type of Technique”, “Material” and “Communication Channel” did not indicate significant disparities between the samples that could be translated into aesthetic divergences. However – and although there are divergences in the variable “Visual Elements” (this being one of the most dissimilar variables between the samples) – Osaka and Tokyo’s advertising use the same aesthetic principles, *iki* and *kawaii*, in their most characteristic elements. The collaborations observed between brands and the anime industry in the Osaka sample are aimed at attracting people through fanservice, where non-narrative elements are developed for the purpose of interesting and entertaining fans (Fig. 6).



Fig. 6. Maruhan uses anime characters for self-promotion, Osaka, 2019, Photos by Ana Seixosa.

The exploration of the emotional bond that people have with these image characters aims to put fans in a cycle of searching for an unsatisfactory attainment that ensures their involvement. In the Tokyo sample, the use of celebrities in advertising has the same purpose, where advertisement is a vehicle for celebrity to nurture an affective relationship with fans (Fig. 7). *Kawaii* and *iki* aesthetics are equally explored here since fictional characters and celebrities occupy the same conceptual space [17].

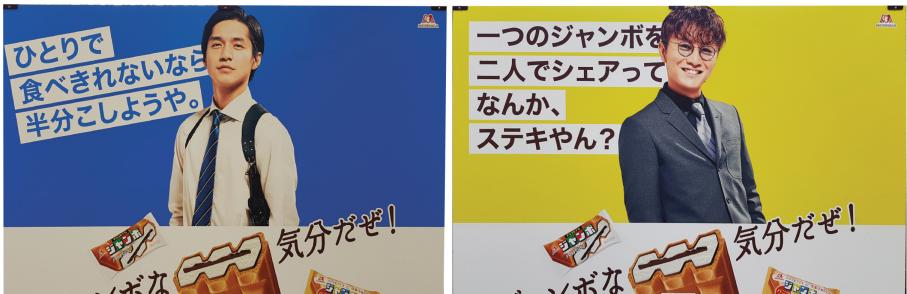


Fig. 7. Kanjani8 in campaign for Morinaga ice-cream, Tokyo, 2019. Photos by Ana Seixosa.

4 Results Discussion

In response to the initial question of this study regarding the ability of outdoor advertising to adapt to the environment in which it is located, the results presented suggest that there are cultural preferences that are expressed in outdoor advertising. In this sense, this research offers guidelines of good practice for brands wishing to enter the Japanese market, particularly in the three cities analyzed.

In Kyoto, brands will be able to communicate intensely, if they do so in a beneficial way for the city's landscape by adapting their interventions according to the variables studied. Partnerships with the anime industry as well as the creation of their own brand

mascots will be well received in Osaka, while the hiring of celebrities in advertising campaigns will boost their success in Tokyo.

Considering the issue of the impact of the restrictions imposed by the Kyoto government on outdoor advertising, the investigation concluded that they limit the representation of “Visual Elements” and denote to advertising characteristics easily associated with aesthetic principles preserved by folk and alternative culture. Given its past and its desire to remain connected to it, the reproduction (or simple insinuation) of these aesthetic principles in Kyoto’s outdoor advertising seems to be more conciliatory in relation to the identity of the city and, in this sense, restrictions help its communication. However, there is a scarcity and repetition of the tone of communication in place of the adaptation and innovation of advertising techniques that would see an improvement in the urban experience – especially in the modern areas of the city where it would coincide with contemporary society.

On the other hand, the looser restrictions on outdoor advertising in Osaka and Tokyo denote characteristics of aesthetic principles absorbed by mass culture – popular among contemporary society. Yet the intrinsic characteristics of these cities could be better represented in advertising that nowadays – and without the same restrictions as Kyoto – absorbs more and more universal styles and values, diluting the place and its history.

After accounting for the quantitative data of this study, the hypotheses H1, H2 and H3 were empirically supported. The subsequent interpretative analysis of some of the most pertinent cases contained within the samples allowed the discovery of other cultural preferences reflected in outdoor advertising that similarly supported the hypotheses in the sociocultural context of each city. The combination of the results found in each of these analyses validated the three hypotheses raised. Finally, we recognize the limitations of this study, namely the fact that most of the brands analyzed diverged between the samples; an imbalance in some variables of the Kyoto sample (predicted from the beginning due to the restrictions imposed); and the choice of analyzing the most characteristic element of each variable over the analysis of each element.

5 Conclusion

This study shows that there are significant divergences between regions, with its contribution being the recognition of a local identity, in outdoor advertising, within an increasingly universal society. Thus, the identification of the elements represented in the advertising of each city analyzed, revealed the intrinsic nature of each of them: the taste and preservation of the traditional in Kyoto; the preference for the playful and contemporary in Osaka; and the tendency of mixing and disseminating cultural elements in mass culture in Tokyo. From this perspective, it is recognized that when advertising incorporates characteristics adapted to the region, it is more likely that the place and its community will support it by perceiving it as inspiring and intensifying its intrinsic attributes. However, there is importance in balance; a need to adapt and innovate within the community – as well as the city itself – which does not possess a sole cultural or aesthetic appreciation. Hence, it is concluded that restrictions imposed on outdoor advertising can be beneficial for the local identity, however there is still a positive potential in the creative freedom of brands within an ever-changing society.

References

1. McClay, W.M., McAllister, T.V. (eds.): Why Place Matters. Geography, Identity and Civic Life in Modern America. New Atlantis Books, United States (2014)
2. The Guardian Homepage. <https://www.theguardian.com/cities/2015/aug/11/can-cities-kick-ads-ban-urban-billboards>, Accessed 21 May 2021
3. Saito, Y.: Scenic national landscapes: common themes in Japan and the United States. *Essays Phil.* **3**(1), Article 5 (2002)
4. Kyoto City Official Website. <https://www.city.kyoto.lg.jp/tokei/cmsfiles/contents/0000057/57538/2shou.pdf>, Accessed 05 Feb 2019
5. Kyoto City Official Website. <https://www.city.kyoto.lg.jp/tokei/cmsfiles/contents/0000057/57538/3shou.pdf>, Accessed 05 Feb 2019
6. Sugimoto, Y.: An Introduction to Japanese Society, 3rd edn. Cambridge University Press, Nova York (2010)
7. Guth, C.: Edo art in Japan 1615–1868. Board of Trustees. National Gallery of Art, Washington (1998)
8. Okakura, K.: Ideals of the East. The Spirit of Japanese Art. Dover Publications Inc, Mineola, Nova York (2005)
9. Koren, L.: Wabi-Sabi for Artists, Designers, Poets & Philosophers. Imperfect Publishing, Point Reyes (2008)
10. Graham, P.J.: Japanese Design. Art, Aesthetics & Culture. Tuttle Publishing, United States (2014)
11. De Mente, B.L.: Elements of Japanese Design, 1st edn. Tuttle Publishing, Tokyo (2006)
12. Kuki, S., Nara, H.: The Structure of Iki, 1st edn. Kodansha International, Tokyo (2008)
13. Oida, Y.: Um ator errante. Beca Produções Culturais, São Paulo (1999)
14. Sato, K.: From hello kitty to cod roe kewpie: a postwar cultural history of cuteness in Japan. *Asian Intercult. Cont.* **14**, 38–42 (2009)
15. Muratovski, G.: Research for Designers: A Guide to Methods and Practice. SAGE Publications Ltd., United States (2016)
16. Stanford Encyclopedia of Philosophy Archive. <https://plato.stanford.edu/archives/win2018/entries/japanese-aesthetics/>, Accessed 01 Feb 2019
17. Galbraith, P.W., Karlin, J.G. (eds.): Idols and Celebrity in Japanese Media Culture. Palgrave Macmillan, United Kingdom (2012)



The Contribution of Green Marketing to Brand Strengthening and Consumer Loyalty: The LUSH Case

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Abstract. The climax of mass production and overexploitation of natural resources began with industrialization, and over the past decades has led to an increasingly imminent decay and degradation of the planet. Thus, the need arises to adopt sustainable modes of production and consumption, in order to reduce environmental impact and, in the case of companies, also reduce production costs, which consequently allows for an increase in profit. Green marketing is a good strategy to make consumers aware of environmental problems and to encourage the consumption of organic products and all their advantages. This article aims to explore the concepts inherent to environmental issues within brands, particularly analysing the cosmetics brand LUSH Fresh Handmade Cosmetics. It was concluded that the adoption of green marketing and the components of corporate social responsibility greatly strengthens the image, identity and value of a brand, making the customer loyal and, therefore, also constituting a differentiation factor and a competitive advantage.

Keywords: Sustainability · Green marketing · Corporate social responsibility · Brand value · Consumer loyalty

1 Introduction

The rapid industrialization we witnessed after World War II, along with technological development, raised the economy's potential to an unprecedented extreme; new production methods made it possible to meet consumer needs with greater efficiency in the use of resources, in large-scale production, and at much lower prices. However, over the past few decades, the reckless exploitation of natural resources by economic activity has generated increasingly worrying environmental problems, resulting mainly from the excessive production of garbage and waste and consequent pollution of seas and oceans [1, 2].

Nowadays, industry follows a mostly linear mode of production and consumption (Fig. 1), in which companies extract resources from nature, needed to manufacture products, in order to sell them to an end consumer who discards them after use, when they no longer fulfil their purpose, consequently generating waste and polluting ecosystems [3]. Even though this take-make-dispose system has allowed for increased efficiency in production and resource use, according to the Ellen MacArthur Foundation [3, p. 14],

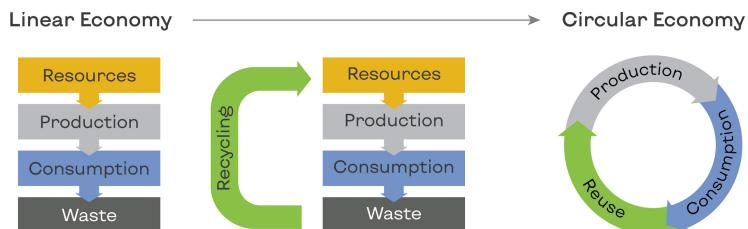


Fig. 1. Summary diagram of the linear and circular economy models. Source: adapted from Circular Economy Portugal (2021).

“(...) any system based on consumption rather than on the restorative use of resources entails significant losses all along the value chain”, so it is not viable in the long run. Thus, there is an emerging need for transition to a more sustainable model of production of goods and services, with the implementation of closed and circular production cycles, in which materials are recycled, products are reused and there is no waste [3, 4]. The paradigm shift thus involves designing products that avoid waste and pollution, made of more sustainable materials and technologies - the so-called designing out waste and pollution; maintaining materials in use, designing to recycle and rebuild products when necessary; and regenerating natural systems, providing soils with the nutrients they need to renew themselves, and favouring the use of renewable energy over fossil fuels [5].

That said, awareness of environmental problems has become increasingly important and prominent on society’s agenda, so consumers’ and communities’ concerns about the environment have been gradually growing and are now more present than ever [6, 7]. Consequently, this has triggered an interest in consumers to adopt new purchasing behaviours and to prefer eco-friendly products with a reduced environmental impact - even being more willing to pay more for such products - which, in turn, has motivated companies to increasingly explore and invest in meeting these needs [6–8], directing their market positioning in this direction. Thus, with the new business opportunity brought by environmental concerns, according to market and consumer demands, companies began to define green marketing strategies that include environmental and social issues [2, 9], such as reducing pollution and improving the working conditions of their employees, as a way to maintain a good image, add value and compete with others [2]. With these new scenarios, companies “(...) must turn to social and environmental responsibility practices (...)” [9, p. 17]¹, since they bring benefits not only for the environment but also for themselves, both in terms of brand value and cost reduction, increased profit and consumer loyalty, who sees in brands an effort to meet their needs and environmental demands.

2 Green Marketing as a Brand Value Creation Strategy

(...) the sustainability factor is increasingly perceived as an instrument to obtain competitive advantages by organizations, either because companies embrace the

¹ Our translation. “(...) devem voltar para práticas de responsabilidade socioambiental (...)” [9, p. 17].

cause due to the obligation to follow legal determinations established by governmental bodies, or because they present themselves as responsible for the preservation of the environment, or also because they realize that following the assumptions of being 'green' can make them more efficient [9, p. 18]².

Sustainable design, or eco-design, has become a popular trend within product design and development; however, it is not enough to develop eco-friendly products with environmentally sustainable materials, but first and foremost, it is necessary to change consumption patterns and reduce resource use [7]. In this way, the process of developing a product is no longer oriented to the product itself, but is conducted according to the market, so designers must, in addition to technical issues, also have knowledge of the psychological and social factors that lead the consumer to buy the product, in order to meet not only the needs of the consumer but also the market [*ibid.*].

Thus, green marketing, also known as ecomarketing, sustainability marketing or environmental marketing, emerged in the 1970s – eco-friendly products only became popular in the 1990s –, and is characterized, according to Cheung et al. [8, p. 28], as the “(...) holistic management for identifying, anticipating and satisfying the requirements of customers and society, in a profitable and sustainable way”. Essentially, green marketing incorporates the sustainability factor into the marketing mix, i.e., it is a practice of producing, selling and promoting eco-friendly products and services that do not harm ecosystems, presupposing and linking at the same time an ecological, sustainable and environmentally aware brand image. On the other hand, it is often used strategically by companies that prioritize a corporate social responsibility (CSR) practice, which consists of a commitment by the brand to adopt ethical behaviour in the social, environmental, and human spheres [10], with a way of operating that does not harm society or the environment, so it encompasses not only a strong contribution to sustainable development, but also issues such as fair trade and labour. Thus, even though environmental issues are not an intrinsic concern for many companies [11], for brands that take sustainable development into consideration this can be a competitive advantage as it allows them to access new markets, increase profit [2] and enhance quality and brand value [1]. Moreover, companies adopting these strategies seek, in addition to gaining competitive vantage, a compliance to the trends of environmental concern in the environment, take advantage of green market opportunities, and increase the perceived value and quality of their products [1, 2]. Nowadays, more consumers are concerned about the environmental impact of social and individual activity, so they are more likely to buy eco-friendly products, and, on the other hand, consumers are more likely to buy the products of a socially and ecologically responsible company – “green marketing can change marketing practices in the world, and further make a difference by building customer needs for green products “[1, p. 1754]. According to Chang and Chen [1, p. 1755], “(...) companies should develop green marketing activities to identify customers' green attitudes and

² Our translation. “(...) o fator sustentabilidade é cada vez mais percebido como um instrumento para obtenção de vantagens competitivas pelas organizações, seja porque as empresas abraçam a causa em função da obrigação de seguir determinações legais estabelecidas por organismos governamentais, ou porque se apresentam como responsáveis pela preservação do meio ambiente, ou também pelo facto de perceberem que seguir os pressupostos de ser 'verde' pode torná-las mais eficientes” [9, p. 18].

behaviors, to evaluate the market of green products, to segment the green market into different niches based on the consumers' needs, to formulate green positioning strategies, and to adopt a green marketing mix program" in order to differentiate themselves from others and create brand value. Therefore, it is important to establish a relationship between green marketing and CSR strategies and brand value, consumer brand loyalty and perceived quality.

Although the field of brand positioning in the green market is still little explored in the literature, the theme has received a lot of attention, especially in the last decade. In a study on the factors that influence brand equity in the green market of electronic products – green brand equity –, Chen and Chai [2] concluded that there is a positive influence of image, satisfaction and trust of and towards green brands in brand equity, so the authors recommend the strengthening of these pillars and the integration of green marketing in the communication strategy for a higher profit margin. Cheung et al. [8] concluded that trust in green products is influenced by their perceived value, which in turn is influenced by perceived quality, results that are in line with the studies conducted by Chen and Chai [2], Chen and Chang [12], and Chang and Chen [1]. Widystutti et al. [11], in a study conducted in Indonesia on Unilever consumers, also concluded that the implementation of green marketing and the components that constitute CSR bring many advantages for consumers and the company, reinforcing the value of the brand image. In this way, brand positioning in the green market proves to be a favourable strategy to be adopted by companies, insofar as it highlights the differentiation factor as a result of the importance attributed to the brand's green attributes, consumer satisfaction and trust in the brand, thus existing a strong competitive and profitable advantage in this type of communication [13].

3 Case of Study: LUSH Fresh Handmade Cosmetics

Providing personal service is the best environmental practice. If we can get you connected to the appropriate product for your needs, you get really good value for money, we get a regular customer; the consumption of unneeded product falls and money is no longer wasted. When you think about the product people really want, they want products to be made from rainbows, unicorns and waterfalls and we've got it! (Mark Constantine, 2018) [14].

Towards understanding the applicability of the concepts studied in a real context, we chose to analyse the communication strategy and market positioning of the cosmetics brand LUSH Fresh Handmade Cosmetics, or simply LUSH, in order to understand how the brand uses green marketing and corporate social responsibility strategies to add value, influence purchase intentions, and provide a pleasant experience to the consumer, who then remains loyal to the brand.

LUSH is an organic cosmetic brand founded in 1995 in Poole, England, by Mark Constantine, Liz Weir and Mo Constantine, with 951 stores in 55 countries around the world. LUSH positions itself in the luxury cosmetics market, its main mission being to sell products of natural origin, fresh and produced by hand using fresh ingredients such as fruits, vegetables, roots and oils, sown and harvested for the purpose of manufacturing – the brand's own stores have a layout that is reminiscent of fruit and flower markets with

bulk buying. The brand's strategy is very much about transparency in all spheres of the company, as they advocate a policy of minimal waste in production, fair trade and working conditions, work daily to make their products not only vegetarian but vegan, and advocate for human and animal rights. They incorporate the components of CSR by participating in campaigns against animal testing, demonstrations for the rights of the LGBT + community, and movements such as Black Lives Matter.

The brand often joins Non-Governmental Organizations (NGOs) to support social and environmental causes, highlighting these actions in its in-store and social media campaigns and always seeks to be aware of the working conditions of its suppliers, often traveling to their countries of origin as a way to check and ensure the quality of life of workers and the quality of ingredients [14]. Since many of the brand's ingredients come from tropical areas and deforestation has endangered and even extinct many species in the rainforests, LUSH has recently stopped using palm oil in their manufacturing and has even created a soap that supports the regrowth of Orangutan populations, by donating part of the profit to these funds [15]. Besides this, the brand has also recently invested in Regenerative Farming, a type of agriculture that "reverses deforestation, restores degraded soil, increases biodiversity, and even urges an environment to resurrect itself to its original state" [*ibid.*], supporting their farmers not only in restoring the lands and improving production, but foremost in reversing deforestation and ensuring the quality of farmers' livelihoods. Another example of this practice and concern for society and the world we live in is one of the brand's most popular products, "Charity Pot", a vegan hand and body cream launched in 2007 that, with every purchase, 100% of the company's earnings go to a fund that encompasses hundreds of charities around the world, whose cause must fall into at least one of three: environmental, animal and humanitarian [*ibid.*]. To this day LUSH sells the Charity Pot and donates the full value of its sales, having already helped thousands of charities around the world only with this product.

Moreover, still in the line of zero waste, LUSH chooses not to use any kind of packaging in its solid products such as soaps and shampoos, using recyclable materials and plastics in those that actually need packaging and encouraging the consumer to return the packaging for reuse. The company opts for a circular economy model, including reusing cardboard waste at the time of manufacturing to produce paper bags [14]. For online shipments, LUSH also chooses to pack products in a biodegradable cellulose base and a recycled cardboard box with renatured packing peanuts inside that can be composted and have their own orders be packed without plastic [15].

According to the brand [14], between 2017 and 2018, natural ingredients made up 65% of the materials used in production globally, compared to 35% using materials of synthetic origin. Having emerged as a response to a need for organic products that did not exist at the time, to this day LUSH is concerned with manufacturing products under the most sustainable conditions possible and has not lost its identity with internationalization. It is also important to mention that the brand chooses to use the digital medium to inform consumers about the product, through the implementation of the mobile application LUSH Lens, as a response to what they call digital packaging, in which the customer can take a picture of the product in store and have access to the list of ingredients and all the information that would be on a package or product label. The brand even distinguishes itself in this point since all products have a packaging

date and a photograph of the person who produced that product [16]. LUSH also invests in offering personalized customer service in its stores, worrying about understanding the customer's needs and recommending the right product with the most suitable and sought-after ingredients and, if none of the products meets the customer's expectations, the brand tries to consider customer suggestions and unmet needs and make products that meet them, which strengthens the relationship with the consumer and the consumer's trust in the brand.

On the other hand, in almost 26 years of existence, the company has never used paid advertising, using only store windows, online presence in social networks and the brand's website, and word of mouth, a marketing strategy that presupposes passing the word among satisfied consumers who highlight their positive experience with the brand, which consequently attracts new customers. That said, part of the employees' work goes around educating the costumers about sustainability issues, policies, and practices, a more responsible consumption and also conveying LUSH's values, mission, and vision, becoming real communications and ambassadors of the brand [17]. LUSH also communicates through a quarterly magazine called Lush Times, available in stores and on their website, in which they share information about the company, products, and exclusives, besides other things, even including testimonials about costumers' their daily lives and their experience with the brand [*ibid.*]. LUSH is also very present in the social networks, where they instigate consumers to share their experiences with the products, giving particular attention to any concerns and problems they might experience, as the brand believes the in-store experience must continue in the digital world, with the same level of personalized service and advice, so that the consumers can feel listened and valued [*ibid.*], therefore strengthening the costumer-brand relationship.

The strategies mentioned above can be considered ideal for reinforcing the brand's identity in the eco-friendly products market, since they reveal the brand's effective concern with the social, environmental, and humanitarian issues it defends, without the need to advertise the sustainability in all spheres, since the values convey that sustainability in themselves. LUSH also uses the YouTube social network to educate consumers and the community about the use of its products, their benefits and different ways of using them, as well as issues such as cyberbullying, the power of social networks today and the need to talk about issues such as the false image conveyed by them. Through the approach to problems of today's society, far beyond the advertising of its products as mentioned above, it is possible to conclude that LUSH prioritizes the education and awareness of its consumers for what really matters and effectively creates a sense of community and communion with the brand, emphasizing the importance of creating effectively sustainable products, increasing the likelihood of consumer loyalty and reinforcing the quality, value and image of the brand.

4 Final Considerations

In summary, through the concepts and strategies studied, it is possible to state that the adoption of circular economy principles in manufacturing and green marketing and corporate social responsibility strategies at the brand communication level bring many advantages to the company, not only for sustainable development but also at the competitive level, increasing profit and reducing expenses. Currently, society and consumers

are much more concerned about issues related to planet degradation, global warming, plastic waste and the pollution it generates due to the slow deterioration over the years, so companies should take this opportunity to meet the needs for eco-friendly products and, in this way, reinforce their image positively and attract more customers [1, 13].

According to Delgado-Ballester and Munuera-Alemán [18], brand trust involves the consumer's knowledge and experiences about and towards the brand, so it evolves and is influenced according to the interactions and direct contacts with the brand, being the buying experience the most important in establishing this trust. Having this said, it is possible to state that, currently, the more brands and companies turn their mission and identity to sustainability as a whole, with the implementation of ecological production strategies and relationships of quality and fair work with employees, the better their positioning in the market will be and the more likely they are to offer a good experience to consumers who, consequently, pass the word on the strong qualities of the brand and strengthen the brand value [9, 13, 18, 19].

Through the study of the communication strategy of LUSH Fresh Handmade Cosmetics, it was possible to conclude that the brand uses and applies, in an exemplary way, the principles of circular economy in the manufacture of its products and that the strong involvement and support to environmental and humanitarian causes is an advantage and a differentiation factor compared to other brands in the cosmetics market. Consumers are increasingly looking for natural products, not only due to the current trend of environmental awareness, but also because they are better for health and show versatility due to organic ingredients and different possible uses [20]. However, it is considered important to emphasize the need for and importance of conducting an empirical study on the LUSH brand by comparison to other brands in the cosmetics industry, such as The Body Shop and Rituals, which apply the same principles, in order to understand what distinguishes them and what leads the consumer to prefer one over the other.

References

1. Chang, C.-H., Chen, Y.-S.: Managing green brand equity: the perspective of perceived risk theory. *Qual. Quant.* **48**(3), 1753–1768 (2013). <https://doi.org/10.1007/s11135-013-9872-y>
2. Chen, Y., Chai, L.: Attitude towards the environment and green products: consumers' perspective. *Manag. Sci. Eng.* **4**(2), 27–39 (2010). <https://doi.org/10.3968/j.mse.1913035X20100402.002>
3. Ellen MacArthur Foundation. Towards the circular economy: economic and business rationale for an accelerated transition (2013)
4. Circular Economy Portugal. Sobre Economia Circular (2021). https://www.circulareconomy.pt/?page_id=413. Accessed 15 Feb 2021
5. Ellen MacArthur Foundation. What is the Circular Economy? (2017). <https://www.ellenmacarthurfoundation.org/circular-economy/what-is-the-circular-economy>. Accessed 13 Feb 2021
6. Ansar, N.: Impact of green marketing on consumer purchase intention. *Mediterr. J. Soc. Sci.* **4**(11), 650–665 (2013). <https://doi.org/10.5901/mjss.2013.v4n11p650>
7. Zhang, B., Li, J.: Design for environmental protection: measuring the appeal factors of green products for consumers. *Ekoloji* **28**(107), 1699–1707 (2019)
8. Cheung, R., Lam, A.Y.C., Lau, M.M.: Drivers of green product adoption: the role of green perceived value, green trust and perceived quality. *J. Glob. Scholars Mark. Sci.* **25**(3), 232–245 (2015). <https://doi.org/10.1080/21639159.2015.1041781>

9. Tavares, T., Beltrão, N., Filho, H., Ferreira, A.: Marketing verde como estratégia para pequenas empresas: agregando valor à marca e fidelizando clientes. *Rev. Sodebras* **9**(103), 17–24 (2014)
10. Seelig, M.I., Sun, R., Deng, H., Pal, S.: Is it all for show? Environmental brand identification on skin care and cosmetic websites. *J. Mark. Commun.* 1–21 (2019). <https://doi.org/10.1080/13527266.2019.1685566>
11. Widystuti, S., Said, M., Siswono, S., Firmansyah, D.A.: Costumer trust through green corporate image, green marketing strategy, and social responsibility: a case study. *Eur. Res. Stud. J.* **XXII**(2), 83–99 (2019). <https://doi.org/10.35808/ersj/1476>
12. Chen, Y., Chang, K.: The nonlinear effect of green innovation on the corporate competitive advantage. *Qual. Quant.* **47**(1), 271–286 (2013). <https://doi.org/10.1007/s11135-011-9518-x>
13. Hartmann, P., Ibañez, V.A., Sainz, F.F.: Green branding effects on attitude: functional versus emotional positioning strategies. *Mark. Intell. Plan.* **23**(1), 9–29 (2005). <https://doi.org/10.1108/02634500510577447>
14. LUSH UK: The secret Lush cosmetics master plan (2018). <https://uk.lush.com/article/secret-lush-cosmetics-master-plan>. 24 Feb Accessed 2021
15. Cunningham, N.P.: Is lush cosmetics at the front of sustainable cosmetics? (2019). <https://medium.com/@npcbayshore1/is-lush-cosmetics-at-the-front-of-sustainable-cosmetics-17c8711b3606>. Accessed 1 Sept 2021
16. Vy, N.: How the making and marketing of sustainable brand affect consumer behaviour – case company: LUSH handmade cosmetics. Bachelor's Thesis. Lathi University of Applied Sciences, Lathi, Finland (2014)
17. Pottier, A., Muíños, A.C.: Lush Cosmetics Portugal Marketing Plan (2017). Lisbon. <https://pt.calameo.com/read/005312124af55bbd57332>. Accessed 3 Sept 2021
18. Delgado-Ballester, E., Munuera-Alemán, J.L.: Does brand trust matter to brand equity? *J. Prod. Brand Manag.* **14**(3), 187–196 (2005). <https://doi.org/10.1108/10610420510601058>
19. He, Y., Lai, K.K.: The effect of corporate social responsibility on brand loyalty: the mediating role of brand image. *Total Qual. Manag.* **25**(3–4), 249–263 (2014). <https://doi.org/10.1080/14783363.2012.661138>
20. Amberg, N., Fogarassy, C.: Green consumer behavior in the cosmetics market. *Resources* **8**(137), 1–19 (2019). <https://doi.org/10.3390/resources8030137>



The City Is Not a Brand: A Critical Analysis of the Narrative and Appropriations of “Porto.”

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Abstract. This paper addresses the role of brand design in the validation of hegemonic narratives on the identities of cities, issued by place brands and local administrations. Drawing on concepts from Laclau and Mouffe’s discourse analysis, we address *place identity(ies)*, as floating signifiers, appropriated by global and local discourses in order to gain hegemony, through the naturalization of their narratives.

We examine these mechanisms at work in the visual branding of the city of Porto, as a case study. Through a critical analysis of the brand’s rhetoric and implementation, issued and controlled by the City’s Council, we identify a set of problematic equivalences that symbolically entail the obliteration of public debate. As a counterpoint to the Council’s allegedly consensual narrative, the collection and analysis of appropriations of the “Porto.” brand offers an under-acknowledged map of local dynamics, revealing a city where antagonistic views coexist.

The above evinces the need to issue alternative representations that challenge hegemonic discourses; as well as the need to promote critical thinking and public awareness, namely of the mechanisms that work to reduce them. Acknowledging the potential of design as a social tool, we issue two recommendations: that in order to cultivate a paradigm of plurality and citizen awareness, the word representation is employed instead of identity, when referring to representations of places; and that in order to produce representations that effectively reveal and enhance local singularities, the retrieval and re-creation of local aesthetics and narratives is a privileged methodological choice.

Keywords: Place identity · Hegemonic discourses · *Subvertising*

1 Introduction

In recent years, place identity has become a popular expression, used in the promotion of cities and regions as tourist destinations and investment targets. The success of such strategies frequently brings about transformations in the physical environment, as well as in the social fabric and economic activity of cities. In the city of Porto, these transformations have been taking place at a very fast pace for the last two decades (Fernandes et al. 2018), raising tensions between residents’ necessities and market imperatives.

Until recently, before the Covid-19 pandemic, the city was at the height of a touristic boom. It was twice awarded “Best European Destination”¹, the number of arrivals had been growing exponentially for a decade, and so had accommodation capacity. Meanwhile, housing prices almost doubled. The city as a product conflicts with the city as home. The “Best European Destination” is not necessarily the best place to live.

Place identity is the distinctive factor at the base of a sense of belonging and a marketing strategy. Reclaimed by the critical voices contesting the effects of tourism, local identities paradoxically play a central role in current re-branding narratives (Bismarck 2019). While capitalizing on the cultural value of local populations, branding exercises often stimulate gentrification, contributing to threaten the presence of residents in the city (Icomos 2018), particularly low-income populations. In Porto, the loss of longtime residents and community life (Queirós 2016) entailed the loss of social and cultural diversity, raising concerns on the loss of city’s identity, in different sectors of society (Fernandes et al. 2018; Icomos 2018).

Adding to this, in different domains and geographies, the tension between local and global makes surface. The speed of the transformations that affect urban environments and the threat of the homogenizing effects of globalization, triggers a grasp on local identities (Maalouf 1998). But as they assume such value, they become the object of fabrications. If local identities sell, they shall be made available. “Tourism has this cannibal tendency to devour what attracted it and to transform the real in simulacra and the event in spectacle.” (Pereira and Domingues 2017). Thus, authenticity becomes the object of a touristic quest (MacCannell 1973), and the longing for “real” places free from tourist-oriented fabrications, arises within the local population². Authenticity as an antidote to a pervading sense of fake. Local identities to escape a sense of sameness.

This paper takes the branding of the city of Porto as a case study, to examine the role of brand design in the validation of hegemonic narratives on the identities of cities, issued by place brands and local administrations. We discuss the implications of the appropriation of the expression *place identity* by place marketing discourses, demonstrating how its use, as a synonym for place branding, benefits the hegemony of brand’s representations of places and associated political agendas. Drawing on concepts from Laclau and Mouffe’s discourse theory, the paper analyses the brand’s rhetoric and implementation, identifying a series of problematic equivalences that symbolically entail the obliteration of public debate. As a counterpoint to the brand’s homogenized narrative, the second part of the paper offers a perspective of the plurality of positions co-existing in the city, through the mapping of appropriations of the brand’s visual identity.

2 Place Identity

The concept of place identity was first introduced in the field of environmental psychology in the late 1970s (Prohansky 1978, as cited in Hauge 2011). It was initially described

¹ Porto was elected European Best Destination prize in 2012, 2014 and 2017, a distinction awarded by a website dedicated to European tourism promotion. A campaign was launched to support the city’s candidature and the awards were much celebrated and publicized by the City Council.

² On this matter see: <https://www.theguardian.com/cities/2019/jan/28/no-one-likes-being-a-tourist-the-rise-of-the-anti-tour>.

as “an individual’s incorporation of places into the larger concept of self” (Prohansky 1983, as cited in Peng et al. 2020). In the next decade, an important distinction was introduced between two aspects of place identity: people’s place identity and the place identity of a place. According to Paasi, the place identity of a place “refers to those features of nature, culture, and people that are used in the discourses and classifications of science, politics, cultural activism, regional marketing, tourism, governance, and political or religious regionalization, to distinguish one place from others.” (Paasi 2001, as cited in Peng et al. 2020).

A recent bibliometric review on the use of the concept over the last 40 years (Peng et al. 2020) indicates that the presence of the term in academic journals in a variety of disciplines has significantly increased, particularly since 2006. A recent trajectory from the humanities and social sciences towards architecture, hospitality, leisure, sport, and tourism has been identified, and the authors suggest a current shift toward place products or place marketing.

Drawing on Laclau and Mouffe’s discourse analysis, we propose to examine the appropriation of the expression *place identity* by marketing discourse as an attempt to seize what the authors have named a *floating signifier*: an expression which is “particularly open to different ascriptions of meaning (...) that different discourses struggle to invest with meaning in their own particular way” (Jørgensen and Phillips 2002). In our case, more than investing *place identity* with its own meanings, branding discourses appropriating the expression, and by doing so, readily benefit from the meanings that are commonly associated with it.

Place marketing literature recognizes *place identity* as an elusive and paradoxical concept (Kalandides 2011). Kalandides (idem) identifies as many as six different uses of the term. His distinction between the conceptions of place identity as “place image” or as “objective reality”, is relevant to the present study, for it is precisely the confusion of these two uses that we see as problematic. While the word *branding* is explicit on the constructed nature of its products, and generally connoted with profit, the word *identity* is “very unstable and difficult to understand” (Domingues 2012). As pointed out by Minnaert (2012, p. 107) “Nation branding has some similarities with propaganda, a term that has a negative connotation because it emphasizes the constructed nature of the image and the clear focus on influencing the perception.” Conversely, the word *identity* is associated with intrinsic, essential characteristics. When attributed to a product, the word’s use is not problematic, for the product itself is inherently something fabricated. But when applied to a place, it can easily entail the merging of the concepts of identity as a representation, with identity as intrinsic character.

It is pertinent to compare the extensive use of the expression *place identity* in the context of place marketing (Kalandides 2011), with that of the word authentic in the promotion of tourist destinations, particularly those assigned with heritage value. The characterization of places as authentic, targets travelers seeking truthful experiences. As there is a market for authentic places, authenticity is often staged (MacCannell 1973), and “indicators of authenticity” are incorporated in marketing discourses (Alvelos 2003). In practical terms, it is the “perceived authenticity” of a place that makes a destination attractive (Rodrigues 2019). The word validates the place and the experience it offers as true.

What the word *identity* insidiously affords brands, in the context of place branding, is that same validation mechanism. It automatically presents brands as something that belongs to the place, as opposed to an image produced for promotional uses, something natural, as opposed to something fabricated, therefore as something true.

Because the branding of places involves a multiplicity of uncontrolled variables and stakeholders (Kavaratzis 2009, as cited in Melo and Balonas 2019), it is particularly subject to contestation. Therefore, it has a stronger need to pursue hegemony in order to be accepted, in relation to corporate branding. The process of naturalization is a very effective means to grant hegemony to a brand's representation of a place.

Furthermore, considering that branding is as much a tool for “planning developmental policies as branding in the private sector is about business strategy” (Hanna and Rowley 2008); that more than a vision of the city, place brands project visions for the city, it becomes evident how these visions and associated development plans may benefit from the naturalization process we have described (Leurs 2009). It becomes a powerful instrument for the legitimization of political agendas.

3 “Porto.”

In 2014, one year after the first election of Porto’s current Mayor, the city was presented with an official visual identity. All over the city, 600 billboards displayed the new logo and the associated network of icons. Their application on light rail vehicles took the new brand beyond the city’s limits, reaching the surrounding region³. In virtual space, the City Council’s websites were renewed accordingly, and a news portal was launched, named after the brand. Porto meets “Porto.” [Porto period].

Since then, the “Porto.” brand has become a ubiquitous presence in public space, from outdoor communication to the labelling of buildings, municipal vehicles, public transports, building sites, and municipal workers. Following a widespread international practice, large three-dimensional logos were placed in touristic locations.

The new visual identity, signed by designer Eduardo Aires and White Studio, comprises a hierarchical system of logos, as well as a modular system of 70 grid-based icons, representing characteristic elements of the city, as well as generic ones, designed in solid blue over white. The main logo displays the city’s name in a bold sans-serif typeface, followed by a full stop.

3.1 The Rhetoric Behind the Brand

Our analysis of the rhetoric that supports the “Porto.” brand is based on the critical examination of the brand’s book “Porto.” (Aires et al. 2016), as well as its Identity Manual (Aires 2017), supported by declarations of the authors in various contexts, and correlated with aspects of the brand’s implementation, also considered as discourse. Both documents are signed by Eduardo Aires, with contributions from Porto’s current Mayor, Rui Moreira, and former head of communication, Nuno Nogueira Santos. The book

³ For early examples of the brand’s implementation in public space see: <https://www.behance.net/gallery/20315389/New-identity-for-the-city-of-Porto>.

presents the new “visual identity” and explains the vision and intentions that oriented its development. The Identity Manual adds specifications on the rules of its use.

Drawing on the notion of *chain of equivalence* (Laclau and Mouffe 1985), we focus on the identification and deconstruction of a discursive expedient that involves establishing equivalences that support the naturalization and consequent legitimization of the brand, as well as the associated narratives and political vision⁴.

Laclau and Mouffe conceive of discourse as “an attempt to dominate a given field of discursivity” (idem), articulated around privileged signifiers called *nodal points*. These are partially fixated *floating signifiers*. In our case, the main *nodal point* is “Porto”. The city’s identity is what the City Council’s discourse attempts to fixate. Nevertheless, our focus is not on how this identity is constructed by associations with concepts such as tradition or cosmopolitanism, for example; it is rather on the discursive process through which the brand is used to establish a *chain of equivalence*, linking the meanings of *City* and *City Council* - and how the hegemony of this discourse fixates meanings in such a way that we come to think of them as natural (Jørgensen and Phillips 2002).

The first equivalence we have identified reproduces the one discussed in the previous section, concerning the interchangeable use of the expressions *place identity* and *place branding*. The Identity Manual opens with a short statement by the Mayor of Porto in which, the use of the Portuguese word *marca* links the concepts of brand, character, and soul. In this context, this word can signify both brand or “the distinctive character of something”⁵. Porto’s Mayor uses this ambiguity when he says that “Porto never had that graphic translation of its (character/brand). The city never used graphic design to mirror its soul. To mirror its (brand/character).” (Moreira 2017) The interpretation and translation of the word *marca* are arguable on both occasions. The ambiguity itself cannot be translated.

But more telling than this is the equivalence of the word *brand* with the word *soul*. As argued in the previous section, the interchangeability of these concepts entails the equivalence of a construct, at best distilled from a place, for promotional purposes with that place’s character. By doing so, it naturalizes the construct, potentially obliterating criticism.

The second equivalence benefits from this constructed legitimacy, in order to use the brand as a link between the City Council and the City as a whole. The Council’s stated aim to erase the distinction between itself and the city, constitutes the second and fundamental equivalence we wish to examine. The Identity Manual clearly states that the “Porto.” brand was designed to represent more than Porto’s City Council. It aims to represent the city itself, and to “express all of Porto” (Santos 2017a). Indeed, a hierarchical structure of logos places the Council under the City (Fig. 1). According to Aires, a plain “Porto.” is at the top of a “hierarchy that should be respected” (Aires 2017). At the same level is another version of the logo, in which the word is framed by a thick rectangle; this version, as the designer explains, allows the brand to coexist

⁴ A similar analysis concerning the city of Braga (Carvalho 2016) has used Laclau and Mouffe’s conceptual framework to demonstrate how certain signifiers were invested by the City Council to support its project and business interests and appropriated by local powers to construct and reinforce their hegemonic positions.

⁵ <https://www.infopedia.pt/dicionarios/lingua-portuguesa/marca>.

“with more information without losing its clean character” (idem). These logos are, we assume, assigned to the city, since the institution is represented by a third logo that adds a pictogram representing the city hall to the framed version.



Fig. 1. Logos representing the city and the City Hall © Eduardo Aires/White Studio

This information is nevertheless contradicted in the manual section that specifies in which circumstances the different logos should be employed. This section states that both the plain “Porto.” and the framed “Porto.” versions are to be used whenever more than one municipal enterprise is to be represented (specific logos were designed for each municipal enterprise). However, it is not clear in what situations should the version with the City Hall pictogram be used or what its expected role is.

In this aspect, the manual is ambiguous enough to allow for the logos’ meanings to be defined by the client, through implementation. Thus, the City Council’s website provides two versions of the logo, clearly identifying the framed version as the institutional logo, while the simple “Porto.” is identified as the city’s⁶. In practice, this use is confirmed: the framed version is often used in communication and initiatives by the City Council, such as the Council’s newspaper, its website and municipal workers’ uniforms, while the logo that clearly identifies the Council is reserved for bureaucratic communication. This was openly admitted by Nogueira Santos: “Nowadays, Porto’s City Hall doesn’t sign many things, just some official paperwork, when it is strictly necessary to do so. Everywhere else, it signs as the city” (Santos 2017b).

There is indeed a high degree of indistinction between the city and its administration in the use of the logo, and consequently in public perception. In this way, the identity of the city, which we have identified as the *nodal point* in this discourse, is equated to the City Council’s identity. This indistinction has been deliberate from the very beginning: “We, City Council, institutional, formal, want to confound ourselves with Porto. And the more we confound ourselves with the city, the more we have to win (Santos 2017a). As discourse - through words or actions - works to confound these two concepts and entities, it may be citizens who find themselves confounded. The ambiguity of this last “we”, for instance, may leave one wondering who it refers to and who is it that has something to win in the process. Once again, Santos (2017b) elucidates us: “We wanted to, intentionally, create a confusion between the two, the city and the autarchy. Because the more we mix ourselves with the city, the more the autarchy wins.”

What we wish to stress here, is the fact that this indistinction is beneficial to the city’s administration, but not necessarily to citizens. It benefits the executive in the sense that it equates its interests with those of the city, which are not necessarily always coincident. We argue that blurring public awareness of these distinctions reduces citizens’ ability for critical thinking and empowerment. In this case, design is clearly a tool for

⁶ <https://www.cm-porto.pt/marca-porto/marca-porto>.

operationalizing this intention: the brand acts as a merging link between the city and the City Council. It is a necessary element to establish the *chain of equivalence* legitimizes both the brand and the Council's vision and development plan.

The City Council's attempt to fixate the city's identity, gaining hegemony over its definition, is materialized in a rather obvious manner in one particular feature of the logo: the full stop that punctuates the city's name. As argued by Laranjo (2016), the full stop closes any possibility for argumentation. Aires himself suggests this: "Porto, period. It is unquestionable, unavoidable, incomparable." (Aires 2017).

In this sense, the full stop can be perceived as authoritative. This interpretation gains consistency if we notice the use of this connotation in the brand's application to the visual identity of Porto's Municipal Police: a full stop to the word police, a fact that was not replicated with any other municipal service.

Furthermore, the affirmation contained in the full stop is presented as emerging from the city. Aires claims that "the city affirms itself" and also that "the affirmation is not external to the city. It is something intrinsic to the city." (idem) "It is done. Porto did it." says Santos, referring to the brand. "It is well done, Period" (2017a). This configures an evident attempt to naturalise the brand, granting its narrative with the highest level of hegemony a discourse can achieve. The more it is accepted as natural, the less it is contested.

A tone of categoric affirmation runs through the document. The Mayor describes "Porto." as the "shortest claim in the world" (Moreira 2017), and although the text is not explicit on the content of this claim, it appears to be related to a sense of permanence and tradition. A sense that is infused in the city's motto, dating from the XIX century⁷. (that the brand recuperates, as referenced in the brand's book). "Always the same Porto" (idem). Not only Porto is what it is, it is what it has always been. This appraisal of tradition and timelessness that crystallizes Porto's character, reveals an essentialist conception of the city, once again naturalizing the brand and associated discourse.

3.2 Appropriations of "Porto."

Place branding aims to project unified and favourable versions of city's identities (Govers and Go 2009, as cited in Lecompte et al. 2017) yet cities are made of contradictory and often contending realities and visions, and thus cities have multiple identities (Massey 1991). Based on this premise, we propose a counterpoint to the brand's unified narrative, through the mapping of visual appropriations of the "Porto." brand, that portrays the city as an articulated moment in a network of social relations and understandings (idem). The appropriations we have identified were categorized into four groups: capitalizations, contaminations, political appropriations, and subversions.

Capitalizations. In the first group we gathered forms of appropriation that capitalize on the brand. This type of appropriation in order to gain associations with the city has recently been acknowledged by Casais and Monteiro (2019). Moreover, the possibility of

⁷ "Ancient, most noble, always loyal and undefeated city of Porto". The city's motto is related to the XIX th century liberal revolution.

a formal and controlled use of the city's visual identity by products or services operating in the city was envisioned by the City Hall from the onset of its implementation⁸.

Figure 2 depicts three examples of this. From left to right: an informal advertisement uses the logo to indicate the area where services are offered; an association of technological companies roughly imitates the logo to advertise an event; a food delivery service appropriates the brand's iconographic style and typography. All of them use the logo in order to benefit from its visibility and status.



Fig. 2. Appropriations of the city's visual identity | image on the left [courtesy Pedro Ferreira]

Moreover, the city's leading football club incorporated lettering similar to that of the "Porto." brand in its logo⁹. There have been interpretations connoting the use of the colour blue in the city's visual identity, with Porto Football Club (Moura 2014). Although the authors have denied this, stating the choice was motivated by the characteristic blue tiles that coat several buildings in the city¹⁰, given the club's popularity, this choice certainly contributes to the brand's approval. This seems to configure a case of mutual capitalization.

Contaminations. In 2015, project "Fair.kiez", was presented in Berlin, with a visual identity with evident similarities with that of "Porto."¹¹ Its authors were accused of plagiarism, and the brand was removed from circulation. The issue was much discussed in Porto: while various professionals have put the issue in perspective by situating the city's visual identity as part of an international design trend (Laranjo 2016; Moura 2015), the Council saw plagiarism as proof of the brand's quality¹². Also noticed were the less

⁸ <https://www.publico.pt/2014/09/25/local/noticia/porto-vai-ter-uma-nova-imagem-e-e-azul-1670892>.

⁹ <https://www.fcporto.pt/pt/clube/historia>.

¹⁰ <https://www.publico.pt/2014/09/25/local/noticia/porto-vai-ter-uma-nova-imagem-e-e-azul-1670892>;

¹¹ https://www.behance.net/gallery/56780825/fair-kiez?tracking_source=search_projects_recommended%7Ckiez.

¹² <https://www.jn.pt/local/noticias/porto/porto/berlim-copia-a-imagem-grafica-do-porto-4594646.html>.

flagrant similarities of the Porto visual identity with that of the Prague Summer School of Design¹³, dating from 2012 (Ribeiro and Providência 2015).

It is not our point here to discuss matters of precedence or plagiarism, especially considering that online simple image search confirms that this graphic language has become a trend. In the Portuguese context, there are several examples of municipalities that recently renovated their visual identities following a similar international formula: specific aspects of local cultures are represented by icons, using a standard graphic language. While the content is specific, the form is generic.¹⁴

On the opposite line of thought and action, a competing proposal¹⁵ for the city's identity considered that "Porto doesn't have to reinvent itself according to externally prescribed structures and languages" (Porto Pelo Porto). Based on the valorisation of local aesthetics, the project proposed the participatory retrieval and re-creation of preexisting typographies already spelling the city's name in public spaces.

The homogenization of graphic languages used in place branding on a global level, presents a paradox worthy of note, as it contradicts their stated purpose: to help places differentiate themselves (Porto Pelo Porto). Ultimately, by following global graphic trends rather than drawing inspiration from local aesthetics (Laranjo 2016), these representations become characteristic of a historic period rather than a place (Moura 2015).

Political Appropriation. The third type of appropriation is political and was performed by the Mayor of Porto, in the context of his second electoral campaign. Figure 3 depicts two outdoors corresponding to the campaigns of 2013 and 2017. We can observe that the latest campaign has adopted the style of the city's typography.

From the brand's inception, this close connection between the Mayor's vision and the brand was intentional, as confirmed by Santos' declarations, referring to the influence that Rui Moreira's manifesto for the city had in the brand creation: "I would say that almost the entire book, "Uma questão de carácter", from 2009, is a pact about the brand. In so, it greatly enabled its creation. Because it was my job to create the briefing and pass it on to the designers, I had an extraordinary manual available" (Santos 2017b) By this point, we can see a circle closing: the Mayor commissioned a brand for the city he strongly inspired, and subsequently appropriated its premises for political purposes.

Subversions. Hegemonic discourses, "are always in danger of being undermined" (...) by other ways of fixating the meanings of signs" (Jørgensen and Phillips 2002). In this last section, we present a selection of subversive appropriations of the "Porto." brand, that configures an antagonistic dispute over the city's identity and a contestation of the council's hegemonic discourse (Laclau and Mouffe 1985)¹⁶.

¹³ <http://kulachek.com/Prague-School-of-Design-Winter>.

¹⁴ See for example: <https://www.cm-valongo.pt/pages/437>; http://www.fprovidencia.com/portfolio/camara_aveiro/.

¹⁵ <https://portopelporto.wordpress.com/>.

¹⁶ For a broader collection of visual manifestations on Porto's walls, expressing criticism on a number of issues this paper addresses, not necessarily configuring *subvertising* actions, see project ABriga: <https://www.facebook.com/media/set/?vanity=ABriga112&set=a.105745704607561>.



Fig. 3. Election campaigns outdoors: above 2013 [courtesy Arquivo Ephemera], bellow 2017

The most notorious of these subversions was “Morto.” (Fig. 4). Stickers emulating the logo were placed around the city in the summer of 2017, a few months before the Mayor’s re-election. Only one letter was changed, but the message was blunt: “morto” translates as “dead”. In a reference to the “best destination award”, the version on the right casts an ironic critique of the city’s gentrification.

This *subvertising* action would probably have gone mostly unnoticed, had it not been for the mayor’s reaction to it: in his Facebook page, he expressed his outrage at the authors, who in his words, could only “hate the city”¹⁷. The Council went as far as filing a complaint against unknown offenders, and the *stickers* were removed.

Melo and Balonas (2019) conducted a content analysis of the Mayor’s post and ensuing comments. Alongside the acknowledgement of the support shown to the Mayor’s statements through over 8000 likes, it revealed a diversity of opinions and feelings towards the brand. It also revealed that the post prompted a discussion where citizens brought up controversial issues such as gentrification and concern for the loss of the city’s authenticity. This fact is a good indicator of the success of the *subvertising* action: as noted by Laranjo (2017) this action takes an element that is meant for promotional purposes and “transforms it into an instrument for debate and scrutiny”.

Eduardo Aires has expressed the view that the brand’s appropriation is the best sign that the visual identity was accepted and that even subversive appropriations are seen as a positive sign of interest (Aires, 2019). Yet, this apparently tolerant position is not shared by the municipal executive. An intolerance to contestation, and the denial of the existing tensions, by attempting to reduce the authors of subversions to “haters” of the

¹⁷ <https://observador.pt/2017/08/07/morto-em-vez-de-porto-camara-apresenta-queixa/>.



Fig. 4. Critical subversions of the “Porto.” Brand | [courtesy Inês Barbosa; courtesy Luís Camanho]

city, not only confirm authoritative tendencies¹⁸, but also reveal the aim to assert the image of a consensual city. The brand and its graphic expression play a crucial role in the pursuit of this goal.

Inevitably, the mayor’s post and reaction gave visibility to contestation, stimulating the production of further subversions (Fig. 5). Most of them expressed critique by turning the city’s name into words with negative meanings, such as *crooked*, *filthy*, or *porn*, while others seem to reclaim the need for debate or suggest an uncertain future, by simply removing one of the letters, leaving a gap, or by replacing the full stop with a question mark.

Other elements of the city’s visual identity have been appropriated subversively such as the icon network. From the city’s walls, this *subvertising* movement naturally expanded to virtual space, where digital examples still circulate.

These appropriations are selected examples of a struggle over meaning (Laclau and Mouffe 1985) that contest the Council’s dominant narrative and “question the legitimacy of any supposed monopoly over the visions of the city and its images” (Barbosa and Lopes 2019). We conclude with an image from the documentary film “Porto is not for sale”¹⁹, which displays a stencil of the city’s logo, next to the affirmation “the city is not a brand” (Fig. 6). The subtitle translates someone’s opinion on the city’s current state: “Porto is a façade”, a constructed outward appearance, perhaps deceptive. Much like a brand, we add. The stencil seems to remind us “this is not a pipe”, beware of “the treachery of images”, as Magritte (1929) put it. Beware of the distinction between things and their representations.

¹⁸ On this matter see also: <https://www.publico.pt/2018/06/02/local/opiniao/a-cidade-do-porto-nao-tem-piorio-1832893>.

¹⁹ Available at <http://www.acordesdequinta.com/2019/01/docs-porto-is-not-for-sale-de-laura.html>.



Fig. 5. Critical subversions of the “Porto.” brand | Clockwise from upper left: ©Ana Miriam; anonymous; courtesy Inês Barbosa; courtesy Pedro Ferreira; ©Ana Miriam; ©Ana Miriam



Fig. 6. Still from documentary film “Porto is not for sale” 2019 [courtesy Laura Gonçalves]

4 Conclusions

The mapping of appropriations provided by this paper, reveals the diversity of coexisting relationships with the brand and the vision it represents. It reveals local synergies, but also tensions, power dynamics and contrasting forces, intentions, and desires. First and foremost it is made evident that the city’s reality - the reality of any city - is far from consensus. It is multiple, and dissent is part of the expression of that diversity.

We have argued that the naturalisation of place brands, particularly those issued by agents in positions of power, works against citizen awareness, critical thinking, and empowerment, deterring debate on their representations and narratives, and obliterating alternative discourses by other stakeholders, with different intentions and demands.

The assessment of these stakes evinces the need to promote public awareness, namely of the mechanisms at work to reduce it, and to issue alternative discourses that challenge

hegemonic narratives. By revealing and deconstructing discursive strategies employed in the branding of the city of Porto, this paper aims to contribute to the clarification of the public perception of the issues at stake. Furthermore, considering the social and political role that design plays in such processes, we issue two recommendations concerning the production of visual representations of places.

The first is a contribution to a recommended revision of the vocabulary associated to design exercises that produce visual representation of places. We argue that when referring to their products, it is preferable to employ the word *representation* instead of *identity*. While the word *identity* refers to the object being represented, the word representation refers to the artifice that represents. Its nature is presented in a transparent way. The separation between things and their representation is kept. Furthermore, the word representation also refers us to the scope of democracy. Not only it is evident that representations are constructs, issued by someone, and consequently, that representations are multiple, it also reminds us that they should represent in the democratic sense, which presupposes inclusion.

Concerning the visual exercises themselves, we recommend that in order to produce representations that effectively reveal and enhance local singularities, the collective retrieval and re-creation of local aesthetics and narratives is taken as a privileged methodological choice. These practices, we argue, are good basis for the construction of representations that favour diversity and inclusion in urban environments.

Acknowledgments. This research is being developed within the project “Visual and semantic identities of the city of Porto: an ascertainment of the contributions of informal dwelling”, funded by the Foundation for Science and Technology (FCT) and the European Social Fund (ESF), through the European Regional Development Fund, under the grant PD/BD/150641/2020.

The following people generously contributed to this paper by allowing us to reproduce their images: Inês Barbosa, Laura Gonçalves, Luís Camanho and Pedro Ferreira. To all of them, many thanks.

References

- Aires, E.: Uma palavra para o Porto. In: Porto. Manual de identidade. (2017). <https://www.cm-porto.pt/files/uploads/cms/cmp/7/files/21/01-manual-14-digital-2017.pdf>
- Aires, E., Moreira, R., Santos, N.N.: Porto. Câmara Municipal do Porto, Porto (2016)
- Aires, E., Moreira, R., Santos, N.N.: Porto. Manual de identidade (2017). <https://www.cm-porto.pt/files/uploads/cms/cmp/7/files/21/01-manual-14-digital-2017.pdf>
- Alvelos, H.: The fabrication of authenticity: graffiti beyond subculture. Ph.D, Royal College of Art (2003)
- Barbosa, I., Lopes, J.T.: Descodificar as paredes da cidade: da crítica à gentrificação ao direito da habitação no Porto. Sociologia: Revista da Faculdade de Letras da Universidade do Porto, vol. 38, pp. 6–29 (2019). <https://doi.org/10.21747/08723419/soc38a1>
- Bismarck, P.L.: A cidade na época da sua reproduzibilidade financeira. Punkt (2019)
- Carvalho, A.: Discursos hegemónicos sobre a cidade_ “desenvolvimento” e “crescimento verde” em Braga. Cidades (33) (2016)
- Casais, B., Monteiro, P.: Residents’ involvement in city brand co-creation and their perceptions of city brand identity: a case study in Porto. Place Brand. Public Dipl. **15**(4), 229–237 (2019). <https://doi.org/10.1057/s41254-019-00132-8>

- Domingues, Á.: Lugar e identidade de quem? In: Vaz-Pinheiro, G., (ed.), espaços relacionais: um novo campo expandido para a arte e pensamento: i2ads ArinSite (2012)
- Fernandes, J., Carvalho, L., Chamusca, P., Pinto, J.: Gentrification in Porto: problems and opportunities in the past and in the future of an internationally open city. GOT – J. Geogr. Spatial Plan. (15), 177–198 (2018). <https://doi.org/10.17127/got/2018.15.008>
- Hanna, S., Rowley, J.: An analysis of terminology use in place branding. Place Brand. Public Dipl. 4(1), 61–75 (2008). <https://doi.org/10.1057/palgrave.pb.6000084>
- Hauge, Å.L.: Identity and place: a critical comparison of three identity theories. Archit. Sci. Rev. 50(1), 44–51 (2011). <https://doi.org/10.3763/asre.2007.5007>
- Icomos: Technical evaluation report on the conservation of the site inscribed in the world heritage list of UNESCO (2018). [https://www.icomos.pt/images/pdfs/2018/ICOMOS-Portugal_Report%20Porto_180228%20\(EN\).pdf](https://www.icomos.pt/images/pdfs/2018/ICOMOS-Portugal_Report%20Porto_180228%20(EN).pdf)
- Jørgensen, M.W., Phillips, L.J.: Discourse Analysis as Theory and Method. SAGE Publications (2002)
- Kalandides, A.: The problem with spatial identity: revisiting the “sense of place.” J. Place Manag. Dev. 4(1), 28–39 (2011). <https://doi.org/10.1108/1753833111117142>
- Laclau, E., Mouffe, C.: Hegemony and Socialist Strategy: Towards a Radical Democratic Politics: Verso (1985)
- Laranjo, F.: Simplicismo. Público (2016). <https://www.publico.pt/2016/04/19/p3/cronica/simplismo-1825809>. Accessed: 19 Apr 2016
- Laranjo, F.: Algumas notas sobre o Morto. Público (2017). <https://www.publico.pt/2017/08/29/p3/cronica/algumas-notas-sobre-o-morto-1828489>. Accessed: 29 Aug 2017
- Lecompte, A.F., Trelohan, M., Gentric, M., Manuelle, A.: Putting sense of place at the centre of place brand development. J. Mark. Manag. (2017). <https://doi.org/10.1080/0267257X.2017.1307872>
- Leurs, R.: The ‘chain of equivalence’. Cultural studies and Laclau and Mouffe’s discourse theory (2009). [https://politicsandculture.org/2009/11/09/the-chain-of-equivalence-cultural-studies-and-laclau-mouffes-discourse-theory/#:~:text=Cultural%20studies%20and%20Laclau%20%26%20Mouffe's%20discourse%20theory,-By%20politics%20%7C%20Published&text=Cultural%20studies%20frequently%20addresses%20discourse%20theory.&text=They%20make%20it%20plausible%20that,\)%20\(2008%3A%202017\).](https://politicsandculture.org/2009/11/09/the-chain-of-equivalence-cultural-studies-and-laclau-mouffes-discourse-theory/#:~:text=Cultural%20studies%20and%20Laclau%20%26%20Mouffe's%20discourse%20theory,-By%20politics%20%7C%20Published&text=Cultural%20studies%20frequently%20addresses%20discourse%20theory.&text=They%20make%20it%20plausible%20that,)%20(2008%3A%202017).)
- Maalouf, A.: As identidades assassinas. Difel (1998)
- MacCannell, D.: Staged authenticity: arrangements of social space in tourist settings. Am. J. Sociol. 79(3) (1973). <https://doi.org/10.1086/225585>
- Massey, D.: A global sense of place. Marxism Today (1991). http://banmarchive.org.uk/collections/mt/index_frame.htm
- Melo, A.D., Balonas, S.: Stickers on politics. The power of a brand is its weakness – a case of activism and subvertising. In: Ruiz-Mora, I., Gonçalves, G., Somerville, I., (eds.) Organizational and Strategic Communication Research: Global Trends, pp. 173–197. LabCom.IFP, Covilhã (2019)
- Minnaert, T.: Footprint or fingerprint: international cultural policy as identity policy. Int. J. Cult. Policy 20(1), 99–113 (2012). <https://doi.org/10.1080/10286632.2012.722997>
- Moreira, R.: O “Claim” mais pequeno do Mundo. In: Porto. Manual de identidade (2017). <https://www.cm-porto.pt/files/uploads/cms/cmp/7/files/21/01-manual-14-digital-2017.pdf>
- Moura, M.: Original é usar a palavra “original” na mesma frase que Câmara Municipal (2015). <https://ressabiator.wordpress.com/2015/05/>
- Peng, J., Strijker, D., Wu, Q.: Place identity: how far have we come in exploring its meanings? Front. Psychol. 11(294) (2020). <https://doi.org/10.3389/fpsyg.2020.00294>
- Pereira, M.A., Domingues, Á.: World of Wine: a vista do Porto para Gaia com mais um chiringuito. Público. (2017). <https://www.publico.pt/2017/06/16/local/opiniao/world-of-wine-a-vista-do-porto-para-gaia-com-mais-um-chiringuito-1775636>. Accessed: 16 June 2017

- Porto, P.P., Pensamento, P.: <https://portopeloporto.wordpress.com/PPP-2/conceito/>
- Queirós, J.: Políticas de reabilitação urbana e recomposição do tecido social no centro histórico do Porto: representações e discursos de moradores sobre a respetiva evolução recente. *Sociologia* **31**, 29–58 (2016). http://www.scielo.mec.pt/scielo.php?script=sci_arttext&pid=S0872-34192016000100003&nrm=iso
- Ribeiro, M., Providência, F.: Um ponto entre pontos: breve reflexão sobre criatividade e inovação em Design. *Ergotrip Design - Revista dos encontros internacionais de estudos luso-brasileiros em Design e Ergonomia*(1) (2015)
- Rodrigues, C.: Branding Porto. In: *Strategic Perspectives in Destination Marketing*, pp. 198–219 (2019)
- Santos, N.N.: Ponto de partida. In: Porto. Manual de identidade (2017a). <https://www.cm-porto.pt/files/uploads/cms/cmp/7/files/21/01-manual-14-digital-2017.pdf>
- Santos, N.N.: Porto, European design destination/interviewer: C. Fernandes. ROOF – An IN & OUT Magazine (2017b)



Mapping of Graphic-Semantic Representations in Design Teaching

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Abstract. This article proposes a reflection on the visual thinking tools used in graphic design teaching as an active methodology that help the synthesis process of the expressive code and support graphic expression and semantics in design practice. It's intended to analyze more specifically the use of mood boards as an imagery tool in the creation of a brand mark and its relationship with expressive codes. To build a relevant and meaningful brand mark, it is important to be aware of the semantic elements used. Tools like mood boards help students with the aesthetic-symbolic references of the form and make the semantic concepts more perceptible.

At the end we analyze mood boards and their relationship with semantics in the creation of brand marks.

Keywords: Design teaching · Mood board · Brand mark · Semantic · Graphic-semantic · Expression map

1 Introduction

It's intended to analyze the methodological tool used in design teaching that helps the delimitation of graphic-semantic elements in the creation of brand marks.

Expressive ability is essential to the skillset of a designer, since the evolution of the project depends on its ability to externalize, record and communicate ideas. The development of a design project implies the experience of observation, analysis, and synthesis cycles. For this to happen, tools are needed that support perception, demonstration, and the sharing of results. Working with aesthetic-formal codes is one of the central challenges of the design activity in its various fields of activity.

In the context of graphic design teaching, expressive capacity is worked as a way of managing project knowledge, as well as emphasizing the importance of creating a visual support for the semantic meaning of the created artifacts. Considering these aspects, we intend to analyze the methodological tools that allow the mapping of graphic expression and that synthesize the aesthetic-symbolic concepts in graphic design teaching, and their importance in brand mark creation, as well as validating whether the immersive learning context can be a facilitating space for learning, creative thinking and for the generation of new ideas.

2 Active Methodologies and Graphic Design Teaching

In graphic design teaching, the intention is to recreate the experience of a designer in a real work context for the students. Through the use of active methodologies, the student is the main agent of their learning. This method encourages criticism and reflection, which, although accompanied by the teacher, the student is the center of this process, making it possible to guide learning in a more participatory way. The active methodology improves the student's individual autonomy developing it, in this way, they can understand aspects in their various areas of knowledge. This methodology requires an active role from the student, to make them autonomous, responsible and able to update their potential. The active methodology involves research, analysis, reflection, and the development of ideas individually or in pairs.

In this context, strategies are planned to facilitate the transformation of context variables into delimiters for the materialization of a solution that establishes an effective dialogue, where each project involves investigating contexts, identifying problems, formulating objectives, synthesizing concepts, experimenting with proposals, and communicating solutions.

Design, being an interdisciplinary and coordinating activity, requires the student to develop the ability to relate variables in order to find the best solution for the project. However, project knowledge is consolidated through a reasoning structure marked by cycles of advances, setbacks and displacements of thought (Lawson 2011). Through recurring cycles of analysis, synthesis and evaluation, aided by specific methods, the act of developing the project matures and converges towards the clarification of the project concept.

In the design project, each action is complemented by a combination of processes of thought to decide what procedures should be adopted. The process involves the interaction of information, the synthesis of concepts and the transformation of these concepts into meaningful knowledge to produce a coherent answer.

In the educational field, it is essential to create an environment conducive to active participation by students in the strategies they use to articulate this path. The teaching/learning context is also a space to reflect on design practice, where students should be encouraged to decide on the methodological strategies they will use. Ausubel et al. (1980) proposes that, in addition to the content indicated by the teacher, the student's prior knowledge is valued during the learning process. According to the author, this helps to build mental structures and schemes and to provide effective learning.

3 Methods and Techniques Applied to the Project

There are several learning methods in the scope of active methodologies, among them there is a collaborative learning model. This model consists of collaborative learning in which one of the main goals is to encourage teamwork. In its original definition, collaborative learning is a situation where two or more people learn or try to learn something together (Dillenbourg 1999). Through this method, students work as a team, sharing experiences and applying their knowledge directly, on the project. This model presupposes the involvement of all participants in all phases of the project and is intrinsically linked to cooperative learning since students should work in a group with several tasks.

Another method widely used in design teaching is learning based on the investigation of case studies, which is characterized by the research process in the development of a particular person, group, or situation over a period of time. This method is characterized by establishing questions, problems and hypotheses to arrive at the best solution for the problem or exploratory research, which is characterized by the initial investigation to clarify the exact nature of the problem to be solved. This methodology in teaching design is often used in the early stages of the design process in order to gain knowledge of the problem in question. In the creation phase this method helps the foundation and applicability of the proposed solution.

The Project Based learning (PLB) method is a very focused approach to design teaching, where students are involved in research, since the objective is for students to seek solutions to problems, questioning, debating ideas, collecting, and analyzing data, communicating information, their ideas and creating artifacts (Blumenfeld et al. 1991).

As its name implies, it concerns learning based on problems applied to the act of designing. It is a type of active learning methodology widely practiced in the teaching of graphic design, since it allows the student to acquire skills, such as critical thinking, creativity, communication, and problem solving, characteristics essential to the function of a designer. This methodology assumes that students acquire knowledge from a concrete problem, in favor of an abstract concept, allowing them to learn to think and express their learning through the execution of a project. Project-based learning refers to the process, in which the objective is to arrive at a viable final product, based on research and on a problem, stimulating critical thinking and the respective skills of each student, leading the student to collaborate and share experiences with other students.

These methods are just a few used in design teaching, however there are many others, and it is important to keep in mind that new or readapted methods of others are always emerging, because of the experience of teachers in the area.

If the methods consist of the research and collection process that guides towards the intended objective, the techniques are the resources used to implement the method.

In graphic design teaching, there are several techniques that support the implementation of the active methodology, techniques that also help the designer in the exercise of his profession. According to Lupton (2011), in the initial phase of project design development there are several methods and techniques that help problem definition and stimulate creativity at the time of project creation: brainstorming, concept maps, interviews, focus groups, mood boards, graphic diaries, among others.

Specifically, in a graphic brand creation project, the use of mind maps, mood boards¹ and concept boards, is very common as tools that help students with project definition, stimulating their creativity at the same time.

¹ This is a tool with different interpretations, in this context we find this tool as a semantic panel similar to some authors (Baxter 2011; Cassidy 2011; De Wet 2016; Endrissat et al. 2016; Garner and McDonagh-Philp 2001; Lucero 2012).

4 The Importance of Visual Thinking Tools in the Design Process

As previously mentioned, in the development of a design project, there are several processes or steps in the act of creation and there are several techniques used during the process in graphic design teaching.

All design projects begin with the brief delimitation of the problem and, after that, the process passes through several stages until the project is completed. However, the order in which the different stages are performed isn't watertight, according to Lawson (2011), the process is marked by a cycle of advances, setbacks, and changes in thinking.

Many authors define the different phases of design in the development of a design project, but in all of them there are three main phases: analysis, synthesis and evaluation.

According to Jones (1992), there is a predominant thought in each of the phases and classifies the stages of the project into: divergence (includes actions to expand the points of view about the problem, originates questions giving different perspectives on the same issue); transformation (giving space to the structural exploration of the problem and the creation of creative concepts to establish connections in the search for a solution) and convergence (actions are channeled towards the definition of a solution, reducing uncertainties through evaluation strategies).

Cross-cutting to all development processes of a design project is the need to conduct research and assess the concept of the project, because the project definitions are taken based on the knowledge of the project itself.

In a simplistic way, we can define research to seek answers to the questions raised. Preliminary research can be called exploratory research, that this type of research helps to better understand the context to be worked on in the project. After this investigation, it is essential to carry out the analysis and synthesis of the collected data into a visual support, to measure patterns that help the understanding of the whole.

After investigating the issue in question, the concept of the project should be verified, a concept that will support the choices made in the different stages of the process. A concept is the idea behind the design, it is the main idea of the project, what is intended to be conveyed. To define the concept, it is important to know what you want to communicate, what the diagnosed need is and what the final objective of the project is. In design teaching, in the early stages of project development - research, problem definition and concept definition - students obtain a lot of visual information through images. For this reason, visual thinking is an essential tool, as it helps to clarify ideas, the visualization of images that represent concepts helps in the interpretation of the problem and triggers associations of ideas. In this way, the images are treated as information and innovative ideas are created. In this context, the most frequently adopted tools that explore visual thinking in the context of graphic design teaching and that help students in visualizing and communicating the concept, are concept boards, inspiration panels and mood boards (Fig. 1).

According to Lupton (2011) in the first phases of the project - research and creation of ideas - it is common to use concept boards and mood boards as forms of organization and analysis of visual thinking.

Design is a creative activity and inspiration is an essential factor. Designers look for inspiration from various types of sources, which may be intentional (sought by themselves) or unintentional. For Lupton (2011) the design process includes aspirations for

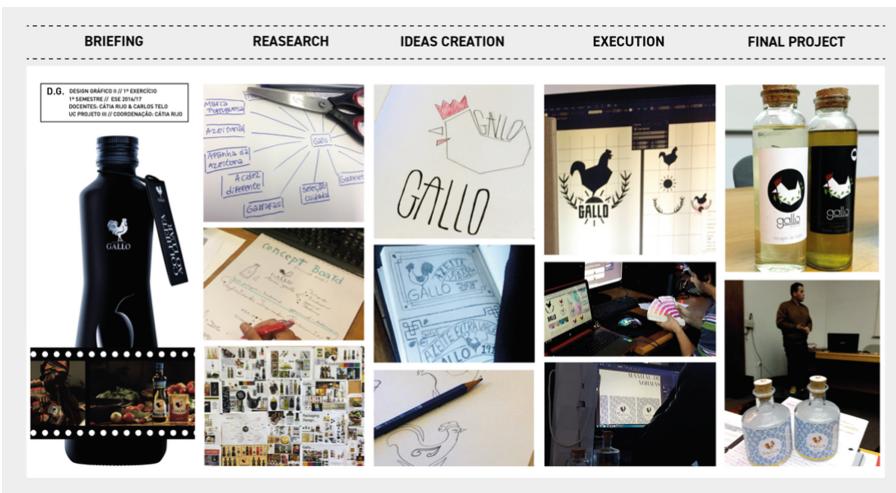


Fig. 1. Example of project design phases are visible in the use of mind map, concept board and mood board in the research. Photos of the author and work of students from graphic design classes.

art, science and culture. Ambrose and Harris (2010) state that designers cross reference from different elements of contemporary life, along with references from the past, returning to the traditions of art and history of design and looking at them as visual stimuli. This inspiration is fundamental in any creative activity. According to the authors, there are many creatives who register the inspiration process through a book of ideas - collection of clippings, photographs, doodles, color palettes, typographic examples, among others.

In this way, the use of tools such as a mood board, concept board and inspiration panel (among others), operate as agents of creation and mediation in the scope of creating a project, since they use visual resources as a form of project design.

5 Mood Board: An Imagery Tool

Slade-Brooking (2016) defines a semantic panel as a visual collage that projects a particular emotion or theme through the selection of various visual elements. Considered as a qualitative tool of visual inspiration (Cassidy 2011; Garner and McDonagh 2002), in the scope of design and when applied during the development process of a project, it serves as a source of sensory reference, especially visual, that uses aesthetic and symbolic elements to define the shape of a product (Löbach 2001). For this reason, it is a visual analysis technique that helps to define the aesthetic sense or style of a project and is often used in the conceptual phase of the design process since it is at this stage that the designer must be able to summarize the symbolism of the project in an image.

For Bürdek (2015), the visualization of images helps in the process of interpreting the meaning of words, for this reason the use of mood boards in the project scope presents itself as an agent of creation and mediation, making the collected data more synesthetic.

This technique offers a visual way capable of stimulating and inspiring the process of project development, “which must be considered because they are more logical and empathic to the design context than the traditional approach centered on verbal code” (Denton and Mcdonagh 2002, p.63).

The creation of mood boards, according to Gusmão (2012), should be guided in stages to ensure the effectiveness of the technique. Jacques and Santos (2009) enumerate five distinct phases: 1st, the exhaustive understanding of the problem presented in the project and what can be achieve through dynamics and techniques such as brainstorming; 2nd the transformation of the verbal understanding of the problem presented in the project into written language; 3rd searches for images that identify or translate the project's objectives, the transformation of written language into visual; 4th creation of the visual ambience, made through the composition of the map; 5th definition of the palette of colors, shapes and textures to be used in the final product; 6th creation of a descriptive text to help its understanding.

In the teaching of graphic design, a briefing usually initiates the project and later definition of the concept and/or ideas that define the projects followed by the creation of a mood board. This visual research tool is often used in the initial stage of a project as it helps to translate verbal language into visual signs. According to Bruseberg, McDonagh and Wormald (2003, p.124) “images are a powerful resource to transmit meanings, particularly values and emotional experiences”. As Gusmão observes (2012), it is up to the designer to articulate abstract or metaphorical concepts, translating them and evoking their meaning interconnected with the concepts.

After executing the mood board, analyzing the colors and typography present in it can help to highlight the emotional stimulus characteristic of the project in question. For Noble and Bestley (2005), to carry out experiments focused on certain groups, to generate feedback on a certain criterion: use of color, typography, image and legibility, allows the designer to gather more specific and detailed information. Using mood boards and exploring these visual aspects can also highlight the emotional sense of the project, when analyzing each of these elements separately, we seek to define in detail the conceptual and visual direction to apply to the work.

The understanding of the processes used by the student, leads to the understanding of critical thinking, the deepening of research and analysis techniques, the resolution of creative problems as well as the learning of graphic techniques. The documentation of the entire work process, will allow the student to show the development of the different stages of the project, providing the justification for their decisions and allowing a final presentation that is easy to understand.

6 Visual Identity Signs: Color, Typography and Symbol

For Slade-Brooking (2016), the creation of successful brands depends not only on good design, but also needs to have meaning. However, concepts and ideas can only be represented through the words that define them as well as through images and visual signs.

Semiotics is the science that studies signs, the relationships between written or spoken signs, as well as the physical references created from ideas (Noble and Bestley 2005).

A designer can use semiotics to create meaningful forms as well as to study existing signs. Lupton (2011, p.88) states that “(...) when creating a logo or a system of icons, designers can look at the basic categories of visual signs in order to generate ideas with various degrees of abstraction or familiarity”. There are three different types of signs: icons, indexes and symbols (based on the categories of the relationship between the sign and Peirce's object).

An icon has a similar relationship with what it represents (for example, the drawing of a flower); an index refers to the elements that compose it and has a continuous relationship with what it represents (symbolizes a physical action or process: smoke symbolizes fire; dark clouds indicate rain); in a symbol it is abstract and arbitrary, its representation is not similar to its meaning and its relationship is purely conventional (for example, the symbols proper to mathematics or the graphic mark of a certain brand or company).

According to Raposo (2008, p.10) “a brand can be an icon, an index, a symbol or all of them simultaneously” for the author, a visual identity that is an image, can also be a metaphor that represents a certain entity and its style, being able to allude to the style of the designer who created it. It is essential, for its creation, to appreciate and manipulate the level of meaning contained in its identity, as well as to understand the reactions of the target audience. It is based on its message and meaning that the way it should be communicated is determined. For this, the use of typography, color and symbol is extremely important.

The multiple possible combinations to be made through the design of a graphic brand depend on the strategy adopted and, on the characteristics, and functionalities of the different elements that compose it (typography, color and symbol) and that translate what each sign represents from a semiotic perspective to a symbolic one (Costa et al. 2013). These three elements are the basis of any visual identity and it is through these that a brand may or may not impact its target audience.

However, when defining the message, it is necessary to correctly define the markets in which the brand operates, as well as to investigate its acceptability and linguistic and cultural adequacy (Costa et al. 2013). Often, a seemingly harmless word, combination of words, image or symbol, suggests unexpected associations that may be offensive to some people or cultures and, therefore, must be evaluated. It is therefore important to consider all possibilities (using imagination or common sense) depending on the complexity of the project/brand.

7 The Importance of Semantics and Mood Boards in Brand Mark Creation

The information collected through the mood board leads to the creation of conceptual routes at a semantic level that, and in turn, determines the message that a project or brand must express. The way the subject interprets the sign depends on their mental models, as well as the way the designer chooses the representation of the object (Isherwood 2009).

When viewing a graphic brand for the first time, the consumer immediately perceives its shape and color. These two aspects instantly create a visual pattern that is completed by being associated with a previous message or experience, according to Formiés and

Vázquez (2006) and this visual pattern is completed through the semantic attributes that relate to its meaning and how it is recognized (Fig. 2).



Fig. 2. Example of a mood board created for the rebranding of the olive oil brand mark “Galo”. Photos of the author and work of students from graphic design classes.

As mentioned earlier, semantics is a linguistic branch that leads to the study of the relationships between signs, symbols and the meaning they represent. It is a field of knowledge that studies the systems of signs that allows people to communicate with each other and “refines why a letter, a set of words, an object, a photograph, a mathematical symbol, a hand gesture, a color or a series of pictograms, acquire concrete meanings in a given society” (Miranda and Quindós 2015, p.23). Semiotics allows the valuation of a form, if it is relevant in relation to what one wants to understand (meaning), and if it proves that the messages of a system of pictograms are correctly understood and interpreted by the target audience.

According to the authors, the basis of the concept of semiotics rests on the work of two philosophers: Ferdinand de Saussure and Charles Peirce, who founded their bases. Their theories centered on the belief that an individual is programmed for verbal language and that it is through words that their view of the world is explained.

Morris (1985) states that the semiotics process relates three factors: The first is the sign itself, the second is what the sign means, the third being the effect that the sign produces on a given target audience considering its interpretation. It also states that the target audience can be considered as a fourth factor. It is through these that the common claim that a graphic brand means something to someone can be justified. The author also states that the sign can be a vehicle or a bridge that transports the target audience to the real sense of the graphic brand.

Miranda and Quindós (2015) point out that Morris (1985) adopts the three categories of relationship between sign and object established by Peirce, stating that if the sign is seen as a symbol, it will be the spokesperson for abstract concepts, establishing an arbitrary relationship between emitter and receiver. The relationship it establishes with the object it represents is founded on a basis established by a previous convention. Depending on the context there are several conditions that affect the meaning of a symbol or graphic mark. These conditions are the environment in which it is understood; the degree of recognition of its meaning; the particular culture of the recipients; social circumstances and different combinations of symbols.

As previously mentioned, if through the use of mood boards, conceptual routes of semantic level are created, then the relationship between semantic attributes and previous experience allows the brand positioning in the brain to be generated. It is through memory that the link and information related to the brand are remembered.

According to Formiés and Vázquez (2006), the semantic differential technique allows the evaluation of opposite adjectives by observing whether there is any relationship between elements such as color, set, visual pattern and semantic attributes that the brand intends to transmit. When conducting a study to assess whether the brand values were fixed in the memory and whether it was striking enough to be recognized and distinguished among other similar brands, its symbols and colors are analyzed separately. The differentiation between the quality and the origin of a brand classifies it in categories such as physical characteristics, functional aspects and emotional characteristics.

The application of semantics can be a tool for analyzing a brand's proposals, referring to its values and representing them by adjectives. This would allow for visualizing dominant visual elements such as the figure, color, size, scale, proportion or contrast and adjusting the final brand so that its graphic representation faithfully reflects the values it intends to transmit (Formiés and Vázquez 2006).

Different studies report that objects, concepts or functions, require a high level of abstraction to be represented, making this task almost impossible. The intrinsic relationship between the graphic brand and what it represents can be described as a semantic differential, this relationship can also be used to determine brand recognition.

Isherwood (2009) points out that all the studies already carried out on semantics suggest that it has an important role in the way the graphic brand is interpreted. This may be related to how the brand and the consumer are related. This proximity may be an index of the semantic and lexical visual connections. The same author notes that familiarity is also an important factor to take into account when creating a graphic brand, as well as response times, as familiar signs activate the consumer's memory more quickly. The author clarifies that the way in which information about a graphic brand is transmitted from person to person, is often not so direct, and cannot be based only on the association made through signs, but it needs to refer to the personality of the brand and the values that are inherent in it, these being understood in its image. "On its own, a logo is just a mark. For it to become more than a graphic device it must acquire meaning in the mind of the consumer" (Slade-Brooking 2016, p.27), in order to build a relevant and meaningful graphic brand it is necessary to resort to a series of interconnected elements that can represent or transmit the brand's values.

8 Conclusions

In design education, the use of active methodologies helps in recreating the way in which design process works and there are several effective methods and techniques that teachers use in graphic design classes. These kinds of methodologies help this type of teaching since the student is responsible for their own learning process. In the area of graphic design, it is proven that the use of tools such as mood boards and concept boards, among others, help in visual thinking, especially when used in the early stages of a project because they help the students understand the meaning and concepts in an objective graphic design product.

Mood boards are an imagery tool that support students with the association of semantic elements with graphic elements, they are an aesthetic-symbolic reference tool that give adequate space to produce conceptual alignment and sensory inspiration.

This type of analysis is especially important in the creation of brand marks, since they contain a great symbolic load. Through the analysis of mood boards, students can analyze references in terms of color, typography and shape, which are essential elements in the creation of brand marks.

References

- Ambrose, G., Harris, P.: *Design Thinking*. AVA Publishing Ltd, London (2010)
- Ausubel, D.P., et al.: *Psicología educacional*, 2nd edn. Interamericana, Rio de Janeiro (1980)
- Baxter, M.: *Projeto de Produto: guia prático para o design de novos produtos*. Tradução (2011) Itiro Iida. 3. ed. São Paulo: Edgard Blücher
- Blumenfeld, C., et al.: *Educational Psychologist, Motivating Project-Based Learning: Sustaining the Doing, Supporting the Learning* (1991)
- Bruseberg, A., Mcdonagh, D., Wormald, P.: The use of images to elicit user needs for the design of playground equipment. In: Mcdonagh, D., et al. (eds.) *Design and Emotion*, pp. 114–118. CRC Press, London (2003)
- Bürdek, B.: *Design: History, Theory and Practice of Product Design*, 2nd edn. Birkhäuser Basel, Basel (2015)
- Cassidy, T.: The mood board process modeled and understood as a qualitative design research tool. *Fashion Pract.* **3**(2), 225–251 (2011)
- Costa, J.; Bosovsky, G., Fontvila, I., Radabán, A., Culleré, A.: *Los Pilares Del Branding: Anatomy of the Brand*. Costa Punto (2013)
- Dillenbourg, P.: *Collaborative Learning: Cognitive and Computational Approaches*. Advances in Learning and Instruction Series. Elsevier Science Inc., New York (1999)
- De Wet, A.: An educational tool to encourage higher level thinking skills in the selection of images for fashion design mood boards: an action research approach. *Int. J. Fashion Des. Technol. Educ.* **10**(1), 16–25 (2016)
- Endrissat, N., Islam, G., Noppeneij, C.: Visual organizing: balancing coordination and creative freedom via mood boards. *J. Bus. Res.* **69**(7), 2353–2362 (2016)
- Formiés, I., Vázquez, A.: Brand Analyzes through the semantic differential. Automotive brand cases (2006)
- Garner, S., McDonagh, D.: Problem interpretation and resolution via visual stimuli: the use of ‘mood boards’. *Des. Educ. Int. J. Art Des. Educ.* **20**(1), 57–64 (2002)
- Garner, S., et al.: Mood boards as a design catalyst and resource: researching an under researched area. *Int. J. All Aspects Des.* **7**(3), 16–31 (2015)

- Gusmão, C.: Semantic Panel as a Methodological Technique in the Teaching of Design Practice in Design (2012)
- Isherwood, S.: Graphics and Semantics: The Relationship between What is Seen and What is Meant in Icon Design (2009)
- Jacques, J., Santos, R.: The semantic panel as a tool in product development. Annals V CIPED (2009)
- Jones, C.: Design Methods. Wiley, New York (1992)
- Lawson, B.: Como arquitetos e designers pensam. Oficina de Textos, São Paulo (2011)
- Löbach, B.: Design Industrial: bases para a configuração dos produtos industriais. Edgard Blücher, São Paulo (2001)
- Lucero, A.: Framing, aligning, paradoxing, abstracting, and directing: how design mood boards work. In: Designing Interactive Systems Conference, DIS 12, Anais. ACM Press, New York (2012)
- Lupton, E.: Graphic Design Thinking: Beyond Brainstorming. Architectural Press, Princeton (2011)
- Miranda, E., Quindós, T.: Diseño y Pictogramas Campgrafic Editors, 1st edn. (2015)
- Morris, C.: Psychology: An Introduction, 9th edn. Prentice Hall College Div (1985)
- Noble, I., Bestley, R.: Visual Research. AVA Publishing SA (2005)
- Raposo, D.: Identity Design and Corporate Image. IPBC (2008)
- Slade-Brooking, C.: Creating a Brand Identity: A Guide for Designers. Laurence King Publishing (2016)



The Heritage and Identity of the Pmate Project: Critical Factors for the Redesign

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Abstract. This study aims to analyse, describe and reflect on how Mathematics and Teaching Project (Pmate) history can influence the most relevant creative decisions when restructuring and redesigning it. Pmate is a 32-year-old research project based on an online platform created and coordinated by a team from the University of Aveiro. Its mission is to achieve academic success and promote scientific culture through the development of content and its application by technologies. In this article, relevant moments of Pmate's history and the evolution of its identity are identified, defined and discussed through the collection of information, specifically through interviews with people involved in the project during its implementation and the analysis of graphic documentation produced. The result is the outline of the relevant critical factors guiding the new updated Pmate's brand and service.

Keywords: Communication design · Identity · Pmate · Online platforms

1 Introduction

This article analyses a section of the Pmate 4.0 project by the University of Aveiro that, according to its strategic plan, aims to restructure, reorganise, improve and implement the Pmate platform in multiple contexts. This project is being carried out from a multidisciplinary perspective, including design, computing/programming, marketing and content creation. The opportunity and the scale of the work allowed the project team to act articulately from the unveiling of the problem to, starting from the legacy of the pre-existing project, define the guiding program that will lead to the redesign of Pmate.

Inheritance is understood as the set of data and history – the legacy – collected about the project, the documentation produced, the chronological evolution and the values and practices adopted (Cambridge Dictionary, n.d.). These documents make up the project's history and the testimonies of how it communicated and was understood by users, how these artefacts are interpreted or referenced today. Thus, this documentation is considered relevant for the definition and analysis of the legacy of this project, taking into account its

evolution, moments of higher impact and development. The aim is to identify what are the most representative features to implement in Pmate 4.0 and those that can influence the redesign of the identity and organisation of the (new) Pmate brand.

2 State of the Art

One of the concepts to highlight as contextualization for this project is the importance of design management in a project like Pmate. Currently, design is used as a strategic communication tool for any business, contributing to its success and valorisation, exemplified by the response to the needs of a company, solving it by designing a new product, service or concept (Best 2015). Design contributions can happen at different stages of a project, from conceptualization to production, through the market study in which a company is involved, the communication and connection with the consumer and even the strategic positioning among competitors (Best 2015).

Another point to showcase is the existence of a corporate identity associated with any organization. This identity is the one that, according to Best (2015), represents and communicates the company's values, illustrated by the logo or the products, but primarily by the service provided. These values are the basis of the strategic plans to be outlined concerning the brand development, that will then communicate with the consumer, representing the whole company, and it is through design management that these are thought through and applied, as stated by Borja de Mozota: "If the purpose of design management is to identify and communicate how design can contribute to a company's strategic value, then identifying design opportunities is the first step towards this" (Borja de Mozota 2003 apud Best 2015).

In this context, the platforms Khan Academy and Edmodo were considered examples of good practices of these concepts. Both have undergone recent redesign work (2017 and 2019), currently presenting a changed or renewed identity. These platforms, despite being analogous to Pmate, have a different positioning, strategically speaking, and are distinguished by their global recognition (although Pmate's work also assumes this expression through collaboration with CPLP countries in the past) and their wide portfolio of available resources.

Khan Academy (Figs. 1 and 2) is a non-profit organization that promotes quality education for all, online, free and for everyone, regardless of location, social conditions, or age, investing in various fields. In 2017, encouraged by Marta Kosarchyn and May-Li Khoe (vice presidents of engineering and design, respectively), Khan Academy began a redesigning process regarding its identity and platform. The goal was to create a stronger, more independent platform; credible, flexible, and easy to use, regardless of their users' experience; and aesthetically stimulating and attractive, thus motivating its use (Khandker and Khoe, n.d.). According to Laurie (KA moderator), this new graphic identity also solved some of the technical problems created by the previous logos, some of which were the scaling and the lack of recognition. It also worked as a renewal of the brand's image, since it had grown to provide more resources (Laurie @KA 2018).

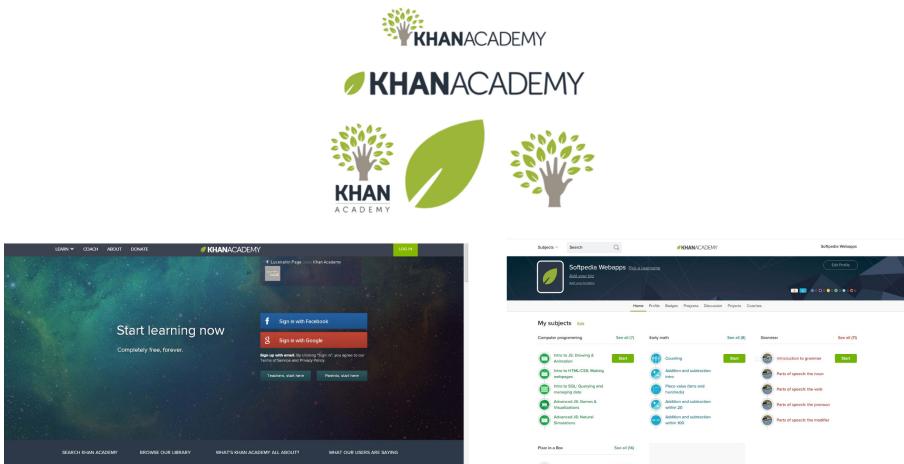


Fig. 1. Khan Academy identity evolution: old logos and platform

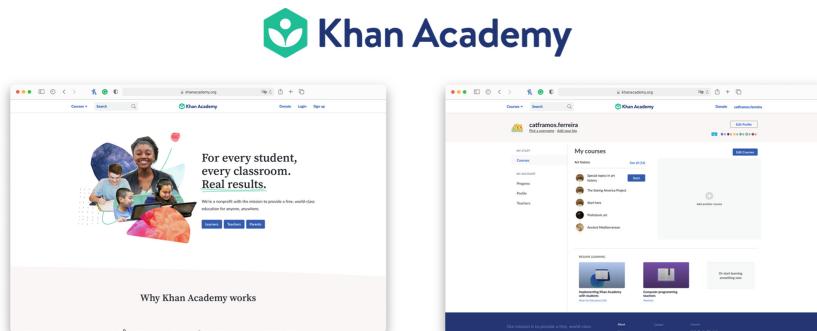


Fig. 2. Khan Academy identity evolution: current logo and platform

Edmodo (Figs. 3 and 4) is an international community that allows communication between students and teachers as an assisted learning platform, the access to content banks and synchronisation with external programs (Edmodo 2019). Its use is limited to the mandatory school years. Besides the free version, it is possible to subscribe the premium one which grants access to more content and progress monitoring, among other tools (Pardo-Bunte 2021). Edmodo has gone through several variations of visual identities, with the last one, in 2019, being one of the most radicals. Up until this point, these changes were mild, with few modifications and an evident progression between each logo. According to Romo (n.d.), a designer at Edmodo, there had been several inconsistencies in the use of the brand since 2016 and, in 2019, the platform announced: “A New Edmodo for the New Decade” (Edmodo, n.p. 2020), which consisted of a revamp not only of the brand’s logo but a redesign of the entire platform, with the introduction of new and improved features.



Fig. 3. Edmodo identity evolution: old logos and platform

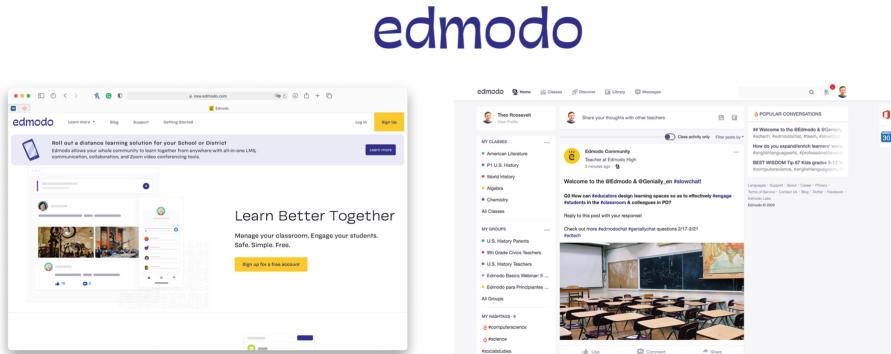


Fig. 4. Edmodo identity evolution: current logo and platform

For both platforms, changes to the graphic (and institutional) identity are strategic decisions by the brands to become more contemporary, introduce new content, improve user interaction, or define their target audience. These are examples of how design can be a tool to redefine objectives or innovate services provided, assuring the success of the brand and a good acceptance by the user audience.

3 Methodology

This article follows an exploratory qualitative methodology, justified by the defined context of this case study, the methods for data collection in the form of interviews, the reference of benchmarking as a source of information, and the research development itself, in which theory-building is achieved, after the research process. According to

Coutinho (2014), this methodology is characterised by a more descriptive, inductive, and interpretive logic due to the empirical approach to obtain data.

Sets of graphic objects were referenced and analysed - old logos, graphic elements and documents presenting the project-, semi-structured interviews with some of Pmate's most relevant figures and information collected from the platform's resources and communication elements.

The project, as a whole, followed the *Double Diamond* model, created by the Design Council in 2004 (Fig. 5), as a model for the holistic organisation of research, with this article corresponding to the first diamond of this diagram. The research presented here falls under the divergent process *Discover* - characterised by the understanding of the problem. The result is the review of this knowledge, aiming to enable the creation of a brief for future phases, falling under the convergent process *Define* (Design Council 2019).

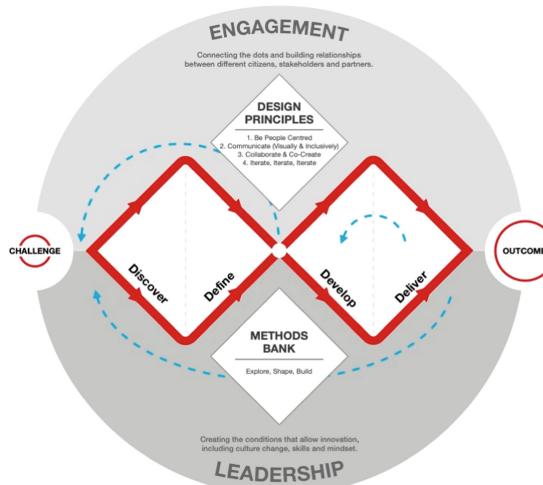


Fig. 5. Double diamond, design council, 2019

Starting from these analyses we were able to define the relevant features for the redesign of Pmate's identity, limiting the number of possibilities and defining the conceptual framework for the new image, within the values and objectives of this initiative.

Since Pmate is a project that has been in operation for 32 years, it has experienced different stages of development and led by different members, so most information today is scattered and not systematised. In this sense, it was necessary to contact people involved in Pmate and the Pmate 4.0 project as sources of information. According to Silverman (2000 apud Coutinho 2014), an interview allows the researcher to adapt or add questions and request explanations according to the conversation, something that would not be possible with other methods of information collection, such as questionnaires or quizzes. In this case, it was relevant to speak to personalities in charge or involved in important roles and phases of the project. The interview method used is called, according

to Patton (2002 apud Coutinho 2014), *informal conversational interview*. According to the author, questions should be naturally prompted during the conversation. In this case, some basic questions and talking points were created, which were not shared with the interviewee, to ensure that all relevant topics would be addressed.

With the first contact, it was possible to understand the evolution of the platform, identify relevant moments, define objectives and main drivers of the project, as well as discuss advantages, challenges and future ideas for its development. With the second interview, we reached more conclusions regarding the role that Pmate played inside and outside the UA. From the conversation with participant 3, a designer in the Pmate team, it was also possible to identify the different phases of the evolution of Pmate's identity, the Competições Nacionais de Ciência (CNC), gather graphic documentation produced along with the project's logo and understand the implementation of its strategy.

4 Project Development

Concerning the interviews, their content was qualitatively analysed, and their results were examined and compared using a comparative table, which organised the answers obtained into categories, following Bardin's proposal (2016), and respecting their discursive features.

Participant 2 of these interviews allowed the access of a set of Pmate's dissemination documents elaborated from the beginning of the 2000s. These documents contain information regarding Pmate's objectives, parallel projects, initiatives and competitions, among other details. From the 50 files shared, we highlight 10 for the graphic elements they present, illustrating the evolution of the project's identity. Participants 1 and 3 also made possible the analysis of the posters from the 25th-anniversary exhibition of this project. Besides the graphic information collected, it was also possible to validate the information discussed during the interviews.

The Pmate 4.0 project programming team also made available images of old screens used in tests and competitions between 1991 and 2018. Graphic elements in the CNC reports (2015–20), logos and posters published on Pmate social media, and more documentation available online were considered and analysed. All the representative graphic elements of this research are exhibited in the chronology that follows (Fig. 6).

From the combined analysis of these documents is possible to state that design took on special importance in the development of Pmate from the time when technology began to allow for more customisation and its corporate identity went through four distinct phases. The first logo was designed by the founding team themselves (phase 1, Fig. 7). In this phase, the identity was solely the usage of the logo on official documents and some secondary logos created for the existing competitions. This first logo underwent minor changes in the following years, with no apparent consistency or planning.

With the project's growth, its identity and divulgation started to gain importance. In 2003 the first redesign operation took place (phase 2, Fig. 8), with the participation of designers from the UA, summoned for this specific project. This new logo is already part of a complete corporate identity that included graphic solutions for the existing competitions based on Pmate's image. This more defined delineation of this identity is visible in the way that, in the following years, the versions created were designed from

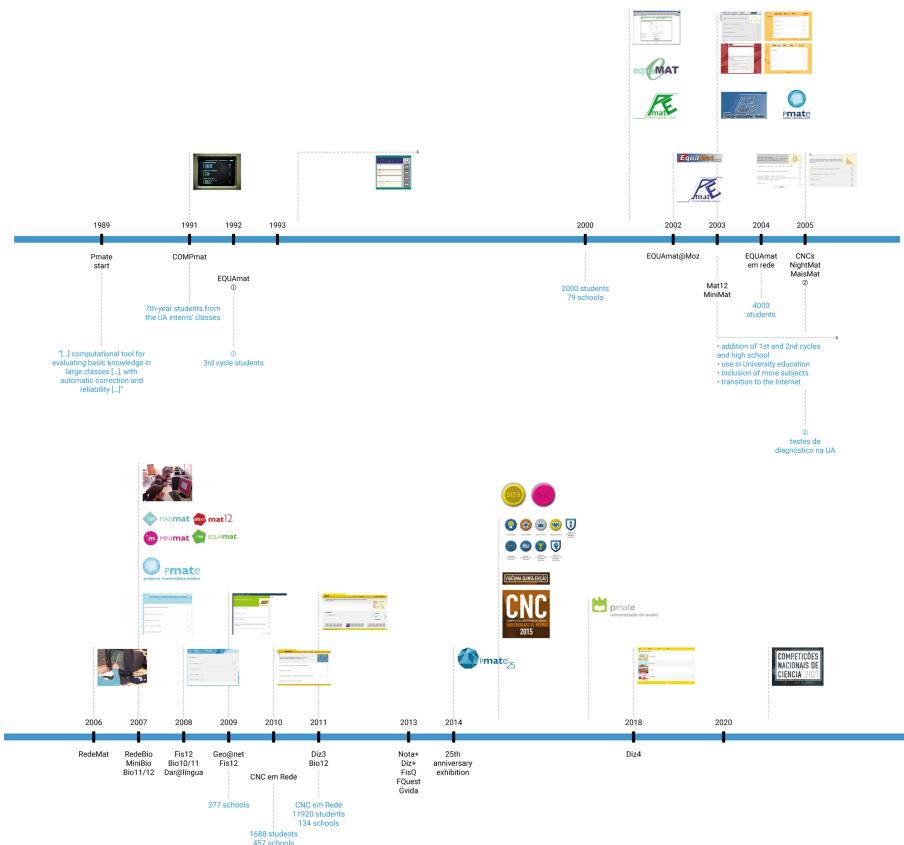


Fig. 6. Pmate: graphic chronology



Fig. 7. Pmate logo evolution, phase 1

this one, highlighting characteristics such as typography and the use of bold elements, the blue colour, the composition and the graphic elements that are maintained. From 2013, with the financial cuts and lack of funding, the functions of a designer in the project shifted from the production of very varied content - from magazines, communication of events and projects - to marketing, as a way of presenting Pmate to local companies and attracting investors, updating the questions for training and working on the identity of the CNCs.



Fig. 8. Pmate logo evolution, phase 2

Finally, with the new strategy of the UA, assuming the unification of its global corporate image, Pmate gained a new graphic image, applied (approximately) from 2017. Like all the other departments and organic unities, it was designed similarly to the University's logo, according to the rules defined by the project designers (phase 4, Fig. 9). This change confirmed Pmate's loss of autonomy, by then already in decline due to lack of resources. It is seen by participants 1 and 3 as an evolution to connect with the UA, but also as a step back in terms of branding, which was already recognised by its audience. Simultaneously, with these changes, and from the first CNCs, several images were designed, every year, in order to advertise these competitions at schools. However, from 2015, an image can be identified that is maintained (with some changes) during the following events.



Fig. 9. Pmate logo evolution, phase 4

Regarding the logos, an evolutionary line can be defined between the second (Fig. 8) and the third (phase 3, Fig. 10) created, through the evolution of the graphic shape, with increasing complexity - starting from four geometric shapes to a multifaceted solid - that also accompanies the gradual progress of the project with the addition of resources, competitions and events, having been interrupted with the last alteration in which all Pmate's own identity and graphic autonomy is lost. With the exclusion of this last process, despite the constant evolution, several elements keep the brand recognisable and made the logo easily associated with the platform, particularly the blue colour, associated, from early on, and the typography. On the other hand, it is possible to document, among other variations, the way the name of the project was written, with successive changes regarding the writing of capital letters and the highlighted ones in bold - both in the



Fig. 10. Pmate's logo from circa 2014, phase 3

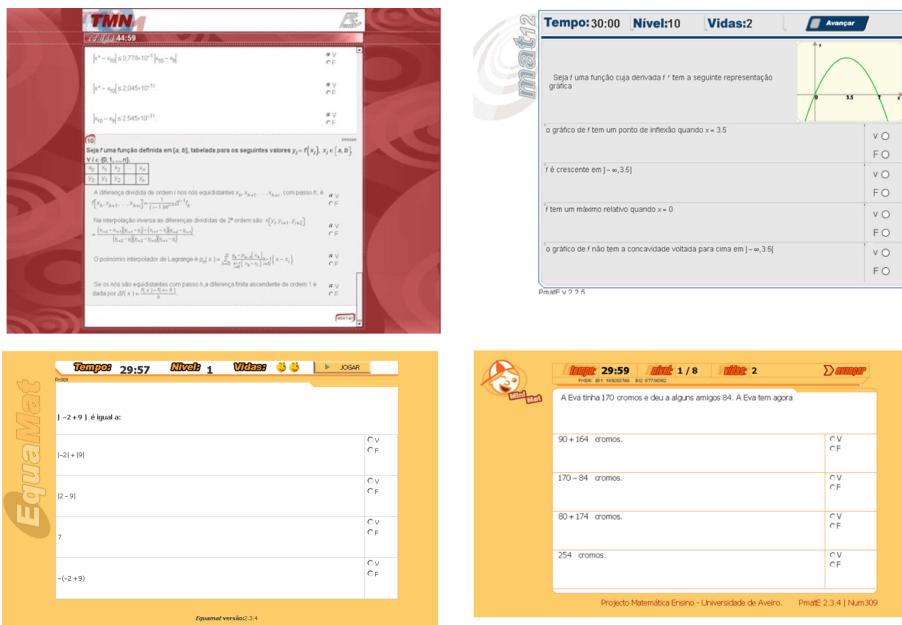


Fig. 11. Quizzes from 2003: TMN, Mat12, EquaMat and MiniMat

logo of Pmate and the competitions. Despite the shift in readability that these changes caused, the project continues to be referred to as PmatE in many official documents.

Concerning the evolution of the training and competition interfaces, these show more versions than the four phases of the project's identity. Although several of these changes are justified by the rapid technological evolution, the lack of criteria while creating these screens is visible by the constant transformations, without evident justification, and by the existence of several designs simultaneously (Fig. 11).

The comparison factors between the interfaces for this analysis were the screen organisation, the general layout of elements and buttons, fonts, colours, logos and graphics used, in addition to headers and footers. It was possible to identify inconsistencies in all the criteria: distinct layouts for all the tests, typographies and use of colour without concordance, graphic elements and logos with different positioning, organisation of the questions and answers in different ways, different positions and names given to the “NEXT” button, the lack of coherence in the use of bold elements, among others. On the other hand, some of the elements maintained are the order of options for the answers - T/F - and the positioning and alignment of the question on each screen.

In the cases of 2007/08 (Fig. 12) and 2010 (Fig. 13), it is possible to observe an attempt to resemble Pmate's identity, namely through the use of the graphic element of the logo as the background or the concordance between the dominant colours (background, header and/or footer) and the colour associated to the type of test. Possibly due to the stronger association to the CNC brand and not to Pmate, it is not possible to indicate considerable changes that have emerged as a consequence of the most recent rebranding of Pmate, apart from the use of that logo in the footer of the screens.

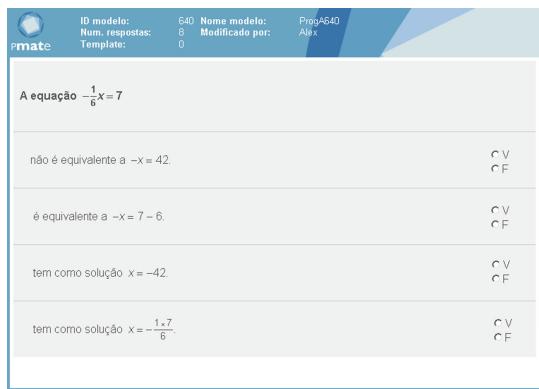


Fig. 12. Quiz from 2007/08

Fig. 13. Quiz from 2010: geo@net

5 Final Considerations

In this article, we identified the most relevant moments of Pmate, the way it evolved and the role of design in this evolution.

From these analyses, it is possible to infer that all these changes show the way the project has been organized, not only regarding the design perspective but the whole management strategy. Many of the decisions seem to be a response to momentary situations and without medium-long term strategic planning.

Also, the relationship (or lack of it) between the Pmate brand and the CNC brand is a relevant point to highlight. CNC gain a scale beyond the platform itself, communicating graphically and strategically as a singular and autonomous brand from Pmate.

As a contribution to the restructuring and redesign of Pmate, we underline the need for a better organization of the brands belonging to the project, and the definition of a strategy and identity that accompanies not only the development of Pmate, but that, contrary to the last rebranding, values its legacy, graphically represented by the characteristics that,

over time, began to be intrinsic to its identity, namely those that were the most striking and recognized logos of the project, still used today, simultaneously with the current one, in elements such as the website (Fig. 14).



Fig. 14. Home page Pmate (background colour and tab icon match the previous version of the Pmate logo)

References

- A New for the New Decade Edmodo. <https://go.edmodo.com/a-new-edmodo-for-the-new-decade/>. Accessed 23 June 2021
- About Edmodo. <https://go.edmodo.com/about/>. Accessed 15 May 2021
- About Khan Academy. <https://www.khanacademy.org/about>. Accessed 15 May 2021
- Bardin, L.: Análise de Conteúdo. Edições 70, São Paulo (2016)
- Best, K.: Design Management: Managing Design Strategy, Process and Implementation, 2nd edn Bloomsbury, London (2015)
- Cambridge Business English Dictionary: Cambridge University Press, Heritage (n.d.). <https://dictionary.cambridge.org/dictionary/english/heritage>. Accessed 23 June 2021
- Coutinho, C.P.: Metodologia de Investigação em Ciências Sociais e Humanas: Teoria e Prática. 2nd edn. Edições Almedina S.A., Coimbra (2014)
- Design Methods Step 1: Discover. <https://www.designcouncil.org.uk/news-opinion/design-methods-step-1-discover>. Accessed 23 June 2021
- Design Methods Step 2: Define. <https://www.designcouncil.org.uk/news-opinion/design-methods-step-2-define>. Accessed 23 June 2021
- Khandker, N., Khoe, M.L.: Wonder Blocks: on the creation of Khan academy's design system. In: Design Systems (n.d.). <https://www.designsystems.com/about-wonder-blocks-khan-academy-design-system-and-the-story-behind-it/>. Accessed 15 May 2021
- Laurie @ KA: Update: Khan academy has a new logo! Khan Academy (2018). https://support.khanacademy.org/hc/pt-br/community/posts/360018195071-Update-Khan-Academy-has-a-new-logo?page=3&sort_by=votes. Accessed 23 June 2021

Pardo-Bunte, M.: Edmodo review. In: Better Buys (2021). <https://www.betterbuys.com/lms/reviews/edmodo/>. Accessed 23 June 2021

Romo, L.: Edmodo branding, illustration and animation. In: Rectangulaire (n.d.). <http://www.rectangulaire.com/edmodo-branding>. Accessed 15 May 2021

What is the framework for innovation? Design Council's evolved Double Diamond. <https://www.designcouncil.org.uk/news-opinion/what-framework-innovation-design-councils-evolved-double-diamond>. Accessed 15 May 2021

Figures

Fig. 1: (top to bottom) available at https://support.khanacademy.org/hc/pt-br/community/posts/360018195071-Update-Khan-Academy-has-a-new-logo-?page=3&sort_by=votes. Accessed 15 May 2021. <https://www.courses.com.ph/khan-academy-free-mathematics-courses-and-more/>. Accessed 29 June 2021. <https://webapps.softpedia.com/app/Khan-Academy/>. Accessed 29 June 2021

Fig. 2: available at <https://www.khanacademy.org>

Fig. 3: (top to bottom) available at <https://1000logos.net/edmodo-logo/>. Accessed 15 May 2021. <https://weblab.deusto.es/olarex/cd/europamedia/English/edmodo.html>. Accessed 29 June 2021. <https://mgleeson.edublogs.org/category/edmodo/>. Accessed 29 June 2021

Fig. 4: available at <https://new.edmodo.com>. Accessed 15 May 2021. <https://view.genial.ly/5e4eaaf0c66c4d71977070de/presentation-edmodo-class-chemistry>. Accessed 29 June 2021

Fig. 5: available at <https://www.designcouncil.org.uk/news-opinion/what-framework-innovation-design-councils-evolved-double-diamond>. Accessed 15 May 2021

Fig. 7–13: Pmate, provided by Pmate team and previous members.



Research Project in Communication Design: Development of a Management Model

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Abstract. The present study results from a set of studies developed in the scope of the project and design methodologies. Through non-interventionist and interventionist methodologies with qualitative basis, a management model was developed to apply in research project in the communication design field. On this way, this study evidences the importance of using suitable methodologies, applying project management and design management concepts, and lastly demonstrates how Design Thinking and visual thinking methods can improve the outcomes of the projects when these disciplines were used together. This research has as main goals to clarify the research project management in communication design, to demonstrate the importance of an application related to a management model in a research project in a professional practice context, to contribute for scientific knowledge. The present study intends also to understand how the project management can help, whether reasoning the problem in a holistic view or within a specific framework.

Keywords: Design management · Project management · Communication design · Research in communication design · Design methodologies

1 Introduction

This study succeeds a set of studies developed previously, which began with an analysis and synthesis of project [6] and design methodologies [7] used in a selected case study. Besides this, a study was developed where both methodologies were converged [8], as well as a study about the importance of using visual and Design Thinking methods [9] during the development of the research projects. These studies culminated in the development of a management model for research projects in communication design. This research emerges due to the need of having a project methodology that enhances the findings of research projects in communication design. In this way, through this study, it was expected to evidence that the application of a model in research projects in communication design context, can foster the development of new scientific knowledge, emphasize the valorisation of the holistic view and of the design management, as well as enhance results and economic and social development.

In addition, through this research, it was possible to understand which is the contribute of research in communication design applied in professional context, which is the importance of the scientific knowledge and its applications in research projects management in communication design, what kind of transference of knowledge exists between research groups and society/companies, and at last, what is the contribute of project methodologies to the findings of research projects in the context of the regional, national and international development. With the intent of solving the problem of an inexistence of a project methodology that enhances the findings of research projects in communication design, it was used research methods as literature review and exploratory interviews, as well as a component of active research through a curricular internship at a research group simultaneously, with the goal to understand the differences between what the authors said and what happens in the practical context.

Thus, this research has as main goals to present the development of a management model to apply in research projects in communication design, to evidence the importance of the application of research in communication design in professional practice context, to contribute to the scientific knowledge in communication design field, and to understand how the project management can help whether in the understanding of the holistic view, whether in the respective solution, through the implementation of design tools that allowed the designers to have a holistic perspective about the projects during its development.

Therefore, the article focuses on the development of a management model, where design and visual thinking tools were used. These tools were fundamental to visualize, organize, analyse, synthetize ideas, to find patterns and cause-effect relations during the development of the research projects.

2 Methodology

To conduct this study, the authors applied a non-interventionist and interventionist methodologies with a qualitative basis. The non-interventionist methodology was divided in three steps: literature review, exploratory interviews, and exploratory descriptive diagrams.

In the literature review phase, the main authors of the design methodologies field were studied. Besides this, the main ideas of each author were analysed and synthesized.

Relatively to exploratory interviews, designers and other professionals involved in the project were interviewed. These exploratory interviews contributed to a better understanding of each case study, both structure and organization wise, contributing to the development of the visual elements developed afterwards.

In case of the visual thinking methods, mind and concept maps were developed to obtain a detailed and holistic perspective about each project.

After the exploratory interviews and concluded the organization of the information of each case study through the tools of visual thinking, the designers and other professionals involved in the projects were invited to discuss the visual panels, with the purpose to complete the concept maps and/or achieve new insights relevant to the development of the project. Besides this, these methods allowed to find some common key concepts between the projects.

In the methodologic interventionist phase, active research was developed through the professional experience in the curricular internship at a research group. In this stage it was also used design thinking and visual thinking methods to diverge and to converge the information, and subsequently achieve findings related with the synthesis of project and design methodologies of the five case studies.

3 Theoretical References

During this research it was possible to observe that the principles concerned with research methodologies in the design field had origins in the 60s of the 20th century. According to Rittel (1972), design methodology has as main goal to clarify the nature of the activity, as well as the structure of the problems ([2], 1984). Nevertheless, according to Lawson (1972), the design methodology can be considered a scientific methodology ([2], 1984). Besides this, through [2], 1984 we perceived that the first design methodologies that emerged in 60s of the 20th century, have three common phases in the design process: The analysis, which corresponds to the collection and classification of information relevant to the problem (divergence); the synthesis, which concerns the formulation of potential solutions to the problem, taking into account the research carried out in the previous phase (transformation); and, the evaluation, where the solution that effectively solves the problem (convergence) is considered ([2], 1984).

In this sense, design methodologies began to acquire some importance for designers and theorists in this field, as they facilitated design thinking and enabled an automatism of the respective process. In addition to these aspects, design methodologies also make it possible to structure the problems of projects, as well as clarify the nature of the design activity, with the purpose of guiding the practice of design, contributing to the improvement and development of theories and methods. However, due to changes in social, economic, technological, and environmental factors, the many methods developed over time have experienced some changes to adapt to the challenges of contemporary society.

As for design management and project management, the ideas assimilated in the research of these disciplines consist of a correlation between them. For this reason, we decided to approach them together and not separately, as design management incorporates the management of design projects individually, fostering the development and improvement of projects and their respective organizations. In this sense, we observed a change in design thinking, which consisted of a radical change in the general way an organization does business. This new way of thinking considered fundamental assumptions, values, norms, and beliefs that structure an organization. In addition, there was also a change in the paradigm of strategic objectives in project management.

If before, project management was directed towards the projection of tangible products to the public/consumer, now it is directed towards projecting innovation and services. With these changes in thinking in the overall strategic goals of management, new problems related to project management and development also emerged. In this way, design management emerges as a catalyst for the success of managing the design process and the creative process in the most appropriate way, considering the problem to be solved

and the objectives to be achieved. In turn, project management allows the project manager to coordinate the work team around operational, tactical, and strategic planning to ensure that the project is developed within the stipulated time and budget.

Thus, combining research with these two components allows the development of products with greater knowledge about the processes and methods, considering scientific evidence, with the objective of satisfying the needs of the consumer more effectively, with the possibility of generating new scientific knowledge if the solution is innovative in its process and/or in its findings.

Regarding design thinking, according to [1] (2006) the “(...) design management engages design thinking in the organisational strategy, identifies opportunities for design, interprets the needs of the organisation and its customers, and looks at how design contributes to the business as a whole.” ([1], 2006, p.26) Through the previous affirmation of [1] (2006) it is possible to observe that the Design Thinking is a tool indissociable of design management. In this way, we can observe that Design Thinking is a methodology used in many professional fields. However, when applied in the design discipline, it seeks to stimulate the thinking of designers and/or team in the development of the project, making the professionals involved think beyond traditional ideas and methods to solve problems.

The successive applications and uses of design thinking have allowed this method to assert itself as a catalyst and promoter of innovation. However, this method cannot be separated from other areas of knowledge nor considered a competitor to management disciplines. Thus, since design thinking is a process that takes place in strategy and innovation research, it is closely related to the disciplines of marketing, engineering, and information technology. Through various methods of Design Thinking it is possible to solve problems in a real context, in an efficient way, where companies, products and services are valued and, consequently, their position in the market. This discipline is based on fundamentals such as innovation, the development of sustainable solutions and the development of human-centered solutions.

Allied to design thinking is the discipline of visual thinking. According to [3] (2007) the visual thinking simplifies “[...] a complex process without losing details. [Identifies] key common areas at project level. (...) [and provides] a powerful tool for visualization of project assessment and re-evaluation.” ([3], 2007, p.5). This is a method that combines the concepts of non-linear thinking with holistic thinking. Normally, information is organized using contrasts, colours, sizes, shapes, lines, and arrows as a method to hierarchize the information and generate a level of importance. This method uses mental visualization and interpretation strategies and processes that allow you to analyse and synthesize information. Furthermore, the simplification of complex information, through visual information, makes it possible to identify concepts as well as common relationships between different themes or research areas.

In conclusion, through the analysis and synthesis of the main concepts related with the disciplines that this project integrates, it is possible to observe that a project methodology in communication design can foster the development of new scientific knowledge, emphasize the valorisation of the holistic view and of the design management, as well as enhance results and economic and social development.

4 Active Research

4.1 Development of the Management Model

The development of this management model emerges to add value to research in communication design and to develop a management model that enhances the results of research projects in communication design, valuing design as a scientific area by society, contributing to the creation of a research culture in design in Portugal, and, finally, to solve the problem of lack of rigor and ability to manage information in research groups during the development of projects.

Considering the research realized through the non-interventionist and interventionist methodologies, a management model was developed (Fig. 1, Fig. 2) to apply in management of research projects in communication design. This model was developed based on the analysis and synthesis of case studies, in the literature review and in a curricular internship. Firstly, a synthesis model of project methodologies if the case studies was developed, constituted of eight stages: the state-of-the-art; the analysis; the synthesis; the project; the communication design management (definition of the means and communication strategies, content production, prototyping and validation); final product; project implementation; and content dissemination at scientific level [6].

Subsequently, with the support of the synthesis model of project methodologies it was developed the synthesis model of design methodologies of cases studies, composed by nine stages: the diagnosis; the preliminary research; the research; the analysis; the system definition; the design; the validation; the production; and the implementation [7].

Once we developed the synthesis models of project and design methodologies, we converged the knowledge obtained during the study of the case studies, the literature review, and the internship in a research group. Considering these aspects, we started to develop the management the management model to apply it in research projects management in communication design. The model is constituted of nine sequential phases:

- Phase 1 — Problem definition (Project diagnosis);
- Phase 2 — Research (Collection of information);
- Phase 3 — Analysis;
- Phase 4 — Synthesis;
- Phase 5 — Project development;
- Phase 6 — Prototyping;
- Phase 7 — Production;
- Phase 8 — Implementation;
- Phase 9 — Dissemination.

However, the model presents some stages inside each phase, so we present each phase with more details below, with the intent to explain the process in each stage.

The **phase 1**, consists in problem definition (project diagnosis), and integrates eight activities, namely: the briefing; the gathering of information; the development of similar studies; the analysis and organization of the collected information; the second definition of the problem (when applicable); the development of strategic, operational, and tactical

planning to manage the project; and at last, the construction of a project schedule to assist in its management.

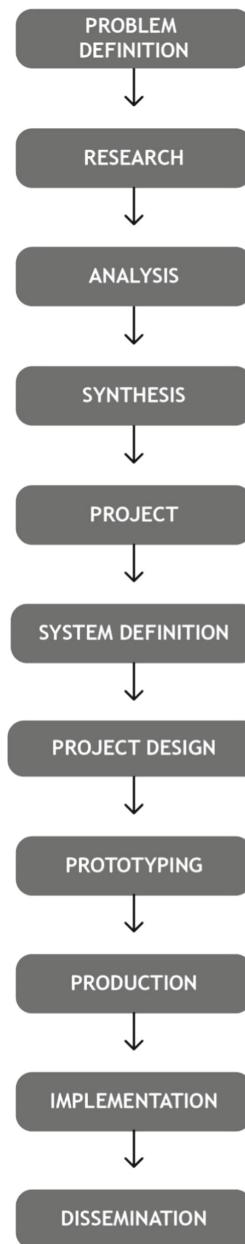


Fig. 1. Exploratory diagram of management model. (Source: The authors)

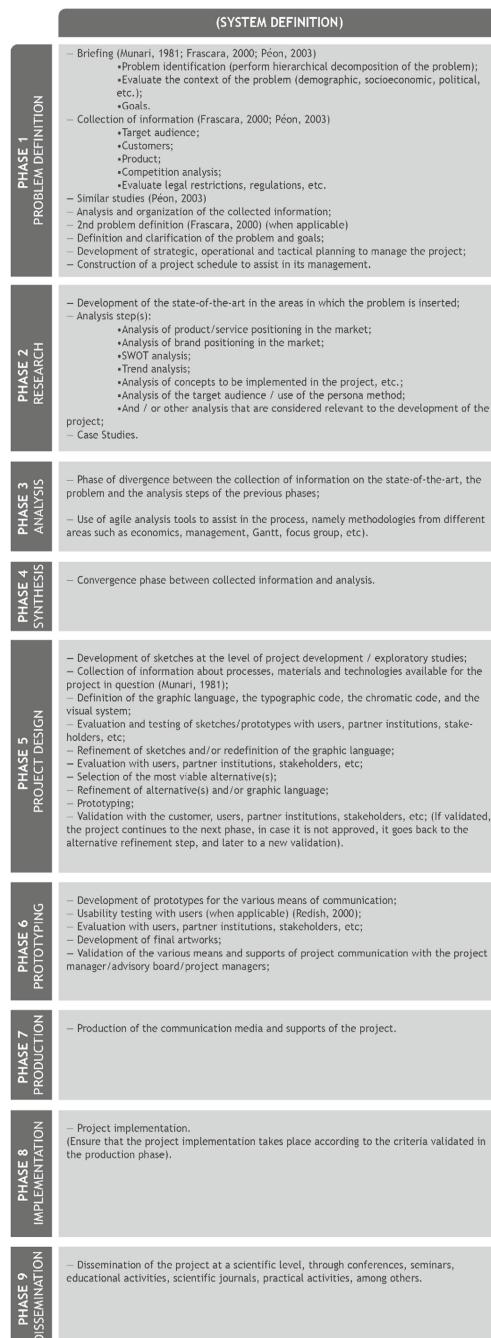


Fig. 2. Descriptive diagram with guidelines of management model. (Source: The authors)

The **phase 2** integrates the research (collection of information) being composed by three activities. The activities are the development of the state-of-the-art related with the problem of the project; the analysis phase; and the study of the case studies related with the nature of the project.

In the **phase 3** the analysis is carried out. In this stage occurs the divergence between the information collected during the state-of-art, the problem, and the previous stages of analysis. In this phase, it is important to use analysis agile tools to help in the process.

The **phase 4** is related to the synthesis stage. In this phase it is carried out the convergence between the information collected and the analysis previously realized.

In the **phase 5** occurs the design of the project and integrates ten processual activities. This stage starts with the development of sketches and/or exploratory studies at project level; the collection of information; the definition of graphic language; the evaluation and testing of sketch/prototypes; the refinement of sketches and/or redefinition of the graphic language; the evaluation with users, partner institutions, stakeholders, etc.; the selection of the most viable alternative(s); the refinement of alternative(s) and/or graphic language; the prototyping; and at last, the validation with the customer, users, partner institutions, stakeholders, etc.; (If validated, the project continues to the next phase, in case it is not approved, it goes back to the alternative refinement step, and later to a new validation).

The **phase 6** focuses on prototyping. Firstly, are developed prototypes of the several supports and means of communication; when applicable, are realized usability tests with users; the evaluation with users, partner institutions, stakeholders, etc.; the development of final arts; and at last, the validation of the various means and supports of project communication with the project manager/advisory board/project managers.

In the **phase 7** consists in production of the means and communication of the project.

In the **phase 8** occurs the project implementation. Ensure that the project implementation takes place according to the criteria validated in the production phase.

The **phase 9** is related to the dissemination of the project at a scientific level, through conferences, seminars, educational activities, scientific journals, practical activities, among others.

4.2 Management Model Flowchart

Considering the model management presented previously, it was developed a flowchart (Fig. 3), that demonstrates the process of its application in management of research projects.

The project starts with the problem definition (phase 1), followed by the stages of research (phase 2), analysis (phase 3), and synthesis (phase 4).

In fifth place, occurs the design of the project, which integrates the development of sketches, the material and technologies research and the definition of graphic language. After this, an evaluate phase takes place with the partners, stakeholders, target, among others. In case of the negative report, the changes needed are carried out. In case of a positive report, the project continues to the next activity related with the refinement of sketches and/or redefinition of the graphic language. Concluded this activity, there is an evaluation phase. If the evaluation was negative, the project developed turns back to the previous phase and the changes needed are carried out. On the other hand, if the evaluation

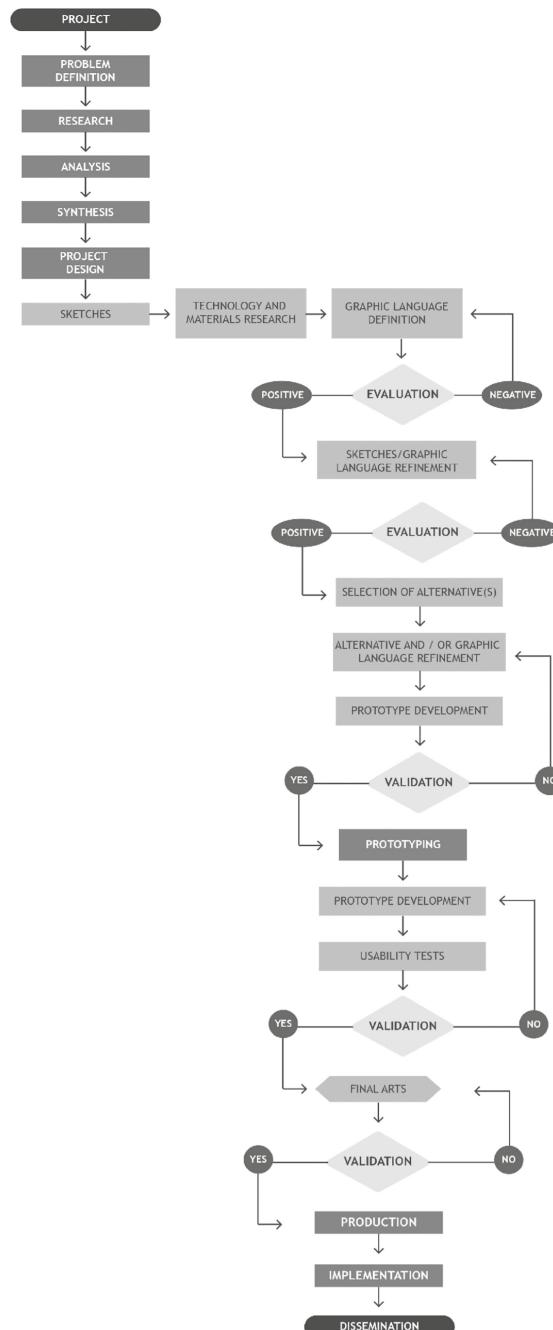


Fig. 3. Flowchart of management model. (Source: The authors)

was positive the project continues to the selection of the alternative(s). Subsequently the refinement of alternative (s) and/or graphic language occurs, and prototypes are developed. When the prototypes are finished, a validation phase occurs. If the prototypes weren't validated with the project manager and/or advisory board, it will be needed to turn back to the refinement of alternative(s) phase and/or graphic language.

If the prototypes were validated, the project continues to the prototyping phase (phase 6). In this stage prototypes are elaborated, and usability tests are carried out. After this, a validation phase occurs. Subsequently, final arts of the project are developed, followed by another validation phase. When the final arts are validated, the project continues to the production phase (phase 7). After this, its implementation (phase 8), and subsequently its dissemination (phase 9).

5 Discussion

The management model developed aims to improve the findings of research projects in communication design. This is a model suitable and transversal to different fields in communication design, since the case studies are related to areas such as development of agri-food products (including the exportation market factor in one case), that could include: cosmetic/pharmaceutical products, cultural research, and environmental promotion. According to [1] (2006) viewpoint, the project management in the graphic design field, results from a translation of strategies and processes of design into a solution. In this way, to develop this model it were considered the main ideas of the literature review developed as well as the experience obtained in an internship at a research group, as a way to synthesise and translate the main strategies and design processes used in the case studies, in a management model of research projects in communication design. In addition, according to Rittel (1984), a design methodology has as main goal to clarify the nature of the activity, as well as the structure of the problems ([2], 1984). So the model developed attaining these aspects too.

In [4] (1980) perspective, the project design methodologies are important to materialize the thinking process, which improves the decision making and the final outcomes. ([4], 1980). In this way, the method presented aims to improve the management methods, the decision making, and simplify the design process using visual and design thinking tools, provided a holistic view of the project during its development. Since the areas of case studies are so distinct, the visual and design thinking methods were essential to obtain a holistic view of the projects and find patterns and relations between them. According to [5] (2013) "Applied design thinking in business problem solving incorporates mental models, tools, processes, and techniques such as design, engineering, economics, the humanities, and the social sciences to identify, define, and address business challenges in strategic planning, product development, innovation, corporate social responsibility, and beyond." ([5], 2013, p.60) Besides this, [3] (2007) using visual thinking methods simplifies "... a complex process without losing details. [identifies] key common areas at project level. (...) [and] Provide a powerful tool for visualization of project assessment and re-evaluation." ([3], 2007, p.5). As we can observe, using these methods was essential to develop the management model, allowing us to simplify the information and to contribute to a better understanding of the case studies.

In summary, during this research, project and design methodologies of five case studies of different intervention areas at communication design level were analysed. Through this analysis, it was possible to achieve two synthesis models related to project [6] and design [7] methodologies respectively. At first instance, it was possible to achieve these goals due to the use of visual and design thinking methods, that allowed us to understand the design processes and the ways of thinking of nowadays. In addition, using the Design Thinking methodology was fundamental, since the nature of that methodology allows the designer to use several methodologies and ways of thinking simultaneously, as the visual thinking methods for example. The visual thinking methods allowed us to simplify the information and to contribute to a better understanding of the case studies. Besides this, provided us a holistic view of the design process.

Allying the case studies with literature review, and with the internship at a research group it was possible to develop a management model for research projects in communication design suitable to the nowadays world challenges, increasing the outcomes of the research projects at a socioeconomic level of the communities involved, contributing to the development of the regions at regional, national and international level.

As a way to solve the problem of an inexistence of a project methodology that enhance the findings of research projects in communication design, the management model developed allowed us to evidence the importance of the application of research in communication design in professional practice context, to contribute to the scientific knowledge in communication design field, and to understand how the project management can help whether in the understanding of the holistic view, whether in the respective solution, through the implementation of design tools that allowed the designers to have a holistic perspective about the projects during its development.

However, to increase the findings with this model, we recommend physical visual displays, using visual boards in a big scale during the development of the project. Seeing and interacting with the information displayed in those boards empowers visual thinking, the brainstorming processes, triggering dialogue, allowing innovative ideas, new strategies, solutions, and management solutions.

In conclusion, the implementation of this method in research projects management in communication design, has the potentiality to increase the project conduction and output, optimizing the contributions for the project different stakeholders.

References

1. Best, K.: *Design Management*. Lausanne, AVA Publishing (2006)
2. Cross, N.: *Developments in Design Methodology*. John Wiley & Sons Ltd, Chichester, New York, Brisbane, Toronto, Singapore (1984)
3. Edkins, A.J., Kurul, E., Maytorena-Sanchez, E., Rintala, K.: The application of cognitive mapping methodologies in project management research. *Int. J. Proj. Manag.* **25**, 762–772 (2007). <https://doi.org/10.1016/j.ijproman.2007.04.003>
4. Jones, J.: *Design Methods Seeds of Human Futures*. John Wiley & Sons Ltd, New York (1980)
5. Mootee, I.: Design thinking for strategic innovation: What they can't teach you at business or design school (2013)
6. Oliveira, D., Neves, J., Raposo, D., Silva, J.: Research project management in communication design: Methodology proposal. *Adv. Intell. Syst. Comput.* 1203 AISC, 96–102 (2020). https://doi.org/10.1007/978-3-030-51038-1_14

7. Oliveira, D., Neves, J., Raposo, D., Silva, J.: Research project management in communication design: design methodology applied to communication design research. *Adv. Des. Music Arts* Springer, 79–93 (2020). https://doi.org/10.1007/978-3-030-55700-3_6
8. Oliveira, D., Neves, J., Silva, J., Raposo, D.: Synthesis Models of Project and Design Methodologies Applied in Research Projects in Communication Design, 1st ed. Springer International Publishing (2021)
9. Oliveira, D., Raposo, D., Silva, J., Neves, J.: Visual Representation of Design Process: Research Projects in Communication Design. **2**, 602–613 (2021). https://doi.org/10.1007/978-3-030-61671-7_56



How Creativity and Celebrity Trust Promotes Intention to Visit a Destination

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Abstract. Video advertising has been widespread through TV and, over the last 10 years, through social media. The creation and production of video advertisements is increasing and therefore the creation of videos that are creative and credible is relevant in communication. In tourism, the intention to visit a destination often depends on the information that is obtained, where video ads are one of those sources of information. Videos that include celebrities as main characters are common and influence tourists to visit destinations they have not visited before.

Therefore, this research aimed to analyze a research model, through the SMARTPLS software, where creativity and celebrity were conceptualized as intention to visit antecedents.

The data obtained from a sample of 231 individuals shows that advertising credibility has positive effects on intention to visit a destination. Additionally, we found that advertising credibility depends on creativity and celebrity trust. Thus, important contributions will be suggested.

Keywords: Creativity · Celebrity trust · Advertising credibility · Intention to visit a destination

1 Introduction

Trying to communicate in the best way with the public is a key factor in the advertising of products, services and brands and it is expected to enhance this same communication through the creation of appealing videos. Creating and producing videos that are creative, credible and adapted to the environment and context is increasingly a marketing objective, very useful when trying to reach a wider audience.

Specifically talking about the creation of videos about places, studied in this paper, it is essential to align the characteristics of this type of communication with tourist

strategies to help increase knowledge about destinations, reach a specific audience and remain competitive.

Knowing that consumers can be persuaded from opinions and messages from trusted sources (such as celebrities) about products, services and brands [1], more and more marketing strategy involves celebrity endorsers in order to promote the brand image [2], reduce risks perceived by the consumer [3] and increase sales [4].

In this context, this research aims to understand whether the credibility of the video advertising campaign created by the municipality of Pampilhosa da Serra, where the main character is a celebrity, had positive effects on the intention to visit. Furthermore, it is intended to study whether this credibility is linked to the confidence in the celebrity and the creativity of the video.

2 Theoretical Background

2.1 Video Ad Creativity and Credibility

From a consumer perspective, according to [5], in the Global Survey of Trust in Advertising study with more than 29,000 respondents from 58 countries, more than half of respondents, 56%, trust email messages with consumer consent, 48% trust search results ads, online video ads and social media ads, and 42% trust online banners. Additionally, 55% of respondents feel willing to act on social media ads, 52% on online video ads, 50% on banner ads, 49% on image ads, and 45% on text ads. These percentages reveal the importance of creating videos that meet the expectations of both communication campaigns and consumers.

Videographic narratives are structurally constructed from a continuous succession of events and happenings, the plot, where questions, surprises and conflicts happen to the characters and are presented in a chained way [6], as we can see in cinema or literature. The types of surprises and conflicts can be with the character itself, with an opponent, with society, with everyday life, among others. The screenwriter of the advertising video has a duty not to be monotonous. In the process of conquering audiences, creativity presents itself as an essential element, never so valued, together with informativeness, in advertising.

According to [7] creativity can be understood “in a way that allows for objective observation and measurement and is compatible with common and historical usage. [...] Some specify that creative contributions must be true, generalizable, and surprising in view of what happened at the moment of discovery.” (1965, p. 663). In advertising, it is usually associated with novelty, the unusual or something different from what has already been done. It is a process of representing a product or service in a new way, with new connections, preserving trust in the message [8]. According to [8] and [9], it reveals itself as one of the guiding behaviors favorable to purchase/consumption intention. Furthermore, considering that video distribution is done on an online platform, it requires a more creative approach than advertising on traditional television, not only because of the amount of content available, but also because of the “pay per click” model and the potential for viral spread of especially creative and remarkable ads [10].

Also important is the credibility of the ads. Not only related to advertising video, but also the use of public figures as characters. With the abundance of information

made available to consumers, building ad credibility is a challenge for advertisers. In advertisements aimed at tourists, in particular, it will be interesting to verify if the advertisement is credible for the destination, that is, if it offers, for example, accurate and complete information and if it guarantees the quality of the place, as presented.

In turn, according to [11] in the study on public figures and digital influences, the attributes or personal characteristics that a public figure must have to participate in advertising campaigns are honesty and credibility. Of course, building the desired credibility is not an easy and quick process and is related to an individual's actions and postures in society, but, in fact, "celebrity trust has a positive effect on both the credibility and credibility of the brand, and that these effects are moderated by the ethnicity of the consumers, with no effects on age or gender." [12].

Therefore, from the literature review, following research hypothesis was postulated:

H1: Advertising creativity has positive effects on advertising credibility.

2.2 Celebrity Trust

A celebrity endorser is "a famous person who uses public recognition to recommend or co-present with a product in an ad". In the same perspective, [13], define a celebrity endorsement as 'an agreement between an individual who enjoys public attention (a celebrity) and an entity (e.g. a brand) to use the celebrity for the purpose of promoting the entity'.

The effectiveness of a celebrity endorser depends on its credibility. According to [1] source credibility is based on trustworthiness, attractiveness and expertise of the communicator and these characteristics influence the perception of consumer about the ad [14].

[2] defines trustworthiness as the perception of consumer face endorser's integrity, honesty and believability. This information is based on reputation of the endorser [3]. Other authors [15] consider that trust is based on two dimensions: cognitive and affective. Cognitive dimension is the rational while affective corresponds to emotional (based on feelings) part of human judgement.

Several studies demonstrated that celebrity endorsement has positive impacts on people behaviour. When compared to noncelebrity endorsements, celebrity endorsement is more effective on consumer perception [16].

The study of [17] showed that celebrities have an impact on advertising effectiveness and brand recall, resulting also in higher purchase intention [18].

When the ad has a celebrity, it helps building brand equity [19] and attitudes toward the advertisement [20].

The credibility of a celebrity endorser positively influences the credibility of the brand [21]. The dimension trustworthiness (of source credibility) has also a positive influence on social media advertising, advertising appeal, brand credibility, brand equity, brand loyalty, corporate reputation [22–24] as well as on consumer perceived quality [25]. It also helps individuals to generate positive eWOM about products and services of the brand [26].

Consequently, the following research hypothesis will be tested:

H2: Celebrity credibility has positive effects on advertising credibility.

2.3 Intention to Visit

In tourism context, intention to visit a destination is one of the most analysed concepts.

It is defined as the tourists' perceived likelihood to visit a specific destination within a certain period [27]. This process of choice of a destination is influenced by destination image [28], familiarity [29], motivations to travel [30] and perceived risks [31].

With the increasing use of the Internet, online information sources also have an effect on tourism behaviour and credible information reduces the perceived risk and increases the intention to visit a destination [32]. Thus, the following research hypothesis was considered:

H3: Advertising credibility has positive effects on intention to visit a destination.

When tourist chooses a destination, it is a rational component of the analysis of benefits among the various alternatives that he researches on websites, blogs and social media [33].

On the other side, tourists also analyse congruity, between a consumer's self-image, his/her ideal social self-concept, and destination image [34]. In advertisements of destinations the use of celebrities helps building this congruity. According to [35] destination ad with a celebrity endorsed increase visit intention. For that, characteristics such as source credibility and self-congruity explains tourist travel intention [36].

Also in films of destination, there is a tourists' emotional attachment to film celebrities that lead to intention to visit that destination [37]. By visualizing a travel destination, tourists have positive emotions that influences visit intention [38].

Finally, eWOM is also a factor that influence travel intention [39] as well as the feeling of security and trust [40]. In this sense, the following research hypotheses will be tested:

H4: advertising creativity has positive effects on the intention to visit a destination.

H5: celebrity trust has positive effects on the intention to visit a destination.

3 Methods

3.1 Survey Instrument

To get the purpose of the research, we used a cross sectional, self-administered survey consisting of 14 items. The structure of survey were three parts: (1) In the first part we included an advertising video of the city "Pampilhosa da Serra" located in center of Portugal, available on Youtube (<https://www.youtube.com/watch?v=Sag2Gw6W9CM>), which has an Portuguese celebrity as character. (2) In the second part, we included items adapted from previous studies measured by 5-point likert scales ranging from strongly disagree (1) to strongly agree (5). In third part, the survey has demographic questions.

Hence, to measure advertising creativity we used 4 items from [9]. To measure advertising credibility, we follow 4 items from [12] research. Additionally, celebrity trust was measured by 4 items from [12] and, to measure intention to visit a destination we followed [29].

3.2 Data Collection

To collect data, we presented the video to participants and after we shared with participants the questionnaire link. The participants fulfill the questionnaire with a portable device such as smartphones, laptops or tablets.

3.3 Sample

The sample of this research has 231 participants which referred that the character in mostly cases (90,9%). The individuals have ages which ranges between 18 and 71 years old and most of them (61,9%) has ages between 18 and 29 years old. The education of the participants was undergraduate, in most cases, (50,6%) (Table 1).

Table 1. Sample.

Variable	Dimension	N	%
Gender	Male	68	29,4%
	Female	163	70,6%
Age	<20	45	19,5%
	20–29	98	42,4%
	30–39	28	12,1%
	40–49	39	16,9%
	≥50	21	9,1%
Education	Basic school	33	14,3%
	Undergraduate degree	117	50,6%
	High school	69	29,9%
	Pos-graduate	12	5,2%

4 Results

In order to test the research hypotheses, our sample size permits that we use the Structural equation modelling (SEM) through maximum likelihood estimation, considering the rule of 5:1 (responses:items) [41]. We chose Partial Least Squares - Structural Equation Modeling (PLS-SEM) to estimate the conceptual model because it enables the researchers to assess causal relationships. The PLS-SEM is appropriate for exploratory research and does not require normality of data [41]. Additionally, PLS-SEM is executed in two steps. First, we analyzed the reliability and validity of measurement model and secondly we analyzed the relations between constructs as suggested by [41]. The PLS-Algorithm was executed on SMART PLS v3.3.2 [42].

4.1 Measurement Model

The analysis of the measurement model included the analysis to the Common Method Bias, confirmatory factor analysis and discriminant validity.

Common Method Bias

We collected responses from the same respondents and, there was a possibility of common method bias. For that, we pre-test the survey to avoid vague concepts and complex syntax and double-barreled questions. At the first page of the survey, all the respondents were informed that answers are anonymous and there are no right or wrong answers to each question. We also performed Harman's one factor test, and the result showed four factors and first factor explained 21,46% of the variance.

Also, we ran a series of regression models to calculate the Variance Inflator Factor (VIF). VIF values are ranged between 1,290 and 3,959 which is below the threshold value (VIF <5). We also verify the normality and we verified that Skewness (Sk) and Kurtosis (Ku) do not diverge from normality (Sk <3; Ku <7) [41]. Additionally, we calculated the Kaiser-Meyer-Olkin (KMO) as well as Bartlett's test of sphericity to measure sampling adequacy. The KMO is 0.829 and is above the minimum threshold (KMO >0.7) and Bartlett's test is significant at p <0.05. Therefore, the data are suitable for factor analysis.

Confirmatory Factor Analysis

The validity, reliability and standardized loadings (λ) were analyzed. Therefore, Table 1 shows that standardized item loadings are above the minimum threshold value of 0.7 [41], which were acceptable for further analysis.

Table 2. Measurement model

Construct	Itens	λ	t-values	p values
Celebrity Trust (CET) ($\alpha = 0,879$; $\rho_A = 0,888$; CR = 0,917;AVE = 0,734)	CET1	0,908	48,779	0,000
	CET2	0,869	31,487	0,000
	CET3	0,832	23,836	0,000
	CET4	0,815	21,149	0,000
Advertising Credibility (ADC) ($\alpha = 0,871$; $\rho_A = 0,880$; CR = 0,911;AVE = 0,720)	ADC1	0,851	33,397	0,000
	ADC2	0,829	30,076	0,000
	ADC3	0,828	27,971	0,000
	ADC4	0,885	50,465	0,000
Intention to visit destination (IVD) ($\alpha = 0,878$; $\rho_A = 0,894$; CR = 0,942;AVE = 0,891)	IDV1	0,935	60,956	0,000
	IDV2	0,953	104,761	0,000

(continued)

Table 2. (continued)

Construct	Items	λ	t-values	p values
Advertising Creativity (CREA) ($\alpha = 0,806$; $\rho_A = 0,868$; CR = 0,871; AVE = 0,632)	CREA1	0,850	34,441	0,000
	CREA2	0,842	26,770	0,000
	CREA3	0,884	7,462	0,000
	CREA4	0,870	49,425	0,000

Notes: λ = Standardized Coefficients; α – Cronbach's alpha; AVE – Average Extracted Variance; CR – Composite reliability. CET-Celebrity Trust; ADC-Advertising Credibility; IVD-Intention to visit destination; CREA-Advertising Creativity.

For all constructs we obtained the average variance extracted (AVE), ranging from 0.632 to 0.891 and Composite Reliability (CR) ranging from 0.871 to 0.942 (Table 2). These values are above the threshold values (AVE > 0.5; CR > 0.7). Additionally, we examine that standardized loadings (λ) are above the recommended value for each construct and their significance is considered ($p < 0.05$) [43]. These values showed convergent validity and reliability for all constructs.

Discriminant Validity

To access the discriminant validity, first we examine the Fornell and Larcker criteria [44] and we verified that the correlations between constructs are below than square root values in diagonals of the AVE (Table 3).

Table 3. Discriminant validity: Fornell and Larcker criteria

Construct	CREA	ADC	CET	IVD
CREA	0,795			
ADC	0,452	0,849		
CET	0,357	0,468	0,857	
IVD	0,467	0,417	0,234	0,944

Notes: diagonal entries are square root of AVE values; all correlations are significant at level 1%; CET-Celebrity Trust; ADC-Advertising Credibility; IVD-Intention to visit destination; CREA-Advertising Creativity.

Second, we examined the discriminant validity through the cross-loadings criterion [45]. Table 3 shows a comparison of the column loadings, and each indicator exhibits that indicator's loadings on its construct is higher in all cases compared to all its cross-loadings with other constructs (Table 4).

Third, we examined the discriminant validity through Heterotrait-Monotrait (HTMT) ratio of correlations [45]. Table 3 shows HTMT values below than threshold value (HTMT < 0.9) (Table 5).

Table 4. Discriminant validity: cross-loadings

	CREA	ADC	CET	IDV
CET1	0,252	0,403	0,908	0,126
CET2	0,308	0,447	0,869	0,212
CET3	0,356	0,410	0,832	0,265
CET4	0,297	0,324	0,815	0,186
ADC1	0,372	0,851	0,357	0,382
ADC2	0,387	0,829	0,308	0,327
ADC3	0,368	0,828	0,437	0,273
ADC4	0,407	0,885	0,471	0,420
IDV1	0,387	0,383	0,197	0,935
IDV2	0,488	0,403	0,242	0,953
CREA1	0,850	0,397	0,339	0,389
CREA2	0,842	0,336	0,228	0,316
CREA3	0,584	0,222	0,233	0,174
CREA4	0,870	0,431	0,320	0,509

Notes: CET-Celebrity Trust; ADC-Advertising Credibility; IVD-Intention to visit destination; CREA-Advertising Creativity.

Table 5. Discriminant Validity (HTMT ratio of correlations)

Construct	CREA	ADC	CET	IDV
CREA				
ADC	0,520			
CET	0,416	0,524		
IDV	0,514	0,472	0,260	

Notes: CET-Celebrity Trust; ADC-Advertising Credibility; IVD-Intention to visit destination; CREA-Advertising Creativity.

Therefore, we obtain discriminant validity through Fornell and Larker criterion, through cross-loadings criterion and through HTMT ratio of correlations.

4.2 Hypothesis Testing

To test the hypothesis, we analyzed the structural model and the Table 6 shows the path coefficients which represent the relations between the constructs. The results confirmed that 4 hypotheses were confirmed. Additionally, we found that R² value of Intention to visit a destination is 0.272.

Table 6. Hypothesis testing

Hyp.		β	t values	p values	95% confidence interval	f^2	
H1	CREA→ADC	0,327	4,106	0,000	[0,169..0,479]	0,136	Supported
H2	CET→ADC	0,351	5,491	0,000	[0,223..0,473]	0,156	Supported
H3	ADC→IVD	0,265	4,152	0,000	[0,142..0,394]	0,066	Supported
H4	CREA→IVD	0,353	5,178	0,000	[0,212..0,480]	0,132	Supported
H5	CET→IVD	-0,015	0,248	0,804	[-0,135..0,105]	0,000	Not supported

β = Standardized path coefficients; CET-Celebrity Trust; ADC-Advertising Credibility; IVD-Intention to visit destination; CREA-Advertising Creativity; f^2 -Effect size;

5 Discussion

To test the research hypotheses, we verified the analysis of the standardized path coefficients (Std β). In addition to this analysis, the significance of each relationship was verified through the Student's t value and p-value.

Reinforcing the role of advertising creativity, the H1a hypothesis is corroborated by our study ($\beta_{\text{CREA} \rightarrow \text{ADC}} = 0.327$; $p < 0.01$; $f^2 = 0.136$). From this analysis, we confirm that advertising creativity is an antecedent of advertising credibility as El-Murad and West [8] and Lee and Hong [9], shows on their research. According to Hair et al. (2016) f^2 values of 0.02, 0.15, and 0.35 for the significant independent variables represent weak, moderate and substantial effects, respectively. Thus, the effects of advertising creativity on advertising credibility are moderate.

Research suggests that celebrity trust has positive effects on advertising credibility [12] and our study corroborates this ($\beta_{\text{CET} \rightarrow \text{ADC}} = 0.351$; $p < 0.01$; $f^2 = 0.156$). Literature reveals that signals from trusted celebrities can transfer credibility to other related constructs, including advertising credibility [12]. Therefore, we considered that hypothesis H2 was supported by our study.

Our research evaluated the effects of advertising credibility on the intention to visit a destination. The results show that advertising credibility has positive effects on the intention to visit a destination ($\beta_{\text{ADC} \rightarrow \text{IVD}} = 0.265$; $p < 0.01$; $f^2 = 0.066$) which leads us to support hypothesis H3.

The intention to visit a destination is also influenced by advertising creativity, because the results show that there are moderate effects between these two constructs ($\beta_{\text{CREA} \rightarrow \text{IVD}} = 0.353$; $p < 0.01$; $f^2 = 0.132$). We consider that hypothesis H4 was supported by our investigation.

H5 is not supported by our study since the results show no significant effects among the variables ($\beta_{\text{CET} \rightarrow \text{IVD}} = -0.015$; $p < 0.01$; $f^2 = 0.000$). This conclusion can be justified by the fact that almost all respondents in this study recognized the character in the video, and thus it was not possible to obtain variability among the answers obtained.

In summary, our study corroborated most of the hypotheses under study which leads us to consider that the research hypotheses deduced from the literature were supported in this research. Furthermore, the conceptual model tested in this research presents a

relevant explanation of the intention to visit a destination by the variables under analysis ($R^2 = 0.272$).

Therefore, our research provides important contributions to science. On one hand, the conceptual model presented presents the tested relationships between the concepts. This paper highlights the effects of advertising creativity and celebrity trust on advertising credibility and presents the impact of advertising credibility on the intention to visit the destination.

As practical guide, our research highlights that advertising is important for individuals feel the desire to visit destinations. In the current context, where the COVID-19 pandemic has caused a downturn in visits to tourist locations, our research identifies that advertising credibility influences the intention to visit the destination. Thus, our study identifies that video advertisements that are credible to individuals improve the intention to visit.

Our study also suggests that an advertising video with a believable character and creativity promotes advertising credibility. Therefore, mechanisms are suggested to produce creative ads and also to hire recognized and trusted celebrities from the industry.

6 Limitations and Future Research Directions

Our research has significant contributions for marketing and advertising professionals. However, our study has limitations of different kinds, and the conclusions must be understood in the context of this study.

The study looked at the effects of creativity and celebrity trust in a single video. This may have been a limitation, so it is suggested that further research be carried out with other advertising videos from other city brands.

Our study analyzed the responses of 231 participants who are mostly young. This is a limitation. It is suggested that further studies be analyzed with data collected from other samples.

Finally, this research did not analyze some variables that may have influenced the analysis of our model. Thus, it is suggested that models be studied where the variables creativity, counterargument and self-congruence with advertising are included.

Acknowledgment. This work is funded by National Funds through the FCT - Foundation for Science and Technology, I.P., within the scope of the project Ref^a UIDB/05507/2020. Furthermore, we would like to thank the Centre for Studies in Education and Innovation (CI&DEI) and the Polytechnic of Viseu for their support.

References

1. Ohanian, R.: Construction and validation of a scale to measure celebrity endorsers' perceived expertise, trustworthiness, and attractiveness. *J. Advert.* **19**(3), 39–52 (1990)
2. Erdogan, B.Z.: Celebrity endorsement: a literature review. *J. Mark. Manag.* **15**(4), 291–314 (1999)
3. Wang, S.W., Scheinbaum, A.C.: Enhancing brand credibility via celebrity endorsement: trustworthiness trumps attractiveness and expertise. *J. Advert. Res.* **58**(1), 16–32 (2018)

4. Derdenger, T.P., Li, H., Srinivasan, K.: Firms' strategic leverage of unplanned exposure and planned advertising: an analysis in the context of celebrity endorsements. *J. Mark. Res.* **55**(1), 14–34 (2018)
5. Nielsen, H.: Earned Advertising Remains Most Credible Among Consumers; Trust in Owned Advertising on the Rise. <http://www.nielsen.com/us/en/press-room/2013/nielsen--earned-advertising-remains-most-credible-among-consumer.html>. Accessed 27 June 2021
6. Nunes, J.O.: Enredo. <https://www.joaonunes.com/2008/guionismo/curso-rapido-o-enredo/>. Accessed 27 June 2021
7. Torrance, E.: Scientific views of creativity and factors affecting its growth. *Daedalus* **94**(3), 663–681 (1965)
8. El-Murad, J., West, D.C.: The definition and measurement of creativity: what do we know? *J. Adv. Res.* **44**(2), 188–201 (2004)
9. Lee, J., Hong, I.B.: Predicting positive user responses to social media advertising: the roles of emotional appeal, informativeness, and creativity. *Int. J. Inf. Manage.* **36**, 360–373 (2016)
10. Alegro, T., Turnšek, M.: Striving to be different but becoming the same: creativity and destination brands' promotional videos. *Sustainability* **13**(1), 139–155 (2021)
11. Grupo Marktest: Portugueses valorizam honestidade e credibilidade das figuras públicas na publicidade. <https://www.marktest.com/wap/a/n/id~2513.aspx>. Accessed 27 June 2021
12. Hussain, S., Melewar, T.C., Priporas, C.V., Foroudi, P., Dennis, C.: Examining the effects of celebrity trust on advertising credibility, brand credibility and corporate credibility. *J. Bus. Res.* **109**(1), 472–488 (2020)
13. Bergkvist, L., Zhou, K.Q.: Celebrity endorsements: a literature review and research agenda. *Int. J. Advert.* **35**(4), 642–663 (2016)
14. Gupta, R., Kishore, N., Verma, D.P.S.: Impact of celebrity endorsements on consumers' ad perception: a study of Indian consumers. *British J. Mark. Stud.* **3**(8), 34–49 (2015)
15. Franklin, D., Marshall, R.: Adding co-creation as an antecedent condition leading to trust in business-to-business relationships. *Ind. Mark. Manage.* **77**(1), 170–181 (2019)
16. Saeed, R., Naseer, R., Haider, S., Naz, U.: Impact of celebrity and non-celebrity advertisement on consumer perception. *Bus. Manage. Rev.* **4**(3), 154 (2014)
17. Singh, R.P., Banerjee, N.: Exploring the influence of celebrity credibility on brand attitude, advertisement attitude and purchase intention. *Glob. Bus. Rev.* **19**(6), 1622–1639 (2018)
18. Pornpitakpan, C., Francis, J.N.P.: The effect of cultural differences, source expertise, and argument strength on persuasion. *J. Int. Consum. Mark.* **13**(1), 77–101 (2000)
19. Keller, K.L.: Choosing the right brand elements and leveraging secondary associations will help marketers build brand equity. *Mark. Manage.* **14**(5), 10–23 (2005)
20. Goldsmith, R.E., Lafferty, B.A Newell, S.J.: The Impact of corporate credibility and celebrity credibility on consumer reaction to advertisements and brands. *J. Adv.* **29**(3), 43–54 (2000)
21. Elberse, A., Verleun, J.: The economic value of celebrity endorsements. *J. Advert. Res.* **52**(2), 149–165 (2012)
22. Samat, M.F., Hashim, H., Yusoff, R.N.: Endorser credibility and its influence on the attitude toward social media advertisement in Malaysia. *Rev. Int. Bus. Econ. Res.* **4**(1), 144–160 (2015)
23. Spry, A., Pappu, R., Cornwell, B.T.: Celebrity endorsement, brand credibility and brand equity. *Eur. J. Mark.* **45**(6), 882–909 (2011)
24. Yoo, J.W., Lee, H.S., Jin, Y.J.: Effects of celebrity credibility on country's reputation: a comparison of an Olympic star and a political leader. *Corp. Reput. Rev.* **21**(3), 127–136 (2018)
25. Osei-Frimpong, K., Donkor, G., Owusu-Frimpong, N.: The impact of celebrity endorsement on consumer purchase intention: an emerging market perspective. *J. Mark. Theor. Pract.* **27**(1), 103–121 (2019)

26. Kutthakaphan, R., Chokesamritpol, W.: The use of Celebrity Endorsement with the help of electronic communication channel Instagram. Mälardalen University School of Business, Thesis. Society and Engineering (2013)
27. Ahn, T., Ekinci, Y., Li, G.: Self-congruence, functional congruence, and destination choice. *J. Bus. Res.* **66**, 719–723 (2013)
28. Qu, H., Kim, L.H., Im, H.H.: A model of destination branding: integrating the concepts of the branding and destination image. *Tour. Manage.* **32**(3), 465–476 (2011)
29. Bianchi, C., Milberg, S., Cúneo, A.: Understanding travelers' intentions to visit a short versus long-haul emerging vacation destination: the case of Chile. *Tour. Manage.* **59**, 312–324 (2017)
30. Wong, I.A., Law, R., Zhao, X.: Time-variant pleasure travel motivations and behaviors. *J. Travel Res.* **57**(4), 437–452 (2018)
31. Fuchs, G., Reichel, A.: Tourist destination risk perception: the case of Israel. *J. Hosp. Leis. Mark.* **14**, 83–108 (2006)
32. Tan, W.K., Wu, C.E.: An investigation of the relationships among destination familiarity, destination image and future visit intention. *J. Destin. Mark. Manag.* **5**(3), 214–226 (2016)
33. Chen, Y.C., Shang, R.A., Li, M.J.: The effects of perceived relevance of travel blogs' content on the behavioral intention to visit a tourist destination. *Comput. Hum. Behav.* **30**, 787–799 (2014)
34. Beerli, A., Meneses, G.D., Gil, S.M.: Self-congruity and destination choice. *Ann. Tour. Res.* **34**(3), 571–587 (2007)
35. Van der Veen, R., Song, H.: Impact of the perceived image of celebrity endorsers on tourists' intentions to visit. *J. Travel Res.* **53**(2), 211–24 (2014)
36. Ong, Y.X., Ito, N.: I want to go there too!" Evaluating social media influencer marketing effectiveness: a case study of Hokkaido's DMO. In: Information and communication technologies in tourism 2019, pp. 132–144, Cham, Springer (2019)
37. Yen, C.H., Teng, H.Y.: Celebrity involvement, perceived value, and behavioral intentions in popular media-induced tourism. *J. Hospitality Tour. Res.* **39**(2), 225–244 (2015)
38. Ghosh, T., Sarkar, A.: To feel a place of heaven: examining the role of sensory reference cues and capacity for imagination in destination marketing. *J. Travel Tour. Mark.* **33**(1), 25–37 (2016)
39. Jalilvand, M.R., Heidari, A.: Comparing face-to-face and electronic word-of-mouth in destination image formation. *Inf. Technol. People* **30**(4), 710–735 (2017)
40. Han, H., Hyun, S.: Image congruence and relationship quality in predicting switching intention: Conspicuousness of product use as a moderator variable. *J. Hospitality Tour. Res.* **37**(3), 303–329 (2013)
41. Hair, J.F., Black, W.C., Babin, B.J., Anderson, R.E.: Multivariate Data Analysis. Pearson Education Limited (2018)
42. Ringle, C., Wende, S., Becker, J.-M.: SmartPLS 3 (2015)
43. Chin, W.W.: The partial least squares approach for structural equation modeling. In: Modern methods for business research, pp. 295–336. Lawrence Erlbaum Associates Publishers, Mahwah, NJ, US (1998)
44. Fornell, C., Larcker, D.F.: Evaluating structural equation models with unobservable variables and measurement error. *J. Mark. Res.* **18**, 39–50 (1981)
45. Henseler, J., Ringle, C.M., Sarstedt, M.: A new criterion for assessing discriminant validity in variance-based structural equation modeling. *J. Acad. Mark. Sci.* **43**(1), 115–135 (2014). <https://doi.org/10.1007/s11747-014-0403-8>

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