Designing for Interaction: Strategic Approaches to Increasing Engagement in Interactive Installations

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Abstract

The following paper explores how design can affect user engagement and presents three design modification applied to the *Proxemics* interactive installation as a case study: ambient visual cues, voice-guided instructions, and contextual information. These modifications were designed for improving the interaction experience. Whereas each approach had different influences, contextual information was most effective in reducing user hesitation and allowing smoother interaction. The study followed a structured methodology combining qualitative and quantitative approaches to observe how these design changes shaped user behaviour. These findings could contribute to an understanding of how thoughtful design modification can shape and refine user engagement within interactive installations, offering considerations for future work in interactive design.

1 Introduction

Following the presentation of an interactive installation called *Proxemics* at an exhibition featuring a diverse array of interactive and non-interactive works, we have noticed that some users exhibited a degree of uncertainty or hesitancy when approaching the interactive installation. This observation suggests that the incorporation of a confirmation mechanism either auditory or visually might have mitigated these uncertainties and fostered increased engagement with the installation. A deeper investigation into the dynamics of user interaction, coupled with various visual and auditory feedback mechanisms, could unveil insights into enhancing user engagement and participation in interactive installations within the context of public exhibitions.

This observation has led us to hypothesise that a confirmation mechanism, either auditory or visual, might play a crucial role in alleviating these uncertainties. Such mechanisms would then react, giving an immediate response to the users by reassuring them that they are interacting with the installation correctly and hence encourage more active participation. With the introduction of these feedback systems, a relatively engaging and immersive interaction could result, thus increasing users interest and engagement in the installations. A better understanding of the dynamics of user interaction could be realised if a more comprehensive investigation were to be carried out.

This study investigates how users interact with the installation and what available visual and auditory feedback mechanisms are able to enhance it further. This will lead us to new insights into how user engagement and participation can be optimised in interactive installations,

especially in the context of public exhibitions. The remainder of the thesis is structured as follows: after a review of related literature and an investigation of problems surrounding user engagement in interactive installations, the paper proceeds to the case study and discussion of proposed design modifications. Further sections describe the methodology and the results, leading to a critical discussion of the findings and their implications.

2 Related Work

Interactive installations are one of the most significant advances in new media art, offering experiences where the viewer is integrated into the contents of the work. An interactive installation is a volumetric and, most of the time, site-specific, digital technical construction with communicative and artistic purposes (Dondi et al., 2022) [1] (Cao et al., 2021) [2]. These installations are usually computer-based and frequently use sensors, which measure different phenomena such as motion and proximity that the artist has designed in such a way that it makes reactions depending on the participant's action (Urbanowicz & Nyka, 2016) [3] . Interactive installations engage the audience in a way that makes the art achieve its intention. That can range from enabling the observer to walk through, over, or around the installations to asking the observer or the artist himself to be in some way part of the artwork.

In the field of interactive installations, a gap exists between the intended experiences crafted by designers and the actual experiences of the audience. Such divergence shows to the difficulty of translating conceptual visions into experiential realities that have a wide appeal to various users. This emphasises the multiplicity of interpretations by audiences based on individual backgrounds and their expectations. Wei et al.'s study in 2020 [4] focuses on this disparity between the experiences intended by designers of interactive installations for their audiences and what the audience actually experiences. Through the analysis of an interactive installation at the Science Museum in London, the authors develop a model to illustrate and understand these hurdles, termed "deviation". This model can illustrate how a range of levels and types of deviations are possible, therefore explaining how people interact with installations in reality, which designers would not otherwise expect. The importance of this research may be that it helps to inform designers and curators about how to design more compelling, meaningful interactive installations by recognising complexity in audience engagement.

Works like that of Mast et al. (2021) [5] go a long way toward offering further insight into the finer details underlying the design of installations with potential user engagement. The transformation of initial onboarding to sustained participation is really at the heart of this analysis. The user journeyfrom how the onboarding experience pans out to active participationis explained using the states of 'Awareness,' 'Interest,' and 'Intention' to highlight the most relevant stages that characterise users' engagement in interactive environments. It can be clearly observed from this model that the interactive media variables are within controllable parameters, where the variability of different outcomes is at a different level of user engagement (Krzyzaniak et al., 2022) [6]. This underlines the critical need to cognise these parameters in a strategic manner, so as to be able to optimise user interaction and participation.

3 Hurdles in User Engagement

This section delves into various hurdles that can impede active participation within interactive installations based on academic literature. From design complexities to technological barriers and social dynamics, these hurdles are a range of challenges that designers and participants could encounter in various interactive environments.

3.1 Design Complexity

In order to create immersive environments, it is necessary to comprehend a variety of elements when designing interactive experiences that accommodate various modalities and phases of

interaction. Designers have to manage a user's engagement from the first interaction to continued participation and finally disengagement.Achieving alignment between the installation and user experiences and expectations requires the early and continuous integration of feedback mechanisms throughout the design process. In order to ensure that the artwork truly connects with its audience, this iterative refinement helps close the gap between the designer's vision and the participant's actual experience. The intricacy of creating interactive experiences is emphasized by Bilda et al. (2008) [7], who also stress the value of good teamwork and communication in this multidisciplinary project. In order to create interactive, audience-participatory artwork for the public, Sommerer and Mignonneau (2002) [8] suggest applying the concepts of complex system theory. They do this by examining whether complexity can arise within this system and by suggesting a relationship with the complexity of design found in interactive artworks and installations.

3.2 Technological Competence and Performance Anxiety

Interactive installations that presume a certain level of technological proficiency may put visitors who are not familiar with the technology at a disadvantage or even cause them to get anxious when performing in front of an audience. This phenomena, in which user involvement and performance are impacted by fear or anxiety about technology, is not specific to interactive art but rather occurs in a variety of fields where technology is integral (Tarafdar et al., 2015) [9]. This implies that participants' fear over interactive exhibits may originate from a similar source of technology-related anxiety, highlighting the necessity of creating designs that are user-friendly and inclusive for all users, regardless of their level of technological ability.

Brosnan (1998) [10] investigated the relationship between computer anxiety and performance, finding that anxiety affects the quantity of accurate answers received in activities involving technology. This demonstrates how important it is to consider users' comfort levels and familiarity with technology when designing interactive experiences in order to prevent worry from impeding participation or engagement.

3.3 Visitor Shyness

Some people may experience situational shyness when they interact with interactive exhibits, which are meant to encourage active participation from visitors. This impact results from the demands these exhibitions make on viewers to actively interact, frequently in the absence of explicit directions or assistance, which causes self-conscious restraint. A research by Scott et al. (2013) [11] investigates this phenomena by looking at how interactive art shows might be intimidating to spectators who aren't used to or at ease with performative participation, even though their goal is to democratise art engagement. The study, "Goffman in the Gallery: Interactive Art and Visitor Shyness," makes use of the dramaturgical theory of Erving Goffman to comprehend the social dynamics that are present in interactive art environments. It implies that situational shynessa condition in which visitors are uncertain of how to engage with the exhibit and, as a result, may feel self-conscious about their engagement in front of otherscan result from the uncertainty of roles and expectations in these contexts.

3.4 Lack of Instructions

In interactive art installations, a lack of instructions can drastically lower visitor engagement since it might cause uncertainty and hesitancy about how to engage with the artwork in the right way. In the absence of explicit instructions, guests can be unclear about the expected involvement, which could result in a passive experience as opposed to an active investigation. This lack of interest is especially noticeable in settings where the artwork's interactive components are hidden or need special activities to activate (Cordeiro et al., 2017) [12].

Studies demonstrate how important instructions are for helping users engage with technology in museum environments. For example, research has demonstrated that when visitors

experience interactive artworks without any kind of instructional indication, their level of involvement may be impeded by feelings of doubt and self-consciousness around the possibility of misinteracting with the artwork (Scott et al., 2013) [11]. This hesitancy may lessen the immersive experience that the artwork aims to create, reducing the opportunity for visitors to fully appreciate the installation.

3.5 Lack of Contextual Information

Another significant hurdle is the lack of contextual information in an interactive installation or artwork. As highlighted by Szubielska et al., (2021) [13] , those participants who received both titles and comprehensive curatorial descriptions of the artworks showed more engagement and rated the installations higher in comprehensibility compared with participants who received no such information or knew only the titles.

Inherently, interactive installations are replete with elements that are abstract and conceptual. Where an audience is not given sufficient context, they will likely have a hard time capturing the meaning or even the intended interactivity within an artwork, which can lead to confusion and lack of interest. In contrast, clear, accessible information that could elucidate the artist's purpose or aspects in the installation with which the observer should engage tended to elicit more profound, interested interaction. Being familiar with artworks, whether through knowing their titles or descriptions, enhances the overall aesthetic experience (Belke et al., 2010) [14].

Without context, the viewers may not fully enter into any interactivity inherent in the installation. This is because in such installations, where the audience was supposed to have an interaction with the work of art, human nature becomes that of either hesitation or reluctance if not told how one can interact with a piece of work. For instance, the viewer is not sure whether it is possible to touch or move the installation, so that there is only passive observation and no real interaction, reducing the possibility of a deeper engagement.

3.6 Lack of Multi-User Support

Creating spaces where people can interact at the same time without interfering with one another's experience is a key component in overcoming the issue of building interactive exhibits for multiple users. Bartindale et al. (2011) [15] conducted astudy in the subject matter on interactive museum exhibits intended to convert visitors from spectators to participants. The research emphasised design strategies that prioritised multi-user design, enabling numerous people to simultaneously contribute information and engage. These approaches aimed to support the transition of museum visitors into active participants within a temporary exhibition, showcasing both the opportunities and limits of designing for personalised user-generated content in public spaces. This case study shows the importance it is to create interactive systems that support multiple users while also enhancing their participation and engagement. Designers could create more engaging and inclusive experiences that promote user engagement and cooperation by emphasising personalised content and allowing for simultaneous interactions.

4 Case Study: *Proxemics*

Proxemics is an interactive art installation designed to explore user interaction through proxemic behavior, focusing on how different distances affect user engagement. The installation operates through three distinct zones of interaction: far (Figure 1), mid (Figure 2), and close (Figure 3), each eliciting a different visual response from the system.

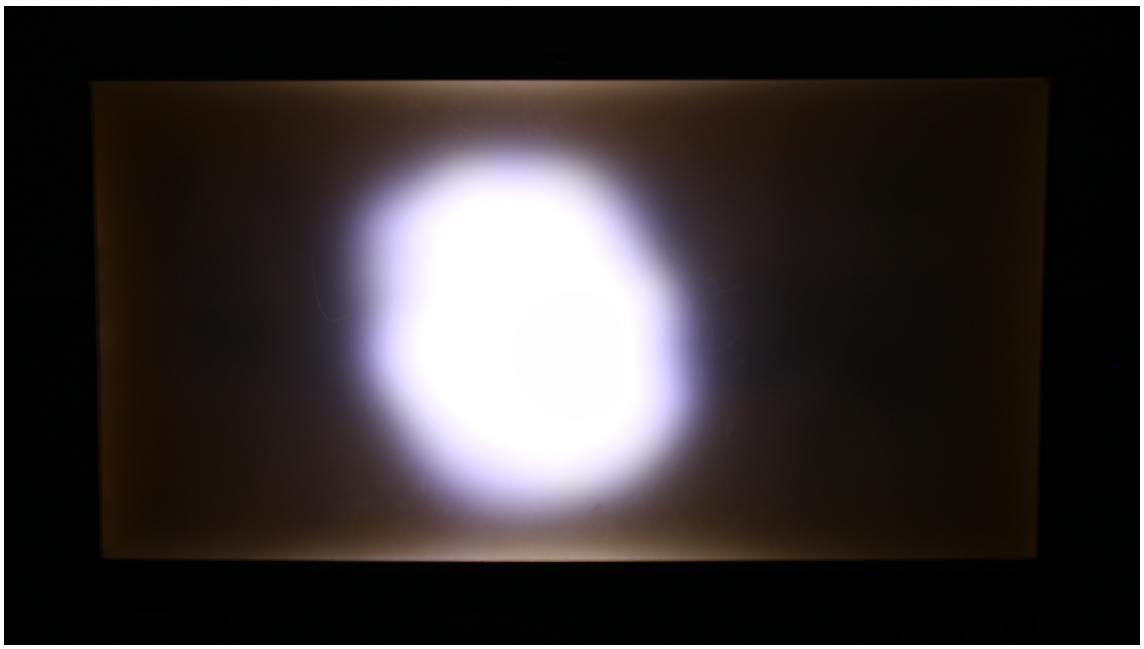

Figure 1: *Proxemics* far distance.

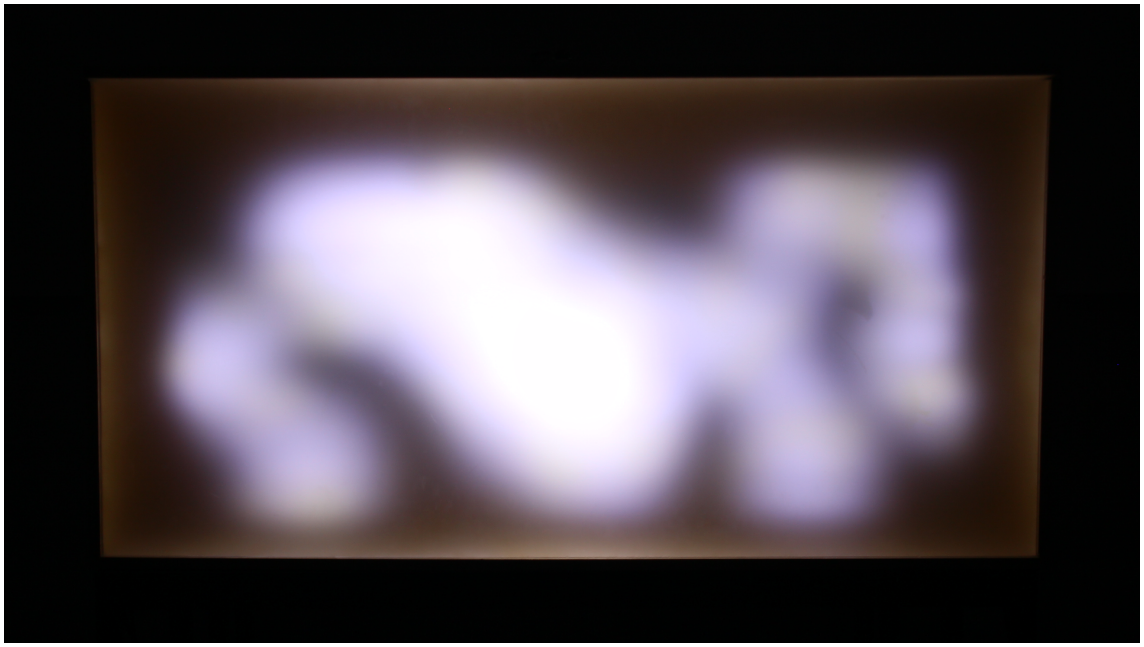

Figure 2: *Proxemics* mid distance.

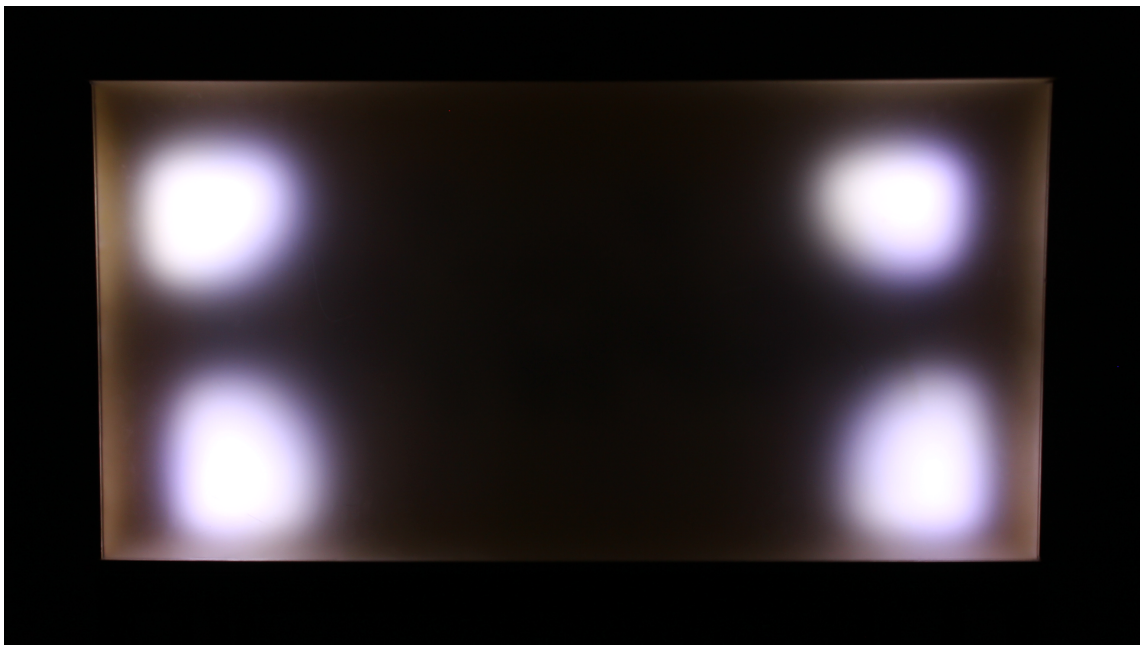

Figure 3: *Proxemics* close distance.

In the far zone, when the user is at a significant distance from the installation, they perceive a single, calm, and organic blob of light. This design aims to evoke a sense of tranquility and detachment, reflecting a less personal, more observational interaction. As the user approaches and enters the mid zone, the calmness breaks, and the lights disperse and move dynamically across the installation. The behaviour becomes more active, with the lights spreading out and shifting positions, symbolising a transition into a more engaged, yet still socially distant, interaction. Upon moving into the close zone, the behaviour of the lights changes once more. In this zone, the lights appear to retreat and hide in the corners, creating a sense of evasion as if avoiding direct interaction, symbolising the personal and intimate space that is often guarded in human interaction.

The structural design of *Proxemics* features a wooden frame that houses 243 LEDs, covered with light-diffusing acrylic to ensure a soft, even distribution of light. This setup eliminates the visibility of individual LEDs, providing a smooth, continuous light surface that enhances the aesthetic experience. At the heart of the installation is an ESP32 microcontroller, which orchestrates the behaviour of the LEDs by processing user proximity data and triggering the light patterns according to the users distance from the installation.

Proximity detection is achieved using a VL53L1X Time-of-Flight (ToF) Distance Sensor. This sensor measures the distance between the user and the installation by calculating the time it takes for light emitted by the sensor to travel, reflect off the user, and return to the sensor. The ESP32 microcontroller then processes this data in real-time, adjusting the animation of the LEDs based on the users position within the three zonesfar, mid, and close.

The installation serves as a practical tool for studying user behaviour in interactive installations. By mapping different light patterns to specific spatial zones, *Proxemics* allows for an investigation into how users respond to varying levels of engagement. This interaction model not only explores the relationship between the installation and user engagement but also serves as a basis for future insights to enhance user engagement in similar interactive installations.

5 Proposed Design Modifications

A series of design modifications are proposed to address the key barriers to engagement identified in the analysis. This set of modifications focusses on improving usability and interaction dynamics of the *Proxemics* installation, with maintaining its core functionality as such. The

main aim is to increase overall accessibility and reduce uncertainty during interaction with the installation, based on both theoretical insight and inspiration drew from other works.

5.1 Addressing Technological Competence and Performance Anxiety

The concept of calm technology by Mark Weiser and John Seely Brown (1996) [16] presents a solution in the process of reducing anxiety over technological incompetence and poor performance in interactive systems. This approach can be used to relieve the anxiety that results when new and unfamiliar technologies are presented to users by suggesting that all technologies must be designed to always exist within a user's peripheral attention rather than demanding close focus at all times. The idea is to design systems that are more human-centred so that people can interact with them with little thought or technical know-how. This method shows how calm technology can engage and enlighten its users without being overbearing, making the accessibility to interactive experiences be reached by more people.

Figure 4: BreathLab by Random Studio.

This method of interaction can for example be used in a retail settings, such as the "BreathLab", an interactive installation by Random Studio (Figure 4)[17] where the primary objective is to enhance the consumer experience through an immersive, yet subtly engaging, way of improving their breathing techniques. This strategy uses gently pulsing light, inviting the user to participate in the installation without burdening them with cognitive overload, thus prioritising an engaging navigable retail setting without overwhelming the user.

Design Modification 1: Ambient Guidance

Using ambient feedback through subtle changes in light, sound, or movement, allows users to understand the state of the system without directly interacting with it. The installation could for example change colours or patterns based on the number of people in a space, providing a gentle cue of the space's occupancy without requiring focused attention. In this case, as the user approaches *Proxemics* they will be detected by the distance sensor. Once the installation has recognised the users presence it will give a subtle notification by using pulsing light acknowledging that user they have been recognised and that the user has the ability to interact.

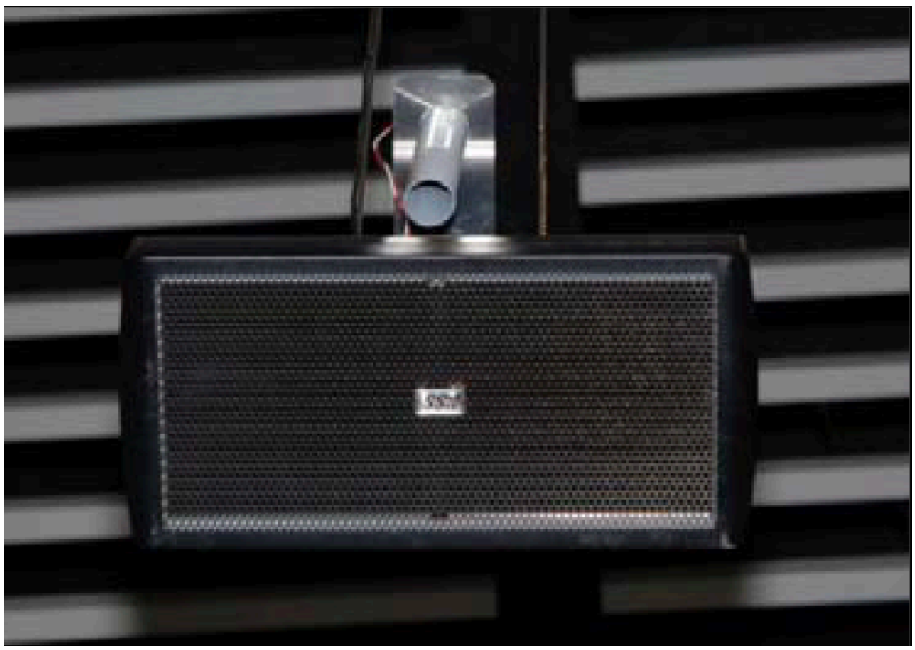

Figure 5: Directional speaker and a PIR sensor. (Kortbek & Grnbk, 2008)

5.2 Adressing Visitor Shyness and Lack of Instructions

In their research, (Kortbek & Grnbk, 2008) [18] explore how interactive technologies can be implemented in art museums without taking the audience away from the art itself. This approach uses the human body as an interface through which interaction can take place, and viewers can interact with digital content through their natural movement. In this regard, the technique guides the viewers implicitly on how to engage with the installation, with no direct signs or orders. They also use subtle audio-visual cues to guide visitors further. Such cues offer unobtrusive instructions on how to interact with the technology, thereby enhancing the understanding and interaction of the visitor without becoming noise against the artwork in the installation. In so doing, the approach effectively mediates the introduction of interactive technology with the need to retain the visual and aesthetic authenticity of the museum experience.

The research applied the use of Gentle Audio Augmentation in an exhibition setting. By using audio spots which are marked by silver circles on the floor. Situated above these at a height of four meters are the directional speakers and a passive infrared sensor. When a visitor steps into a circle, the sensors turn on and trigger the speakers, which plays a recording of artist's voice commenting on the works. The sound does not exceed the edge of the circle, thus ensuring a comfortable and individualised auditory experience. The system uses randomised visitor-initiated audio clips and starts new clips based on the visitor's movement. They continue to play these clips in cycle until each has been played out equally. Unlike headphone-based audio guides, this system maintains the social space of the gallery with the use of sound, permitting integration of ambient sounds and, ideally, conversation between gallery attendees, thus extending the collective experience of the work and its audio interpretation. This implementation allows for very high visitor interaction in a personalised way, maintaining the social atmosphere with collective involvement in the exhibition space.

Design Modification 2: Dynamic Voice Guided Instructions

Voice-guided interaction can address the lack of instructions in interactive installations by providing clear, context-sensitive audio prompts that guide users through their engagement with the technology. When the user approaches 'Proxemics,' at 3300mm, a distance sensor detects them and triggers a single instruction using a calm-sounding female voice. The voice guides the user on how they should interact with the installation in a short audio prompt.

This brief auditory prompt serves as a subtle cue, ensuring the user understands their next step without overwhelming their experience. This method should not disrupt the experience of the installation, since it delivers the instruction at the moment when the user is detected, giving enough guidance to support interaction without breaking the flow of engagement. The following instructions is used in the voice guided instructions:

> You are about to explore the concept of personal space. As you approach, notice how the creature responds to your presence. Your movements will determine how it reacts. Step closer to engage with the creature. As you move through the three zones, observe the change in its behavior. Pause, step back, or move forward. How does your distance influence the interaction? When you're ready, step away to complete the interaction.

5.3 Addressing Lack of Contextual Information

As Pekarik (2004) [19] identifies, art museums have long struggled over how much interpretation to place next to works. Traditionally, these museums provided little didactic interpretation to allow for a purity of personal interpretation; however, this quickly led to disengagement among guests not interested in or apt to derive additional meaning or educational merit from it. This tension between too little or too much context can similarly affect user engagement in interactive installations.

Drawing from cognitive fluency theory, as explored by Belke et al. (2010) [14] , we can infer that the ease with which users process and understand the elements within an installation plays a crucial role in their level of engagement. In their study, Belke and colleagues demonstrated that when participants were given semantically related titles for artworks, their cognitive processing was smoother, leading to higher aesthetic appreciation. Conversely, when the provided titles were unrelated or ambiguous, participants found the artwork more difficult to interpret, resulting in lower levels of enjoyment.

Design Modification 3: Contextual Information Signage

A sign placed before the installation gives the title and background information on the installation. This addition is intended to provide enough understanding for any user as to what the installations purpose is and explaining the interactive elements. The sign, therefore, would reduce uncertainty and guide users guide users in their engagement. It explains the core actions users can take do and what the response might be, aiming to make it more intuitive.

The following text, based on the original concept presented at *Proxemics* as signage similar to a exhibition-like setting:

> **PROXEMICS**
> This interactive installation explores how personal space and territorial behavior affect human interaction. It highlights three zones of distance: public, social, and intimate, each representing different levels of comfort and engagement. As participants move through the space, the installation responds to their proximity, encouraging reflection on how these zones shape behavior and communication. It invites audiences to think about how they navigate boundaries, both in human interactions and in encounters with artificial entities, blending natural and constructed spaces.

6 Study Design

An experimental test to assess the user engagement effect induced by the proposed design modifications on the *Proxemics* installation involved 16 participants in four groups (Table 1). Groups were comprised of four subjects that interacted with the installation individually. This test uses a between-subject design to compare how different modifications influenced

user interaction without exposing participants to multiple conditions, thus minimising potential learning effects or biases (Cohn, 1995)[20].

Group 1	Control Group	Original, no modifications.
Group 2	Design Modification 1	Ambient Guidance
Group 3	Design Modification 2	Voice-Guided Instructions
Group 4	Design Modification 3	Contextual Information

Table 1: Group descriptions

Each participant was individually invited into a controlled environment where the installation had been set up to emulate an everyday exhibition space. Upon entering the space, they were aware that they would experience an immersive art installation, and they were directed to interact with it as they would intuitively in any other gallery setting. No instructions of any kind whatsoever were given to mimic the real world in which guidance would be minimal. During the interaction, the participants proximity data was logged continuously by the VL53L1X Time-of-Flight distance sensor; quantitative measures of user engagement included:

- Total interaction time with the installation.
- Time spent in each proxemic zone: far (> 2000 mm), mid ($2000 - 1000$ mm), and close (≤ 1000 mm).

These metrics allow for an objective assessment of how each design modification influenced user behaviour and engagement levels.

After the participant has interacted with the installation, they were asked to fill in a questionnaire that gathers both qualitative and quantitative feedback. In the form of a System Usability Scale, the questionnaire gauges the participants' ability to interact, how well they remained interested during the experience, and at which point they may feel confusion or difficulty. It also evaluates how well they understand how their motion affects the responses of the installation. The open-ended questions provide an opportunity for participants to indicate those elements that they perceive as facilitating or hindering interaction, expressing the way the design influences their engagement, and provide keywords that, in their opinion, describe the idea being communicated by this installation.

Among the different approaches to administering questionnaires, the pen-and-paper formats is the most efficient in ensuring that the responses are clear and adequately thought outespecially for open-ended questions. Because of the simplicity of this approach, this would be more enabling for participants to engage more deeply with the questions and giving more comprehensive and detailed answers (Kelly et al., 2008)[21].

The questionnaire is composed of the following components:

1. System Usability Scale

1. I quickly understood how to interact with the installation.
2. I found the interactive installation boring at times.
3. The installation held my interest from beginning to end.
4. I felt uncomfortable at certain points during the installation.
5. I found it easy to understand how my movements influenced the installation.

Scale: 1 = Strongly Disagree, 5 = Strongly Agree.

2. Open-ended Questions

1. Can you describe any specific aspects of the installation that either enhanced or hindered your interaction?

2. How did the design of the installation influence your willingness to interact with it?

3. Provide up to three keywords related to the concept that this work aims to communicate.

The System Usability Score was gathered from the responses of the participants to five statements. The responses were recorded on a 5-point Likert-scale, ranging from 1 (Strongly Disagree) to 5 (Strongly Agree. In the positive worded statements 1, 3, and 5, 1 point was subtracted from the participant's score. For the two negatively phased statements, which were statements 2 and 4, the score was subtracted from 5. The adjusted scores were added together to achieve a total score ranging from 0 to 20. The total was then multiplied by 5 to convert the score in a range from 0 to 100.

7 Results

This section will present the results and analysis of both combined quantitative data and individual participant feedback, offering a holistic insight into user engagement with the interactive installation. The results are presented in such a manner that, after considering general trends, detailed analysis of specific design modifications is pursued: voice-guided instructions, ambient guidance, and contextual information. The research further investigates the individual ratings and open-ended responses with a focus on unique user experiences and outliers. As well, the System Usability Scores for each group will give further insight into how these modifications influenced participants' views about usability and interaction. The plots in this section may show irregularities due to tracking being restricted to the y-axis. For clarity, we will interpret fractional peaks as artifacts that may indicate movements along the x-axis, although this axis was not tracked

7.1 Control group

In Group 1, the participants exhibited interaction patterns that were rather varied. For instance, participant 1a deeply engaged with the installation: 50.47 seconds in the close zone, 28.27 seconds in the mid zone, and 59.06 seconds in the far zone (Figure 6). It shows that this balanced investigation shows it was not constrained by the lack of design modifications to interact with the installation within various zones. By comparison, participant 1b spent the most time in the far zone at 129.79 seconds, while only 17.39 seconds were spent in the close zone. Yet the rating for ease of understanding the installation given by participant 1b was high: Rating 1 = 5, which would indicate that some users feel confident in their ability to engage even at a distance. The mean overall SUS score for Group 1 accounted for 80.0, highest among all groups, indicating a rather good user experience without the need of extra instructions or cues (Figure 7).

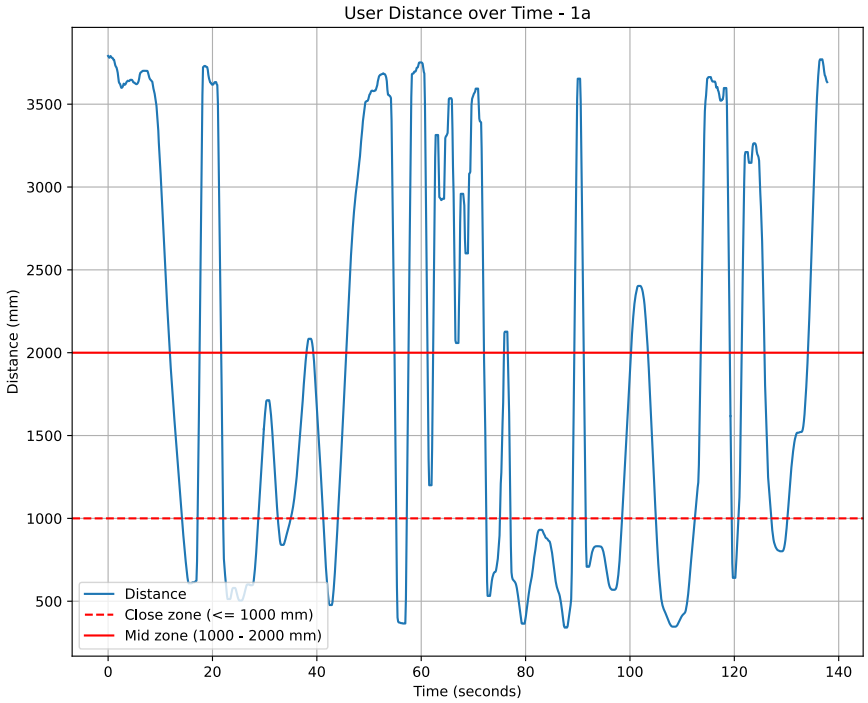

Figure 6: User Distance over Time - 1a

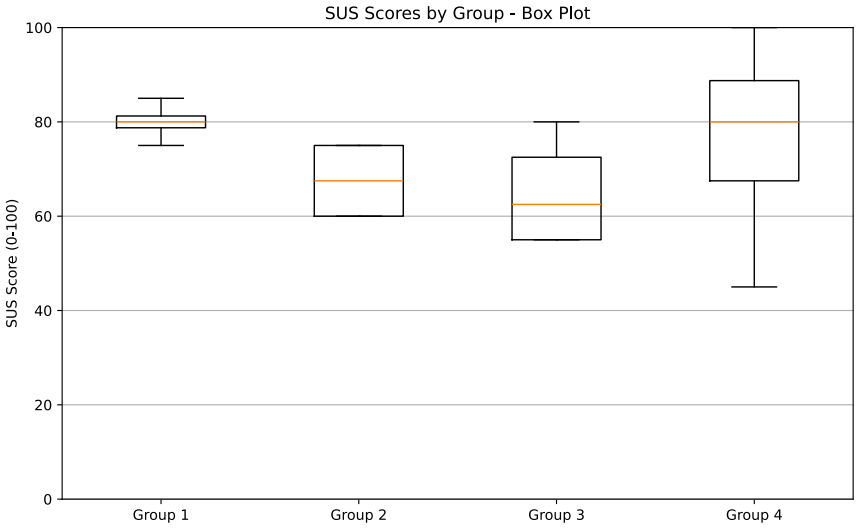

Figure 7: SUS Scores by Group - Box Plot

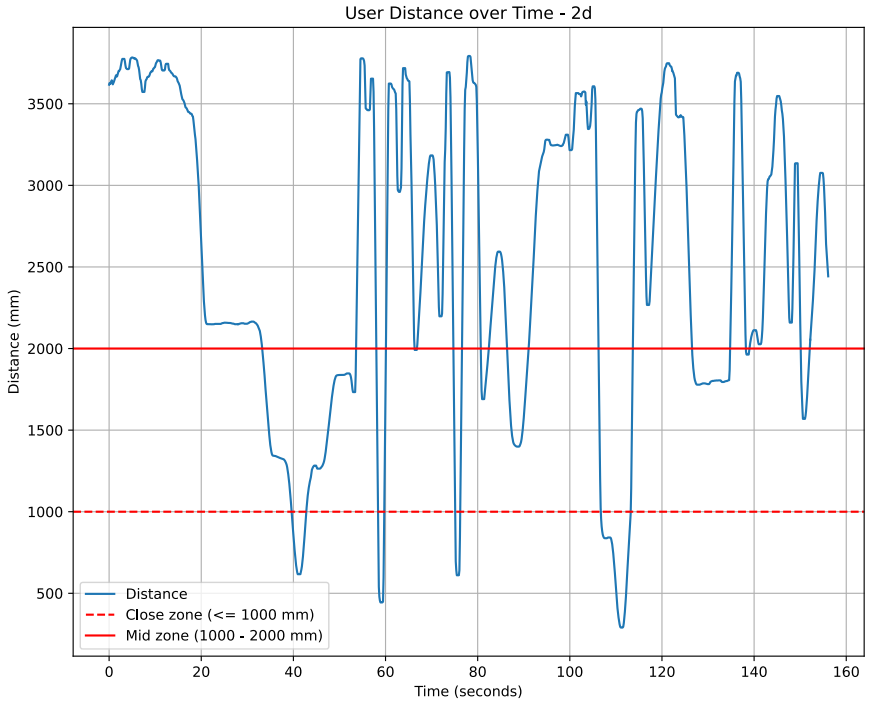

Figure 8: User Distance over Time - 2d

7.2 Impact of Design Modifications

Voice-Guided Instructions

Group 2 did appear to have shorter times in the close zone with the voice-guided instructions; for example, Participant 2d had 12.24 seconds in the close zone in comparison with longer times in the mid zone, at 37.41 seconds, and far zone, at 106.44 seconds (Figure 8), respectively. This thereby could indicate that the voice instructions were not effective in prompting closer interaction with the installation. Participant 2b gave ratings for ease of understanding interaction relatively low: Rating 1 = 2, suggesting that voice instructions detracted from the experience. They went on to state a preference for no voice guidance. Similarly, the overall SUS score of this group is moderate, at 67.5, reflecting those challenges where voice guidance is more confusing than helpful for some participants.

Ambient Guidance

In group 3, wherein participants where the participants were shown the installation with the Ambient Guidance modification, the subtlety of the feedback might have been challenging to notice for some. Participant 3b spent 39.91 seconds in the close zone and 15.98 seconds in the mid zone (Figure 9). During open question 1, participant 3b referred to the interaction as "very effective in triggering engagement," showing that in this case the Ambient Guidance feedback was successful. With the exception of participant 3d, who spent no time in the close zone (Figure 10) and giving a low rating with respect to the ease of understanding interaction (Rating 1 = 1), indicating that the participant was not able to engage properly. This shows that the ambient cues may not be clear enough or strong enough to encourage closer engagement on the behalf of all participants. Given the fact that the third group showed the lowest result in the SUS test (65.0), compared to the other groups suggests that while the Ambient Guidance did improve engagement for some, for most participants it did not significantly enhance engagement of the installation.

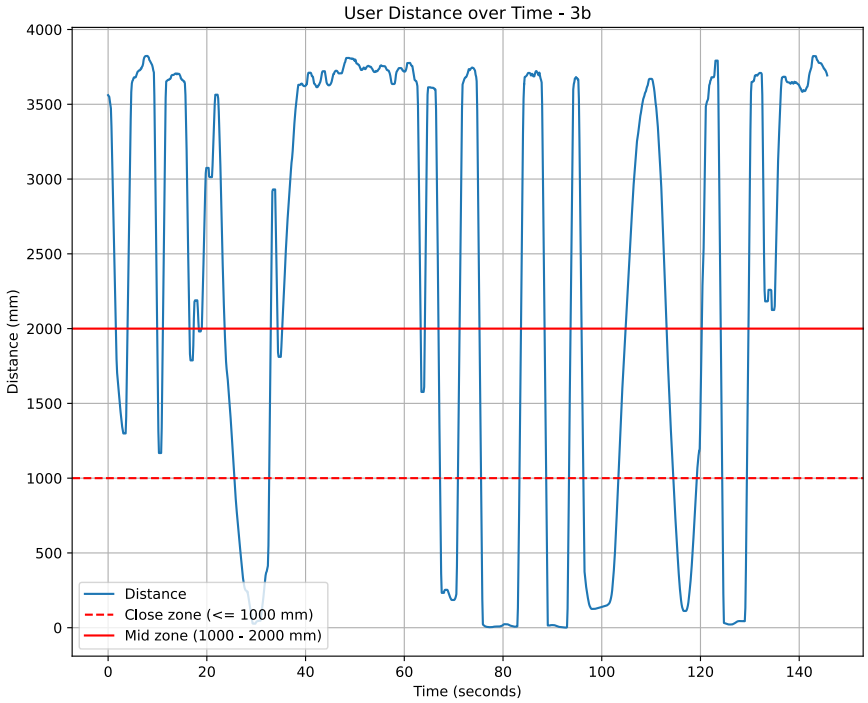

Figure 9: User Distance over Time - 3b

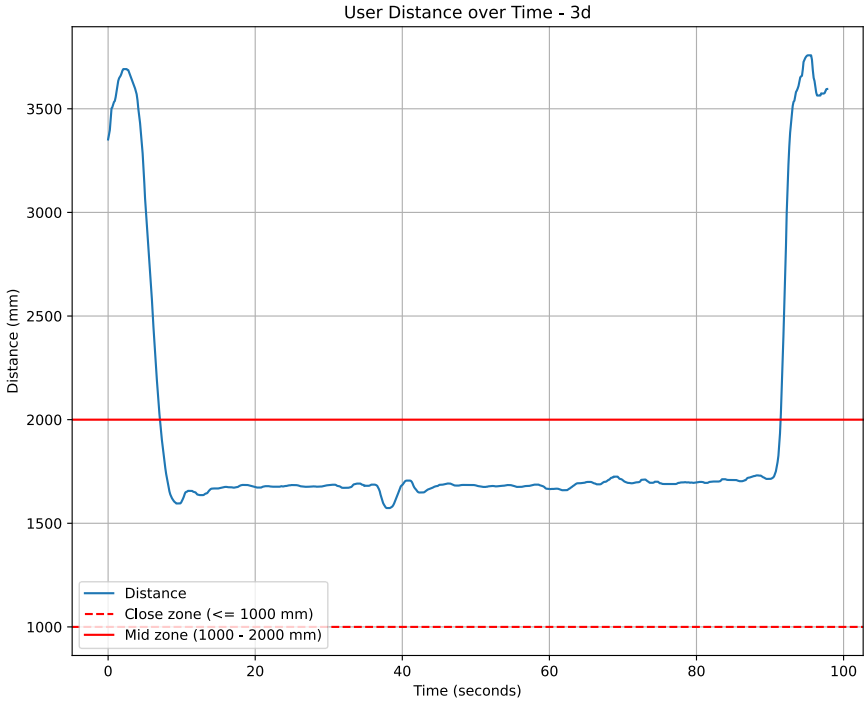

Figure 10: User Distance over Time - 3d

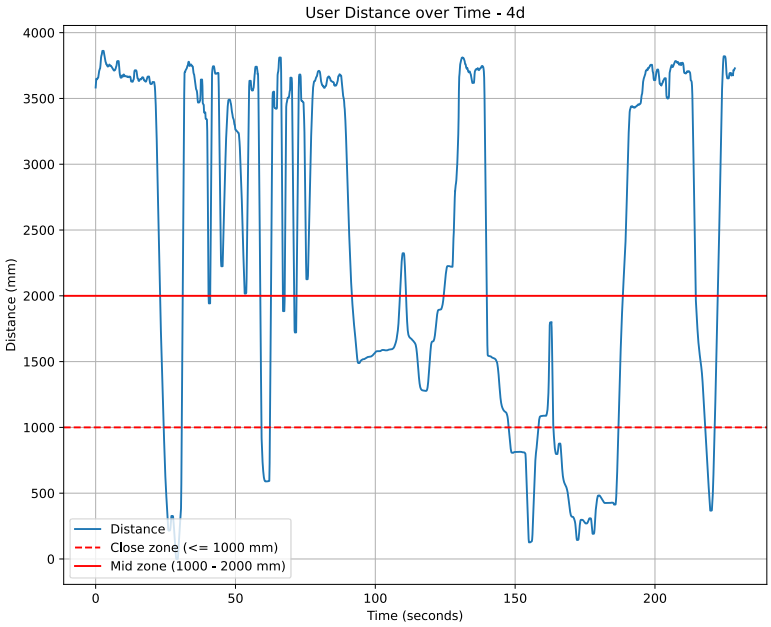

Figure 11: User Distance over Time - 4d

Contextual Information

Contextual information provided to Group 4, appeared slightly higher levels of engagement. Participant 4d was in the close zone for 46.91 seconds and in the mid zone for 54.41 seconds (Figure 11). It also appeared that the contextual signage had provided participants except for one with a clear framework on how to interact with the installation: participant 4c gave a high rating for ease of understanding interaction (Rating 1 = 5) and described keywords aligning with the concept of the installation. Participant 4b stated that it was completely unclear on how to interact with the installation (Rating 5 = 1) although they most likely have read the contextual information as we can see on the proximity data which is inline with the other participants from this group (Figure 12). The SUS score of 76.25 for Group 4 could possibly reflect the positive influence of the contextual information in guiding the participants to an intuitive interaction.

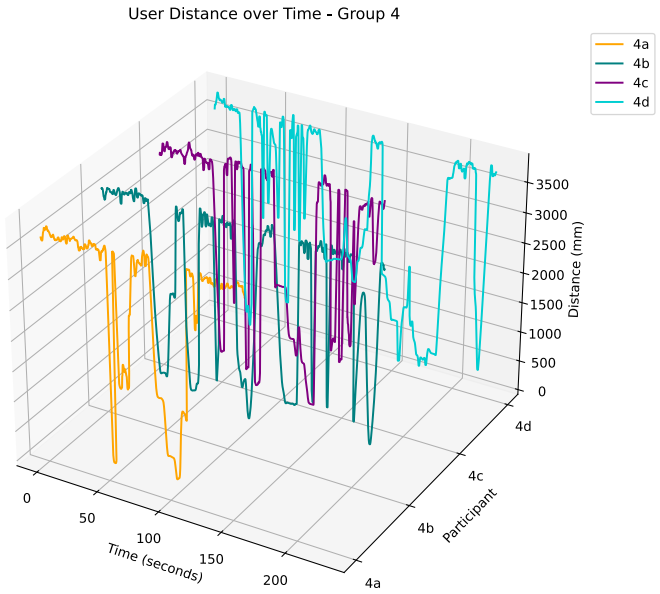

Figure 12: User Distance over Time - Group 4

8 Discussion

The results of this study show that design and engagement in interactive installations have a complex relationship, while the intention of the design modifications was aimed at improving user experience, the results demonstrate that such interventions may not be effective in such a straightforward manner. In fact, the results suggest that sometimes it is in the best interests of an installation to leave it unmodified if better results are intended concerning both engagement and usability.

Effect of Design Modifications

The control group who interacted with the installation with no modifications showed the highest SUS. The intuitive feeling of discovery and self-agency could be due to the fact that participants were free to discover the installation themselves. The study was conducted in a controlled setting without any imposed structure, rather than a typical environment of an interactive installation. This contradicts the general assumption that adding instructional layers automatically enhances interaction. Truong et al. (2015)[22] further highlight the limitations of controlled studies and emphasises the need for longer evaluation periods to gain meaningful insights into user interactions and system effectiveness.

The group presented with ambient guidance, received a mixed result. While the ambient cues-were design to instigate interaction, many participants found the cue veiled by its subtleness. In terms of the implementation of ambient guidance, although aesthetically pleasing, the lower SUS score indicates it is not always clear enough for users to deduce how they should interact with the system.

The introduction of voice-guided instructions yielded mixed results. Where voice instructions might be expected to clarify interaction, in the study it has been reported as unnecessary or distracting. The more modest SUS score found in this group reflects this ambivalence. While voice instruction may clarify the way people navigate through an interaction, also had the potential to feel intrusive. What this might tell us is that the verbal part of the feedback has

to fit in carefully so it does not disturb the interactive experience. A challenge does lie in balancing the amount of information via voice instructions so as not to overwhelm the user while supporting him.

On the other hand, the group provided with contextual information seemed to maintain a pretty good level of engagement and more positive response. The written information about *Proxemics* seemed to reduce uncertainty and promote an increase in engaging with it more confidently. This may show how contextual information about an interactive installation can make it more accessible and clear, especially in situations where a user does not know how to interact with an installation. Contextual information is a great way to lighten the cognitive load and make the experience more approachable and enjoyable.

Limitations of Controlled Settings and Real-World Engagement

In this study, participants were invited to take part in the installation in a structured, controlled environment, which differs significantly from how visitors typically encounter such systems in public spaces like museums or exhibitions. In the 'wild', people approach the installation without explicit background information, knowledge or instruction, with perhaps the setting of the environment doing most in shaping their expectations (Szubielska et al., 2021)[23]. In a museum or public setting, the ambient context, other users, and the surrounding atmosphere all contributes to the experience of an interactive installation. As such, the challenges and feedback mechanisms tested here might have shown alternative results had the installation been deployed in a more natural, public setting where users are driven by curiosity and casual discovery rather than following the instructions of an controlled setup. Of course the intension and benefit of a lab-setting is to collect clean data but it risks reducing external validity, the findings might not accurately reflect how people would engage with the installation in real life (Lew et al., 2011)[24].

Cyclical Design Methodology as Future Steps

As a continuation to this study, it would be beneficial to adopt a cyclical flow of the iterative design process (Elblaus et al., 2012)[25]. This approach focuses on a continuous loop of prototyping, testing, analysing, and refining, whereby each iteration builds from the results of the previous cycle. By following this method, designers can refine the installation with feedback from users, making sure that every iteration better enhances the engagement and usability of the installation. This process is cyclical in nature, where flexibility and responsiveness may let the design evolve with time and come closer to the improving relationship between user interaction and the engagement of an interactive installation.

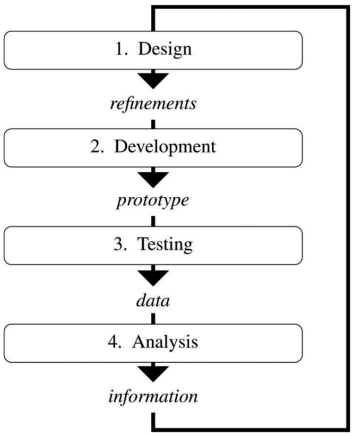

Figure 13: The cyclical flow of the iterative design process (Elblaus et al., 2012).

9 Conclusion

This study explored different design variations of the Proxemics installation and how they might affect user engagement. The group who experienced the original installation, without design variation, seemed to be most engaged. The design modifications that were tested, such as ambient cues or voice instructions, didn't exactly turn out as intended. For some participants these modifications were too subtle to notice or too distracting. However, adding contextual information helped provide users with a clearer understanding of how to interact with the installation.

This controlled environment study shows some of the difficulties of evaluating an interactive installation, that it does not mirror how users may interact with such installations as it does in real-world enviroments. In the future, refining the design based on continuous user feedback could help strike an optimal balance between guidance and the sense of exploration that makes such installations enjoyable.

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