How to supply designers effectively with knowledge about accessibility and inclusion?

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The present paper analyses the flaws of current accessibility evaluation tools and techniques compared to the needs of industrial designers. This is part of an on-going research that investigates effective ways to supply project developers with knowledge about accessibility and inclusion. The outcomes based on empirical study conducted with industrial designers underline the need of supportive tools more integrated to design activity.

1. Introduction

Inclusive design is a philosophy that adopts the principle of designing to enhance accessibility and usability for a wider range of people, including the disabled and the elderly. Physical, sensorial and cognitive capabilities decrease with ageing process and thus, the understanding and the use of everyday products become a challenge. In fact, the ageing of population has emerged as a new issue for product development teams. As a result, during the last decades many methods have been developed to inform designers about accessibility and usability problems in new design concepts.

Despite the diversity of methods currently available (Hitchcock et al 2001; Marshall et al 2004; Macdonald et al 2006; VERITAS D4.1.3_v2, 2010; Clarkson et al. 2007) and the value of the information provided by them, the majority is underused in industrial context (Zitkus et al. 2011). In order to understand the design practice and the non-adoption of accessibility and usability evaluation-tools a study was carried out at three British design consultancies. A total of 14 industrial designers (product, packaging and graphic designers with an average of 10 years experience) were involved in the research described here. The methods selected to the study combined observations with interviews and feedback evaluations in which designers were presented back with the findings from the data analysis for their verification and feedback.

The data gathered followed a structured analysis proposed in grounded theory (Corbin and Strauss 1990). The interviews transcripts were added to observation data and then analysed, interpreted and classified into categories. The categories and subcategories were separated and organized to structure the major themes under analysis. Diagrams were created from the data analysis as a representation media to be presented back to the designers and gather their feedback which was also categorized and analysed.

Techniques	Process integration	Interface	Results	Difficulty of integration
User trials / User observation	Early in the conceptual phase, through similar products, or later through rapid prototypes.	Observation of real users and/or get their feedback after the trial.	Inspiring. Re-assessing the product means to run trials again.	Sample selection, time and ethical issues. Designers have to know recurrent problems to prioritise changes.
Third-Age Suit / Age Explorer		Designers observe themselves with physical restrictions or different levels of restrictions.	Inspiring. Re-assessing the product means to wear the suit again.	Designers have to know the most recurrent problems to prioritise changes. Exclusion is not quantifiable.
Simulation Toolkit				
INCLUSIVE CAD	During the conceptual phase through CAD models.	Simulation of functional demand on lower limb muscles, hip and knee joints.	Results are graphical and interactive. The use of colours facilitates the understanding.	The simulation covers only a limited range of movements and tasks; therefore it is only applicable for a range of physical capabilities and products.
HADRIAN		Virtual interaction with user avatars.	Results are dependent on the accuracy of task performance.	Exclusion is limitedly quantifiable due the range of tasks & users' database.
VERITAS project			Exclusion would be quantifiable due to a broad anthropometric and capabilities database.	Designers have to know how to perform the task.
VICON project		Virtual simulation.		
Impairment Simulator	During the conceptual phase through new concept images.	Simulation of some of vision and hearing capability loss	Results are graphical and interactive.	Exclusion is limitedly quantifiable due to the focus on sensorial capabilities
Exclusion Calculator	Early in the concept phase, through task analyses.	Virtual interaction with a range of applicable tasks.		Designers have to know how the task is performed.

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As this study is part of a research in progress, new data has been constantly added to old one and both are constantly scrutinised, interpreted and verified.

2. Available techniques to evaluate accessibility and usability in design process

A previous study explored and detailed the advantages and disadvantages of a range of tools and techniques currently available to evaluate accessibility and inclusivity (Zitkus et al. 2011). Among the techniques are participatory design, user trials, simulation suits, digital human modelling, virtual resources and others. Some of these techniques are described in more details below and table 1 compares them to the designer's needs in industrial context, such as integration into design process and the results each tool provides.

Only one accessibility evaluation technique – user trials – among the nine techniques listed on the table was mentioned by the designers that participated on the study. The study highlighted that designers use other sources of information about accessibility such as guidelines.

2.1. Ergonomics data and guidelines

According to the study, designers commonly find necessary to refer to ergonomics data during new concept development. The use of tables, books and website with ergonomics information seems to be integrated to the design activity.

> "There is ergonomic information that you can just go to internet, you know, those that talks about ageing groups and handles positions, size of handles, and things£" (27:30 – designer 03)

> "We will reference ergonomics tables and stuff like that, but we rely on them (client) affectively." (18:15 – designer 02)

Competitor analysis is also another way to research alternatives to project solutions.

> "£then searching on internet or other sources to know about competitors, range of possibilities and sources of inspiration" (02:25 – designer 05)

From the observation carried out, the internet seems to be an agent that supplies the designers with technical information. This information varies from ergonomic data to patterns of materials, internal components specifications, such as measurements, weight, etc.

For project that targets elderly people, designers find a need for more information, then they look for guidelines that could give them directions to cope with usability and accessibility issues.The reliance on guidelines can be noted on the comments below.

> "There are lots of standards as well that would define that sort of information (accessibility information)." (43:18 – designer 03)

> "I guess there are very clear guidelines... It is on PRC national piece of safety agency guidance on..., so that says the size of text and stuff like that..." (25:30 – designer 02)

The designers rely on guidelines to comply with the accessibility issues of the new concept. However, their comments also underline that they are deficient information and sometimes incompatible to the new concept design.

> "The guidelines lose its power when it comes to innovation, it doesn't cover the innovative product features." (05:00 – designer 08).

Two designers mentioned that they could balance the deficiency of the guidelines by including some user trials assessments.

> "There are standards which drive how large a piece of text should be, you can print things out in various sizes and get feedback from the user group." (38:53 - designer 03)

2.2. User trials or user observation

User trials and user observation are well known design evaluation methods that enable designers to understand user's need and develop empathy to them. The value of these techniques is proved to be high as they fruitfully highlight accessibility and usability problems that designers would not realise by their own assessment. However, although the possibility of involving the users exists, the majority of the interviewees said it would occur very rarely.

> "£even when I worked in companies that project things specifically for the elderly, it was rare in the extreme anybody who was elderly would be involved in the process£ the users were not part of the process." (19:50 – designer 02)

> "As we know, not every company can get access to (user), then it is probably better if they've got some kind of evaluation £" (37:35 – designer 01)

Even in one case mentioned where one of the consultancies was doing a non-commercial packaging project the involvement with users did not happen.

> "So, it was a project that we looked at elderly people and inclusion, but it wasn't a commercial product in quite the same way. It was part of a separated university research project, but we produced some packaging that allow interaction between elderly and vulnerable people and packaging... but we didn't get directly from the vulnerable and elderly people, the target consumer, but we did get the feedback from the experts, because they have lots of experience in interaction requirements and so all points were considered." (22:47 - designer 06)

2.3. Self Evaluations

This technique is often the most used one applied in the design process. Generally, by trying products or by testing new design mock-ups of their concepts, the designers check its accessibility, usability and other aspects related to the product interaction (Norman, 2002). Self observation of products similar to the one to be developed generally happens before the conceptual design phase. At this point the self-observation has an inspiring role in the design process as the designers can find problems that will bear in their minds when designing a new concept.

As described in the interviews, the participants of the study generally rely on their own assessment.

> "A lot of it I would say is based on common sense, we tend to tell to ourselves what is legible or not." "I think lots of it comes with experience, the way our minds work, it becomes obvious if something is small and illegible£." (35:25 - designer 03)

> "I think lots of time that happen, that stuff (accessibility considerations) comes from experienceЄ you are making subconscious decisions of what is good and bad accessibility. So, I think most of that coming from trying and testing ways of doing things." (27:28 - designer 06)

> "Єwe've got brought in the same way but just bearing in mind the users we were designing for." (13:26 - designer 04)

3. Testing new design concepts: the difficulties involved in accessibility evaluations

The designers' responses outlined that despite the range of tools (listed on table.1) that seems to be a good support to assess the accessibility of new products, they are barely used in the industry as part of the design process. This indicates that either the techniques do not work according to the design process or that there may be inadequacies on the application interface or on the results provided.

The last column of Table1 highlights the difficulties related to each technique to be integrated into the process or to deliver accurate results. Most of them rely on tacit knowledge that designer would need to realistically perform tasks or to prioritize problems. The non-use of these methods and tools may be related to the incomplete results supplied by these techniques, as a result of which designers rely on traditional ergonomics data and guidelines.

3.1. The limits of guidelines

According to the study, designers are still looking at the support provided on documents like standards and guidelines, though they recognized their limits and incompatibilities with new ideas.

Past studies indicated some disadvantages of guidelines. For instance, firstly Cardoso et al (2003) spotted that guidelines do not cover all product possibilities or the entire range of features and thus, they cannot tackle the entire accessibility problem that the designers face during product development. Secondly, the deficiencies in the guidelines' theoretical basis hinder their connection and relationship. Although 'the need for internationally coordinated standards' was recognised and actions were recommended by Stephanidis et al (1998), there is still not significant progress in harmonizing international guidelines. Thirdly, other studies indicated that the more the guideline approach is general the lesser it support the design activity (Burns et al. 1997; Law et al. 2008). These deficiencies of the guidelines are confirmed by the participants by underlining the fact that the information given in the guidelines are not sufficient to the designers and, thus, they have to complement with tests and evaluations.

3.2. User trials or user observation barriers

Although two of the interviewees mentioned that they could test the features of a new concept design with the potential users, the majority of the comments along the interviews are that users are not part of the design routine. Even in projects that were targeted specially at elderly. The example mentioned by one of the designers highlighted the issue: the case of a non-commercial package that "looked at elderly people and inclusion" relied on expert comments about the design features rather than testing the new concept with the potential users.

According to past studies, in industrial context the barriers of involving users in the design activity are mainly related to time and budget constraints (Goodman-Deane et al. 2010; Dong et al. 2004). Time related to selecting and recruiting a representative sample, added to time for organising and running user trials, negatively affect the design process. The more the time a technique consumes, the less probable is its adoption by the industry;

Additionally, other problems such as ethical concern regards recruiting elderly and disabled users should be included. Moreover, confidentiality issues should not be ignored as in industrial context new designs are hidden from the public to maintain its innovative aspects until its launch.

All the above constraints challenges design teams to employ user participation, as a consequence of which many designers opt to their own assessments of new product's accessibility.

3.3. Self Evaluations misconceptions

In order to guide their decisions regarding accessibility and usability, designers rely on their own evaluation of the design features. In fact, their experience and awareness of end-users might support them through the assessments. However, design experience and awareness of end users do not balance the disadvantages of self evaluations.

Firstly, design teams are generally composed by healthy and young adults that cannot feel other individual's capabilities.

Secondly, the disadvantage of using self observation is more evident when the product under analysis is the product being developed by the designers whom are doing the evaluation. In this case, the mental model of the designers is not the same of the users, mainly because they know too much about the product. The familiarization plays a crucial role in this case, which negatively affects their judgment about the problems that can happen when users will be using the product. The team "can no longer put themselves into the role of the viewer" after being involved in the project for a long time (Norman 2002: 155).

Finally, they cannot find a wide range of accessibility problems and thus their decisions are driven by wrong assumptions based on their own assessments.

4. It is time for more integrated design accessibility evaluations

The techniques mentioned above either are difficult to integrate to industrial design process or do not supply the designers with sufficient or reliable information. This means a call for accessibil-

ity evaluations that are more integrated to the design practice.

In industrial context, software analysis has been used for FEM (Finite Element Method), mould flow, stress strain and other evaluations. The outcomes of previous study highlight that CAD and other graphic design tools are totally integrated to the design activity among different design domains. Ideas generated during the conceptual phase are likely produced within computer graphic systems (Zitkus et al. 2012). Computer graphic systems therefore can be used to inform designers about accessibility and inclusion of some features while these features are being designed in new concepts. This could possibly be done by software evaluations through interactive information.

For example, there are products or interfaces in which text size is too small to be legible or text that are written in certain colours that the background- foreground colour contrast is too low to be visible. These features are common problems in which everyday products' demand exclude people with visibility problems to see and use them. A design advisor (Zitkus et al. 2012) would analyse the input data automatically generated while designers are creating ideas within computer graphic system. Designers would interactively provide additional information, for example the 'reading distance' for legibility assessment. The outcomes would therefore vary according to the values entered in the system. The design under development could continuously be assessed every time changes occur in the design features. This could indicate early in the design process accessibility issues related to physical aspects of new designs. These evaluations would happen with minimal impact into the process.

5. Conclusion

Despite the range of methods and tools developed along the last decades, the findings of empirical studies with designers highlighted that only one method – user trials – is acknowledged. However, involving the users in the process seems to be incompatible with industry interests, such as project timescale and confidentiality. In order to avoid wrong assumptions driven by product developers own judgment, the paper claims the needs for more integrated accessibility design evaluations. A design advisor integrated to computer graphics is proposed to be incorporated to design activity while ideas are generated.

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