Visual Capabilities: What Do Graphic Designers Want to See?

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Abstract. Capability loss simulation has great potential to improve the inclusivity of designs, through helping designers to understand the needs of people with reduced capabilities. However, its uptake in the design industry has been low, particularly in graphic design. This may be partly due to a poor fit between design tools and the work processes and tool requirements of designers.

This study aimed to address this by seeking designers' input into the design of concepts for vision loss simulation. Five design workshops were conducted, each with one or two graphic designers. In each, participants were given a list of requirements for simulator tools, summarised from previous studies, as well as 15 cards describing a range of simulator concepts. They then developed their own concept and explained the reasoning behind it.

The resultant concepts are presented and analysed in this paper. Key aspects that designers consider important in simulator tools are identified.

Keywords: Design tools · Inclusive design · Simulation · Vision impairment · Design workshops

1 Introduction

Inclusive design is "The design of mainstream products and/or services that are accessible to, and usable by, as many people as reasonably possible … without the need for special adaptation or specialised design" [1]. The ageing population and an increasing awareness of the needs of people with disabilities has raised the importance and profile of inclusive design.

Nevertheless, the uptake of inclusive design in industry is limited [2] and the use of many inclusive design methods and tools is low, particularly among graphic designers [3]. In particular, capability loss simulation is one tool with great potential to improve inclusivity, through helping designers to understand the needs of people with reduced capabilities. However, one study found that only 19% of graphic designers surveyed were even aware of such a tool, and only 10% of them used it [3].

Part of the reason for this low uptake may be a poor fit between design tools and the work processes and tool requirements of designers [4, 5].

The study reported in this paper aimed to address this by understanding more about designers' requirements for capability loss simulation tools. The study was part of a

wider project [6]. Previous parts of the project found a lack of awareness of simulator tools, poor communication between clients and designers regarding visual accessibility, and a preference for a software tool [3, 7].

The current study focuses on understanding graphic designers' own perspectives on the design problem. It used design workshops in which the designers created concepts for vision loss simulation tools. In doing so, it aimed to identify key aspects that designers themselves considered important in such tools.

2   Background

2.1   Capability Loss Simulation

Capability loss simulators are a type of inclusive design tool. They give designers a brief personal experience of some of the functional effects of capability loss [8, 9] and thus help them to understand and empathise with the challenges faced by people with capability loss. Simulators can take the form of equipment that restricts one's motor or sensory capability, such as body suits [10] or pairs of glasses [11, 12]. Software can also be used to show how things might appear to someone with a sensory impairment, e.g. [13, 14].

Capability loss simulators are not intended as a replacement for involving users, because they are limited and cannot convey the full experience of someone living with an impairment. However, they provide a useful complement to user involvement, helping designers to internalise information about capability loss and inclusive design. They can also be used when examining products and prototypes, providing initial usability feedback before designs are taken to users.

There is a limited amount of research that evaluates existing visual capability loss simulator tools in terms of designers' needs. Dong et al. [15] evaluated a range of tools including the Cambridge Simulation Glasses and the Inclusive Design Simulation Software [13]. She identified that designers had a number of requirements not currently met by the tools such as the need for more up-to-date case studies.

In addition to this, Cardoso [16] identified that simulator tools must give the designer the ability to calculate population exclusion, be easily adjusted to the user, and include the separation of specific medical conditions of the eye. He concluded that the simulator tools he evaluated "required further revision in order to be effectively and efficiently utilized", highlighting the need for more work in this area.

Previous parts of the current project [6, 7] also identified some requirements for capability loss simulators, particularly for graphic designers. These are summarized in Sect. 3.4.

2.2   Designers' Requirements

Other research has looked at designer's inclusive design tool requirements more generally. Nickpour and Dong [17] found that some designers had concerns that certaintools would limit their creativity and negatively impact on product aesthetics. They also identified that some barriers to inclusive design came from clients.

Recommendations for successful tools include making tools quick and easy to use, flexible, stimulating, concise, inspiring, usable and useful [15, 18].

3 Method

3.1 Overview

Five design workshops were conducted, each with one or two graphic designers. In each, the participants were given summarized requirements for simulators, based on findings from the previous studies. They were also given 15 cards describing a range of simulator concepts. Participants were asked to develop their own concept and dissemination method and explain the reasoning behind it.

Four of the workshops were held with a single graphic designer. One workshop involved two designers simultaneously, due to their time constraints. However, they each completed the exercise individually, creating two separate tool concepts.

A participatory design method was chosen because the "object of study is the tacit knowledge developed and used by those who work with technologies" [20]. It also introduces less bias than a more traditional co-design task where the input from the researcher is greater. The aim was to create a more user-centred result than the researchers would achieve if they put together a tool concept on their own based solely on previous findings.

Audio recordings were taken of each session and these were analysed using NVivo. Participants were also given the option of sketching their ideas. However, due to the time limitations of the study none of them did so, instead describing their ideas verbally.

3.2 Sample

The sample consisted of six practicing graphic designers, both freelance and working for design agencies, based in Cambridge and London. The two designers who took part in a workshop together were from the same design company. The rest of the participants did not know each other. Two of the participants had taken part in previous research.

3.3 Procedure

The workshop was piloted with three colleagues. Each workshop took no longer than an hour, and took place in the graphic designer's chosen location. It had three parts:

1. A 15-minute presentation, introducing the research area and the task the designers would do during the workshop;
2. A 30-minute design task. Participants were given prompt materials (see Sect. 3.4) and asked to develop their own concept for a simulation tool. They had access to drawing equipment and the Internet if needed;

3. A 15 min interview in which the participants explained their tool concept and justified why it would be more useful than existing simulator tools in graphic design.

The University of Cambridge granted full ethical clearance for the research.

3.4 Materials

The participants were given the following design brief:

"I would like you to come up with, and justify your own simulator tool concept, and dissemination method that you think would be useful in graphic design. You can use any of the concepts that have been presented to you, or come up with a new one. You should also use the list of requirements to justify your concept and dissemination method. This tool needs to be practical, so you must take the cost of the tool, and time taken to learn how to use it, into account. It must also work in the current graphic design industry in the UK".

The list of requirements for simulator tools was also provided. These were distilled from previous studies in the project [6, 7] and summarized as follows:

"The tool must:

– *Help graphic designers communicate the importance of visual accessibility, and explain their design decisions, to their clients;*
– *Be quick and easy to use;*
– *Be cheap or ideally free;*
– *Be easily accessible and fit into the designer's existing workflow;*
– *Be advertised to and available to graphic designers.*

The tool may also benefit from:

– *Being endorsed by charities such as the RNIB;*
– *Being easy for other stakeholders and clients to use;*
– *Explaining its limitations;*
– *Generating empathy;*
– *Being valid and reliable;*
– *Using population data;*
– *Simulating a range of impairments at a range of severities."*

Concept cards (see Fig. 1) were developed by the researchers based on existing tools and ideas discussed in previous studies. They were intended as a prompt to provide direction and context, in order to product more useful results in a limited time.

A wide range of concepts were included to help prevent participants from fixating on one particular tool type [20]. As a result, concepts varied in cost and ignored practical constraints such as access to technology. The images used were underdeveloped and simple to encourage the participants to think and to prevent fixation [21]. The participants were encouraged to use the concepts as inspiration. They could discard, select or combine concepts or develop completely new concepts, as desired.

Fig. 1. The concept cards in use in one of the design workshops

There were three concepts in each of five categories:

- **Computer based simulators:** InDesign/Adobe drop-down menu, operating system level simulation, a website where you can upload designs;
- **Simulator glasses:** simple cardboard glasses, a range of plastic glasses, LED glasses;
- **Virtual reality:** a simulated user with impairments interacting with an environment on-screen, simulated impairment in an interactive environment on-screen and virtual reality glasses;
- **Mobile phone/tablet application (app):** using the camera on the phone/tablet to simulate impairment, taking photos and then apply an impairment to them, examples of good and bad design;
- **Other methods:** viewing design from a distance, printing designs smaller than intended, a poster of good and bad practice.

4   Results

4.1   Concept 1

Concept 1 has two parts. The first part is embedded functionality in Adobe software. Various impairments at varying degrees of severity can be chosen from a dropdown menu, and simulations are then applied to designs on the computer screen. Population data is used to calculate the number of people excluded. There is also a button to print or export the simulation.

The participant felt that this would fit well into the workflow of graphic designers as they do not have to leave their normal software to use it. The population data is important as it would demonstrate to the client exactly how important it is to consider the visual capabilities of their particular target audience.

The second part of the concept is an app for mobile phones and tablets, combining all the app features suggested on the concept cards. The participant felt that this would help in client-designer communication because an app is portable and accessible to

most people. They said it *"is like a cheap version of the Google Glasses, everyone's got them [a mobile phone]… there's no barrier really to using it"* and *"it would generate empathy between the designer and the client, and get the client to think about things"*.

4.2 Concept 2

Concept 2 has three parts: embedded functionality in Adobe Systems software; integration with the Live Surface software; and a combination of apps.

The main part is a dropdown menu in the Adobe software, allowing the designer to apply a range of simulations. The designer can also click a button labelled 'statistics' which opens a website in the designer's web browser, exports the design, and carries out an analysis on it. This suggests to the designer where the problems lie and how to improve the design. It also generates statistics to show to the client, such the proportion of the population that would be excluded from being able to use the design.

The second part of the tool is based on Live Surface. This existing software exports designs from Adobe Illustrator and shows them on an item or in an environment, to give an idea of what they would look like in the 'real world'. The concept adds an additional feature to Live Surface that shows what a design would look like in this context to someone who was visually impaired.

The third part of the tool is a tablet or mobile phone app that works in real time to show the designer what the world would look like with a visual impairment, as well as allowing them to take photos and providing advice on good and bad practice. This could be used in design meetings and also to educate the designer, as it is very simple and easy to use and to transport, and it would be very cheap.

The participant explained that they would value the ability to show the client what the user would see. For example, *"you can say … the design we've got is too complicated with too many colours … If I was colour blind I would see it like this… if it [the tool concept] existed now I would definitely use it"*.

4.3 Concept 3

Concept 3 includes a dropdown menu in Adobe Systems software and an app simulating a range of impairments. The app allows the designer to take photographs of objects and designs. Simulated impairments can then be applied to the photos, and the app provides advice on how to improve the designs. The participant explained that it was important to have the app for communicating with the client, as it could show a more realistic representation of what the design would look like: *"being able to view it [a design] through a phone for instance, would be really useful"*.

The app would also be linked to the Adobe software, which would store the results. The participant explained *"I think that would be the number one way, yes, to go through Adobe"*. The Adobe software would also contain a drop-down menu with options for simulating a range of impairments, along with up-to-date population data.

4.4   Concept 4

Concept 4 is based on an existing piece of commonly used design software (such as Adobe software). This software connects to an app on a phone or tablet, which allows the designer to take photos to select colours and check if they pass a colour blindness test[1]. The participant explained *"if you could see in your window that there was an exclamation mark next to [a design] and it wasn't compliant [with accessibility requirements] then it would it came up with a remedy straight away for it. That would be perfect!"*.

The software would also contain a drop-down menu, allowing designers to apply simulations of common visual impairments to their designs. These simulations are associated with up-to-date population data.

The basic version of the software would be free and included in existing design software. Add-ons could be purchased with more information on specific impairments. There could also be a heavily simplified version aimed at school children to help them understand other people's impairments.

4.5   Concept 5

Concept 5 is an e-mail sent to all graphic designers in the UK to educate them about visual impairments and make them aware of inclusive design tools. It includes examples of good and bad designs with simulated impairments overlaid on them, and describes possible design solutions. It also contains links to purchase options for other materials, such as simulation glasses and a software plug-in.

The email would be attractively designed to encourage designers to read it and take the information in. The participant explained *"I'd like to see some sort of email come through with examples of 'this is what it looks like to a normal person', 'this is what it looks like to [someone else]', and then 'click here for your free pair of glasses'"*.

The participant emphasized that the importance of the educational aspect of this tool. It is important to affect designers' thought processes and attitudes long-term.

4.6   Concept 6

Concept 6 is a free feature in commonly used graphic design software such as Quark or InDesign. It simulates a range of impairments and allows designers to quickly check their designs. Each impairment is associated with up-to-date population data for the UK and other countries.

The participant explained that it was particularly important to simulate colour blindness. They felt that this was the impairment that designers find most difficult to understand, and they did not realise how common it was. The participant explained: *"colour blindness: I find that hard. There are certain colours you know aren't good,*

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[1] Note that a colour-blindness test on individual colours is not feasible due to the nature of colour-blindness. However, colour-blindness simulations and tests on designs as a whole are feasible and do already exist (e.g. [22, 23]).

but in my mind I don't think 'hmm this design is lacking because someone colour blind' [couldn't use it effectively]".

5   Discussion

5.1   Common Features

Five out of the six concepts were integrated with existing graphic design software, such as Adobe software, Quark and InDesign. This matches the findings from previous studies in this project [6] that indicate a preference for a software tool and the need to minimize disruption to the design process.

In addition, four of the concepts involved an app that linked in with the software. This was intended to allow designers to work in real-time and to take, save and send photos of designs. It also has the benefit of being cheap to download. Participants felt that the ability for the app to work in real-time would generate more empathy than static images. Interestingly, the need for an app was not identified in previous studies in this project. This may have been because previous participants were more fixated on either software or a wearable tool, due to the prompts that were provided.

Five of the concepts also involved presenting population data or statistics on the prevalence of the simulated impairments. Three of the participants particularly mentioned the importance of ensuring that this data was up-to-date.

5.2   Meeting Prior Requirements

The participants were presented with a list of twelve prior requirements for a simulator tool, distilled from previous work (see Sect. 3.4). Many of these requirements were met by all six concepts. These included the need for the tool to:

- Be quick and easy to use;
- Be cheap or ideally free;
- Generate empathy;
- Be valid and reliable;
- Simulate a range of impairments.

Most of the concepts also met the requirements for the tool to:

- Aid client-designer communication;
- Fit into the designer's existing workflow;
- Be advertised to and available to graphic designers;
- Use population data.

However, three of the requirements were often not met by the concepts:

- Being endorsed by charities such as the RNIB;
- Being easy for other stakeholders and clients to use;
- Explaining its limitations.

This suggests that either these requirements are less important to the graphic designers than the others, or that they are less easy to implement so that participants did not know how to go about including them. Alternatively, they may have thought that these were details that could be worked out by someone else. Further research should seek to determine the reasons for this.

5.3   Comparison with Existing Simulators

These concepts differ from many of the existing simulator tools such as wearable glasses (see Sect. 2.1). Some existing software simulators allow the designer to apply a simulated impairment on-screen to a design (e.g. [13]). However, they typically require the designer to leave their design process to access the software, as it is not embedded into a design package. This was identified as a fundamental flaw of existing tools.

5.4   Limitations

The most popular tool platforms and content may not necessarily be the most useful to include in a simulator tool. A more unusual idea might be more useful to graphic designers, yet may have only been thought of by one participant. This may be due to fixation, lack of time, or the participants' lack of knowledge. This is particularly true as, although graphic designers are creative types, they may not have any expertise in creating design tools or software.

One example of a more unusual idea could be the LiveSurface idea proposed in Concept 2. The idea is that the designer could export their design (such as a poster) into a simulated 'real world' so that they could see what it would look like on billboards in the street, taking into account different visual impairments, viewing distances and lighting levels etc. This idea was based on a piece of software that the participant regularly uses when specialising in logo design, however no other participants came up with this idea.

Therefore, the concepts produced in this workshop do not necessarily indicate the best formats for simulators. However, they do give an indication of what the graphic designers participating in the study could envisage working in practice. They also indicate what their priorities for such tools are.

6   Conclusions

This study used design workshops to understand more about graphic designers' perspectives on vision loss simulation tools. In the workshops, the designers produced six concepts for tools. Common features of these concepts included integration with existing design software, the ability to take photographs and apply simulations to them in real-time, perhaps through an app, and the provision of up-to-date population data on capability loss. These give an indication of the kinds of things that the graphic designers could envisage working in practice and that they consider to be important in such tools.

Most of the concepts met many of the initial set of requirements for the tools. This provides some corroborative evidence that these requirements are indeed important. These include the need for simulation tools to be quick and easy to use, cheap or free, valid and reliable, and easily available. They should also generate empathy, simulate a range of impairments, aid client-designer communication and fit into designers' existing workflow.

The concepts did not meet a few of the points listed in the initial requirements: being endorsed by charities, being easy for other stakeholders and clients to use, and including an explanation of the tool's limitations. This may be because the participants did not consider these to be important, because they thought they would be dealt with by someone else, or because they considered them too hard to implement in practice. Further research is needed to determine the underlying reasons for this.

This study indicates some avenues for the future development of simulator tools. In particular, it highlights the importance of such tools fitting in with designers' existing work processes and design software.

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