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741. Designing in Health: Developing Shared Knowledge through (Un-)Prototyping

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ABSTRACT Design and Health are two distinct disciplines that have their own way of thinking, yet they both aim to generate new knowledge. Designers do so by making things and developing prototypes that are tested in context, with the end users. The interactions that take place between the end-users and the tested prototype(s) enable knowledge to emerge about the context, the challenge, what works and what does not (Figure 1). However, the development and testing of prototype(s) in health contexts can be challenging, particularly when it involves clinical professionals who already have large demands on their time.

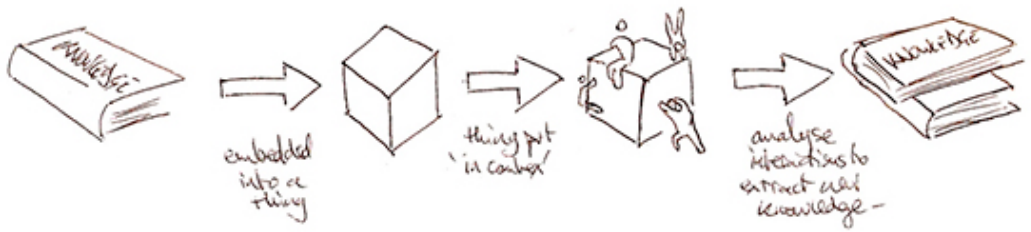

Figure 1: Generating knowledge through testing in context

To illustrate these challenges, three case studies are described. The first highlights the compromises designers make when prototyping to overcome constraints (e.g. time and financial resources) while ensuring responses from the end-users. The second case study demonstrates the role prototypes have as boundary objects to engage hard to reach end users and support them in co-design. The last case study consists of 'undesigning ideas' as a way to understand the knowledge they embed to develop prototypes. In each of the three case studies, prototypes with various degrees of fidelity were used at different stages in the design development process, for different purposes and challenges, and with a range of stakeholders.

Regardless of these differences, prototypes share a common aim: to develop new knowledge that is then embedded into the next iteration of the design development. In each of these case studies, we will share our experiences of how prototypes and prototyping can support meaningful co-design practices, eliciting and integrating the expertise of multiple stakeholder groups with the aim of promoting innovation in healthcare or for health outcomes.

Keywords: prototyping, prototypes, knowledge, levels of fidelity, engagement, participatory, co-design

Introduction

Brazilian theatre activist Augusto Boal (2004), who created the 'theatre of the oppressed,' once said:

> 'Words are emptinesses that fill the emptiness (vacuum) that exists between one human being and another. Words are lines that we carve in the sand, sounds that we sculpt in the air. We know the meaning of the word we pronounce, because we fill it with our desires, ideas and feelings, but we don't know how that word is going to be heard by each listener.'

If words are limited, it seems worthwhile investigating other ways of communicating when conducting research, especially when working with vulnerable people. Design uses prototypes and making as a means to communicate, for different purposes, which may be applicable in different contexts and/or with other disciplines, such as health. Yet, Design methodology and methods are very different from those usually applied for health. Designers' approach to developing and/or testing prototypes with key stakeholders can be challenging, especially in such a demanding context. Such challenges are illustrated through three case studies below.

Background

Design and Healthcare have two distinct ways of approaching the world and conducting research. However, Bec's thesis (2015) demonstrates the potential for these two worldviews to work together. By conducting a design-led research methodology that is highly informed by the knowledge and expertise of health professionals, novel outcomes and new knowledge were generated. In his research, Bec developed a series of games promoting physical activity and identified a range of factors to engage the target audience. In this case, the games reflected the factors identified as engaging yet the latter could be used to generate interventions to promote physical activity among this audience.

Design is different from Science and has developed its own methodology and 'designerly way of knowing, thinking and acting' (Cross 2007, p55). The fields of Health and Design research can be differentiated by their methods of interacting with the end-users (e.g. patients, hospital staff) since Design uses making as a method of inquiry. As stated by Sanders (2002), diversifying the method of investigation when interacting with the end-users leads to developing different types of (tacit) knowledge (Figure 2).

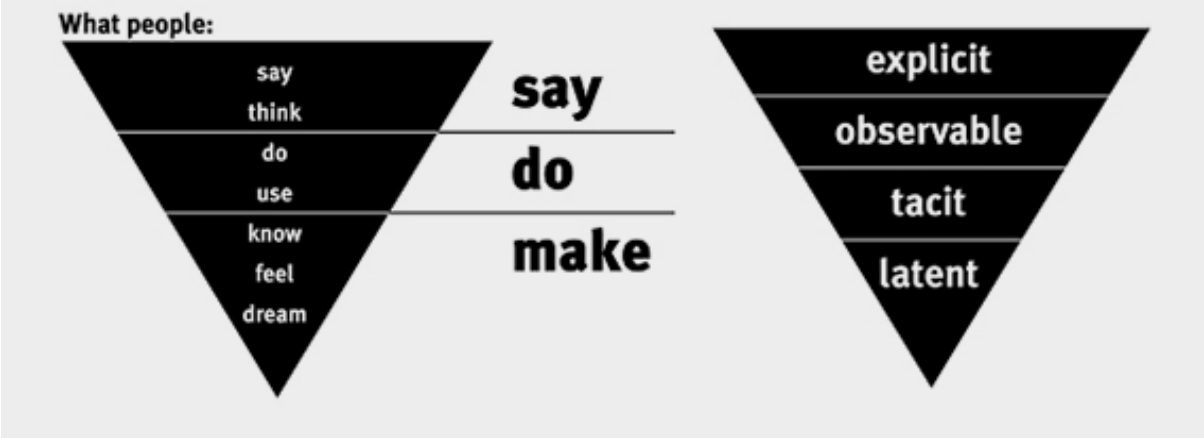

Figure 2: Different ways of inquiring reveal different types of knowledge (Sanders 2002)

Described by Bec (2012), designing through making 'things' is a way to synthesize the (tacit) knowledge gained so far and combine the theoretical and practical understanding. The understanding taking shape (i.e. the thing(s) being made) is then tested in context, with the end-users, allowing knowledge to develop. Figure 1 shows how the interactions that take place between the end-users and the thing(s) can develop insights and knowledge. That knowledge is enriched when thing(s) are tested in context iteratively.

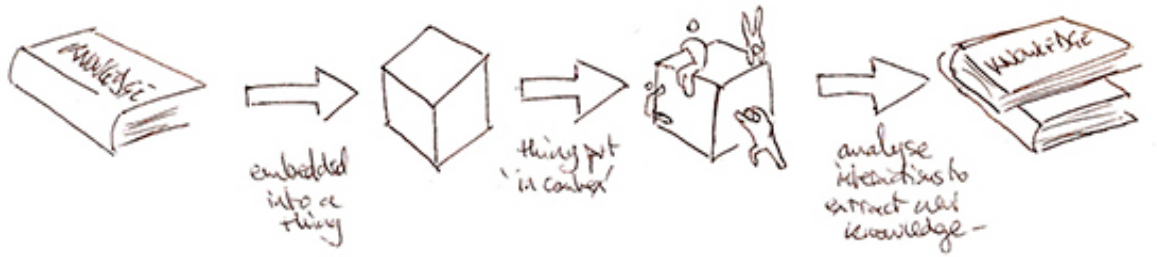

Figure 1 - Generating knowledge through testing in context

We can consequently say that 'knowledge' in Design implies making or prototyping and testing those prototypes in context, with end-users. In the context of this paper, a ‘prototype’ can be defined as the representation of an idea or a concept using a medium of communication that is either in 2D (e.g. drawings, visuals) or in 3D (e.g. tangible artefacts or objects).

It is crucial to highlight prototypes can have different levels of representation of the reality, which refers to the levels of fidelity as defined by Houde and Hill (1997). A low degree of fidelity refers to prototypes that can be very simple (e.g. using a match box to represent a computer mouse), whilst a high degree of fidelity would include more details. Choosing to create a low- or high-fidelity prototype depends on the audience and on its purpose. Houde and Hill (1997) explains there are three main aspects prototypes can cover: the ‘role’ (function of an artefact in the users' life), the ‘look and feel’ (sensory experience of using an artefact), and the ‘implementation’ (techniques and components). They suggest a number of prototypes are created to explore the three aspects

independently, then an 'integration' prototype (Houde and Hill, 1997) is built (after a number of iterations) as a way to synthesize those three prototypes.

Case Studies Description and Findings

This paper outlines three case studies in which prototypes of different fidelities were used to enhance the designer's understanding about the potential or effectiveness of the imagined solution among the end-users. In each case study, the designer was part of a wider multi-disciplinary team composed at least one person from a health background (e.g. research nurse).

Case Study 1: Prototyping with High-Fidelity to Engage

The first case study (CS1) describes the main author's PhD study entitled 'Using design-research methodology and games to promote physical activity among adolescents'. This research comprised a series of three interventions in secondary schools in Sheffield (UK). The first intervention explored participants' tastes and preferences to imagine solutions (games promoting physical activity) that would fit the end-users' profile and lifestyle. After analysing the data, an imagined solution was developed and tested through a second intervention. Using feedback obtained from the second intervention, an integration prototype was created and tested across a third intervention. In the context of this paper, we will focus on prototyping at two stages within the development of the games: 1) when testing the concept of the imagined game throughout the second intervention; and 2) when developing an integration prototype to test in the third intervention.

1. The aim of the user-centred intervention was to clarify what the imagined solution might be (in this case, a game concept) and what the solution might look like to ensure engagement. The key here was to create a series of activities that would be of a high enough fidelity to sufficiently engage the target audience, whilst also using minimum resources. Therefore, a series of workshops taking the shape of 'micro-experiments' was conducted to find out how engaging the concept of the imagined game might be (e.g. types of games, duration) before creating an integration prototype. To inform the design of the integration prototype, participants were engaged in 'Saying' (through focus group discussions), in 'Doing' (playing existing games) and in 'Making' (creating their own game). These activities were facilitated by testing existing games (which therefore have high levels of fidelity) to explore graphics, game mechanics, and style. These existing games were used as stimulus to investigate the three aspects named by Houde and Hill about each component of the game. The micro-experiments in this context are seen as a range of activities (i.e. focus group discussion, play testing, creative) led to inform the design development of the game, not to find similarities in the results.

2. Following the data analysis of the intervention described previously, the designer developed a component of the integration prototype of the game (i.e. the currency

dispenser). Based on the knowledge built until then, an 'ideal currency dispenser' was created (left on Figure 3). This 'ideal currency dispenser' was manufactured in plastic (ABS) using a 3D printer to design a dispenser that is robust enough to be carried around and to limit cheating. However, this ideal prototype was expensive and slow to manufacture, raising issues for delivering the right amount of boxes (one per player and fifteen players) in time for testing. A more affordable prototype was therefore created (right in Figure 3). Therefore, only the core system (i.e. buttons with beads) was manufactured on the rapid prototype and inserted into a card-board box, which considerably reduced cost and manufacturing time.

Figure 3 – Reducing the cost of manufacturing the currency dispenser

Case Study 2: Prototyping with High-Fidelity to Communicate Effectively

CS2 is a project that took place in a northern city in the United Kingdom which explored ways to improve the experience of people going through treatment for a heart attack, from admission to the hospital through to receiving rehabilitation after discharge. A series of six co-design workshops were conducted, involving a mix of staff from the local cardiac ward and participants who had experienced a heart attack. A total of six participants attended the workshops; four patients and two patient representatives from the Public and Patient Involvement group - shortages on the ward meant no staff could attend many of the workshops. Despite this, the ideas developed throughout these co-design workshops were aimed at both the patients and the ward staff. For this paper, we will focus on an idea for a booklet developed for the staff and to facilitate their interactions with patients. The designer iteratively developed two integration prototypes at different levels of fidelity which were introduced to the ward staff to elicit their feedback. This input from staff was used to modify and refine the prototypes further.

In CS2, the co-design activities led to the development of an information booklet concept. The booklet was to be used by the staff as a guide to provide the right information at the right time in the healthcare process. Since this booklet was imagined by the patients, it was crucial to also gather feedback from the staff. The booklet was made of A3 pages that were printed in colour on a normal paper (80g) and inserted into a coloured A4 folder sourced from an office supplier. As a first integration prototype, it was the first time that the data generated throughout all the workshops was put together, yet further information was needed. Since no members of staff attended the workshops, the team went to the ward to look for staff members during their working hours to introduce the prototype and receive feedback from them. After leaving the booklet in the staff room for four weeks, the design team found that only a few (superficial) responses had been gathered. Based on the feedback gathered from both patients and staff, the designer developed a higher-fidelity prototype (with more refined visuals, better quality paper and a new custom binding for removable pages). When this prototype was re-presented to the staff members, feedback was very positive, highlighting the huge potential for this booklet and its application to other scenarios (e.g. in the ward or other hospitals). As such, this example highlights the need for careful consideration of prototype fidelity when creating mock-ups and prototypes, as the people testing them may not share the designer's imagination of 'what could be.'

Case Study 3: (Un)Prototyping to Develop (Tacit) Knowledge

CS3 concerns people diagnosed with neutropenic sepsis, a life-threatening complication that can develop following the treatment of a cancer. There is a need for patients identified with neutropenic sepsis to self-assess a range of symptoms they might have on a daily basis (e.g. rise of temperature combined with increased tiredness) and to report them to their health professional. Some preliminary research was conducted prior to the design team joining the project, which defined its scope as to ensure the self-assessment and reporting by the patients of the symptoms described above. Then the multidisciplinary design team has facilitated a series of on-going workshops, four having been completed to date. Two patients diagnosed with neutropenic sepsis were involved in the first workshop along with a core team of four nurses specialized in cancer services, who were the only participants involved in the following workshops. The first workshop triggered ideas among the nurses, and the role of the design team was to structure these ideas and develop prototypes to test in context, with the future end-users.

CS3 was different from the two previous cases since in this project, the participants (nurses) were generating concepts through brainstorming/ideation activities, the idea being that the designer would create an integration prototype(s) by the end of the project. Throughout the workshops the facilitators used 2D visuals to explore the three aspects an integration prototype must cover (i.e. 'role', 'look and feel', 'implementation'). However, the participants often developed new ideas without really understanding the reason(s) behind each idea. Facilitators therefore used a series of tools and frameworks (see 'COM-B' from Michie et al. 2011), to better understand the core message(s) and purpose around each idea. This led to realising that some ideas such a 'welcoming chemo box' was not created for clinical reasons, but more as an empathic tool or a 'nice gesture'

given by the staff to patients when diagnosed with neutropenic sepsis. Facilitators had to deconstruct each idea generated by the participants to better understand the meaning behind them. Un-prototyping the prototypes was becoming a way to develop understanding of the requirements and problem(s) to build an integration prototype(s).

Discussion

Throughout these case studies, interesting aspects are raised about prototyping and the use of prototypes to develop understanding and knowledge.

CS2 suggests the (integration) prototypes created (of the booklet) and left in the staff room acted as 'boundary objects', a term used in knowledge mobilisation to describe the transfer of knowledge, in this case embedded into a booklet. Often, designers (especially in the early stages of prototyping) tend to be in the field to develop a full understanding about how users react to the prototype(s) (see Figure 2). This relates to Archer who posits it is crucial to:

> 'have a comprehensive knowledge of the primary sources' (Archer 1995, 8).

Being part of the primary research is therefore a way for designers to gather and use the (tacit) knowledge developed in the field to create the next prototype(s) version. However, due to time and human resource constraints (e.g. involving clinical staff who have many demands on their time), this is not always possible. It is crucial for designers to find ways to engage those giving feedback, one aspect of which is consideration of the level of fidelity of the prototype(s) to ensure the feedback given informs the design of the following iteration.

As mentioned previously, the prototype(s) presented to users don't always represent the vision designers have in mind. Even if the prototype(s) do(es), users might not be able to create the leap between what is presented to them and the designer's vision. This is partly due to the (tacit) knowledge developed up until that point in the design development process and combined with a process of imagining what the world might be rather than what the world currently is (more specific to health research). It is therefore useful to diversify ways of communicating and/or to have faith in what is being created. For instance, prototyping an idea at a low level of fidelity might receive little or negative feedback when the same idea prototyped at a higher level might be received much more positively.

Hence in certain situations designers may have to find creative ways of engaging participants to ensure gathering feedback. This is particularly true when testing an idea early in the design development process. There is a need to evaluate how viable and engaging a concept might be without having to develop an integration prototype that demands higher budget and time. As presented in CS1, one way to do so is through hacking existing products (here games) to get a sense of effectiveness without relying on high resources. Depending on the context, the use of physical objects can be used creatively by designers to reach the aim(s) set, yet as presented in Bec (2015) this creativity can also be applied when developing methods to interact with participants in

co-design activities (e.g. use of playful tools such as dice to engage participants in generating ideas/giving feedback).

The outcomes in user-centred interventions are therefore highly influenced by the designers, whether their role is to facilitate (end-users led) or to design (designer-led). Even in CS2, where end-users are the main driver to designing an outcome, the designer still has a lot of influence in the project, whether it is about planning the workshops activities, facilitating them (e.g. use of drawing to visualize the discussion taking place between participants), analysing the data coming out from them, or prototyping. As CS3 demonstrates, prototypes embed a form of knowledge, whether they are created by the designers or the participants. The visual and/or tangible nature of prototypes enhances participants' reaction to them (e.g. genuine, instant reaction or discussion) and therefore engagement, as discussed by Kelley (2012), IDEO founder.

Conclusion

Making and developing prototypes is inherent in Design. Visual and tangible prototypes allow a range of stakeholders to communicate in an engaging manner. They therefore seem particularly suited when applied in multidisciplinary projects, especially health-related. Prototypes replace the written or spoken language that is traditionally used to communicate and it is from that perspective that they become powerful, as an alternative language to develop understanding and knowledge.

There are different degrees of fidelity (varying from low to high) to take into consideration when developing prototypes based on the outcome wanted and at what stage in the design development process the prototypes are used (e.g. getting feedback about a concept vs an integration prototype). Furthermore, designers must take into consideration the various forms of resources available (e.g. human, financial, technological). Therefore, designers must make compromises between the availability of these resources and the level of fidelity of the prototype(s) to promote engagement and meaningful feedback from the stakeholders involved.

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