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The significance of secondary user experience when designing for medical diagnostics

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Abstract

Products within the category medical diagnostic equipment have a hierarchy of users, each with their own needs and experiences with the product. Hypothesising that the patients are neglected in the design process of these products, this article explores if this is so and if they should be given more consideration. User experience goes beyond usability, and there is no fixed template or predetermined solution for 'good user experience'. The patient user experience includes their own direct experience with the product as well as the co-experience with the radiographer or other medical professional. In addition, the patient has a transferred experience from the radiographer's direct experience. When designing for medical diagnostics all these aspects need to be considered in order to elevate today's solutions and get higher quality results, better work environments and an overall better experience for the patients.
Mammography is used as a case in this article because of the interesting dynamics between the radiographer and the woman undergoing the examination, and their respective user experiences. The findings from this case are transferrable to other diagnostic equipment.

Keywords: User experience, secondary user, product design, mammography

1 Introduction

User experience (UX) is most often discussed in relation to interaction- or service design. (Alben, 1996; Gabriel-Petit, 2016; Standard, 2010) However, the methodology of UX-design can in many cases be transferred to conventional product design, bringing with it a valuable perspective on users and their interaction with the product. In the medical field, particularly in medical diagnostics, there is a hierarchy of users with distinct experiences. Hypothesising that the patients are neglected in the design process, this article explores if this is the case, and if they should be considered more important. The goal of this article is to raise designers' consciousness of the patient's user experience in the design process of medical diagnostic equipment. As user-centred design becomes more or less mandatory in governmental acquisitions, this subject is very much relevant for designers intending to design products for the medical field.

Early in the design process, one of the most important tasks is to identify stakeholders, or users of a product (Rogers, Sharp, & Preece, 2011). It is important to know who they are, their needs, and their motives when interacting with the product. Many products have more than one user, and when this occurs, it is natural to want to differentiate between them and emphasise some more than others. When considering the design of diagnostic equipment users can be categorised as primary, secondary or tertiary users (Eason, 1987). Primary users are the medical professionals that operate the diagnostic equipment, whether they be radiographers, nurses or physicians. They are the users in direct contact with the product, and have a prolonged and repeated interaction with it. Secondary users are the people who are being examined, the patients. Their interaction with the product is passive, with limited control over it. Tertiary users are department heads or people in charge of acquisition, they are not in contact with the product at all, but they do have deciding power and an interest in the quality of the product.

1.1 User experience and product design

User experience (UX) has been an important aspect of Human-Computer Interaction for many years, but it is perceived as being separate from traditional product design (Baskinger, 2010). There are however many concepts in UX that are transferable, regardless of whether the product contains a computer or not. When deciding which users to take into consideration in the design process, looking at how their user experiences differ could be a valuable basis for evaluating their importance in the design.

1.2 Why mammography?

Breast cancer is the form of cancer that affects the most women in Norway, with more than 3000 new cases in 2013 alone. Mammography, that is x-ray imaging of the breast in compression, is regarded as the best way to screen for breast cancer in women without symptoms of the disease. The Norwegian mammography screening programme was initiated in 1996 and was fully instituted across the country in 2005. This programme invites all women between 50 and 69 to a biannual mammography examination. Research pertaining to the examination itself is mostly focused on getting accurate pictures, which of course is the most important aspect of mammography. In the screening programme alone there are close to 200 000 examinations per year, not including private clinics and hospitals (Aas et al., 2007). Of the examined women, 98.5 % are completely healthy, but still have to go through an emotional, painful and stressful procedure. Making improvements to their experience would therefore affect a lot of women, regardless of the results of the examination. Mammography is a clear example of a situation where there are both a primary and a secondary user, where the secondary user is virtually powerless in the interaction with the machine. Thus it is a suitable case for this article, with many interesting aspects in terms of product design and user experience.

1.3 Methods

This article is largely based on a literature review of studies regarding design methodology and -concepts, combined with articles from medical journals. Via the department of radiology in Stavanger University Hospital one of the authors got a thorough introduction to the mammography equipment and process (*Interview with radiographers at Stavanger University Hospital*, 2015), as

well as an opportunity to experience the examination first hand (*Mammography examination*, 2015). Informal and unstructured interviews were conducted with 7 participants of the Norwegian mammography programme (*Interview with anonymous women from the Norwegian mammography programme*, 2015), although due to restrictions regarding privacy and the scope of the project these participants were all women previously acquainted with one of the authors.
The term patient in this article is used cautiously, and avoided in the case of mammography. Most of the women are completely healthy and should not be pathologised. There are men who undergo mammography examinations, though this is extremely rare (Brystkreftforeningen, 2015), so the term woman is used when referring to the examined person in order to avoid confusion when talking about the different users.

2 User Experience

2.1 A brief overview on user experience

Many have tried to define UX, with varying degree of success. The ISO-standard ISO 9241-210 defines it as 'a person's perceptions and responses resulting from the use and/or anticipated use of a product, system or service' (Standard, 2010). The originator of the term, Donald Norman, offers a similar definition: 'User experience encompasses all aspects of the end-user's interaction with the company, its services, and its products' (Nielsen & Norman, 2015). According to Marc Hassenzahl (Hassenzahl, 2008) this is hardly helpful, as 'all aspects' can be defined by convenience and 'desirability' is forever subjective and elusive. His definition is: '[UX is] a momentary, primarily evaluative feeling (good-bad) while interacting with a product or a service'. (Hassenzahl, 2008, p. 12) This results in several challenges when it comes to evaluating a design, as it is extremely difficult to read a user's mind while interacting with a product, and there are many potential sources of error. Hassenzahl goes on to expand his definition by including so-called 'be-goals' – basic human needs that when fulfilled in interaction with technology, will make the user attach hedonic attributes to the product. 'Good UX is the consequence of fulfilling the human needs for autonomy, competency, stimulation (self-oriented), relatedness and popularity (others-oriented) through interacting with the product or service. Pragmatic quality facilitates the potential fulfilment of be-goals.' In short, usability is merely a tool that makes it more likely for these needs to be fulfilled – not the end goal. This definition underlines the complexity of user experience (Desmet & Hekkert, 2007), there is no fixed template or predetermined solution.

2.2 The secondary user experience

Easons definition of users (Eason, 1987) has been widely used by designers to define the stakeholders of a product, and is the basis for the definition used in this article. Traditionally, the primary users have become the focus when designing, whether it be products, user interfaces or services. However, there are those who believe that the secondary user experience needs more attention. Alsos and Svanæs (Alsos & Svanæs, 2011, p. 86) define the secondary user experience as '[…] part of the overall experience of the secondary user that can be attributed to (1) the primary user's interaction with the system, or (2) the secondary user's interaction with the system, with the primary user as an intermediary.'. This refers to a system, but is of course also applicable to products, as long as there is some sort of interactive element. Their research showed that even when the secondary user had no direct contact with the system, the secondary user had a definite user experience based on the actions and perceived experience of the primary user. They expand

on Eason's definition of the secondary user and define it more clearly, though in terms of Human Computer Interaction (HCI). In their definition, the secondary user does not interact with the system, but with the primary user. They rely on the primary user to obtain information from the system, and are influenced by the primary user's experience. But in a medical diagnostic setting, this definition falls short. The secondary users have their own, distinct interaction with the equipment, as well as an interaction with the primary user. As Alsos and Svanæs' research indicates that the secondary user has a user experience even without a direct interaction with the system, it is clear that the secondary user experience is a composition of experiences.

2.3 The importance of the secondary user experience in a medical diagnostic setting

In a medical diagnostic setting the primary user uses the equipment, and the equipment 'uses' the secondary user in order to produce results. By Eason's definition, the medical professionals are the primary users, as they operate and use this equipment every day. But the patients have an experience with the equipment as well, an experience that is very much affected by their emotions and their interaction with the primary user. In a study conducted by Montague (Montague, 2009) twenty-five women were interviewed about their experience with foetal monitoring systems during child birth. The experience turned out to be composited of both positive and negative feelings related to the machine, but definitely constituting a user experience with the machine even as passive users.

Another example of a secondary user experience that most people can relate to is in odontology – going to see the dentist. The equipment is designed to perform a specific function and to be usable for the dentist, but can in many cases seem intimidating to the patient and result in a perception of greater pain and discomfort. In studies pertaining to dental fear and anxiety, the sight, smell and sound of the dental equipment has been stated as a significant factor (Kleinknecht, et. al. 1973). This means that the visual, olfactory and auditory aspects of a design can influence the user experience.

There are many products within the medical field where the secondary user experience could be an issue – but in the field of diagnostics it is always an issue. In MRI, CT or ultrasound scans, in visual or auditory tests, or in mammography or other x-ray examinations: there is always a primary user and a secondary user, where the latter is subjected to an examination via diagnostic equipment.

3 The case of mammography

The mammography machine consists of a radiation source, a transparent compression pad and a detector, which is imbedded in the plate where the breast is placed. See figure 1. The radiographer can control the height of the machine and the amount of compression, while feeling the woman's breast to ensure sufficient compression before they expose the breast to radiation and produce a digital image. See figure 2. The basic design of the machine has been largely unchanged over the years. The radiation source has undergone some innovation, gradually reducing exposure time and radiation dosage. With the switch to digital imaging, the detector changed accordingly, but visually it is quite similar to the older machines.

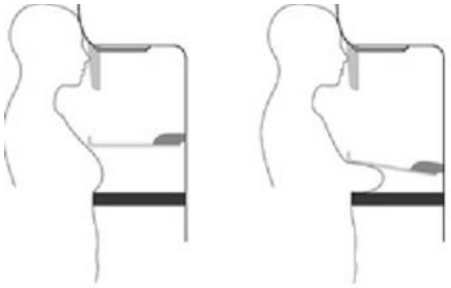

Figure 1 Mammography procedure

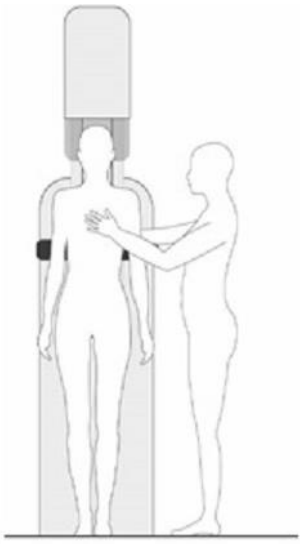

Figure 2 The radiographer assists the woman in positioning

The primary users of the mammography machine, the radiographers, have seen incremental improvements to the design over the past couple of years. This includes easier, step less height adjustment, foot pedals for pressure adjustment and better visual feedback. There have also been changes meant to improve the experience for the secondary users, mainly rounded edges to the pressure plates and automatic release of the pressure once the exposure is finished. The material of the detector plate has also been changed to become more thermally comfortable.
In introducing tomosynthesis, an imaging technique that produces 3D images of the breast by taking multiple images at different angles, there were additional changes to the specs of the machines. Some producers merely adapted the 2D-machines, with mixed results – making some machines very impractical for the radiographer and others that would need more than twenty seconds in order to complete the image, twenty seconds of continual compression and discomfort for the woman. Others can produce 3D images in a matter of 3 – 5 seconds. As such there are significant differences from manufacturer to manufacturer.

3.1 The user experience of mammography

Women participating in the mammography screening programme for the first time report feeling anxious, insecure, and as if they're 'part of a production line' (*Interview with anonymous women from the Norwegian mammography programme*, 2015; Solbjør, Skolbekken, Østerlie, & Forsmo, 2015). The radiographers have a responsibility for keeping the schedule and ensure efficiency, while the participating women have a need for information and reassurance. This is a challenging environment for a design, with many negative associations to compete with even before the users have made contact with the machine.
In open-ended conversations of one author with women participating in the Norwegian mammography programme (*Interview with anonymous women from the Norwegian mammography programme*, 2015) it was commented that the worst part of the examination is not the compression itself, but rather the indignity of having to 'tuck in the stomach', 'turn your head', 'push out your rear', etc. Some report having to stay in extremely uncomfortable poses for a long time, re-

sulting in cricks and aches. This is part of the experience that relies heavily on the skill of the radiographer, both in communicating and guiding the woman.

Trust is an important part of the mammography experience (Solbjør, 2008), as many of the women participating are very vulnerable and anxious. The trust is twofold – trust in the machine, and trust in the interpretation of the pictures. Women seem to have more worries about the machine than the medical expertise of the personnel, questioning the quality of the pictures. They doubt that the machine can manage to get the complete picture, as surely there must be parts of the breast that it can't depict (Solbjør, 2008). Radiographers confirm that the woman's state of mind greatly influences the procedure, and state that if a woman is tense they might need to increase the pressure by as much as fifteen percent in order to get decent pictures. (*Interview with radiographers at Stavanger University Hospital*, 2015)

The experience of pain during the procedure has been explored in many studies, with extremely variable results. While some state that only 1% (Stomper et al., 1988) experience pain, others give a figure of up to 85% (Kornguth, Keefe, & Conaway, 1996). Several reasons for this has been suggested, mostly that the design of the study and the scale that the participants use to rate the pain will greatly affect the outcome. It is generally agreed that the number probably resides between 50 – 60% (Sapir, Patlas, Strano, Hadas-Halpern, & Cherny, 2003). The aforementioned women from the Norwegian mammography programme (*Interview with anonymous women from the Norwegian mammography programme*, 2015) disagreed on how painful it was, with descriptions varying from "a bit uncomfortable" to "almost comparable to child birth". When undergoing the procedure herself (*Mammography examination*, 2015), one of the authors was surprised to experience hardly any pain at all.

Qualitative studies have shown that most first-time mammography participants have heard a lot of 'horror-stories' from their friends and relatives, and that this, in combination with the radiographer's demeanour and lack of information beforehand, probably makes the experience more painful and uncomfortable than it would otherwise be (Robinson, Hogg, & Newton-Hughes, 2013). Interestingly, in the same study the women report that the design of the equipment was a source of the pain. The machine was described as 'cold, hard, solid, with sharp edges', and that the position they were to maintain caused them discomfort. The study also suggests that the design of the machine makes the women feel powerless and subordinated, and calls for a redesign of the equipment with a focus on rebalancing the power back towards them.

A product manager of mammography equipment from one of the world's leading manufacturers (*Interview with anonymous employee at leading mammography manufacturer*, 2015) has admitted that they do not really take the woman's view into account in the design process[1]. If they happen to change elements to benefit the women it is more of an afterthought than a conscious design decision, harsh though that may seem. The reason for this is that the radiographers are the primary users of their product and the only ones who are included in the design process.

[1] Due to confidentiality considerations, the name and company of this source is omitted.

3.2 The radiographer

The perceived discomfort of the mammography examination seems to be alleviated by verbal information from the radiographer prior to the procedure (Shrestha & Poulos, 2001), especially with women who have never undergone the procedure before. Radiographers have different ways of communicating with their patients, and usually try to adapt their approach to their assessment of the patient (Booth, 2008). The radiographer's personality and confidence play an important part in the radiographer-patient interaction, but pressure from the department and the need for a good diagnostic image also influences it. As such, it is near to impossible to guarantee that the information given and the chemistry between the woman and the radiographer is satisfactory.

4 Discussion

In the context of medical diagnostics, it is necessary to expand Alsos and Svanæs' definition of the secondary user experience to include a third aspect: the secondary user's direct contact with the system. This contact may be less extensive than the primary user's, but it is consequently affected by the secondary user's lack of control and experience with the product. This makes the direct user experience of the secondary user even more fragile and justifies dedicated design consideration. But there are more aspects to the secondary user experience than just the direct contact with the product. The secondary user experience can be considered as three different experiences (see figure 3).

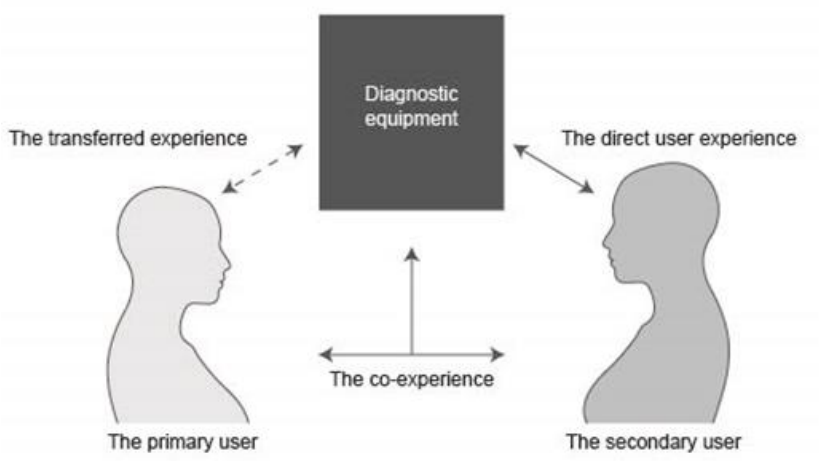

Figure 3 The secondary user experience comprises three different experiences

In addition to the direct user experience, there is also the experience that derives from the contact with the primary user: the co-experience that involves their communication and interaction with each other as well as the product. A third experience is hereby introduced: a transferred experience from the primary user, which means that if the primary user experiences problems or frustrations, this will affect the way the secondary user experiences the situation. When considering this transferred experience, the traditional consideration of the usability for the primary user is cast in a different light. If the primary user has a negative experience due to bad design solutions, the secondary user is affected as well. This means that it is important not to neglect the primary user's needs, even if the goal is to improve the secondary user experience.

The importance of the experience of patients and other users of medical services has become increasingly in focus, and the Norwegian government emphasises it in their regulation for acquisition of health care services (Difi, 2013). This means that tertiary users – those responsible for acquiring the product, should favour products that can document their consideration for the secondary users and their experience. The increased focus on the patients and other users of medical services has become apparent ever since the National Health Care Reform in 2002, which states that it is important that the users' advice and experiences are regarded highly in both planning - and execution stages. (Veenstra, 2005)

Is this enough for designers to pay more attention to the secondary users in the design process of medical products? Maybe not. But the secondary user experience is an interesting one – particularly because it involves challenges without a given answer. Making the mammography machine ergonomically sound for the radiographer is well studied (Costa, Oliveira, Reis, Viegas, & Serranheira, 2014; Springer, 2007) and relatively straight forward to do, but how to achieve Hassenzahl's 'be-goals' for the woman undergoing the examination? It is clear that it is not possible to isolate the design to merely the machine –the entire experience has to be taken into account and designed for. This is of course transferable to almost all diagnostic equipment, whether it be an MRI examination or a vision test.

If improving the secondary user experience is not deemed a worthy cause in itself, it has direct implications for what is always the primary concern in medical diagnostics – producing accurate results. As radiographers have confirmed (*Interview with radiographers at Stavanger University Hospital*, 2015), it is much harder to get high quality images when the woman undergoing a mammogram is afraid or tense. The woman's experience is highly dependent on good communication and information from the radiographer, namely the co-experience of the situation. The radiographer's communication skills can be compromised by the need to keep the schedule and produce high quality images. Here there is a potential for a very destructive circle. A woman, who is uncomfortable, afraid or in pain, can avert a good image. In turn, a radiographer might be stressed too, and unable to reassure the woman, averting a good image herself. Relating to this context, making compromises to the design might make the operation of the equipment less practical for the radiographer, but if such a compromise improves the experience for the woman and therefore reduced her level of anxiety, the results could mean an easier process for the primary user as well. From the above, the authors of this article conclude that the term secondary user implies a distinct hierarchy of users and often the secondary users' needs indeed remain secondary. However, Eason's definition categorises the users based on the extent and/or nature of their *contact with the product* (1987). Secondary users often have extensive contact and interaction with products and services, especially in the medical sector, and here it might be beneficial for design research and practice to address this group as independent and equal stakeholders rather than secondary users.

5 Final remarks

The terms primary, secondary and tertiary users may be inappropriate in designing for medical diagnostics, but in the future the distinction may become less relevant as patients are given more freedom to choose their own treatment and affect the way the treatments work (Helsedirektoratet, 2015). Further research could include studying whether the patients' experience would improve

by being able to control the examination – letting the patient push the button, so to speak. In mammography, this could translate into controlling the compression themselves, for instance. If technology improves, it might be possible to make the secondary user into the primary, by creating "mammography stations" where the woman performs the entire examination herself. It would be interesting to discover how this would affect the perceived experience of the examination. It appears that today's political climate would encourage design for secondary users in the medical field. However, it is not clear if this is part of design practice today. In fact, there is some evidence that there is a lack of consideration for these users, at least when it comes to mammography equipment. In other diagnostic equipment, where the secondary users have even less direct interaction with the product, there are some studies (Alsos & Svanæs, 2011; Montague, 2009) that suggest that they do have a user experience, albeit a limited one, as they still have a co-experience and a transferred experience. Thus their perspective should be taken into account when designing and developing such products. It is also necessary for product designers in the medical field to include the entire experience in their design, not just the product. In this way it is possible to make a design that strives to accomplish both do-goals and be-goals for both primary and secondary users. If successful in this, medical diagnostics would be elevated and achieve higher quality results, better work situations for the professionals, and an altogether better experience for the patients.

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