Towards the use of “negative effects” in technology design and evaluation

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Negative effects of computer use are reported in different studies; but so far no standardized framework exists to work with these issues throughout a user-centred design process. “Negative effects” are the result of user, context and task characteristics and they diminish the performance, the perceived ease of use or even prevent people from using technology. In this paper we discuss different aspects and ideas in order to debate “negative effects” as origin of design and as evaluation criteria. The high-level goal of this approach is to avoid negative effects by design. This paper describes a number of basic thoughts and considerations to describe the idea of how and why “negative effects” should be considered throughout the design process.

Negative effects, design evaluation, human values in design, design methodology

1. INTRODUCTION

Different studies provide evidence that there are negative effects of technology use in reference to context of use, task and user characteristics (e.g. [3][5][15]). Negative effects can be manifold: fear, (computer) anxiety, emotional arousal and discomfort during interaction (etc.). No specific HCI methodology (e.g. a framework) dedicated to these aspects is known although these effects exist and have proven consequences on usage, user experience and perception (i.e. to consider negative effects during a user-centred design process for ideation, requirements engineering, prototyping and evaluation). Our interest in these factors emerged from our work in the area of Ambient Assisted Living (AAL), which focuses on intelligent ambient systems in the home and extended home that support users in their daily living.

The theories that inspired this work initially were Value Sensitive Design (VSD), a theory that provides a framework to support designers in designing ethically correct products, and Worth Centred Design, which suggests designing for worthwhile and meaningful outcomes. Both approaches, in different ways, address negative effects implicitly [8][11]. However, these approaches might not be sufficient to avoid negative effects at the level of use, where different negative manifestations of user experience influence or negatively affect the use of modern information technologies. Our approach aims at using negative effects such as discomfort, indicators of negative arousal, anxieties and fears as one of many factors that informs design. Thinking even further, such an approach may consider “negative effects” as a source of design ideas, design solutions

and as evaluation criteria throughout the whole design process. We are not arguing to exclude other (positive) user experience and value factors from the user-centred design process. However, we claim that a specific focus on “negative effects” might positively inform the design process and that the consideration of such effects might positively complement existing approaches. With the proposed idea we are certainly not attributing negative effects to users and their behaviours, but in contrast argue that design and HCI should be able to cope with and avoid different negative effects and their sources.

We discuss some initial thoughts and issues that seem to be relevant for a discussion of if and how “negative effects” of technology use should be part of user-centred design. With this idea we try to lay the groundwork for an enhanced perspective in this area, focusing on “what users don’t want”, what might disturb them and what negatively influences their performance or experience rather than solely on “what users want”, what they like and what brings them to ICT. The expected outcome of this approach is a sound comprehension of the issues and a balanced set of methods that can be used throughout a user-centred design process to work with such factors. In the long run we aspire to create a framework to work with negative effects in different user-centred design phases. Further, we emphasize that negative effects, discomfort, negative arousal or even anxieties and fears identified in early design stages can be used as criteria for later evaluation (= avoid negative effects) of the solutions proposed [7].

2. THE CONTEXT OF RESEARCH:

In the following part we briefly describe design issues that arose from selected projects we conducted. AAL in general is a sensitive field and needs a special consideration of negative outcomes.

Working with elder people: We are currently working on assistive and accessible systems for elderly people (e.g.: [16]). In most design cases - given by the system design and by the idea of the proposed technology - the potential positive consequences are discussed and taken into account (in design and evaluation). In contrast negative effects are often overlooked and are not considered as important (with the designers assumption: The positive effects will correct the negative ones). But in this context HCI needs to reveal and work with such insecurities, discomfort, potential negative user experiences, anxieties and fears during different design phases and evaluate against such criteria. We believe that a contrary approach that considers potential negative outcomes of technology use at the same level as positive ones could help to overcome this issue.

Talking to users during the requirement phase we noticed that we had methodical limitations when prototyping and mediating the complexity of the system and in conveying the concept of the system adequately: what it will do for users, what will it cause, not cause, how will it benefit or harm the users' idea of independent living. We do not claim that this lack of methods is a new finding. What we want to postulate is that even if positive effects were expected (or imposed by the design idea), and even as participants understood the idea of a system, in some cases we noticed that elder people felt insecurity and discomfort (reported as qualitative feedback). As far as we found out, this was not necessarily due to the information that was given to the users, but rather this negative user experience and discomfort was caused by the idea of the system or the specific design of the system. We want to tackle such observations by postulating the idea of using such “negative effects” in design in order to better pinpoint solutions to the users' needs, wants, and expectations.

3. RELATED WORK AND THEORETICAL GROUNDING

Friedman et al. introduced a design framework called Value Sensitive Design (VSD) in order to design computer systems for different involved stakeholders in an ethically correct way. Their approach is based on the fact that people have a clear value system and feel negatively aroused if their value system is harmed (privacy, security, identity, etc). They argue that this approach (and related methods) is able to

embed systems smoothly into real world settings, and computer systems would be better accepted [11][18]. In similar ways Cockton's worth maps can help to determine system constraints [8].

Fear and anxiety, as reported in [3][23][24][21], are important and diverse key terms for the researchers of technological barriers causing emotional disturbance. An early definition of computer anxiety [14] is “...a resistance to talking about computers, fear or anxiety about them, and hostile or aggressive thoughts about them.” According to Jay [14] computer anxiety includes anxiety about current or future interactions, negative global attitudes, anxiety about operating computers successfully, kinds of impact on society and/or specific negative thoughts or self-critical internal dialogues during computer interactions or when considering future computer interaction.

As stated computer anxiety does not irrevocably lead to technology denial. Computer anxiety is rather a personal issue and as well related to a person's ability to cope with particular situations of discomfort [2][23]. It is suggested that computer anxiety also refers to conceptions of self, society and culture as computer systems may be seen as cognitive and emotional disturbance [24]. Computer anxiety is seen as rather a long-lasting attribute of a person (“Trait”) and not specific to a particular situational stressor (“State”) [3]. As a result debilitating thoughts when interacting with a computer system may be caused, including self-deprecatory cognitions about one's capabilities (self-doubt) and on-task thinking [22].

A more implicit form of negative effects – in contrast to computer fear and anxiety - has been reported in different studies describing the “discomfort” caused by the social and emotional context of the application during interaction. Ramsey found that looking bad in front of others, feeling stupid asking other people for help, “bad day” feelings, negative feelings about “impossible tasks” and feeling tense, nervous and upset might be prevalent issues that influence interaction and performance [20]. Similar aspects as well as anxieties and discomfort have been summarized in different studies (e.g. [19]) together with the proposal of methods to measure such “affects” including bio physiological measurement methods to assess emotions, stress, fears and anxieties (e.g. [16][19][13]).

Overall, negative effects have an impact on performance and further on the level of self-efficacy [12]. Likewise it is known that computer anxiety and self-efficacy determine the levels of perceived ease of use [9]. This means that even when interacting with usable and well-defined interfaces, negative effects might diminish (the perceived) performance, user experience and the perceived ease of use of a system or interface. Likewise, context of use plays

a role in different scenarios. Social psychology reports performance-decreasing effects, caused by so-called “social loafing”. This phenomenon describes people’s decreasing performance in situations where they are acting anonymously in a group of people. “Social facilitation” describes a situation in which people perform worse under social surveillance when doing a complex task [1]. Different studies report negative effects due to social context of computers. E.g.: Bratteberg and Kristoffersen showed the negative effects of the context of public ticketing terminals creating feelings like incapableness and helplessness [5]. Summarizing, VSD frameworks and methods allow to head in the direction of “negative effects” but still provide no particular methodological framework for the issue of prototyping and evaluating value (or emerging negative effects). Computer fear and anxiety has been studied, but more from a “psychological” point of view, so far without a closer consideration in HCI design processes. Discomfort and contextual issues have been reported and methods in the area of “affective computing” allow HCI practitioners to measure “negative effects”. Though literature shows that negative aspects of computer use have been recognized and tackled in design and evaluation phases we still see a need for a more consolidated view that summarized all these different negative aspects. This would allow us to consider and evaluate “negative effects” and what “users don’t want”, their discomfort and insecurities throughout the entire design process (and use it as evaluation criteria).

4. USE IN HCI, DESIGN AND EVALUATION: INITIAL THOUGHTS

Related work shows a need for a consolidated view to cope with different negative effects during design and evaluation phases. Two different levels are identified, in reference to related work and to the example studies presented: the level of “macro use” and “micro use”. “Macro use” refers to the functionality, the meaning of computer systems. It describes what computer systems do or not do and which features the system provides to its users. “Micro use” refers to how the features of the systems are designed in detail and presented to its users. Basically “micro use” describes negative effects that diminish the perceived ease of use, the perceived self-efficacy and the performance. In general we see three different usage phases where negative effects might occur (see Table 1): Pre-usage: refers to negative effects arising even before using a system (“what will this thing do?”), Usage phase: negative effects that arise during system usage, and Post-usage: negative consequences emerging from former system usage (“What are the consequences

of use?”).

Our aim is to use existing and introduce new methods and approaches that are able to support HCI practitioners in uncovering, preventing (by means of design) and evaluating negative effects at different stages and levels through out the whole design process. Table 1 describes a rough idea of the possible consequences and impact of “negative effects” for each of the different levels of use and usage phases - without claiming completeness.

Table 1: Negative effects on a Macro and Micro Level

	Pre-usage	Usage	Post-Usage
Macro Use	Computer denial (no usage at all)	Value harm or negative effect due to system features	Expected negative consequence of computer use
Micro Use	Feature denial (partial or decreased usage)	Decreasing self-efficacy and performance	Expected negative consequence of feature use

In the following section we discuss current approaches and methods, which can be fruitfully applied to work with negative effects in the following four domains: (i) Value (ii) Context (iii) User and (iv) Task. We refer to the level of use and the different phases defined in Table 1. We argue to discuss these methods in order to apply and use these during a user-centred design process. There might be more methods and approaches toward measuring (negative) emotions and (negative) affective reaction to computer systems and their features. However, with this overview we want to better underline our research idea without claiming completeness.

4.1 Value Harms and negative effects on a macro level

To comply with the macro level of use, value harms need to be identified. VSD [11] and particularly the value dams and flows method presented by Miller et al. [18] can be used. Likewise worth maps by Cockton can be applied to consider “adverse outcomes” of computer systems [8]. However, methods to prototype and evaluate against value harms and the resulting negative effects on design level (micro-level) are not available yet. We believe that aesthetics and emotional factors, as well as cultural background and collected social experience play a major role in this “negative macro effects”. Such methods would help to foresee the “consequences of computer use” on a macro level.

4.2 Negative effects caused by Context of use (micro level)

As discussed, studies show that context may

strongly influence the experience of negative effects. In this way user research should head towards understanding possible (temporary) emotional states of the users in the context of use. Different emotional states and traits as well as contextual situations need to be considered. A major challenge might be the identification of these states, which are rather system independent and might apply to one situation but not to another – thus to a changing context. In this area the idea of “user experience trajectories” by Benford [4] brings in the notion of variable, but well-defined (or guided) user paths through interaction. Such “trajectories” should be able to cope and consider negative effects caused by contextual situations.

4.3 Uncovering user-related negative effects (micro and macro level)

Anxiety-related questionnaires could be applied (e.g. CIM-CA). This method accentuates the important role of state computer anxiety reactions independent of trait computer anxiety [22]. These questionnaires, in general, deal with task and processing efficacy and effectiveness and give a better insight into the user group in terms of negative effects. In addition methods that explore the computer attitude of the target group should be part of analysis. HCI needs to look into (social) psychology and look up for coping strategies in reference to anxiety and discomfort. The challenge is to convert these face-to-face techniques into effective HCI approaches, which are rather system-to-user approaches. When working with users a new quality of methods needs to be introduced: Methods that allow HCI practitioners to uncover and evaluate negative effects. To be clear: By no means do we argue that negative effects of computer use are attributable to users, their limitations or their specific needs or attitudes. Rather, we argue that system design should be aware of user characteristics in order to avoid negative effects by design.

4.4 Task related negative effects (micro level)

Task and goal analysis should inform designers about the requirements for the micro level of use. Users’ discomfort and performance reduction caused by specific actions and task or system solutions need to be analyzed. It is important to be informed if a task is perceived as simple or complex - as this might have an effect on the performance dependent on the (social) context of use [1] – as one example of one possible reason from many in this area. Likewise, affective computing methods can help in this area and are good tools for task related emotional analysis [16][19][13].

5. CONCLUSION

HCI can fulfil its part to overcome negative effects of technology use. We believe that “negative effects” can be a source of design solutions – in AAL but also in many other sensible design areas, especially in areas where users have little IT knowhow and special (accessibility) needs. Designers need to know what users dislike, what they don’t want, or what possibly diminishes their performance or their perception of “ease of use” in order to come up with a broader understanding of design. We do not argue that such an approach should substitute approaches that focus on factors like fun, playfulness, entertainment, etc. We argue that both, negative effects and positive effects need to be considered in an orchestrated way. This is true for AAL but for many other areas as well. We further believe that “negative effects” need to be used as evaluation criteria at different design phases in order to assess if the particular design solution needs to avoid these negative factors. Therefore there is an overall need to identify and evaluate negative effects at different stages of the design process (and use it as evaluation criteria). We see this discussion as an initial idea and a basis for discussion (with open issues and without claiming to cover all possible influencing factors). Our aim in the near future is to enhance the understanding and importance of “negative effects” in design and evaluation with the overall goal to implement a framework for practical application.

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