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IDENTIFYING OPPORTUNITIES FOR THE IMPLEMENTATION OF UX DESIGN IN INDUSTRIAL GOODS DEVELOPMENT

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Abstract

The approach of designing for experience has been developed in interaction design and adopted for product design in the recent years. There are scattered efforts on bringing the approach of designing for experience (or user experience design) to the field of industrial goods. There are few companies and research institutions exploring this field. Recent research and practice focused on exploring different approaches and models of designing for experience. One particular approach of Hassenzahl and colleagues stresses the fulfilment of specific basic human needs in order to provoke positive experiences. There is a number of examples applying specific methods for evaluating or measuring product experiences. We report on current research on the transfer and adoption of particular evaluation methods to the field of industrial goods. Industrial goods development is a usually a long-term complex process with many different stakeholders. In this paper we present findings from a series of expert interviews on the current state of user participation in industrial goods development. Based on the findings, we discuss the potential for the application of UX methods in these processes.

Keywords: Design methods, Experience design, Emotional design

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1 INTRODUCTION

Technology faces radical changes: automation, growing world population and productivity limitations by reaching physical limits of machines. Cyber-physical systems (CPS), e.g. smart grids, agricultural swarm technologies and medical systems are a new generation of systems with integrated computational and physical capabilities (Baheti and Gill, 2011). A substantial increase of productivity of CPS could reached by improving the human-machine-cooperation (Geisenberger and Broy, 2012). Nowadays, designing for users in industrial product development is about anthropometrical, ergonomic and cognitive qualities of the user. In case of industrial goods as complex systems psychological aspects of the human-machine-interface become more important (Sachs et al., 1993). In interaction design and consumer goods development, the approach of designing for experience is widely used. User Experience (UX) incorporate subjective facets of human information processing like emotions, affects and experience. One particular approach of Hassenzahl and colleagues stresses the fulfilment of specific basic human needs in order to provoke positive experiences. There are examples applying specific methods for evaluating or measuring product experiences, e. g. by measuring the fulfilment of specific human needs. We report on current research on the transfer and adoption of particular evaluation methods to the field of industrial goods.
Bringing the approach of user experience to industrial product development seems to increase internal motivation, which could lead to a higher productivity. Our aim is to use the approach of User Experience and User Experience Design for understanding, measuring and designing CPS.

One of the first steps is to implement a strategic participation of users in industrial goods development. In this paper, we present findings from a series of expert interviews on the current state of user participation in industrial goods development. Based on the findings, we discuss the potential for the application of UX methods in these processes.

1.1 Approaches to Users: From Ergonomics to User Experience

Researchers and practitioners of product development have given significant attention to the relationship between humans and technology. Ergonomics has a strong history and an extensive body of applicable knowledge. Accordingly, it plays an important role in the development of many products, especially if there are complex tasks to be understood or to be used. This often applies to industrial goods, where workers have to accomplish tasks of different complexity. Fuzzy criteria such as aesthetics and appeal have been discussed and investigated for a similar period of time. By comparison, understanding and practical findings are rather limited. If aesthetics and appeal play a role in product planning and development, it often is part of broader marketing research that then informs or formulates requests for product design and development. Aesthetics and appeal have always played a minor role in industrial goods development. However, it has also a history that reaches back to steam body engines with ornamental decoration, that should attract potential buyers or make owners and users proud of their (back then) cutting-edge technology machines.
Another classical debate deals with the application of more holistic views on the human-technology relation in product development. Industrial designers stressed holistic design approaches for decades – often as contractors outside of organizational structures or also often in opposition to established engineering approaches. However, it seems that more complete views (rather than holistic ones) on human-technology relation gained acceptance in product development recently. These approaches incorporate not only traditional aspects of physiological and cognitive ergonomics. Beyond that, subjective, emotional, non-instrumental (not task-related) or hedonic aspects gain importance in product development and evaluation. This shifts the focus from functions of the machines to prerequisites, motivations, needs (Hassenzahl, 2003), affects (Scherer, 2001; Desmet and Hekkert, 2007) and emotional experiencing (cf. Hassenzahl, 2003; Thüring and Mahlke, 2007; Roto et al., 2011) of the humans interacting with technology. Many of these concepts and theories are compiled to the approaches of user experience (UX, e. g. Roto et al., 2011), product experience (Desmet and Hekkert, 2007), emotional design (Norman, 2004), experience design or designing for experience.

Hassenzahl and Tractinsky (2006) see UX as a counterpoint or a complement to usability. Usability (i. e. ergonomics) analyses objective qualities (i. e. the pragmatic dimension) of a product. These qualities can usually be investigated directly by observation, measurements or other reliable methods.
UX goes beyond usability by not only asking what and how, but also why humans interact with products (Hassenzahl, 2003). Accordingly, UX helps to widen the view to subjective qualities of human-technology relation, it offers corresponding methods to be applied in product development.
Human experiencing is seen as information processing that controls actions. As a kind of internal assessment, it is constantly, directly and usually unconsciously commenting the human's surrounding (Hassenzahl, 2008; Norman, 2004). In contrast to solely cognitive information, this process evaluates immediately and results in an affective reaction, which then influences human behaviour.
Currently, UX frameworks help for a better understanding of human-product interaction. Besides the academic discourse, there is a vivid use of particular UX methods especially for the evaluation of interactive products in industry, i. e. especially in the field of human-computer interaction or interaction design (mainly software).
UX approaches are gaining acceptance in the field of (analogue) product design for two reasons. For one, physical products are experienced based on the same (cognitive, emotional, affective) processes as software, even though there may be more influencing factors that are harder to identify, control or design. Accordingly, the application of UX approaches in physical product development may improve the user experience (by better need fulfilment, by provoking positive emotions etc.; academic examples are given by Hassenzahl, 2010). This influences the overall assessment of products, so it is relevant for users and producers as well. On the other hand, due to digitalisation of many products, there are more and more hybrids between traditional analogue products and digital applications. Where UX approaches are already established in software design, these are gradually influencing the physical parts of the products as well. Some UX evaluation methods could be easily transferred to physical products, for example Sheldon's (2001) needs scale, Hassenzahl's (2003) AttrakDiff, or Watson's (1988) Positive and Negative Affect Schedule (cf. Siwek et al. 2016). More specific UX methods such as Diefenbach's (2013) Interaction Vocabulary worked only for interactive facets of physical products, while other methods like Burmester's (2010) valence method could not be applied at all (cf. Siwek et al., 2016). While the application of UX methods offers new dimensions of product evaluation (e. g. on the fulfilment of human needs), the corresponding findings are often considered being too abstract. Also, most of the methods focus on evaluation only. Suggested methods for the definition and design of products are close to established methods of industrial design or human-centred design, accordingly there is little change in practice.

1.2 Specifics of industrial goods and CPS

Many consumer products are usually designed for a specific target group, where the same person is buying, using and maintaining the product. When there are different users or stakeholders, e. g. in a family, the differences often do not exceed the variety that is in the target group anyway.
However, many technologically complex products – where the design of human-technology interaction is of great importance – are not intended for private use. Industrial goods, like stationary machinery, trucks, industrial vehicles or medical devices, are destined for professional users in professional contexts. Industrial goods development is a usually long-term complex process with many different stakeholders. Industrial goods have various human-technology relations. Most often, the actual user (i. e. worker) has not decided to buy a particular industrial good. Often she/he has even not decided to use it. Industrial goods are often bought by buying committees (in larger companies) or by owners or managers. In addition to that, there may be differently educated maintenance staff or customers who experience or interact with the industrial good. Accordingly, there are different stakeholders who may differently experience the same industrial good (cf. Olbrich et al., 2013). Contexts, time, competences or motivations of human-product interaction are only few factors that complicate an *ad-hoc* transfer of UX methods to industrial goods development. If all humans potentially experiencing an industrial good should be considered with all their specific needs, this would be an ambitious agenda for any product development process. Accordingly, there seems to be no UX approach or methodology that fits industrial goods development.
As yet, UX research focuses mainly on consumer goods and digital products (cf. Bargas-Avila and Hornbæk, 2011). Recent studies on UX in professional contexts (i. e. with industrial goods) focus on

software interfaces (Lu und Roto, 2015; Kaasinen et al., 2015; Rissanen et al., 2011; Burmester et al., 2015).
Currently, industrial goods are mainly being developed based on objective conceptions of man and their anthropometric and rational-cognitive dimensions. Due to increasing levels of automatization and digitalisation of then cyber-physical production systems, psychic aspects such as emotions, affects and subjective human experiencing of human-technology interaction gain significance. Accordingly, there will be a growing need for UX methods in industrial goods development.
All users are human beings who feel and behave in a similar way whether they are acting as a private consumer or working in a professional environment on the job. Often they cannot decide if they want to use an industrial good they have to. Therefore, there is a need to design even complex industrial goods in a way that they could be used in an easy and comfortable way.
Because most industrial goods will be used in specific contexts, evaluation methods will need to pay regard to this. Accordingly, tests could be either accomplished in field settings or laboratory settings would have to be well-prepared e. g. using virtual reality technology in order to emulate the context. Some of the standard UX evaluation methods have already been applied to different industrial goods in professional contexts (cf. Siwek et al., 2016; Bosse et al., 2016). While AttrakDiff (Hassenzahl, 2003) or Needs Scales (Sheldon et al., 2001) could be applied with workers or patients, the respective findings from the evaluation have only limited value for actual product development. They may rather serve as a measurement of how well a goal was hit. However, it needs to be clarified, how important hedonic qualities are or what basic human needs (even outside of Sheldon's set) should be considered being important in professional contexts (and then again: to which types of users).

2 OPPORTUNITIES FOR UX IN INDUSTRIAL GOODS DEVELOPMENT – FINDINGS FROM A SERIES OF EXPERT INTERVIEWS

The findings presented in this paper have been derived from a series of ten qualitative guided interviews with experts from German technology firms (500–5,000 employees) conducted in late 2015. The experts are members of executive boards, design principals, or experienced R & D, marketing or product management staff. Seven of the participants were working in the design departments, three of them board members responsible for design. One participant was global marketing manager, two were head of R & D. All participants have close relations to the design departments or collaborate closely with designers. The 1-hour interviews have been audio recorded and transcribed (one exception with written protocol).

The focus of the interviews was user integration in strategic design processes. User integration or participation is only one facet of UX but it is one of the best ways to get in touch with users at a very early stage of the design process. It is also a potentially appropriate field to use UX methods for the design of industrial goods. The research question is how small and medium-sized companies involve users into the design process in the technologically driven environment and how to manage this process. It should be pointed out how, when and to what extent users are integrated into the design process and which methods are used to get in touch with the users' needs. What chances and risks were seen in the integration of users?

2.1 User Integration

The evaluation of the interview data revealed the following results. Figure 1 shows the different phases where user integration takes place. A non-stop continuous integration across the whole design and product development process was stated from 50% of the interview partner. The early phases seem the best stage for user integration.

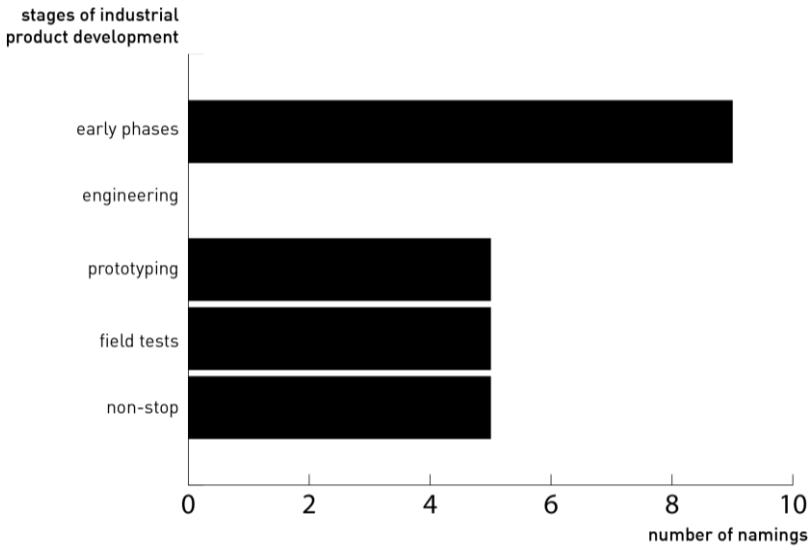

Figure 1. Stages of industrial product development which are incorporate users

2.2 Methods

All companies use interviews in different forms (Figure 2). Also, early prototypes and workshops with users are accepted methods for getting information from them. Observation which is one of the efficient methods to examine user needs is used only by four companies.

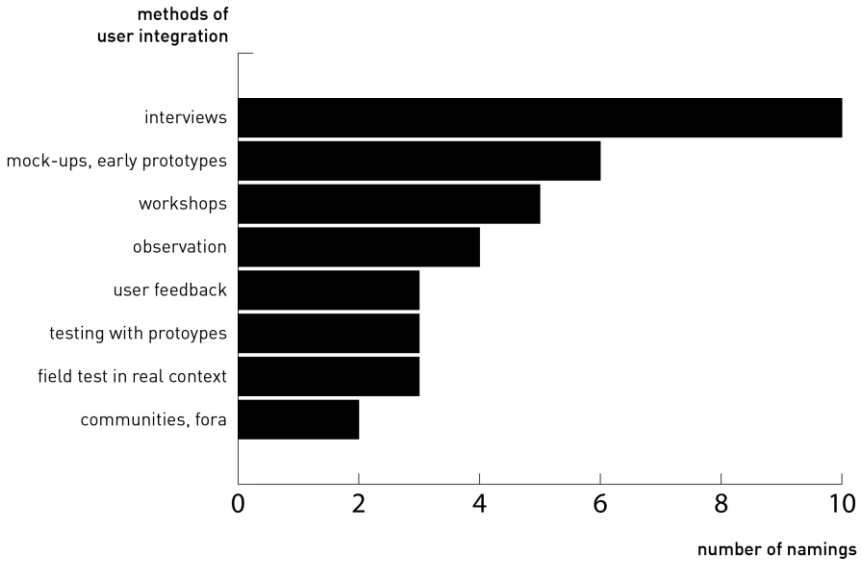

Figure 2. Used methods for user integration

2.3 Chances

That user integration is an important part of developing products was supported from all companies. But what are chances doing this? As possible chances for user integration they pointed out that a strategic and evaluable method is missing to get the reached information in the development process. There is a big lack of knowledge how to handle and edit these data and for which decision the data is needed. Finding useful methods for analysing and evaluating these data is the biggest chance for seven out of ten (Figure 3).

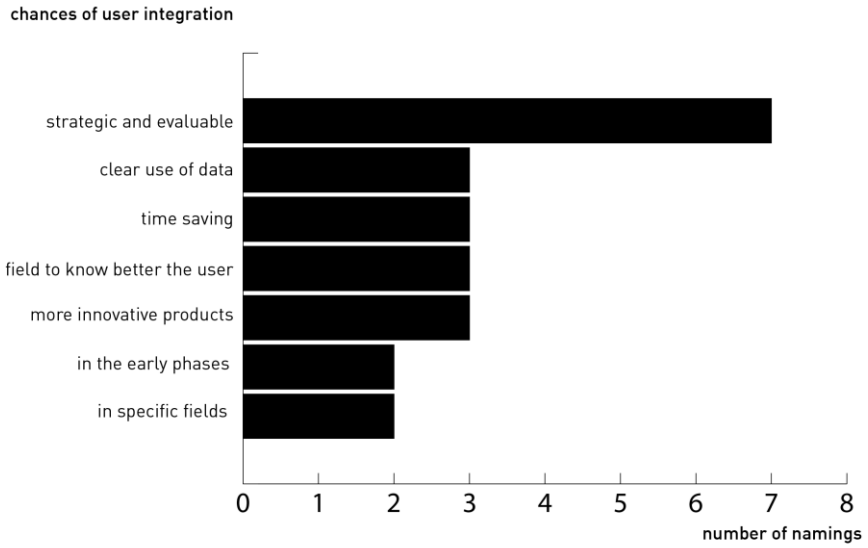

Figure 3. Chances of user integration in industrial product development

2.4 Risks

The missing evaluation methods were also mentioned as the biggest risk together with the fear of more time need in the process (Figure 4).

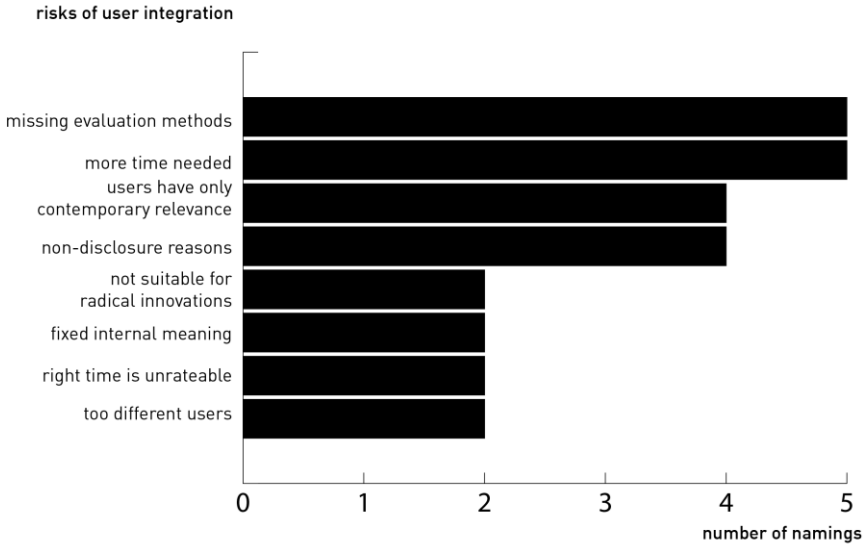

Figure 4. Risks of user integration in industrial product development

None of the participants applies a particular UX approach. Since UX approaches and methods are not state of the art yet in German technology firms, the interviews had to talk around the different facets. The major concern of the interviews was to trace the current state and opportunities for user participation in the design development of the companies. With a closer look, this allows the identification of opportunities for the integration of UX approaches and methods.

One general finding is that the participating companies see potential in strategic user participation. However, it seems not to be clear how participation can be useful and delivering valuable output. Half of the participants conduct user integration throughout the whole development process – but still not within the actual design stage. Currently, appropriate evaluation of data gained from participating users seems to be a challenge for the companies. None of the interviewed companies has a method to integrate the data from user participation into the design process. Here evaluating UX methods could help to enter the data from the users in an appropriate way.

Most of the above described facets of the theories underpinning particular UX approaches have not been explicitly named by the participants. Three of the participants were talking about user's needs. However, they did not talk about needs in the sense of Sheldon et al. (2001) and Hassenzahl et al. (2003) like stimulation, competence or popularity. They used the term needs (*Bedürfnisse*) to name requests for (technical) features, general product qualities or even for products in general. Emotions were named briefly only once in a very vague and general meaning.
Sales, service, product management and marketing departments are currently most closely linked to product users. They often interpret and filter user's opinions and actively stimulate or influence product development processes. However, there seems to be no sophisticated general workflow. Two participants from larger companies reported that actual development staff goes to the field investigating users and products in real-world settings. A substantial number of companies have established steady connections to test users or select appropriate test users from their clients. Lead users are rarely involved in the product development processes of the participating companies. Only one company has used the lead user method to get new ideas developed by user.

In regard to the different types of users (or humans) interacting with industrial goods, it must be stated that buyers, logistics staff or other more specific users are not involved. Equally, the public or branch outsiders are not integrated in the development processes.
There is a variety of methods that is already being applied in order to integrate users in product development. Users are essential part of kick-off workshops in most of the participating companies. All participants apply different forms of non-guided or guided interviews. A substantial number of companies conduct observation of real users in everyday use, usually followed by interviews. Conducting user tests with mock-ups or early product prototypes has been appreciated for supporting decisions and interactively improving product concepts.

3 DISCUSSION

There is a low barrier for user integration especially in design of industrial goods, because there are no "inner barriers" (participant). Even today, it offers the opportunity for designers to know the users and their needs. Based on that, innovative products can be developed for the users, not only for the market. Some of the participants argued that user integration could overrate opinions of single users, which can reduce the acceptance of the outcome of user participation. While this is no exclusive subject matter in UX research, there are UX methods that could help to dispel such doubts.
Despite the danger of delay due to user participation had been discussed by the participants, five of the interview participants stated that it just needs good planning. Again, the appropriate use of dedicated UX methods can help to stick to the schedule.
General findings from market research and participatory design state that test users tend to stick on what they seen and know, accordingly they stick closely to the present and won't develop innovative ideas. These concerns have also been mentioned by some of the interview participants. This is a problem especially in industrial goods development, where time to market can be several years (esp. industrial vehicles or trucks). In regard to UX methods this doubles the issue that UX evaluation methods are more easily available and applicable compared to methods for the actual designing of experiences.
While the participants expect positive impact from strategic user integration, most of them have no refined approach or respective workflow. This leaves a gap that could be filled by UX methods. These could help the designers, improve products and – due to quantitative dimensions – deliver key performance indicators to the management board "on the fly".
The current set of methods (different forms of interviews or user tests on prototypes) shows that there are already facilities, competences and connections for applying user-centred design methods from social and cognitive sciences. This is a good basis for the development and application of similar UX methods in the companies.
Today, the industrial goods companies focus on designing for their standard users only (i. e. the design process is similar to the design of complex consumer products). Accordingly, there would be a long way to go if the goal was to design for the specific needs (and experiencing) of different stakeholder groups.

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