Experience Design in the Field of Capital Goods

Approach and Methods

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Abstract: During the last decade, psychological as well as design research have revealed the role of emotion accompanying cognition in the concept of user experience. Furthermore, in the early 2000s, the industrial goods branch increased its interest in industrial design and human-centred product development. In line with the human-centred perspective of industrial goods, human experiencing seems to be important in the field of industrial goods, too. We argue that adapted user experience methods could increase the products performance, support the user and influence buying situations positively.

So far, however, there has been no discussion about user experience or the role of emotion in the industrial goods industry. In this paper we argue the appropriateness of user experience methods for integration in industrial product development processes based on our concept of industrial goods experience. The paper concludes that the three methods contextual inquiry, cognitive walkthrough and eye-tracking are especially suitable for an industrial experience design when adapted in the right manner. We end by sketching next research steps to underpin our recommendations.

Key words: user experience, industrial goods,

1. Introduction

During the last decade, psychological as well as design research have revealed the role of emotion accompanying cognition in the concept of user experience (cf. e. g. [3, 16, 6]). The concept of user experience (UX) as a product development approach has been well established in interaction design. Also, it is widely used in the field of consumer products.

In the early 2000s, the industrial goods branch increased its interest in industrial design and human-centered product development. Nowadays, Industrial Design is an important driver in product development to create innovative and competitive industrial products (cf. e.g. [11]). Despite its self-conception of being (almost) purely technology-driven, the importance of industrial design strategies has been proven for industrial goods as well [11].

In line with this human-centered perspective of industrial goods, human experiencing seems to be important in the field of industrial goods, too. We argue that adapted user experience methods could increase the products performance, support the user and influence buying situations positively. So far, however, there has been no investigation about user experience in the industrial goods industry. There is just one paper known discussing the concept of industrial user experience [19]. Rissanen *et al.* summarize the results of an international workshop on

industrial user experience and present the main topics of an industrial user experience from the workshop participant's view. Despite, this paper discusses information and communication technologies for the heavy industry it is important for our research.

Following the notion of product experience [21] this paper will focus on the experience of industrial goods like stand-alone production units. It is the aim of this paper, to propose industrial goods experience as a novel area for future design research. To start with, this paper presents the concept of industrial goods experiences. Based on our observations, we are going on by discussing user experience methods which could be used in industrial development process. Therefore we focus on major consiliences and necessary adaptions by transferring these methods from consumer to industrial goods. We expect that, finding suitable processes working with user experience in industrial goods can lead to a similar boost of innovations as seen before in the consumer market.

1.1 Industrial Goods

Industrial goods are defined as "Goods that are destined to be sold primarily for use in producing other goods or rendering services" [1]. In contrast to consumer goods, industrial goods are not sold to the ultimate consumer. The range of industrial goods includes raw materials like oil as well as huge production areas or even nuclear power plants, have been categorized according to different criteria (e.g. [14, 4]). We refer to a sub-division by Geipel [4], who distinguish nine groups of capital goods. In the context of this paper, the three groups *stand-alone production units*, *commercial vehicles and industrial goods for rendering human-centered services* are of interest.

These types of industrial goods, in the following just referred to as industrial goods, are complex and technology-driven products. They differ from consumer goods in major characteristics but also sharing some consiliences as well. In this section, we will briefly clarify the main characteristics of industrial goods, their relation to stakeholders as well as specifics of the development process.

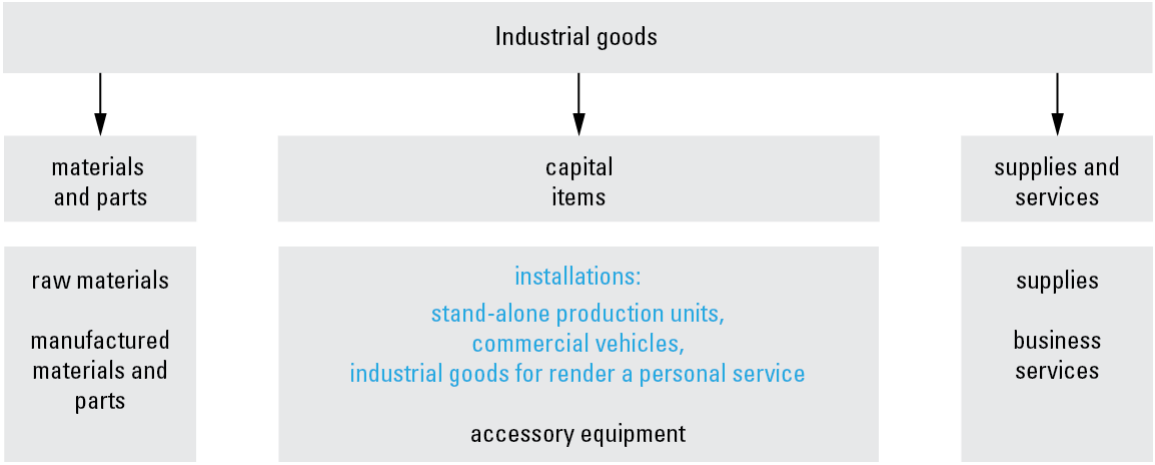

Figure 1: Classification of industrial goods by [14] extended by Geipel's sub-categories (1990)

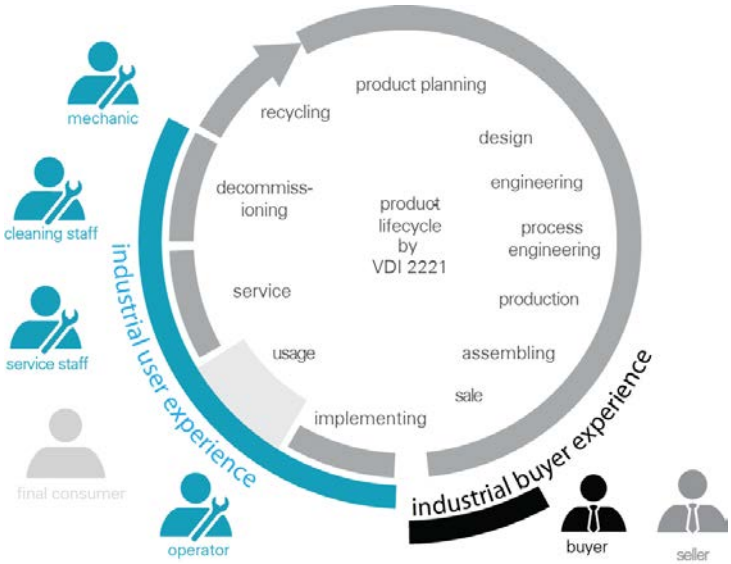

Figure 2: stakeholder at the stage of industrial goods lifecycle

In contrast to consumer products, buyers are not the users in the industrial goods groups mentioned above. Instead there exist different perspectives and behavior of buyers/decision makers, sellers, users, providers/operators and—if applicable—ultimate users. Stakeholders are specific to lifecycle stages. In many cases, those stakeholders are no single individuals. In most of the categories, multi-user scenarios are the rule. The individual experiencing of all stakeholders must be considered. Figure 2 illustrates the industrial product lifecycle and the stakeholders involved in the particular stage of lifecycle.

In contrast to the consumer market, the industrial goods sector is characterized by e. g. derived demands, tailor-made solutions, non-standard prices (e. g. bidding), long decision phases, non-anonymous players or large quantities [17]. In the context of this paper, the most significant difference is the development process, where user-centered design as well as user experience hardly fits as it does in the early stages of consumer products development. Many industrial goods are not only made but also developed to order. Hence, in the industrial goods market (buying) decisions are based not on the product but on trust into the supplier's ability to satisfying the buyer's (and user's etc.) needs [12]. Accordingly, many internal decisions are based with strategy in mind. This will also apply to the approach how product experience is integrated into industrial goods development.

1.2 Product Experience

Human experiencing is understood as a—conscious and unconscious—ongoing reflection on events. It always incorporates the three dispositions *cognition*, *volition* and *emotion* [5]. Humans steadily experience objects and processes within their environment as a "constant stream of self-talk" [5]. The concepts of *user* (or *product*) *experience* focus on psychological effects elicited by the interaction between user and products [10]. Although there are slightly different definitions and concepts of *user experience*, all refer to the fulfillment of various—more or less conscious—needs, concerns or values of users [2, 9]. Most concepts focus on the affective reactions elicited by the interaction between human and product, particularly on emotions. However, in the context of industrial goods it is important to emphasize on a concept of product experience that incorporates emotions as an

essential disposition of any interaction between user and product. Particularly (consciously) emotional interactions are not excluded, but as a core it is subject to the concept of emotional design. On the other side, product experience must be considered distinct from usability. Usability focusses on objective criteria of physiological and psychological ergonomics in order to provide products, which enable users attaining a goal in an easy and efficient way. However, usability can be a source of product experience by serving a concern [3]. The concern of attaining a goal is one of the main dimensions of emotion eliciting described by the appraisal theory [3, 20].

2. Concept of industrial goods experience

Industrial goods experience is the experiencing of an industrial goods product. We refer to experiencing as a constantly, holistic and partly unconscious, both cognitive and affective evaluation of an object. In this paper, industrial goods experience is mainly used to describe human experiencing of capital goods, especially installations like stand-alone production units and commercial vehicles. As well as every good, humans experience industrial goods (e.g. [22]).

For investigate the experience of industrial goods, we distinguish two important stages of the industrial product life cycle: the buying stage and the stage of use. As explained above, stakeholders are specific to the both lifecycle stages. The buying stage includes mainly engineers, buying-agents, marketer and management. The stage of use involves technical staff like operators and maintenance experts. Furthermore, industrial goods are perceived on the consumer side not only by different people but also in different ways. While operators get into physical contact with the industrial good, it often does not exist yet at the buying stage. Then printed documents and trade shows are the most important information sources, most information being provided visually. To sum up, industrial goods are experienced in different life cycle stage, by different stakeholders, in different contexts.
As stages, stakeholders and contexts correlate, we conceptually distinguish three different kinds of industrial goods experiences: the buyer experience, the professional user experience and the public experience.

- **Buyer experience (of industrial goods)** describes how buyers (e. g. as members of the buying center) experience (representations of) the industrial good in a typical pre-order setting
- **User experience (of industrial goods)** describes how users experience the (final) industrial good in its professional domain during actual use.
- **Public experience (of industrial goods)** describes how public persons experience the industrial product. This category can be further divided according to the level of involvement, e. g. patients being physically treated with medical devices in contrast to passengers of public transport in contrast to residents disturbed by commercial vehicles.

In theory, these categories are clearly divided and linked to specific stages, tasks, situations and persons. In reality, there can be overlaps between the categories, e. g. when identical stakeholders participate at multiple stages. Although brand, communication and services are important aspects of experiences in the industrial goods sector in general, we focus on the industrial products, e.g. the stand-alone production unit itself and its properties. Hence, the industrial goods buyer experience is referred to the industrial good at the stage of buying, not to the experience of the process. Table 1 gives an overview on how the three categories differ.

Table 1. Categories of industrial goods experience

	human	product	context	example	
buyer experience of industrial goods	recipient = buyer (engineer, purchaser) organizational decision process involving a group of people organizational and individual concerns homogeneous group of involved people	products do not exist mostly visual representations of similar machines at fairs, brochures evaluation of the whole product model (including image of producer)	work environment (professional experience) abstract consequences of buying decision competitors (bench mark, state of the art) political, legal, technological constraints	vendor acquisition on fair information procurement by brochures sales negotiation	affects buying behavior
user experience of industrial goods	recipient = user multiperson product usage, no possession individual within organizational concerns homogeneous group of involved people	usage in industrial context recitation and evaluation of the physical product based on appearance and function	industrial environment, work context (professional experience) machine environment depends on category (medical device, production unit, etc.)	operate a harvester gear cutting with CNC milling machine driving a bus	affects using behavior
public experience of industrial goods	recipient = private person no possession, multiperson product usage individual concerns inhomogeneous group of people	reception and evaluation of the physical product in service situation indirect product use	private environment (private experience) inhomogeneous machine environment and context of product recitation	patient in MRT walker watches harvester visiting a production plant driving in a bus or cab	affects (brand) image

The above concept of experience in the context of industrial goods has been transferred and derived from theoretical work from a number of disciplines. In the following steps this approach has to be applied and evaluated in the domain of design and design research. Most relevant questions at that stage focus on the evaluation of the theoretical framework as such as well as on consequences regarding design processes in the industrial goods domain.

As a pre-study, we conducted a series of semi-standardized interviews (n = 12) with experts from the industrial goods practice. The interviews have been conducted with the purchasing, marketing and development experts of key accounts in the field of stand-alone production units. Within those 30 minute interviews, the experts evaluated the experience of industrial goods in each of the three different categories public experience, buying experience as well as user experience. The particular evaluation had been done using the *AttrakDiff2* questionnaire by Hassenzahl et al. as part of the interviews in addition to more general questions and depictions of industrial goods in the three categories [7]. Within the *AttrakDiff*, there 28 items grouped to four independent dimensions *pragmatic quality* (PQ), *hedonic quality-identity* (HQ-I), *hedonic quality-stimulation* (HQ-S) and *attractiveness* (ATT). We conducted an ANOVA across the three categories of industrial goods experience for each of the four AttrakDiff dimensions. According to this, there is no significant difference between the product experience assessment of the same industrial good across the three categories public experience, buying experience and user experience (cf. table 2). However, there are single items of the *AttrakDiff* evaluation that differ significantly between the categories of industrial goods experience. Interestingly, these are form instance the items

amateurish—professional or impractical—practical that relate closely to actual usage. However it must be stated that these differences may result from the fact that some of the experts had issues with answering specific *AttrakDiff* items (as described in the qualitative comments analysis below). These difficulties varied across in particular categories of industrial goods experience and may be the primary explanation of the statistically proven differences.

Table 2. statistical evaluation (ANOVA) of the four AttrakDiff dimensions *pragmatic quality* (PQ), *hedonic quality-identity* (HQ-I), *hedonic quality–stimulation* (HQ-S) and *attractiveness* (ATT) across the industrial goods experience categories *public* (PX), *buying* (BX) and *user experience* (UX).

dimension	M_{PX}	M_{BX}	M_{UX}	F	*p*
PQ	0.38	0.39	0.25	0.497	.61
HQ-I	0.75	0.80	0.37	1.120	.34
HQ-S	-0.02	0.32	0.56	0.650	.53
ATT	0.51	0.83	0.27	1.072	.35
professional	1.83	1.92	0.42	5.685	.01
Practical	1.75	1.08	0.42	4.391	.02

In addition to the AttrakDiff questionnaire items, the experts have been asked more general questions. Generally, all of the persons interviewed see themselves as experts in the field of industrial goods, most in the category of stand-alone production units (machine tool industry and plant engineering). The majority works as distributers (n=7), all other as developers and application engineers. To all of the test persons, user-oriented requirements analysis seems important, but is rated less important than technical or financial requirements. Despite the qualitative analysis could not prove a difference of product experience between the public, buyer and user experience categories, nearly all test persons suspect varied assessments of the buyer and the user experience. The non-engineers among the test persons tended to evaluate the machine in a more holistic view (not just technical performance), but have no expectations concerning the stimulation (specific appearance). Some of the AttrakDiff items have been criticized as not matching the scenario, e. g. *gets me closer to people vs. separates me from people* was irritating especially in the public and buying categories. Depending on the group of Geipel's sub-division of industrial goods (see Fig.1), a different emphasis on buyers/decision makers, users, and public persons must be made. That means while the experience-based assessment of industrial goods may not vary across the lifecycle stages for stand-alone production units or commercial vehicles, it may vary significantly e. g. for medical devices.

Considering human experiencing is important in the field of industrial goods. Although, the emotional or value level of industrial goods could not be the focus of the industrial product, it could add advantages to the product. User experience methods could support the performance of the industrial product, increase the health of users and add advantages to buying situations.

3. Methods for experience design in the field of industrial goods

Bringing the concept of experience into the realm of industrial goods could provide advantages. The purpose of the following is to discuss the suitability of user experience methods for integration in industrial product development processes. Due to the specifics of industrial goods, UX must be integrated on a strategic level in general. However, until now there is only evidence of applicable UX methods in other domains. We wish to examine consiliences and the extent of adaption needed to fit UX methods to the specific processes and requirements in industrial goods development.

3.1 Literature review

First, a literature review was done to collect a set of user experience methods. Methods for experience design are discussed in both, literature and practice. We mainly refer to Jordan, Press and Cooper, and Kuniavsky [13, 18, 15]. The publications were identified while reading about user experience in general.

Most of the authors distinguish the UX methods in four groups, which refer to four stages of product development: Methods for *analysing*, *designing*, *implementation* and *evaluation*. Within the user experience approach, a lot of design methods target on defining user requirements. The object of user research is to get a sophisticated understanding of user`s tasks, goals, and context, to make better design decisions throughout the design process. Typical methods include ethnographic research, user interviews, and field observations. In the domain of interaction design, methods for measuring product experience have been developed, e. g. the *Positive Affect and Negative Affect Schedule* PANAS [23] which is widely used. Another method of measuring user experience is the *AttrakDiff* questionnaire [7] which has been developed in the domain of interaction design. Due to its general applicability, it has been translated to different languages and has been incorporated in numerous research projects in different design domain in the recent years [8]. There are user experience methods, which are used in industrial design process, yet. Most established methods are personas, focus groups and prototyping.
The reflected methods should meet at least one of the following requirements:

- meet the principle development process of industrial goods,
- manage more than one stakeholder characteristic
- could be used for one or more of the three categories of industrial goods experience

3.2. Adaption of user experience methods for industrial goods development

Due to the market characteristics of industrial goods, often engineers and designers have knowledge about buyer and user by work practice. Nevertheless, methods of understanding needs, tasks and concerns of users are important to industrial goods.

First, it should be clear, which stakeholder group is of interest. All methods used in the stage of *analyzing* could be done for both, buyers and for users. Ethnographic studies are not uninteresting, because industrial markets are international, global markets. More important methods for collecting user/buyer and using information for developing an industrial good are contextual inquiry and interview. Methods like trend analysis, market analysis or benchmarking are no specific UX-methods and could be done by marketing or purchasing. Important methods for the visualization of costumer/user information are: sequence patterns, scenario, use cases, mental models, personas, mood boards.

For industrial production units (like milling machines), public experience seems to be less important, hence analyzing/testing for this group of recipients are not important. For commercial vehicles, public experience is more important and most important than for e.g. medical devices. For these class of products like the public experience is as crucial as the user experience, hence methods for analyzing private persons confronted with medical products are important.

As a result, the three methods *contextual inquiry*, *virtual walkthrough* and *eye-tracking* should be highlighted. These methods could be integrated into the industrial development process with some effort and expected to generate considerable added value. In the following, the suitability of these methods will be discussed in detail.

Contextual inquiry is a method for examining and understanding "processes, activities and needs of people at work" ([18]:124). It is a special type of interview, which is conducted at the workplace of a stakeholder. Hence, this method could be applied for industrial users and industrial buyers, but not for the public experiencer. In contrast to other methods of understanding user needs, like ethnography or field observation, contextual inquiry could be conducted by designers and engineers. "Because the investigator directly observes the participant, this gives a degree of validity that might be lacking in investigations that rely on participants reports" ([13]:150). Contextual inquiry requires low human and material resources, but higher time and cognitive resources. It is a method used in the stage of analyzing, usually. Because in general, there is a lack of methods of understanding and collecting user needs, contextual inquiry is an important method for the stage of information and requirements collecting in industrial development process. It is highly suitable for the industrial development process especially of stand-alone production units without a greater adjustment. The contextual inquiry will foster the communication between engineer and buyer or user by providing a clear structure and producing documented information. Until now no comprehensible information is collected during visiting processes with customers.

The cognitive walkthrough, quite established for consumer products gives a framework for mentally testing the howl usage of the future product. This could be done for industrial products as a virtual walkthrough in virtual Environments (CAVE). The users experience can be tested in different phases during the development process in the right scale including major assemble groups. Appling these methods iteratively could help balancing divergent requirements. The downside is quite a huge afford for preparation the necessary scenes out of the 3D models. Furthermore changes during the assessment process are not possible yet.

The last method Eye-tracking won't need much adaption. It could be used quite easily as a tool for analysing and evaluating industrial products (especially interfaces). Already used in standardized ways for web applications it would allow the assessment of working processes at 3-dimensional industrial with small changes. Therefore it seems very helpful to evaluate user experience in late development stages.

4. Outlook & Discussion

Our work marks a very first step in bringing together two important fields of design and engineering: industrial goods and user experience. By developing our concept of industrial goods experience we followed the general research discourse around holistic experience but switched the field of interest form a consumer products focus to industrial goods. By doing so we found major consiliences in the content as well as in the methods. Though for bringing the concept to work driving innovations some essential additions are necessary.

The two most obvious ones are the three types of industrial goods experience correlating with three groups of stakeholders: buyer, user and public. Differentiate these three doesn't mean to isolate then from each other. The contrary is right the three categories as well as three groups have to define once again a holistic industrial goods experience. We conducted one first survey focusing on standalone machines trying to identify criteria to measure industrial goods experience. Of course this is far too little for reliable statements regarding the whole concept but it was very valuable as a pre-study. We aim to complete this survey for commercial vehicles and medical devices in 2013 and will conduct supporting focus group interview as well.

One further key issue for an effective implementation is meeting the requirements of established development processes of industrial goods. Therefore we identified three possible methods: contextual inquiry virtual walkthrough and eye tracking as potentially useful to analyze, define and evaluate industrial goods experience. All three methods have strong roots in UX-Design but seem acceptable in engineering design processes as well. This approach will be evaluated in case studies with the purchasing, marketing and development department of key accounts in different industrial goods domains.

5. References

[1] Bennett, P.D. (1995) *Dictionary of marketing terms*, NTC Business Books, Lincolnwood, Ill., USA.

[2] Desmet, P. M. A. (2007) Product emotion, In *Product Experience*, H.N.J. Schifferstein and P. Hekkert, Eds., Elsevier Science, Oxford, pp 379–397.

[3] Desmet, P. M. A. and Hekkert, P. (2007) *Framework of product experience*, International Journal of Design 2007, pp 57–66.

[4] Geipel, P. (1990) Industriedesign als Marktfaktor bei Investitionsgütern, GBI-Verlag, München.

[5] Hassenzahl, M. (2008) User experience (UX). Towards an experiential perspective on product quality, In IHM08, ACM Press, pp 11–15.

[6] Hassenzahl, M. (2010) *Experience design. Technology for all the right reasons*, Synthesis lectures on human-centered informatics 8, Morgan & Claypool, San Rafael, Calif.

[7] Hassenzahl, M., Burmester, M., and Koller, F. (2003) *AttrakDiff. Ein Fragebogen zur Messung wahrgenommener hedonischer und pragmatischer Gestalt*, In Mensch & Computer 2003. Interaktion in Bewegung, G. Szwillus and J. Ziegler (Eds.), B. G. Teubner, Stuttgart, pp 187–196.

[8] Hassenzahl, M., Burmester, M., and Koller, F. (2009) *Der User Experience (UX) auf der Spur.* Available at <http://www.attrakdiff.de/files/up08_ux_auf_der_spur.pdf> [Accessed 26 March 2013]

[9] Hassenzahl, M., Diefenbach, S., and Göritz, A. (2010) *Needs, affect, and interactive products – Facets of user experience*, In Interacting with Computers, vol. 22, no. 5, pp 353–362.

[10] Hekkert, P. and Schifferstein, H. N. J. (2007) *Introducing Product Experience*, In Product Experience, H. N. J. Schifferstein and P. Hekkert (Eds.), Elsevier Science, Oxford, pp 1–8.

[11] Herrmann, C. and Moeller, G. (2009) *Design governance. Design as a key factor for innovation and economic success*, Icfai University Press, Hyderabad, India.

[12] Hobday, M., Rush, H., and Tidd, J. (2000) *Innovation in complex products and system*, Research Policy vol. 29, no. 7-8, pp 793–804.

[13] Jordan, P. W. (2003) *Designing pleasurable products*, Taylor & Francis, London.

[14] Kotler, P., Bliemel, F., and Keller, K. L. (2007) *Marketing-Management*, Pearson Studium, München.

[15] Kuniavsky, M. (2003). *Observing the user experience. A practitioner's guide to user research*, Morgan Kaufmann Publishers, San Francisco.

[16] Norman, D. A. (2004) *Emotional design. Why we love (or hate) everyday things*, Basic Books, New York.

[17] Phadtare, M. T. (2008) *Industrial Marketing*, Prentice-Hall of India Private Limited, New Delhi.

[18] Press, M. and Cooper, R. (2002) The design experience. The role of design and designers in the 21st century, Ashgate, Aldershot.

[19] Rissanen, M. J., Rönkkö, K., and Tripathi, S. (2011) Understanding industrial user experience: an excerpt from 1st International Workshop on Industrial User Experience (WIndUX 2011), In Proceedings of IndiaHCI '11, ACM, New York, pp. 75–78.

[20] Scherer, K. R. (2001) *Appraisal considered as a process of multilevel sequential checking*, In K.R. Scherer, A. Schnorr and T. Johnstone (Eds.) Appraisal processes in emotion: Theory, Methods, Research, Oxford University Press, New York and Oxford, pp. 92–120.

[21] Schifferstein, H. N. J. and Hekkert, P. (2007) *Product Experience*, Elsevier Science, Oxford.

[22] Uhlmann, J. (2012) *Erleben. Ein Grundbegriff für das Design*, In Entwerfen Entwickeln Erleben, M. Linke, G. Kranke, C. Wölfel and J. Krzywinski (Eds.), TUDpress, Dresden, pp. 11–35.

[23] Watson, D., Clark, L. A., and Tellegen, A. (1988) *Development and validation of brief measure of positive and negative affect. The PANAS scales*, Journal of Personality and Social Psychology, vol. 54, no. 6, pp. 1063–1070.