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CONCEPT CREATION IN TRANSPORTATION DESIGN – MODEL AND TOOLS

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Abstract: This paper describes an empirical field study on concept creation in transportation design. Derived from this study, a general model of design concepts is presented. Also, three essential method domains for the creation of experiential design concepts have been identified and are described in the paper.

Keywords: *concept creation, design methods, early stages, field study*

1. Introduction

There is still a contradiction between a limited understanding of concept creation in design (Roozenburg, 1993b, Macmillan et al., 2001, Ulrich & Eppinger, 2003) and its well-recognised high impact on design solutions in industrial and engineering design (Cagan & Vogel, 2002, Cross, 2004, and others). This important role of the early stages of the design process has been widely emphasized not only by design researchers, but also by psychologists and economists (e. g. Lockwood, 2008). Due to current trends in product development, demands on concept creation have significantly risen. Needs derived from society, sustainability, efficiency or universal design have to be connected with actual user needs and an emotionally convincing user experiencing.

The study presented in this paper relies on a domain of design where the user's product experience is the main criterion in the design process. The study builds on a definition of design concepts as the first stable unit of knowledge, which essentially determines the character of the design object. In addition, design concepts are open and abstract as well as relatively independent from specific methodological approaches in different design domains.

2. Research problem

According to design literature, concepts can be classified with regard to their focus into engineering (Roozenburg, 1993a), product (Ulrich & Eppinger, 2003) and experiencing (Keinonen & Roope, 2006). In order to put the design concept into a process context, we rely on the flexible structure of the Munich Procedural Model (Lindemann, 2007) as well as on the contents of the design process model of Uhlmann (2005) that focusses on human experiencing rather that product function. Since human experiencing is holistic, features constituting a experiential design concept are best described as integrating and focalizing the nucleus of the design object, rather than an additive set of criterions.

Literature basis about the process of transportation design is weak apart from the huge amount of books which promote the finished car itself (e. g. Newbury & Lewin, 2008, Tumminelli, 2006). At least a few indications for the existence of product character definitions comparable to the experiential design concept can be found in Lewin & Borroff (2010). The research presented here aims to prove

the existence of experiential concepts in transportation design based on empirical data and describe its creation more detailed. We particularly focus on describing the tools which were used for concept development. These tools lead to an experiential design concept marking the first checkpoint within the solution space. The central research question is: what are the processes of concept development in transportation design and which tools were used within these processes.

3. Design concept in experience-focussed design disciplines

Currently, the term concept is widely used with different meanings, ranging from conceptual art to societal concepts. Finding a common tenor of concept seems very difficult within this variety of possible meanings. The etymological origin lies in the Latin word *conceptum* which means 'something conceived' (Stevenson, 2010). The term *nucleus* which is used by Uhlmann (2005) for design concepts can be understood as a combination of three essential qualities the presumption of the content, a procedural structure and a high concision rate. A nucleus is defined as "the central and most important part of an object" (Stevenson, 2010) and contain the anticipated result, the program of process steps in a very concise matter.

Regardless of the multiple different perspectives, a concept plays a major role in the fuzzy front-end of all product development processes. The concept is created early in the process and defines a huge amount of the critical aspects (e. g. Cagan & Vogel, 2002). Furthermore, the concept comprehensively defines the core of a product at a point of high uncertainty and a lot of missing data. The activities in the stage of concept creation are actually quite inexpensive and unextensive compared to other process steps (Ulrich & Eppinger, 2003), but define the majority of the later effort and costs. However, suitable tools for concept development are still missing. Ulrich & Eppinger (2003) emphasize this especially for a holistic experience and value oriented product development.

The most existing theoretical concept models focus only on functional aspect of the product. This is also the present understanding of conceptualization "Konzipieren" as a stage of the product development process between planning and designing in engineering design (Pahl et al., 2007). In this understanding, the concept represents first principal (Roozenburg, 1993a) or tentative solutions (Cross, 1999).

4. Methods for concept creation

4.1. General supporting tools

Despite there are only very few published empirical studies on concept creation, there is a huge number of general creativity techniques being offered as a support. Specific collections of design methods can be found at different places, e. g. by professional organizations or scientific research (Ponn & Lindemann, 2006). The most important methods within concept creation in transportation design are sketching and drawing (Dewey, 2009; Lewin & Borroff, 2010).

4.2. Classical tools – image boards and mood words

One long-established tool in concept creation is the image board or mood board. It provides the central mood or atmosphere of the object to be designed. Content-wise, it corresponds to essential parts of the product character. The main objective of image boards is the provision of a quick – usually emotional – visual impression and thus the agglomeration of a variety of diverse information. To visual people, image boards are more revealing than data sheets or requirements lists (Wickenheiser, 2005).

Usually, image boards consist of a coordinated collection of images that are often complemented by mood words in order to obtain a consistent visualization. The effect of image boards essentially depends on the selection and matching of single elements such as images, typography and layout. Since there is a particularly large interpretation room in this stage, contrary or unclear interpretations should be avoided. Thus, a consistent depiction of the mood board is intended.

Basic image boards consist of three to five single images; more elaborated ones are collages of various visual and content-wise dimensions. Image boards as a tool can be applied to several areas of

analysis (Institute for Manufacturing, n. d.). The most usually ones are styling boards (providing a certain formal language), scenario boards (defining certain environments) and user boards (describing potential users).

4.3. Recent tools – trends, personas and narrative scenarios

Developed in marketing and adopted for design within the field of human-computer-interaction in the recent years, the development and analysis of user archetypes and narrative scenarios reached design education and practice recently.

Persona as a term is derived from ancient Greek theatre, naming a mask representing the character of the actor which resonates with his voice. Today, it is used to name a certain form of hypothetical user archetypes (cf. Cooper et al., 2007, Pruitt & Adlin, 2006). Personas not only describe representatives of user groups, but also give them a face and – in the sense of resonating – amplify their characters, wishes, needs, motivation etc. Personas are fictive, specific and concrete members of a target group. In contrast to user groups, which are demanding to prepare and often too unspecific (Hanington, 2003), personas reduce complexity. Based on real data, personas can support communication, requirements analysis and decision-making within design processes. Despite being fictive, personas can help making useful knowledge explicit (Grudin, 2006). Since personas are based on real data (which must be gained before), they can summarize and represent certain user groups. Personas can be part of the whole design process. Design decisions can be evaluated with personas quickly and with minimal effort.

Usually, personas have to be put into context, they have to be engaged with the product to be designed. There is a certain range from single use cases to complex user stories, which can be described in narrative scenarios. Those fictive scenarios describe a dynamic context in which the object to be designed can be observed prior to its actual development (Cagan & Vogel, 2002). The use of scenarios has been well established in product development for some time. However, narrative scenarios as "simply a story about people carrying out an activity" (Rosson & Carroll, 2002) is relatively new in product development. In order to deliver reliable insight, narrative scenarios should rely on real data that must be carefully acquired. Trend analysis (Laurel, 2003) is one option for gaining data as an input to scenario development. This includes trends in material and technology, but also trends in society or for example specific regional trends. Such foresight is essential in domains where product lifecycles cover decades.

Those scenarios also support communication, requirements analysis and decision-making within the design process. Correlations between user behaviour, situation and product (properties) can be illustrated and investigated. Scenarios help developing innovative products which pay regard to actual requirements and needs of real users (Best 2003). Therefore, such narrative scenarios should focus on the user, not the product, e. g. engaging the persona. Personas in the context of product use can provide deeper insight into user needs, motivation and experiencing. They support the flow of tacit and experiential knowledge into the design process and the design objects.

4.4. Catalogues, galleries and diaries.

Databases and catalogues are widely used in engineering design practice, whilst there is no common use of catalogues or components in industrial design. In industrial design, there are only few systematic approaches (e. g. Restrepo, 2004), but most practitioners cultivate a kind of internal catalogue of formal and conceptual themes from their personal experience and prior projects.

Another way to work with catalogues is the use of picture galleries which are configured task specific or developed for longer period. Two ways of usage exist for these galleries: either specific pictures are taken from the gallery, or several pictures are shown in a slideshow. In both ways, the designer's imagination is supported. These galleries are commonly used during the research stage and while searching for mood board images.

For a long time, sketchbooks have been a main tool in the design process and design logs accompanied the designer physically through every single project step. The use of a design log was self-evident especially in the early processes stages but has changed fundamentally with the rise of

digital media. Today, design logs are design blogs or project specific web pages. Both are far more open and lack almost all intimacy of a personal book. A recent field study on methods use in industrial design practice, though not representative, illustrates that these kinds of tools as rarely used as methods in the actual design process (Wölfel et al., 2012) , they become communication tools instead.

5. Study setting and methodology

5.1. Samples/Cases

Pre-studies about design concepts in transportation design and industrial design showed strong differences in the intensity of concept usage in both design domains. Accordingly, the main study was exclusively done in the field of transportation design.

Due to confidentiality levels in the automotive industry, the study setting aims to balance industrial relevance and scientific depth by working with four senior designers at Audi and 22 students of the Transportation Design department of Pforzheim University – one of the most acknowledge transportation design schools in the world and the leading school in Germany. The limitation to only one school helps to handle the number of variables and gives room to focus on the individual cases and personal differences. The pre-, main- and post studies include 39 design projects of the 26 participants. The student projects include designs for an Upper Range car for Renault and an iconic car for Audi both made for the time of 2030. The projects of the four professionals were already published designs such as Audi TT or Audi RSQ. The main study concentrates on a subset of six student participants whose task was to design an innovative tractor based on the given term "power" as orientation for the product character.

5.2. Interviews

In total, 30 interviews have been accomplished, resulting in about 16 hours of tape-recorded material. These interviews, undertaken as single or group interviews by using different interview guidelines for different process stages, were chosen as a flexible and direct way of data collection. 16 interviews were made within the concept stage, 14 interviews just after finishing the project.

During the main study with six students, each participant has been interviewed up to three times within the concept stage and once just after finishing the project.

In total, 21 single and nine group interviews with eleven students have been done. For methodological reasons, two interviews with a graduate and three test interviews have been accomplished additionally. Four interviews with senior designers with and without guideline complete the study. Those interviews focussed on the actual design projects as well as the designer's biography with possible relations to their design.

5.3. Document analysis

Written documents have been analysed in order to complement the interview data. The diploma graduation projects are the only projects in the curriculum for which comprehensive documentations are prepared by the students. This is quite special even beyond the context of the school, since written process documentations are very rare in transportation design in general. Usually all presentation effort is put into finishing the design model (real or virtual) and complex supporting visualizations. Working with the diploma documentation is especially promising since the concept development stages are explicitly well documented. The documentations analyzed differ considerably in amount, complexity, structure and style. In general, the design process and its milestones are documented chronologically and retrospectively. However, process steps, design ideas or approaches which did not lead to the final solution are usually not documented. Also, a critical reflection of the design process and outcome is missing. Instead, the personal background and motivation is described explicitly.

6. Results

In all design projects of the study the existence of at least one experiential design concept could be proven – all concepts comprised not only functional and formal aspects, but also character, substance or kernel of the objects to be designed. However, the participants' awareness of the experiential concepts ranged quite much, from "so [the concept is] a first wraparound synopsis of what one wants to do" to "I also always ask myself [what a concept is]".

In most cases the concepts have been developed gradually starting with a single idea, going on with a few elaborated themes until it composed to a cornerstone of the design. In this final state the experiential design concept has drawn guide lines and set thematic barriers for the following design steps. The experiential design concept defines the central aims to design for but not the process structure. In any of the projects in the study, the concept was an early and predominantly stable part of the design and served as a guiding line or revealed helpful borders in the process. If the participants did not explicitly fitted their designs to the concept, they at least "kept it at the back of one's mind" during the process. Accordingly, the experiential design concept represents the origin of the designs not only on a timeline but also in terms of contents. The content of the experiential design concept includes functional and formal aspects, in most cases with a focus on one of them. The product character as third element is defined on a meta-level using the former two as a basement. In the projects of the study, this sometimes lead to a few key details which developed abstract content into a specific geometric object.

In all cases, the experiential design concept has been developed iteratively, dominated by an individual broad sketching process and a scheduled decision process usually with the whole team. Analytical supporting activities were less common. A lot of tools are used within the concept development stage, but most cases were dominated by a quite unstructured usw of only a few similar ones. Most frequent statements (each 80 of 500 codings on methods) concerned general research and search methods, image and story material as well as (freehand) drawings. Additionally and also quite frequent were narrative and similar methods like narrative scenarios/stories (57 codings), personas (46), focus groups (30), claims (28) and brand identity (20). Regarding the experiential focus of concepts, specific methods seem to have a strong impact as well as clear structure – those are combined to a specific model in paragraph 7.2. Expectably, the more successful projects were characterised by a more intense use of tools. The usage of tools also correlated with specific topics/tasks, formulation of the briefing and the profile of the designer himself (Details in Krzywinski, 2012).

7. Discussion and outlook

7.1. Research findings

The study proves the use of experiential design concepts in all projects and thus verifies the integration into design processes in the sense of Press & Cooper (2003), Burdek (2005), Lawson (2006), Heufler (2004) and others. The underlying data are the first field data from concept creation in transportation design that have been collected in this extent.

Previous models of design concepts are general (Boyle, 2003; Ulrich & Eppinger, 2003; Lindemann, 2007) or focussed on functional issues (Roozenburg, 1993b; Cross, 2001; Pahl et al., 2007). The research presented in this paper provides an approach that goes beyond, describing functional, formal and characteristic facets more in detail and linking these to a consistent model. This approach also goes beyond mere addition of principal solutions of product language, usage and technical function as described for instance by Heufler (2004). Instead of this, the experiential design concept relies on the definition of product character on a meta-category and thus on Uhlmann's (2005) meta-level. The application of this meta-category enforces consistence and agglomeration of the lower levels 'formal' and 'functional', as described by Ulrich & Eppinger's (2003) 'concise description'. Consequently, the experiential design concept can serve as a starting point in the sense of Uhlmann's nucleus (2005).

The tools used besides sketching and drawing within the concept creation stage are mainly established methods such as mood boards, personas and narrative scenarios as well as personal and commercial

image databases. Additionally, we found which combination of certain tools and their application to specific tasks has been chosen by different designer types.

Applying the (european) model of complex problem solving (cf. Badke-Schaub 2007) to concept creation, the attributes of dynamics and connectivity are most critical. Tools that are intended to support concept creation therefore must pay regard to these issues. Consequently, two aspects must be considered: general modelling is necessary for mapping connectivity; the estimation of the course of development is needed in order to do justice to the dynamics of the problem. The tools and methods identified in the field study have been evaluated using these two criteria. Only few methods provide general modelling, for instance the definition of a product character. The anticipation of future development is mainly dealt with by the use of scenarios. Based on these findings, a systematic approach for concept creation is derived:

7.2. Model of design concept creation

From the findings, a model of design concept development has been derived (see figure 1). The model contains three domainsof tools: product character, persona and scenario. Each domain includes several single methods. So scenario includes methods like future forecasting or trend research. Tools for Persona development may include market segmentation, demography or working with focus groups. The product character definition might rely on mood boards, mood words, design DNA or core value definitions.

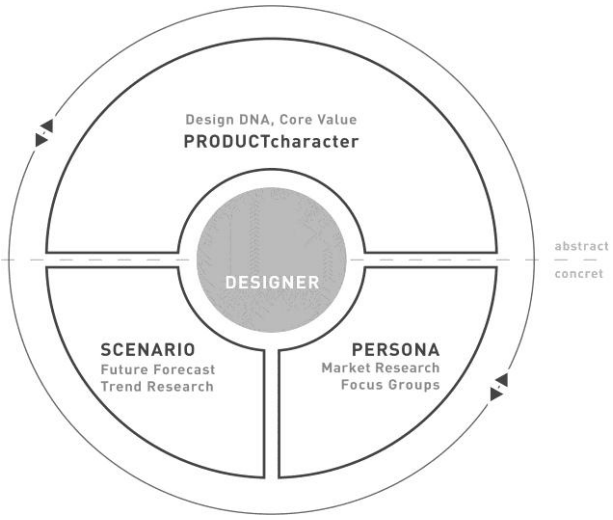

Figure 1: Model of experiential design concept creation

The designer himself is the fourth part and center of the model. This is to visualize the high subjectivity of design concepts as well as the strong bondage with the specific context in which the design project takes place. Furthermore, all personal knowledge of the designer serves as an individual basis for the concept development process.

The Differentiation between abstract and concrete categories of tools is comparable to the basis and meta-level in the model of design concepts itself. This second step from the concrete basis level to the abstract meta level is important because it helps to condense all the detailed information collected with scenario or persona. In most cases, this puts the product character into the center for all following process steps.

The concept is developed iteratively. For novices it is recommended to start down/right the model circle because the development of a persona is in the most cases the easiest way to get into the project. During concept development, the circle must be walked around a few times. The duration and extent of the concept development depends on the size and complexity of the project as well as on the size of the project team. For a single user and a new product two weeks might by a good orientation.

Based on diverse models of complex problem solving the tool categories correspond to the key characteristics complexity, dynamics, intransparency and connectivity.

7.3. Application of the results

The most obvious field of application is education in design. The research findings can be applied to concept creation as well as concept evaluation. Accompanying the study, single aspects have been successfully transferred into education in engineering design and industrial design engineering. Project duration ranged from two days to one semester and concerned tasks from a wide range of industries. From these projects, we conclude that the research findings can be applied to almost any discipline involved in product development.

The main field of application of the findings is product development. The tendency to integrated and holistic approaches (Cross, 2008 and many others) that clearly focuses on values and customers (Cagan & Vogel, 2002 and others) serves as a basis for an advanced common understanding of engineering and industrial design, reducing mental overload caused by exuberant requirements lists (Lindemann, 2007). The study presented here, provides empirical data from one of the most critical node of the design process, namely the junction between free application of various creativity techniques and systematic proceeding within engineering design methodology. Klink (2008) describes this junction as a state between 'chaos and rigidity'.

The model of the experiential design concept and the identification of tools for its creation close a theoretical gap from an industrial design perspective, which is essentially subjective but at the same time structured and transparent. Based on the meta-category of character definition, the model of the experiential design concept provides a clear and comprehensive definition of Lindemann's requirements-matching products (2007), which he considers as a core aim of the development process.

7.4. Outlook

The study presented in this paper serves as a basis for further research on the early creative stages of design processes. The extended understanding of experiential design concepts, their creation and further use in the design process does not only allow better explanation within design education. It also provides several opportunities for developing refined models and further support in the early stages of design processes. In addition to that, an application to other design domains as well as its integration into established design process models should be on the agenda.

Currently, we are about to complete research on the impact of personas and narrative scenarios on knowledge acquisition, requirements analysis and design concept in industrial design. In this study, we are able to prove positive correlation between those methods and the number of derived product requirements as well as the completeness of the experiential design concept.

Further research on the adaption of reflexive tools based on persona and use scenario issues is in progress. For this study, we developed a list of generic questions that should support knowledge acquisition and requirements analysis in user-centred design. A quasi-experimental study with 80 novice engineering designers is in progress. First results are promising, but also show limitations of the transfer of tools between different design domains.

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