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UNDERSTANDING DESIGN THINKING: A PROCESS MODEL BASED ON METHOD ENGINEERING

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ABSTRACT
This article presents a formal model of the design thinking process based on Method Engineering. The foundation of our work is based on observations within an educational context—the 'School of Design Thinking' of the Hasso-Plattner-Institute in Potsdam, Germany ("HPI D-School"). We analyzed the design thinking process, as it is practiced there, and developed a process model that describes all process steps in detail, as well the respective input and output of each phase. A particular emphasis is given to the question, when to iterate in the process. The process model presented in this article contributes to a better understanding of design thinking, especially for educators, companies, and design practitioners. In detail, it could be used to better analyze design thinking projects and adjust them for specific companies or situations, to compare design thinking with other methods (design process models), and to develop IT-based solutions to support and facilitate the design thinking process itself or parts of it.

Keywords: Design thinking, design process, method engineering, process model, design education

1 INTRODUCTION

Design thinking is a specific method to solve complex (wicked) problems [1, 2] and to generate innovative solutions, based on a user-centered approach with multi-disciplinary teams. Design thinking—although introduced and shaped by the design consultancy IDEO [3]—is becoming more and more popular among business schools, and it is applied in R&D departments of companies to foster innovation. Unlike the typical creative design process, which is usually an intuitive and individual process, design thinking consists of a flexible sequence of process steps and iteration loops, each including several tools and resulting in different artifacts. Since it is the idea of design thinking to be applied by multi-disciplinary teams instead of well-trained designers, an explicit understanding of the process is crucial. There exist numerous books and scientific publications about the topic [3-7], but what is missing is a detailed and well-structured formal model of the actual method. Most existing descriptions of design thinking are informal, ambiguous, and not detailed enough.
This article is structured as follows: Section 2 covers related work and presents existing models of design thinking. Section 3 outlines an overview of Method Engineering as the underlying principle for our model. In section 4—the main part of this article—we introduce our proposed model of the design thinking process, and describe the involved elements and the input and outcome of each phase, in detail. Section 5 raises questions about limitations and deficits of the process and concludes with a summary of this article.

2 RELATED WORK

There exist numerous visualizations of design processes. See [8] for an overview. The model of the design thinking process suggested by the HPI D-School can be found in Figure 1. It consists of six consecutive steps (titled 'Understand', 'Observe', 'Point of View', 'Ideate', 'Prototype', and 'Test'), and some lines that suggest iterative loops between these steps—one could move back and forth between the phases of the process, according to the requirements of each step's outcome. Within this model there are no further explanations offered that would explain what is actually happening in each step of the process, or in what case these iterative loops should be performed.

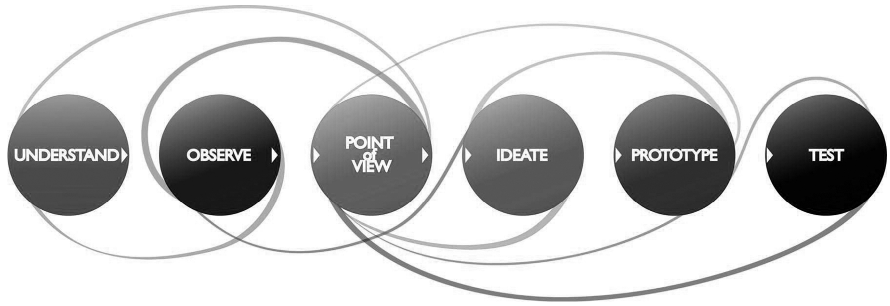

Figure 1. The Design Thinking Process Model at HPI D-School [7]

3 METHOD ENGINEERING

We chose Method Engineering as the underlying principle for the model. Originated in the Information Systems discipline, Method Engineering is concerned with the description, design, adaption, and evaluation of methods, using engineering principles [9-12]. Method engineering allows easier method adaption to project specific needs (so called method tailoring) [13]. Method fragments can also be combined to new methods (co called method composition) [12, 14]. The formal description of a method allows the reproducibility of methods by other researchers and therefore the testability of the method's utility claims. Also, method engineering is able support the teaching of methods. For the formal description of methods, different elements are recommended like the purpose and scope, the process model, and the involved constructs of the methods [12]. Typically a method has specific testable utility claims based on the purpose of the method [12, 15]. Sometimes these utility claims are based on kernel theories [16]. The utility of the method should also be evaluated [17]. As already mentioned, the purpose and scope of design thinking is the creation of innovative solutions for wicked problems. However, the question for which problems design thinking is especially beneficiary (the scope of the method) is still open. The utility claim is that design thinking can achieve its goal more successfully than other innovation techniques. For an evaluation of the method, an operationalization of these success criteria is needed, e.g. that design thinking may produce solutions that are more likely accepted by the relevant stakeholder(s). However, in this paper we will not discuss possible kernel theories of design thinking and any operationalization or evaluation (see e.g. [18] for an evaluative study). We focus on the process model and the involved constructs. Figure 2 shows the used symbols, which are a subset of the Business Process Modeling Notation (BPMN) [19].

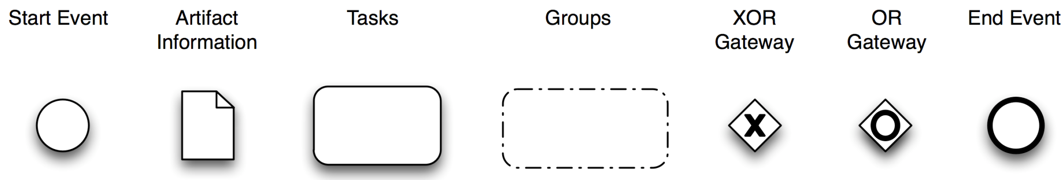

Figure 2. Used Symbols of BPMN

4 A DESIGN THINKING PROCESS MODEL

In this section we present a process model of the design thinking process. Although there exist different models of the design thinking process [4, 5, 20], we focus on the before mentioned model by the HPI D-School. In our suggested model, we 'zoom' into the six circles of the HPI design thinking process, and describe what is actually happening in each step. See Figure 3 for the suggested model of the design thinking process. Table 1 presents additional descriptions of the input and output of each step, as well as a definition of the aspired goal of each step, including the methods how to achieve this goal.

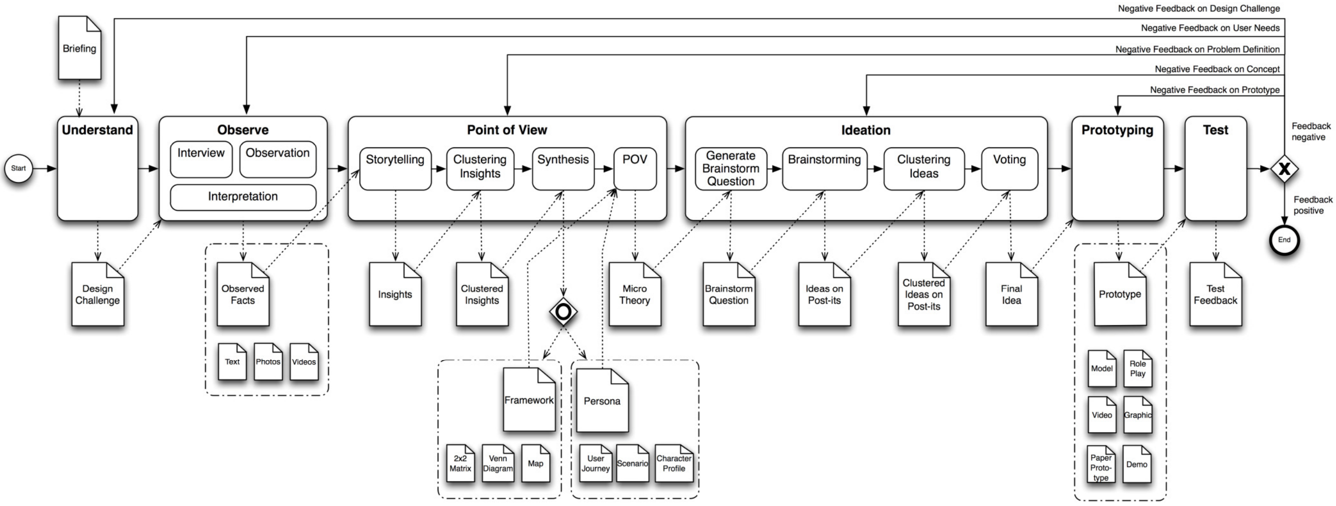

Figure 3. Suggested Process Model of Design Thinking

Table 1. Overview of Goal, How-to, Input, and Output for each Process Step

Process Step	Goal	How-to	Input	Output
1. Understand	Collect existing information, become an expert	Secondary (desk) research	Briefing, media	Collected materials printout, documentation
2. Observe	Gather insights about user's needs	Qualitative Research (interviews, observation)	Problem definition, design challenge, questionnaire, the subject of the project (specific product or service)	Photographs, videos, interview transcripts, documents, audio recordings, notes
3.1 Storytelling	Bring every team member on the same level, exchange research results	Storytelling (verbal narration/report, concurrent writing down by the other team members)	Insights about user's needs (photographs, videos, interview transcripts, documents, audio recordings, notes,)	Written insights and sketches on post-it notes
3.2 Clustering insights	Structure all insights	Grouping of similar insights, finding titles for each group	Insights and sketches on post-it notes	Re-arranged insights; groups of post-it notes
3.3 Synthesis	Condense insights into a visual representation, about the user's needs, identifying 'pain points' as room for improvement.	Clustering, visual alignment of insights in frameworks or as a user stereotype	Written insights and sketches on post-it notes	Framework or persona
3.4 Point of View	Micro theory about user’s needs	Searching for analogies and metaphors	Framework or persona	Point of View as a metaphoric user perspective
4.1 Brainstorming question	Generate brainstorming question that addresses the previously defined problem/user need	No formal method, everybody suggests a phrased brainstorming question	Point of View	Brainstorming question, phrased as “How might we…”
4.2 Ideation	Generate ideas for possible solutions to the defined problem or needs	Brainstorming, brainwriting, etc.	Brainstorming question, post-it notes	Many ideas written or sketched on post-it notes

4.3 Clustering ideas	Structure all ideas	Grouping of ideas, according to specific criteria (e.g. most useful, most feasible, etc.)	Ideas and sketches on post-it notes	Re-arranged ideas; groups of post-it notes
4.4 Voting	Decide on one idea to develop further	Voting of all team members, stick labels to favorites	All ideas	One idea
5. Prototype	Self-explanatory representation of the concept	Prototyping, modelmaking, role-playing, etc.	Selected idea, tools, materials	Prototype
6. Test	Gather feedback from users and stakeholders about concept and prototype	Show the prototype to potential users and stakeholders; let them work with it, try it out	Prototype, maybe questionnaire	Positive or negative feedback, quotes, documentation of the testing

The process starts with a briefing, which is provided by a (real or imaginary) client. Usually this is a very general description of a specific topic or problem area, but without stating what the actual problem is. Since the team members are supposedly not skilled in the respective area, the goal of the first step of the process is to 'become an expert'. This means, all team members try to gather as much information about the topic, as possible. This is achieved through secondary research, such as Internet, newspaper, TV, or book research. Facts, statistics, and background stories are collected and shared among the team. The second step aims at gathering insights from prospective users. Through qualitative research the team collects facts about the users and tries to interpret those. The goal of this step is *not* to ask the users about their needs directly—this is a common misunderstanding about design thinking. Usually, the users are not aware of drawbacks or needs they might have. Therefore the team has to identify needs, based on observations and interviews. The third step is the most complex and complicated. The goal is to define a so-called Point of View (POV)—some kind of a micro-theory about the problem area and the user needs. The way towards this POV involves several sub-processes: The team starts with storytelling, which means the insights from the research are shared among the team. Then, these insights are clustered according to specific themes, in order to identify patterns. During the synthesis these insights are condensed into a visual framework (such as a 2-by-2 matrix, a Venn diagram, or a causal map), or into a user-related persona (could be a character profile, a user-journey, or a usage scenario). This is then transformed into the Point of View, which is a usually verbalized (sometimes metaphoric) description of the specific identified problem and contains a micro-theory about the user's needs. Starting from there, a brainstorming question is generated, that addresses exactly this user need. The brainstorming question usually starts with "How might we…?", to trigger a solution oriented idea generation. In the ideation phase, ideas are generated using classical brainstorming techniques. These are then clustered according to different criteria, such as the 'realistic' ideas, the 'wildest' ideas, or the 'most useful' ideas. The team decides by voting, which idea they want to develop further. This idea is then build as a prototype, which could be a physical model, but also a video or a role-play (for service concepts), or a paper-prototype or an interactive simulation (for digital applications). The prototype should be able to communicate the concept, in order to test the idea. This is achieved by showing the prototype to potential users or to other stakeholders. Their feedback can then be used to iterate the prototype or to improve the concept. The iteration might be executed several times, until the user feedback is positive.

5 ARISING QUESTIONS, LIMITATIONS, AND CONSEQUENCES

Our suggested process model is a descriptive one that visualizes the process as-is—we do not suggest a normative model at this point. However, we identified some points that warrant further investigation. The question when to iterate in the process, and to which step to return to, seems to be quite ambiguous and inexplicit. The arbitrary lines that symbolize iteration loops in the original HPI D-School model (Figure 1) indicate a rather arbitrary choice of iteration loops. In our model, we tried to differentiate the iteration loops according to the type of feedback the user gives: If the feedback is about the specific prototype, the team should return to the prototyping step and modify the prototype.

If the feedback, however, addresses the concept, the ideation step should be repeated (maybe with a refined brainstorming question). And if the feedback shows, that the overall assumptions concerning the problem may be wrong, the team might have to go back to the Point of View or even to the research steps. It is even possible that the feedback shows that the whole understanding of the problem and the related design challenge were not correct, so that it might be necessary to start again from scratch. It is important to understand, that the detail in which the prototype is executed also produces different kinds of feedback. The more 'finished' the prototype looks, the more likely one will get feedback concerning the specific execution of the prototype (such as the colors), but less likely feedback about the overall concept. If, however, the prototype is a very rough one (e.g. a sketched paper-prototype for an interactive application), the feedback might question the concept itself (which might be more valuable for the team) [21-23].

However, iteration can only occur after feedback—and the only feedback in the design thinking process is scheduled in the test phase. Therefore, we see the need to establish more testing steps, earlier in the process, instead of testing only at the end of the process. In that case, the feedback gathered during the project, could be better transferred into systematic iterations. In particular, we would suggest a testing of the Point of View, since this is the central point of the process, where important decisions concerning the future direction are made. This micro-theory about the user's needs might be wrong, and testing it at this early stage would give the team the chance to adjust it, before a lot of time and work is invested.

Another challenge might be to interpret the feedback correctly, or to elicit structured feedback from the test users. Users may not be able to express precisely why they do not like certain aspects of the solution, nor are they aware at which step of the process the problem was developed. We distinguish between two types of feedback errors: false positive and false negative. False positive means that the feedback is interpreted positively although the concept has substantial flaws. False negative, however, means that the user feedback indicates problems that result in withdrawing the concept, although it might be successful. A structured analysis framework that maps qualitative user feedback to the respective process steps might be helpful. Such a structured analysis framework could be developed in future work.

A typical question in the design thinking process is when to stick to the process, and when to change it. Advanced design thinkers may be able to apply the process more flexible, change or skip certain steps, and adapt to external influences. However, the scope of this article is to describe the process in its current form—systematic adaptations could be discussed in further research. However, we think that the descriptive process model of the design thinking method makes it easier to adapt and tailor the method to a specific context.

Of course, the work presented in this article also has some limitations. Design thinking is not only about the process—it's also a culture with specific mindsets and rituals. Also the team structure and the setup of the workspace might be of importance. However, these factors have not been analyzed in this article. Also, we did not analyze possible underlying kernel theories of design thinking, which could explain the claimed effectiveness of the method. Further research is needed to investigate possible influences of these aspects.

6 CONCLUSION

Design thinking is an upcoming hot-topic. Educational institutions about design thinking are established around the world, and there exist numerous publications about the topic. Most of these publications are either a collection of scientific papers [20], a collection of case studies [7], or informal descriptions of methods and instructions [3-5]. What is missing is a formal model of the process that describes it in such a way, that less experienced design thinkers could reproduce the entire process and adapt it for their own specific requirements. The goal of the work presented in this article is to define such a formal model that could be used a) to conduct own projects using design thinking principles, b) to compare design thinking with other formalized design methods, and c) to develop IT-based solutions to support and facilitate the design thinking process itself or parts of it. As mentioned before, our suggested process model is a descriptive one that visualizes the process as-is. Further research would include developing a modified model that addresses the before-mentioned deficits of the process, as well as a structured feedback analysis framework.

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