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Impediments for Experimentation in Novice Design Teams

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Abstract

Despite the increasing interest in design thinking, there still is a lack of empirical understanding on what happens when design thinking, or elements of it, are adopted in organizations not accustomed to such approaches. Experimentation is one of the fundamentals of design thinking, and this study explores the impediments for experimentation in four novice design teams taking part in short-term experimentation sprints in a Finnish financial organization. This study adopted a case-study and action research approach and data was gathered through video-recoding and semi-structured interviews. Four central themes that may become bottlenecks when aiming to adopt experimentation in novice teams were identified: resistance to iteration, overlooking the experimentation ideas of others' and oneself, losing sight of the initial problem to be solved, and a bias towards planning. The study showed that adopting experimentation, in novice design teams requires the team to adopt an appropriate mindset that is open for modifications in the idea and for iteration in the experimentation cycle.

Keywords: experimentation, design thinking, design expertise, novice design teams

1. Introduction

During the last decade there has been an increasing interest in the concept of design thinking: applying design methods and attitudes beyond the traditional scope of professional design, to promote innovation in a variety of businesses. A central insight of design thinking is that "design has become too important to be left to designers" (Brown and Katz, 2011, p. 381). The mentality of thinking by doing (Brown, 2008) and learning through iterative experiments (Liedtka, 2014) is central in design thinking. This refers to the iterative and tangible development practice, where prototypes are built in order to learn about the strengths and weaknesses of an idea and to recognize alternative directions for further development (Brown, 2008). While prototyping is a central practice in fields such as architecture and product development, they are typically used to conceive, describe, and communicate ideas, validate solutions, explore user experiences, and facilitate discussion (e.g. Kelley, 2001, 2005; Boland and Collopy, 2004). In contrast, the emphasis of prototyping in design thinking is "to drive real world experimentation in service to learning rather than to display, persuade, or test" (Liedtka, 2015, p.). Hence, experimentation focuses on creating accumulated learning through trial-and-error cycles

where prototypes may be used, for example, to deliver a given functionality. Experimentation begins by defining what needs to be learned, which then guides what kind of a prototype needs to be created.

Recent research has noted the need to explore the adaption of design thinking methods among novice users (Seidel and Fixson, 2013). The central methods of design thinking, such as experimentation, are usually investigated under experimental conditions or as used by experienced teams (ibid). Furthermore, Carlgren et al. (2016) note that to date there is only very little empirical research on design thinking in organizational settings and only a limited understanding of what happens when design thinking is adopted in established business organizations (Drews, 2009; Carr et al., 2010; Seidel and Fixson, 2013; Carlgren et al., 2016). One of the central ideas of design thinking is, that organizational problems should be approached as design problems (Kimbell, 2011). In this, the concept of design thinking and its key methods are transferred to a non-design environment, and people approaching these 'design problems' will in many cases be employees with no or very little experience with the approach.

Within design research, the characteristics of designers' work and practice have been discussed for over 40 years (Johansson-Skoldberg et al., 2013). Research on design expertise has studied experienced and exceptional designers, and compared the processes of novice and expert designers, in how they approach design problems (Cross, 2004). Design capability can be understood as consisting of different levels of design expertise (Lawson and Dorst, 2009; based on Dreyfus, 2004). In this classification, the first level, novice, is described as follows: "a novice will consider the objective features of a situation, as they are given by the experts, and will follow strict rules to deal with the problem" (Kokotovich and Dorst, 2016, p. 80), and "a novice gets to know design as a series of activities that are organized in a formal process" (Dorst, 2015, p. 57). In this study, we use the term novice design team to refer to a team adopting experimentation as part of design thinking approach in non-design organization. It has been noted, that the development of expertise goes through different phases and in order for one to become an expert, training and education is needed (Cross, 2004). And just as the process of learning to be an expert designer includes its own challenges in adopting the profession's central practices, so does the process of a non-designer adopting the practices of design thinking, such as experimentation. Much of the empirical research in design is carried out on design students (Lawson, 2004; Defazio, 2008) or individual professional designers (Cross, 2004). However, in organizations adopting design thinking as an approach to innovation, design thinking methods are often employed by people who are not educated as designers. Further, rather than studying the messy situations of real-life everyday work (Schön, 1983), studies on expert design are often explored working on simplified tasks in simplified situations (Lawson, 2004). Thus, a better understanding of what happens when key design thinking methods are adopted by non-designers in a real context is needed.

In addition, previous research has noted one of the challenges of conducting academic research on design thinking practice to be "the multifaceted nature of its 'basket' of tools and processes" (Liedtka, 2014, p. 1) and

recognized the need for a framing of design thinking that would make it researchable both in theory and practice (Hassi & Laakso, 2011; Carlgren et al., 2016). Due to the ambiguity of the concept, researchers need to make a choice in framing their focus e.g. to examine particular tools or elements of the process. (Liedtka, 2014). For these reasons, we designed a study that focuses on exploring the adoption of experimentation, one of the critical elements in design thinking, in a "real" context, i.e. in teams of an established organization that are not accustomed (novice) to experimentation. However, unlike most studies that focus on expert design, all the participants of the study had several years of experience working in a specific business and most of them held a manager position at the time of the study, and thus were experienced in working with challenging problems occurring in real organizations. Also, as teamwork is seen as an implicit part of design thinking, (see e.g. Hassi & Laakso, 2011; Brown, 2008; Kelley, 2001), selecting team as the unit of analysis is reasonable. Building on the background presented above, we arrive to the research question for this study: *What team-level impediments for experimentation appear in novice design teams when adopting design thinking methods for the development of internal processes?* The research design included collecting data from four multidisciplinary teams through case-study and action research approaches. In order to study how experimentation is adopted and what might be the impediments for it in novice teams, the authors launched a six week 'experimentation sprint', in which teams were to develop ideas through iterative experimentation. Teams were followed throughout the sprints; each team participated in two to three tutoring sessions organized by the authors. In these, the teams were required to reflect on the experiments conducted and decide on the next steps. After the ending of the sprints, semi-structured interviews were conducted with all participants, individually. Analysis of the data from the four sprints identifies four central themes that may become impediments when aiming to adopt experimentation in novice teams: resistance to iteration, overlooking the experimentation ideas of others' and oneself, losing sight of the initial problem to be solved, and bias towards planning.

2. Literature review

2.1. The Central Role of Experimentation in Design thinking

It has been noted that adopting designerly practices to address complex and open-ended challenges in more contemporary organisations might be useful, since designing disciplines have developed elaborate professional practices to do this (Dorst, 2011). Design thinking, i.e. the use of design practice and competence beyond the context of professional design, such as for example industrial design, with and for people without design expertise (Johansson-Sköldberg, et al. 2013) has emerged as a human centered-approach to innovation during the last decade (Brown, 2008, 2009; Martin, 2009, Gruber et al., 2015). Although the origins of research on design as an activity date back to the 1960's (Cross, 2007; Bayazit, 2004), it was not until approximately ten years ago that design thinking found its way to the management literature (Rylander, 2009). The main message of design thinking for managers is that any discipline can learn and get inspiration from designers' way of

working and thinking, and apply this to their innovation efforts (Brown, 2008; Martin, 2009). When organizations are to address "wicked problems" (Rittel and Webber, 1973; Buchanan, 1992), i.e. problems and decision contexts where ambiguity and uncertainty are high, adopting the design-led approach to innovation is necessary (Gruber et al., 2015; Liedtka, 2014). The design-led approach to innovation differs from more traditional business-like approach by putting the discovery of human needs right at the forefront of the innovation process (Gruber et al., 2015).

Although there are different depictions of the design thinking process with some differences on how the phases and activities are divided and named, all versions underline the iterative nature between the different phases of the process, and go through similar activities starting from user need identification and problem definition, followed by idea and concept generation, and finally testing of ideas through prototyping and experimentations to choose the most potential ones (see e.g. Brown, 2008; Seidel and Fixson, 2013; Liedtka, 2014; Gruber et al., 2015). Iteration, and accumulated learning through multiple experiments is seen as a key task. It is proposed, that in contexts of uncertainty and ambiguity, learning through experimentation will be superior to an analytical approach in decision-making and the continued learning and the iteration of hypotheses will reduce risk and improve success in the innovation process (Liedtka, 2014). In their qualitative study, Carlgren et al. (2016) propose experimentation as one of the five key themes characterizing design thinking in practice, along with user focus, problem framing, visualization and diversity. Although prototyping has long been a key feature in fields like product development and architecture, when it comes to design thinking, the purpose of prototyping is somewhat different. In this, prototypes are used to conduct field experiments in order to test the key underlying and value-generating assumptions of a hypotheses (Liedtka, 2014). Experimentation can be defined as a bias towards iterative testing and trying things out, and moving between divergent and convergent thinking (Carlgren et al., 2016). Hence, rather than a one-step activity, experimentation can be seen to consist of different stages which require different kinds of approaches.

2.2. Differences between Expert and Novice designers

Problems in design are often described as ill-defined and wicked (Buchanan, 1992; Rittel and Webber, 1973) and instead of having one 'right' solution, many possibilities with no clearly defined rules on how to obtain these solutions exist (Goldschmidt, 1997). Design practices have been noted to be quite different from conventional problem solving. At the start of the complex open-ended problem-solving process of design, the only known thing often is the end value to be achieved (Dorst, 2011). The challenge then is to figure out what to create (e.g. object, service, system) and how to create it, and to do this in parallel. This parallel creation of a 'thing' and its way of working is the core challenge in design reasoning (ibid). Indeed, design approach is not about first settling on a problem and then searching for a satisfactory solution, rather it is about constant iteration of analysis, synthesis and evaluation processes between the 'problem space' and 'solution space' (Dorst and Cross, 2001). The way in which novice and expert designers deal with the constant decision making

and taking action that the ill-defined nature of the context of design requires, differs. Previous research has noted novice designers to differ from expert designers in certain inherent practices of design such as prototyping (Deininger, Daly, Sienko and Lee, 2016), problem decomposition (Ball et al., 1997), reflection (Crakett, 2004) and iteration (Seitamaa-Hakkarainen and Hakkarainen, 2001; Adams, Turns and Atman, 2003).

Problem framing, i.e. the (proactive) process of structuring and formulating the problem is often recognized as one of the key features of design expertise, and one that distinguishes outstanding designers from others (Cross, 2004). One of the key capabilities of design expertise has been noted to be the ability to mentally stand back from the specifics and to form a more abstract conceptualization (Cross, 2004; Kokotovichs and Dorst, 2016). Further, it has been argued that experts seem to take a broader 'systems' approach to the problem at hand (Cross, 2003), and that experts analyse the problem from a broad frame of reference (Kokotovichs and Dorst, 2016). Experts perceive more interconnections than novices, both within different aspects of design problem itself, and between the problem and their other experiences (Björklund 2013). Also, due to the domain-related experience it has been noted that experts are believed to be able to store and access information in larger cognitive 'chunks' than novices can, and to recognize underlying principles, rather than focusing on the surface features of problems (Kokotovichs and Dorst, 2016; Cross, 2004).

The design process can be described as a sequence of decisions, which require different cognitive processes (Badke-Schaub, Goldschmidt and Meyer, 2010). Both, widening the problem space via divergent thinking (generating alternative solutions), and narrowing the problem space via convergent thinking (choosing 'the best one'), are important (Badke-Schaub, Goldschmidt and Meyer, 2010). Some studies have noted that creative, productive design behavior requires frequent switching between different types of cognitive activities. This may be due to the need to be able to move quickly between the problem and solution spaces (Cross, 2004). Design experts have been found to have well organized and clearly structured cognitive actions, which result in more active and productive cognitive processes than novice designers (Kavakli and Gero, 2004). Similarly, differences in productivity and extent between expert and novice designers have also been shown already in representing design problems (Björklund 2013). On the other hand, expert designers have been noted to be more solution-focused than problem-focused (Cross, 2004). This is an approach that comes with experience, for example experience in a specific problem domain enables designers to move quickly to identifying a problem frame and proposing a possible solution (ibid). Although generating a wide range of alternative solution concepts is recommended by design theorists and educators, this appears not to be a typical practice for designers (Cross, 2004). Novice designers as design experts may become fixated to a single, early solution (Ullman, 2003) and unwilling to abandon that solution even in the face of difficulties in developing the concept into a satisfactory solution (Ball et al. 2010; Cross, 2004). This premature commitment to a solution is known as design fixation; "a blind, sometimes counterproductive, adherence to a limited set of ideas in the design process" (Jansson and Smith, 1991).

Further, reflection is an important part of design (Schön, 1983). According to Schön (1983), design is a process of reflection-in-action, where the design problem is gradually restructured and improved. Reflection on the problem at hand happens in problem setting, where certain features of the problem space are chosen to be attended and certain areas of the solution space are identified to be explored (ibid). Previous studies have shown that experts seem to engage more in reflection than novices (Crakett, 2004; Petre; 2004; Deininger, Daly, Sienko and Lee, 2016). For example, Deininger et al. (2016) studied how novice designers use prototypes in engineering design, finding experts used conscious reflection on what has been learned from previous prototypes, leading them to reframe the problem and modify the solution, whereas novice designers were often unaware of the prototyping practices that might help them.

As particularly relevant in regards to experimentation, previous research has shown differences between design experts and novices in iteration, a key activity in design. Measures of iterative activities have been showed to correlate positively with design success (Adams, et al., 2003). For example, the study of Adams et al. (2003) on engineering student design processes revealed that more skillful students tend to iterate more. Previous studies have also differentiated between task iteration and mental iterations in design context, where the former refers to repeating design tasks in a project and the latter to repeating cognitive activities i.e. thinking processes inside designers' minds (Jin and Chuslip, 2005). In their study on mental iterations in different design situations, Jin and Chuslip (2005) found, that it is the need for creativity that calls for more iterations in design and in more routine design, the emphasis is on reusing ideas. The involvement of designers have also proven to increase iteration and divergent thinking in design process (Berends, Reymen, Rutger and Murk (2011). Thus, earlier research suggest that experienced designers tend to iterate more whereas people with less design thinking capability have a tendency to move earlier to the convergence mode (Adams et al., 2013).

3. Research design and methods

The research question of the study was to address what team-level impediments for experimentation appear in novice design teams when adopting design thinking methods for the development of internal processes. In order to create a deeper understanding on the subjective experience of novice design teams in adopting design thinking methods, this study adopted a qualitative research approach conducted in an inductive manner. To investigate this phenomenon, the study was designed based on case-study and action research approaches of four novice design teams taking part in short-term experimentation sprints. Rather than developing propositions and testing claims based on current theory, the inductive research approach is concerned with building theories from data (Eisenhardt, 1989). However, unlike in grounded-theory approach (Glaser and Strauss, 1967) which is based on pure inductive approach, and where theory is resulting strictly from the data, Eisenhardt (1989) proposes that researchers should formulate a research problem and possibly specify some

potentially important variables with some reference to existing literature while considering these priori constructs only as tentative (Eisenhardt, 1989; McCutcheon and Meredith, 1993).

3.1. Research design using case studies

Given the limited empirical understanding of the adoption of experimentation in established organizations, case studies were chosen because of their strength in providing in-depth understanding in exploring, describing and explaining complex phenomena in its natural context (Eisenhardt, 1989). It has been noted, that with unfamiliar situations or ones for which there is little theoretical background, the case study approach may be the only available means of investigating a problem (Yin, 1989). Further, in this study the context and the experiences of actors play a critical role, which justifies selecting a case study approach (Benbasat, Goldstein and Mead, 1987; Bonoma, 1985). Furthermore, the selection of the research setting and corresponding cases plays an important role in allowing the variables of interest to be examined directly (Eisenhardt, 1989). There are several reasons, why the characteristics of our research setting go well along with our research design. First, the team members of participating teams were unfamiliar with experimentation as an approach for development. This represents a real situation of deploying experimentation in an organization to members who are not familiar with the approach. Second, the setting enabled comparison of team-level factors across the teams. Each team was from the same organization, and was operating within the same framework and demands, as well as given similar background information and guidance through workshops and tutoring sessions, which aimed at minimizing variation. The researchers acted as tutors for the teams, facilitating the experimentation during the project based on the needs of the teams and providing the needed structural support (see Table 1). The teams also had a fixed schedule so time allotted for the challenge was the same for all teams. The pre-defined structure of the sprints provided a setting where one could approximately predict the timing of different stages of the experimentation cycle, providing an opportunity to simultaneously explore several projects of the population with similar external environments and constraints (Eisenhardt, 1989).

3.2. Data collection

As noted by Yin (1994), gathering evidence from multiple data sources addresses possible problems of construct validity within a case study as the different sources “provide for multiple measures of the same phenomenon” (Yin, 1994, p. 92). In this study data was collected through video-recordings of altogether 12 tutoring sessions, and qualitative interviews with all 15 participants that took part in the four experimentation sprints. After each tutoring session with the teams, the authors reflected on the process of the teams and discussed the difficulties they were facing. These conversations were documented into notes describing the progress and practical actions taken by the team, as well as reflections on the general feelings of the team members. After the closing of the experimentation sprints in spring 2013 and 2014, semi-structured face-to-face interviews were conducted with all team members. During the interviews, the participants were asked to

reflect on the sprint and to recall on their experiences with critical-incident inspired themes (Cope & Watts, 2000) such as challenging and exhausting moments, and turning points. The aim was to gain an improved understanding about their experience of the experimentation sprint and to understand what were the things impeding the team to move forward the experimentation cycle (as was noted already during the tutoring sessions). All the interviews were held in Finnish, the mother tongue of the interviewees and therefore all the excerpts presented in this paper have been translated into English. The resulting 15 interviews lasted between 63 and 98 minutes, averaging at ca. 80 minutes. All the interviews were audio recorded and transcribed for analysis. In addition, comprehensive notes were taken in each of the interviews, which were then transcribed into an interview memo. Finally, after conducting the interviews, the authors conducted retrospective reflections discussing the progress and the challenges met by all of the teams. These retrospective reflections were again recorded (130 mins.) and listened in order to write notes for the data analyses

Table 1 Sprint timeline, author involvement and data collection

Sprint week	1	2	3	4	5	6	After the sprint
Sprint milestones	Two half-day workshops: one on ideation, another on experimentation (held simultaneously for teams A & B in 2013, and C, D in 2014)	1st tutoring (held simultaneously for teams A & B, separately for C & D): team status and evaluation, ensuring reflection and learning		2nd tutoring: team status and evaluation, ensuring reflection and learning (held separately for all teams)	3rd tutoring with teams A & B (held simultaneously): team status and evaluation, ensuring reflection and learning	Closing session (held simultaneously for teams A & B in 2013, and C & D in 2014): teams present the outcomes and reflect on their process and learning	
Author involvement in the sprints	Introducing the experimentation methodology to the individuals, facilitating the two workshops	Tutoring to ensure reflection and learning, and iterative experimenting	Email exchange with the team teams (status check)	Tutoring to ensure reflection and learning, and iterative experimenting	Tutoring to ensure reflection and learning, and iterative experimenting	Leading the final presentations of the team teams recapping key learnings	
Data collection	Reflection among authors, field notes	Videotaping tutoring, reflection among authors, field notes	Field notes (from the email exchange)	Videotaping tutoring, reflection among authors, field notes	Videotaping tutoring, reflection among authors, field notes	Videotaping closing session, reflection among authors, field notes	Face-to-face interviews, writing interview memos, recording retrospective reflections

3.3. Research setting

Data was gathered from a Finnish financial institution of 500 employees, operating both in Finland and the Baltic countries (Table 2). The researchers were introduced to the organization at the moment when the top management had decided to introduce experimentation into the corporate innovation activities. The four teams studied were the first teams in the organization to adopt experimentation. The unit of analysis in this study are teams and the focus is on team-level interaction regarding experimentation efforts and hence, possible organization-level factors are excluded from this study.

Table 2 Characteristics of the organization, the initial idea and the team

The organization under study	A Finnish financial institution of 500 employees, operating both in Finland and the Baltic countries. The institution provides several financial services including wealth management, investments, savings, personal risk insurance as well as incentive and reward solutions to both private and corporate customers. The company has an estimated 250 000 private and 25 000 corporate customers.			
	Team A	***Team B***	***Team D***	***Team E***
Identified problem	*Meetings in our organization are inefficient*	*Too much time is spent on receiving a confirmation to make everyday decisions*	*Process of welcoming customers does not support a great customer experience*	*Too little recognition is received from a work which value is difficult to be measured*
The initial solution idea the team chose to explore and develop	*A new meeting procedure that affected the way meetings were prepared, held and facilitated. Included changes in the physical environment of the meetings.*	*A physical tool and process to support employees in making everyday decisions more independently.*	*A new process and redesigned physical space to improve customer service.*	*A system to share project results internally to support both giving and receiving feedback and improving information sharing.*
Team composition (title / sex / work experience in the organization)	Three-member team: • Communication designer / female < 1 yr • Human resource expert / Female 2 yrs • Personnel manager (business and sales development) / Male / > 5 yrs	Three-member team: • Personnel manager (hr development) / Female > 2 yrs • Marketing designer / Female > 2 yrs • Communications manager / Female < 2 yrs	Four-member team: • Sales representative / Female < 3 yrs • Analyst Male, 13 yrs • Account manager / Male, 5 yrs • Sales development and marketing communications specialist / Female, < 5 yrs	Five-member team: • CRM manager / Male, 9 yrs • Development manager / Female, 2 yrs • Development manager / Male, 10 yrs • Project manager / Male, 3,5 yrs • Development director / Male, 14 yrs
Timing of the project	Spring 2013		Spring 2014	

In order to study how experimentation is adopted in novice teams and what are the possible impediments to it, the researchers launched six-week long 'experimentation sprints', during which the participating teams aimed to develop ideas further by creating learning through various cycles of experimentation. The objective for the experimentation sprints was given by the leadership of the organization, and defined as "how might our organization become the world's best place to work?" The sprints were established for two interlinked purposes: to allow the real-time research of experimentation in action by the researchers, and to introduce the experimentation-driven approach for development to the organization that was interested in "becoming more experimental." These sprints started with two half-day workshops that aimed at providing needed methods and tools for the participants and introducing experimentation as a development approach. These workshops were followed by two (sprint in spring 2014) or three (sprint in spring 2013) tutoring sessions, where the researchers worked with the teams to reflect on their work and together decide the next steps (Figure 1)

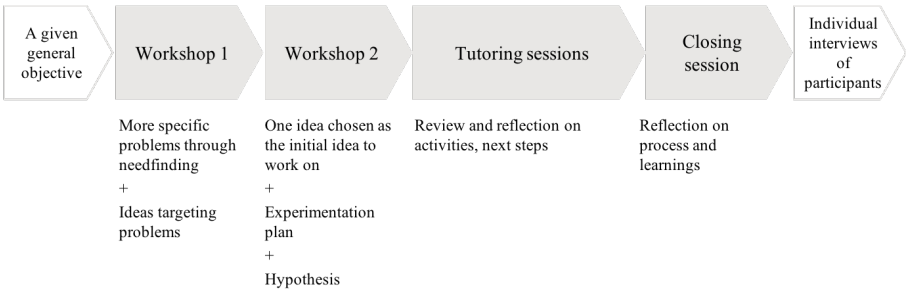
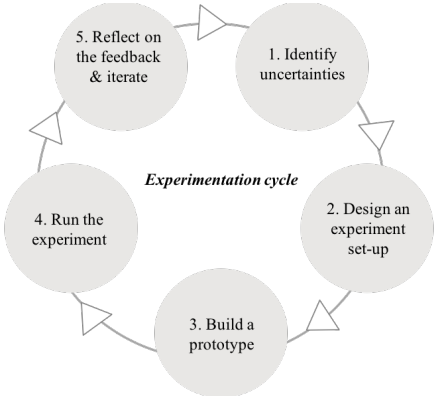


Figure 1 Structure of experimentation sprints

The research setting in the present study provided an opportunity for real-time study through an action research approach. Action research aims both at taking action and creating knowledge about the action while researchers are actively taking part in a change situation (Coughlan and Coghlan, 2002). The role of the researchers in this study was to serve as tutors for the teams, adapting the facilitation of experimentation during the experimentation sprints and providing the needed support and guidance. Further, action research has been noted to be applicable to the understanding, planning and implementation of change in business firms and other organizations (ibid). In the organization studied, top management was interested in introducing experimentation as an additional approach to its innovation activities, which would require a change in how problems are approached. During the experimentation sprints, the teams were required to follow a cycle of experimentation originally designed by the researchers, which formed the framework for teams' action. This experimentation cycle consists of the following five stages: identifying uncertainties, designing the experimentation set-up, building a prototype, running the experiment, and finally, reflecting on the feedback and iterating (see Figure 1). In the first stage, *identifying uncertainties*, the idea is broken down into smaller parts in order to screen for uncertainties that need to be tested. After this, the recognized uncertainties are converted into learning objectives that state what one expects to learn about. The second stage, *designing the experimentation set-up*, is about considering how to create the situation where the desired learning can be

generated. It involves e.g. thinking whom to involve and which environment is suitable for conducting the experiment. The third stage is *building the prototype*, where the team needs to consider what needs to be created in order to meet the learning objective. This is followed by the fourth stage, *running the actual experiment*. The final stage of the experimentation cycle is about *reflecting on the collected learning from the experiment* to draw conclusions for the next one, or deciding that the idea at hand is not worth proceeding with. The tutoring sessions focused mainly on the two phases of the experimentation cycle: reflect on the feedback and iterate (5) and identify (new) uncertainties (1).

Figure 2 Stages of experimentation cycle



Between the tutoring sessions the teams were to work on designing and conducting their experiments, gathering feedback and analyzing the results of their experiments. Tables 3 and 4 presents the main observations from the tutoring sessions of each team. At the end of the sprint, a closing-session was organized where the teams reflected on their process and learning over the six-week period.

Table 3 Main observations from the tutoring sessions of Teams A and B

Main observations from tutoring session Teams A and B, Spring 2013			
	Tutoring session I*	**Tutoring session II**	**Tutoring session III***
Team A	Team had conducted first experiments and were feeling good about having done something concrete. However, already at this point they had turned into a convergent mode in their thinking and were ready to implement their idea. Did not talk about alternative ways to solve the identified problem: Meetings in our organization are often inefficient. Were sharing only the positive and strengthening feedback received for their idea.	Team tried to cancel the second tutoring session, and ended up postponing it. Had not conducted any further experiments after the first tutoring session and did not see the value of the second tutoring session. Team seemed to be very frustrated as they were not allowed to close the project yet. After an impromptu ideation exercise lead by the tutors, the team was able to open their thinking again for further experiments that would be valuable.	Team had conducted further experiments, which were discussed in previous tutoring session. Through these experiments the team had learned critical things to take into account when considering the implementation of the idea. Team reported having challenges in finding test users and were hesitating whether they can "disturb" people with their experiment.
Team B	The first experiment was still ongoing. The team was comparing their progress with Team A and because their idea was on a more abstract level, they were feeling uncertain whether they were on a right track.	First experiment brought to an end and feedback collected from the two-week experiment. Team discusses the results of the experiment and reflects them back on the identified problem. Team is able to recognize important elements of the idea that would need further testing through ideation exercise. However, they are not "in the mindset" of conducting further experiments and do not talk about how the recognized elements could be tested.	No further experiments conducted, but "selling the idea" about the concept to people from different unit.

*Held simultaneously for both teams

Table 3 Main observations from tutoring sessions of Teams A and B

Table 4 Main observations from tutoring sessions of Teams C and D

Main observations from tutoring session Teams C and D, Spring 2014		
	Tutoring I	**Tutoring II**
Team C	Team realized the initial problem they had identified did not exist in the extent they had thought. This had crippled the team to move forward in the experimentation cycle and the team was not able to see alternative ways of how the initial problem could be approached. Team has difficulties in moving into concrete level in their discussion and this happens mainly with the help of questions presented from the tutors.	Team is still having challenges to recognize what could be the 'problems' to tackle. Instead of aiming to test different customer experiences, the team tried to receive this insight by asking customers what they would prefer. Some important learnings have been gained (that would also affect customer experience) but as their mind so deeply in the first solution idea (which turned out to be a false assumption), the team is not able to catch these and build on them.
Team D	Team had conducted the one experiment that they planned during the second workshop. As the team had received positive feedback from their first experiment (also non-supportive one but this was not really recognized), they had the mindset of closing the project and were not motivated to conduct further experiments. Did not remember the initial problem they were aiming to solve and hence, were not reflecting the results of the experiment on that.	Team had not iterated the first experimentation idea but conducted an experimentation which had only an incremental addition to the first one. Seems, that the team had 'done something' just because this was required by tutors. The team is discussing mainly based on their own feelings and experience and not reflecting on the results of the experiments. Although the second experimentation was not received very favorably (team reports this at the beginning of the tutoring session), the team drifts into discussing the technical implementation of that idea.

3.4. Data analysis

The data was analyzed in within- and cross-case analyses. As noted by Eisenhardt (1989) the overall idea of within-case analysis is to become intimately familiar with each case as a stand-alone entity. According to the author (ibid) this process allows the unique patterns of each case to emerge before researchers push to generalize patterns across cases. Also, within-case analysis provides a rich familiarity with each case, which, in turn, accelerates cross-case comparison. Cross-case analysis, on the other hand, forces the researcher to look beyond and view evidence through multiple lenses. (ibid.) Data of this study was analysed iteratively with literature review and the existing literature on design thinking and design practices affected to some extent in the data analysis and the development of the themes. As the purpose of the study was not to develop new concepts or conceptual models, grounded-theory approach (Glaser and Strauss, 1967; Bryant and Charmaz, 2007) was not utilized in the current study. However, rather than limiting the focus of data analysis to predetermined aspects of potential impediments of experimentation efforts based strictly on existing literature, the recognized preliminary themes were created based on reoccurring descriptions or observations that impeded the teams to move forward with experiments.

The within-case analyses started with reading the field notes from the tutoring sessions and the closing session of experimentation sprints and watching the video-taped material while at the same time making notes on what was observed. The focus was on recognizing interactions or situations which impeded the team to move forward in the experimentation cycle, e.g. to recognize what had been learned from the experiment in order to know how to proceed (stage: reflect on the feedback and iterate), or to come up with a suitable medium for learning from the idea (stage: building a prototype). In order to create a solid picture of the cases under study, the recorded retrospective reflections on the cases done by the authors were listened at this point. After finishing the first-round of watching the video material and listening to the retrospective reflections, the transcribed interviews as well as the notes of the interviews were read case by case. At this point, the preliminary case reports were drafted and the preliminary themes for impediments for experimentation in novice teams were recognized. Having these themes in mind, the video material and interview transcripts were reviewed again in order to find more empirical evidence for the emergent themes. The interview transcripts were now systematically coded based on the preliminary themes, and descriptions of meaningful moments and incidents from the video-taped tutoring sessions supporting a particular theme were systematically written down. At this point, there were altogether five themes and all the themes were critically discussed and reflected by the researchers. In order to see the critical elements in the data, all themes were revisited at this point. After revisiting all the themes and going through the exemplary quotations and notions from tutoring sessions, the final four themes were formed. Some of the themes remained the same while others were modified. For example, the theme ‘urge to converge’ was included under ‘resistance to iteration’, and the theme ‘fixation to first experimentation idea’ was changed to ‘losing sight of the initial problem to be solved’ in order to better describe the content.

4. Findings

4.1. Resistance to iteration

Resistance to iteration refers to the team's unwillingness to implement the learnings and repeat necessary experimentation activities after the first experimentation cycle. The participants were able to see the value of iterations only after retrospectively reflecting on the valuable learnings received from them (often not until during the interviews). After having conducted the first experiment all of the teams were seemingly satisfied simply due to having done something concrete and collected feedback. However, after that it became much harder to implement the learnings and run the next experiment. Resistance to iteration turned out to be one of the biggest barriers for experimentation in our study. There seemed to be two main motivations for the resistance: first, the team considering the idea ready to be implemented and further experiments bringing no added value, and second, an urge to converge on the first idea experimented in order to "implement quickly". The first type of motivation, was evident in a few ways. For example, after the first experiment, instead of embracing the iterative approach that aims at learning through multiple experiments, most of the teams (Teams A, B and D) were acting rather defensive or just uninterested towards the need for further development of the solution idea (i.e. implementation of lessons learned, identification of remaining uncertainties and conducting further experiments). The tutors had to emphasize the need for further development in order for the team to keep moving further in the experimentation cycle. Hence, although the iterative nature of experimentation and the objective of learning through multiple experiments was clearly communicated at the start of the experimentation sprints, the iterative learning would have not been realized without the pressure and support of the tutors. For example, Team A suggested first to cancel a tutoring session, and when it finally was held, a member from the team mentioned at the beginning of the session: *"Somehow we feel that we could just implement this already. – So, we did not think alternative ways to experiment our idea."* It was evident that the team was unwilling to be present as they felt that their idea is ready to be implemented already at that stage, and they were not willing to iterate. Considering the idea to be fully developed and ready for implementation after the first experimentation cycle was apparent also in Teams B and C. As a member from Team B noted during the interview:

> *"We were rather shy in that we would have started experimenting something totally new, maybe the so called glamour was gone [after the first experiment]… – Perhaps we could have been more courageous in that, but in a way it felt like this is a complete package already that you cannot change it anymore."*

Further experiments were conducted because it was 'required' by the tutors, not because it was seen valuable by the team, as the following comment by a member from Team B demonstrates:

> Team member from Team B*: "In that one tutoring session when we were asked to conduct further experiments we were like 'why?' and before that session we were still like will these (new experiments) be of any use. But maybe this illustrates how your own feelings are affecting...I think we never really got rid of the idea that it is unnecessary to conduct experiments [laughs].."*
>
> Interviewee*:" To experiment second time?"*

> Team member from Team B*: "Yeah, second time, and it was more like let's run some experiments because we are told to."*

As soon as it became evident that the tutors required teams to conduct further experiments during the experimentation cycle, team members went into a passive mode, demonstrating a lack of ownership of the project and lack of interest to continue with the further development of the initial idea. The following example, where a tutor is trying to activate the team to consider further possibilities for the development of the idea, captures the nature of these situations (Team D):

> Tutor: *"Do you see that there are alternative ways to reach the upper-level goal you have?"*
> *After a short silence, one team member notes and laughs: "Probably..." and looks for other team members who remain quiet.*

Secondly, the resistance to iteration came also through in the teams' eagerness to move from the divergence (generating different options to a possible solution) to convergence mode (choosing the 'best' one) as soon as possible. This urge to converge avoided the team to open the idea again for further testing. For example, as a team member from Team D noted during the first tutoring session when there was still approximately four weeks left of the experimentation sprint: *"In fact, this (first) idea became the one to be implemented also. This is the end result."* This phenomenon highlights one of the central issues; most of the teams considered experimentation to equal the quick implementation of ideas, and because of that the teams were really struggling to keep the idea open for further learning, modifications and accepting a potential rejection of the idea after the first experiment. Urge to converge was also shown in the way teams were selective for supportive feedback for their experiment. For example, in the first tutoring session, a member from Team A stood up during the presentation of their first experiment, walked in front of the screen and pointed towards a positive feedback received from a higher-level manager. This way, the person wanted to emphasize the positive acceptance of the idea. Further, in the following tutoring sessions, most of the teams (Teams A, B and C) brought up only the supportive feedback received from the experimentation. It seemed that the teams were blind, or unwilling to see any non-supportive information, and by highlighting the positive feedback received, they tried to 'receive the permission' to implement the idea already at that stage. As if the measure of success would have been how quickly the idea is implemented, not how much the team is able to learn about and improve the idea. Hence, teams were not able to collect all the relevant information of their experiment as non-supportive feedback was usually recognized only after the tutors explicitly brought up these to the discussion. Thus, receiving supportive feedback from the first experiment may make the team less willing to further develop the idea and unable to recognize the value conducting further experiments could offer. The team may also be so confident about the assumed need of their idea, that they are only looking for supportive information from the experiments and unable to catch the learning from other kind of signals (confirmation bias). Hence, if the team is very confident of the fact that the idea is "ready" and that they have all the relevant information

in order to successfully implement the idea, there usually is little motivation to open the idea again to further experiments.

4.2. Overlooking the experimentation ideas of others' and oneself

This theme refers to not acknowledging ideas presented by other team members as per how to create the experimentation set-up. In order for a team to be able to experiment with the *idea they have for a solution*, they need to come up with *ideas on how to conduct the necessary experiments*. To distinguish between these two idea types, let's call the former a '*solution idea'* and the latter an *'experimentation idea'*. Generating experimentation ideas is a key activity in designing the experimentation set-up: this is where the team designs how they can create necessary learning and tackle the identified uncertainties in the solution idea. This activity is essentially comparable to any idea generation situation, and requires similar psychological safety as any creative endeavor, where team members take the interpersonal risks to propose new ideas or perspectives. This is emphasized in situations where the people involved are not used to creative work (e.g. novice design teams) and can therefore be especially sensitive to the reactions of their peers. Overlooking experimentation ideas suggested by other team members has a discouraging effect and may lead to a situation, where the person who initially suggested something to discontinue with the line of thought, stop pursuing the suggestion, discourage the suggestion of other ideas. Hence, how the team members react to each others' ideas and suggestions can have an effect on how actively different team members will participate in ideation and discussions in the future.

In the studied teams, peers overlooked proposed ideas and suggestions in several ways. For example, not showing an interest towards what another person is saying (lack of concentration e.g. by not looking towards the person (apparent in Teams A, C and D), reading emails from one's phone (Teams A and D), ignoring the idea (by not stating one's own opinion or just being quiet and otherwise very passive, apparent at some level in all teams), shooting the idea down by a discouraging comment ("*Well, I dislike that thought since…*", Team member from Team A) or stating why it is not possible or what makes it too difficult to even consider (apparent at some level in all teams). These behaviors lead to situations where the experimentation idea suggested in the first place did not receive support and died before the potential of it ever really got evaluated. If the team does not build on each others' ideas but instead presents counterarguments towards the suggestions made, the danger is that the team will get stuck before it ever really gets going in the first place. Thus, overlooking the experimentation ideas of others' and oneself might become a bottleneck for the teams to proceed in the experimentation cycle. For example, it was difficult for Team C to get started with experiments and a member described their communication as follows:

> *"It was difficult for us to reach a common understanding...during our discussion we noticed that we had different perspectives and we were presenting counterarguments to each other...it was difficult to reach a common understanding on how to proceed."*

Sometimes an experimentation idea was killed by turning it into a joke (happened in Teams A, C and D). After an idea is turned into a joke, it is very difficult for any team member to discuss the idea seriously anymore. We also noticed that when a team member shared an experimentation idea with the rest of the team and no-one acknowledged it, the person suggesting it in the first place started to turn against his own suggestion and withdraw it from the conversation. As if assurance from others would be needed quickly in order from one to dare to hold on to an idea. Hence, we argue that positive comments, being enthusiastic about others' points of views and building on others ideas and suggestions for experimentation ideas have a pronounced role in the context of novice teams.

4.3. Losing sight of the initial problem to be solved

Another bottleneck for experimentation in the studied teams was the fact that they were not able to maintain in mind the problem they were working to solve, as they started experimenting with their solution idea. Keeping the problem to be solved in mind, and reflecting on it in order to iterate, would have helped the teams to keep the solution space open. Instead, the teams lost sight of the problem as can be seen in a conversation with a team member working on a solution to motivate independent decision-making:

> *Tutor: "…did you speak amongst each other about the objective, during the experiment or if the (solution) motivated independent decision making?"*
> *Team member from team B: "Well no we did not really, maybe at some point exchanged a few words in the corridor…but we did not yet analyze it."*

As a result, the teams drifted into a situation where the solution space kept shrinking as the sprint moved on: they were unable to diverge and search for new potential solutions or for variations of the solution idea. For example, Team B did not ask themselves the question "what other solutions or variations of the current idea could motivate independent decision-making?". The initial problem serves as a "mental anchor" to which the teams could return and openly search for alternatives – and this is what the teams did not seem to have. After the teams had conducted the first experiment, they were not able to reflect on how the learnings affect the solution idea nor to find different perspectives on how to approach the initial problem. This mindset led to trouble especially in situations, where the first experiment was not supporting the initial idea.

For example, before the first tutoring session, Team C had observed that their initial idea as such would not be worth going forward with, and, having lost sight of the initial problem, they were not able to consider other possibilities to tackle the identified problem. Hence, because of the shrunken solution space, the teams were not able to reframe their problem, which led to stagnation. Further, the fact that the team had lost sight of the initial problem came also through in that, that it was not always clear that what were the learning objectives of the experiments. This affected in how well the team was able to collect meaningful feedback from their experiment and hence, to test, whether their solution idea was targeting the problem or not. An example of not

being fully aware of what are the elements of the idea that would be most valuable to learn about is illustrated below:

> Interviewee: "*How did you collect feedback on your experiments*?"
> Team member from Team A: "*We had pictures of thumb up and thumb down in the wall and the users then circled one of those*."
> Interviewee: "*And what was it evaluating*?"
> Team member from Team A: "*That it was a good thing overall*."
> Interviewee: "*You mean the agenda structure and the time pressure for making the meetings shorter and more efficient*?"
> Team member from Team A: "*No, as the idea as a whole. We did not separate that how did people feel related to those different aspects*."

This example shows, that the team did not keep in mind whether the feedback from their experiments provided support for the fact, that their solutions would have been targeting the initial problem, i.e. making the meetings more efficient. Rather, the teams were satisfied if the overall feedback was positive, which probably affected their motivation to continue with further experiments as well as their ability to recognize the need for them.

4.4. Bias towards planning

Bias towards planning manifested itself in the procrastination when moving from thinking to doing. First of all, we came to witness several situations in which the team was well aware of the elements of the solution idea that should be experimented with and even how this could be done (these had been, for example, spoken out loud in the tutoring sessions) but somehow, they were not able to move from thinking to doing. There seemed to be an "invisible barrier" causing procrastination in actually getting the experiments started. During the second tutoring session, when Team A is asked to tell what they have been doing after the first tutoring session, one member explains: *"We sat down for half an hour and did a little planning...but that's it."* The teams were in some way stuck in developing the idea simply as an intellectual exercise, rather than through experiments and feedback from the users. A member from Team E describes this during the interview: *"Before the first tutoring session we only did some planning and ideation on what could be done concretely. The other tutoring session was delayed because we still had not done any 'fieldwork' (experiments)."* There is another example from the second tutoring session of Team A, where the team is discussing different options for how to communicate the remaining time of a meeting, and keeps discarding all of their ideas: e.g. hourglass ("*You probably would not even notice it*"), timer ("*It does not feel good that there would be a read digital clock showing the decreasing time*"). So instead of getting proof to their feelings by quick-testing, the team tries to decide on the best idea.

Although some teams were good at analyzing the experiments (e.g. in case Team B) and extracting learning from them, they were not able to move from analysis to concrete action. During the tutoring sessions, the

discussion often got stuck in analyzing the current situation and the possible new experimentation ideas did not materialize as conducted experiments, nor did the teams take their discussion in the more concrete level in deciding what would be the next steps without the help of the tutors. It is not enough for a team to be aware of the remaining uncertainties regarding the idea, and designing (ideating) an experiment set-up, the team also needs to be able to move from discussion into doing and run the experiment.

Table 5 Data supporting the themes and manifestation of the themes in each team

Theme	Description of the theme	Exemplary quotations from interviews & Observations from tutoring sessions	Manifestation of the themes in each team
Resistance to iteration	Unwillingness to implement the learnings and repeat the experimentation activities of an experimentation cycle after the first cycle is finished	"After the second tutoring session, the feeling dropped because we were like what do we need to do now and we were uncertain that where this was going. And we felt that can't we just implements this already that what the heck are we supposed to experiment anymore?" (Interview, Team member from Team A) At least, if I think that some idea is great and the more you believe in it the less you want to open it again because somehow you think that you will break it. -- You don't want that uncertainty again that you should come up with some new approach (to the problem). (Interview, Team member from Team B). "What happened was, that we first came up with this good idea and we fell in love with it. We were not able to let it go and experiment something else. I think, that in a case where the first experimentation idea would have turned out to be a disaster, it might have been easier to continue with further development…but we just liked our first experimentation idea an awful lot. And so, we were not able to set our brains into such a way, that would allow us experimenting from a whole new direction." (Interview, Team member from Team D) During the first minute a member notes that they have not done anything concrete after the first tutoring session and they see that they could just implement the idea already: "Not the smallest thought on this. Well, maybe a small but not really." (Observation from the first tutoring session of Team A)	**Team A:** The second tutoring session was the most challenging part for the team. There seemed to be a mutual understanding that the idea was ready to be implemented (because of the positive feedback received) and the team did not see value in further experiments. **Team B:** Team wanted to 'play it safe' and tested the first experimentation idea for two weeks, even though learning could have been extracted already earlier. As the feedback from the first experiment was positive, the team was not willing to 'open the idea again for further uncertainties', as noted by one team member. **Team C:** Team conducted various small idea implementations but did not build on the learnings of them to gradually develop one experimentation idea. **Team D:** The team 'fell in love' with the first experimentation idea, and was not able to adopt another kind of approach to test their idea. The team conducted another experiment that differed only incrementally from the first one.
Overlooking the experimentation ideas of others' and oneself	Not acknowledging ideas presented by other team members as per how to create the experimentation set-up and dismissing the experimentation ideas of others' and oneself	"I am not positive whether we were a group of people that could have ideated the best solution so that everyone would have been committed to it. At least I felt at some point that the idea had been taken so far already that there were no other paths to take anymore." (Interview, Team member from Team D) "These two team members have both so strong personalities and they were thinking in a different way than I was. Although I was able to share my opinion in our group, my perspectives and ideas were shoot down pretty quickly." (Interview, Team member from Team B). Team A starts sharing ideas on how could they experiment in different ways the notification of time: Team member 1: So, we could use mobile alarm to tell that the meeting has lasted for 30mins. Team member 2: I dislike the idea as it is the most depressing sound because it reminds about the alarm clock ringing in the morning. (Observation from the second tutoring session of Team A)	**Team A:** High status member has a role of 'evaluating' and commenting others ideas and 'concluding' discussions rather than building on others' ideas. If others don't start to building on the ideas suggested, team members have a tendency to shoot down own ideas also. **Team B:** One team member felt, that her opinions for experimentation ideas were not heard in the team and that she would have not chosen the same idea for experimentation as the others did. She remained pretty much on the background during the sprint. **Team C:** Team members do not start to build on others' suggestions or ideas and in order to keep a conversation going, tutors need to keep on presenting questions. **Team D:** Team members are rather hesitant in proposing new ideas. Most suggestions for experimentation ideas comes from the tutors. Further, the team has a tendency of not taking ideas / suggestions seriously in the sense that each of those would be objectively considered. Few times suggestions are also turned into jokes.
Losing sight of the initial problem to be solved	Inability to maintain in mind the problem the team was working to solve.	During the first tutoring session, as the tutors ask about the initial problem the team decided to solve, no one is able to remember it before without checking it from the notes: Tutor: Remind me again, what was the initial problem you decided to solve?	**Team A:** Team was so convinced of the need of their initial idea that they were not able see other solutions for solving the identified problem. Team was not able to reflect their learnings from the experiment to the initial problem.

		The team starts to discuss about where did they put the materials they worked on during the workshops. After a while one team member responds: "Just a minute, here it is." (Observation from the first tutoring session of Team D) "It was a bit difficult to find further experimentation ideas as our mindset was already so tightly on the meeting room concept." (Interview, Team member from Team A)	**Team B:** **Team C:** As the team found out that their initial idea would not be working as such, they were not able to consider alternative ways to tackle the identified problem. **Team D:** In the tutoring sessions, the team is not referring to the initial problem, nor reflecting the results of the experiment to it. As the tutors enquire what the identified initial problem was, they need to check it from their notes.
Bias towards planning	An 'invisible barrier' causing procrastination to take action and begin with an experiment.	"I think that you should not turn it (experimentation idea) over and over again, that rather you should be more courageous to start experimenting even with a rawer version of the idea. Otherwise you are killing who knows how many good ideas by just pondering and pondering. (Interview, Team member from Team D) After discussing different ways to communicate the duration of the meeting, one team member notes: "What if we would not take this into concrete level yet but we would test this on a thinking-level and ask people that how would they think about the different options we have been thinking: egg timer, hourglass or a light signal." (Observation from the second tutoring session of Team A) "Before the first tutoring session we only did some planning and ideation on what could be done concretely. The other tutoring session was delayed because we still had not done any 'fieldwork' (experiments)." (Interview, Team member from Team C)	**Team A:** Team has a tendency to get stuck on the constrains of why certain idea would not probably be worth implementing. Instead of getting proof to their claims by quick-testing, the team tries to decide on the best idea. **Team B:** Although the team is good in analyzing the experiments and reflecting it on the initial problem, they are not able to turn this analysis into concrete action. **Team C:** Notable amount of time in the tutoring sessions is spent on analyzing the current situation rather than getting into a more concrete future- and action-oriented level in the discussion. **Team D:** As with Team C, the team easily gets stuck on pondering what is not working in the current situation. Further, the team has a tendency to jump over the experimentation phase into planning how a certain idea could be technically implemented.

5. Discussion

The evidence of the effectiveness of design thinking approach have for the most part remained only anecdotal as these claims are not grounded on empirical research (Badke-Schaub, Roozenburg and Cardodo, 2010; Johansson-Skoldnerg et al., 2013). Experimentation, i.e. creating accumulated learning through trial-and-error cycles, is one of the key elements in design thinking. Most studies on experimentation are based on analyses of experienced designers or conducted under experimental conditions with design students. Less is known about how non-design professionals might adopt such approaches. As the concept of design thinking entails, that its key methods are to be utilized in a non-design environment, we need to better understand the possible impediments arising along the adoption among non-design professionals in the 'messy situation of real-life everyday work' (Schön, 1983). Further, previous studies have suggested to link design thinking discussion with the design research discourse in order to deepen the understanding of the elements design thinking consist of (Hassi and Laakso, 2011b; Johansson-Skoldberg et al., 2013). To address this gap, this study explored the adoption of experimentation, one of the critical elements in design thinking, in a real context. By bridging research on design expertise with design thinking management discussion, this study contributes to our understanding on the adoption of design thinking methods in non-design organisations. The study provides critical insights on what goes on in a micro-level, when adopting elements of design thinking among non-design professionals. Given the attention the concept of design thinking has received among academics as well as practitioners, this has so far received surprisingly little attention.

5.1. Buying into the logic of the iterative approach

Our study showed that resistance to iteration might become one of the biggest bottlenecks when adopting experimentation in novice design teams. This is a significant impediment, as iteration is one of the key activities occurring frequently during the design process (Adams, et al., 2003; Jin and Chuslip, 2006). Further continuous reflection of the work at hand and iterating between abstract and concrete thinking has been proposed to be two thinking styles central to experimentation (Hassi and Rekonen, 2018). In our study, the participants needed to be forced to iterate in the process of experimentation. After the first experiment, teams did not see the value in conducting further experiments or were not able to recognize the remaining uncertainties that needed further testing. In this our study supports earlier studies that have noted, that experienced designers tend to iterate more whereas people with less design thinking capability have a tendency to move earlier to the convergence mode (Seitamaa-Hakkarainen and Hakkarainen, 2001; Adams et al., 2003). The prevailing attitude seemed to be, that the idea is ready to be implemented if the first experiment received supportive feedback. This is due to the fact that the teams had challenges in keeping in mind the initial problem to be solved after the first experiment and because of that, were not able to see the remaining uncertainties of the idea to be tested. This differs from early study on expert designers, where it was noted, that proposed solutions in most cases directly reminded designers of further issues to consider in order to learn more about the problem (Kolonder and Wills, 1996). Hence, experienced designers keep the problem constantly in mind

in order to let the problem and solution to co-evolve. Further, previous studies have noted experienced designers to make a preliminary evaluation of their tentative decisions, i.e. to take the time to consider whether it is worthwhile to move forward with the possible solution (Ahmed, Wallace, and Blessing, 2003). In this study, the teams were not eager to learn so much about the problem at hand, as they were more eager to implement the idea quickly.

Strongly linked with iteration, previous studies have noted design process to consist of a sequence of decisions, in which both divergent and convergent thinking is needed (Badke-Schaub et al., 2010) and, that productive design behavior requires frequent switching between different types of cognitive activity (Cross, 2004). The studied novice design teams were struggling with switching back to the divergent mode after the first convergent phase; i.e. after coming up with the first idea for experimentation set-up in order to learn more about the initial idea. In order to get the team to conduct further experiments, the tutors needed to work hard to open the idea again and to get the team to come up with other ideas for experimentation set-up. However, as the teams attitude towards iteration was rather defensive, it often resulted in overlooking the ideas of others' and oneself for new experimentation set-ups. Hence, this urge to converge impeded the team to move forward in the experimentation cycle and often got them stuck with the first solution proposed. Although expert designers update the problem and change goals along the process, they have also been noted to hang on to their initial solution concept for as long as possible (Ullman, 2003), even when facing remarkable challenges in developing the solution to a final concept (Rowe, 1987; Ball and Evans, 1994).

5.2. Moving away from a decision attitude

Being able to move between the solution and problem spaces lies at the heart of design activity and hence, also design thinking (Dorst and Cross, 2001; Dorst, 2011). This means, for example, that after learning more about the problem at hand through iterative experiments, the initial problem might need to be reframed. Framing the problem has been noted to be 'one of the cores' of design thinking (Dorst, 2011; Cross, 2004). How designers create frames is of particular interest when it comes to dealing with open and complex problems. However, the way in which design practices approach problems have been noted to be quite different from conventional problem solving. In design practices, the parallel creation of what to create (e.g. object, service, system) and how to create it, is the core (ibid). This 'framing' and 'parallel creation' turned out to be a challenge also in the studied teams. In cases where the first experiment did not support the solution idea tested, the teams were not able to reframe the initial problem chosen to be solved. This realization that their assumption was not supported, led to a stagnation and the teams were not able move forward in the experimentation cycle. It seemed that some of the teams had decided the solution for the identified problem already at the outset of the experimentation sprint and before the first experimentation. This is in contrary to the one of the key elements of design, reflection (Schön 1983). In this, design is seen as a process of reflection-in-action, where the problem at hand is gradually restructured and improved and hardly ever done in one burst at the beginning of

the design process (ibid). 'Problem structuring' activities have been found to reoccur periodically throughout design tasks of expert designers (Goel and Pirolli, 1992). However, reflecting on the learnings created through experiments in order to reframe the problem and update the initial solution idea along the way turned out to be very difficult in the studied novice design teams. Unlike in design, where the common reasoning is, that 'the problem' cannot be fully understood in isolation from consideration of 'the solution', (Cross, 2004) in more conventional fields, not used to deal with open and ill-defined challenges, the approach to problems usually is more linear (Dorst, 2011).

The discussion in building design thinking capability in novice organizations is now focused much on design methods and tools. However, our study shows that without an appropriate mindset towards the nature of work in design approach, these skills, methods and tools might be difficult to obtain. Changing from the "decision attitude" towards a "design attitude" is easier said than done: the former serves well linear processes when solving existing, rather stable problems with clearly indicated alternatives, and the latter maneuvers with the iterative approach, moving between the problem and the solution in a parallel manner in order to tackle open-ended ill-defined problems (Boland and Collopy, 2004; Dunne and Martin, 2006; Dorst, 2011). As Johansson-Sköldberg et al. (2013, p. 131) have noted, sometimes design thinking is presented as "designer's specific methods taken out of the context as tools ready to use and ignoring the fact that the person using the tools need to have an appropriate knowledge and skills – competence that comes with training - to be able to use them". Building on that note, we argue that adopting an appropriate mindset, that allows problems to be approached in a way that differs from the conventional, plays a central role when adopting the central methods of design thinking, such as experimentation, in non-design organizations.

5.3. Conclusion and future studies

The adoption of key methods of design thinking among non-design professionals need to be explored more in order to establish the necessary supportive tools. The current study investigated the impediments for experimentation in four novice design teams. Four central themes that may become bottlenecks when adopting experimentation as a method for development in novice design teams were recognized: resistance to iteration, overlooking ideas for experimentation set-ups, losing sight of the initial problem to be solved, and a bias towards planning. The study also showed the need to adopt an appropriate mindset that allows keeping the idea open and repeating the activities of experimentation cycle. The fact that the data was collected within one case organization can be seen as limitations to our study. Further, the participants were developing internal processes, not products or services for customers, which may affect their approach and, hence, possibly the occurring impediments. Future work could investigate the activities of experimentation cycle more deeply in isolation, in different kind of context, and throughout a longer time-period in order to gain a more comprehensive understanding on the requirements they set for the team.

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