INTERNATIONAL DESIGN CONFERENCE - DESIGN 2012
Dubrovnik - Croatia, May 21 - 24, 2012.

DESIGN 2012

FLEXIBILITY OF CHOICE AND PERCEIVED IMPACT OF USING DESIGN METHODS

I. A. Owusu, J. J. Daalhuizen, P. J. Stappers

Keywords: Design Methods, Perceived Impact, Self-Efficacy

1. Introduction

This paper explores the way designers perceive the impact of design methods on their work in relation to the freedom they have in choosing and applying the methods. We performed a qualitative case study, interviewing students and practitioners about their experiences and opinions regarding various topics in design processes that are influenced by design methods. While doing so we also investigated the role of psychological factors.

1.1. Background of the study

In a laboratory study by Fricke [1996] it was discovered that, when compared to either rigidly following specific methodological instructions or simply 'muddling through' without any methods, a flexible use of methods was shown to lead to better performance for individual designers. Fricke studied the working processes of 13 designers in detail, comparing their individual approaches to their performances. From his study we derive that: 1) designers differ in their preference for working more or less systematically, based on personal characteristics (e.g. amount of experience), and that 2) the circumstances (e.g. the precision with which the assignment is formulated) influence this preference in a given situation.

When applying Fricke's findings to real world settings, one can investigate the circumstances where design methods play a role – in our opinion these are the two areas of education and practice in which (emerging) designers learn and operate. In practice, methods are often part of the service offering, limiting the flexibility with which designers choose and/or adapt methods. In some cases, a project leader will determine the specific method(s) to be used by the designers. In other cases, designers will have a higher level of freedom in choosing and applying methods. Looking at academia, design methods are often taught as part of a design education. In this context, methods are offered to students through textbooks, lectures and seminars. Students are given chance to practise the use of methods through specific exercises and their proficiency is assessed through various projects. Both practitioners and students do not always have the choice of choosing or applying a method, possibly influencing their perception of its impact on their performance.

Besides this organizational issue, the role of the individual who is using the methods seems crucial yet ambiguous. On one hand, his or her activities determine, to some extent, the effectiveness of the process, as part of the overall design performance [O'Donnell and Duffy, 2007]. On the other hand, the freedom in choosing and executing the methods and potentially guiding the design activity can be limited in both the industry and academic realms. In this context, the designer is influenced by psychological factors that have an impact on his perception and also on her/his behaviour.

Based on these considerations, our research question is: In comparing practice and education, how do designers perceive the impact of design methods in relation to their freedom to choose and apply them?

Regarding the recruitment of the sample and the selection of types of methods, we took a pragmatic approach. The selection criterion for the sample of participants was to involve two actual organizations where design methods were available as written documents. As an educational setting, the Faculty of Industrial Design Engineering (IDE) of Delft University of Technology (TU Delft), where the authors are studying, researching and teaching was taken. The international innovation company frog was selected as an example for design practice. There, the first author was employed as a design research intern while conducting the research. This way, she had access to written documents of both organizations regarding their methods. To answer the research question, she then interviewed students at TU Delft and designers at frog and compared their experiences in situations in which they had a low level of freedom to situations in which they had a high level of freedom in choosing and using methods. Due to space limitations, an extensive description of each method mentioned in this paper was not feasible.

For the purpose of this paper, we define methods that designers use as "design methods" resulting in a comprehensive concept. A large variety of methods, techniques and tools for designing used by the members of the two organizations are considered in this study accordingly. They are ranging from user research methods, such as Shadowing or Context Mapping, to tools and techniques used for problem solving, such as Brainstorming, to methods that help evaluation of designs, such as Usability Testing. What they all have in common is that they help designers throughout their working process to bring structure to their thinking and actions.

The contribution of our study lies in investigating differences between students and practitioners in an exploratory way. Building upon studies that have clarified the use of methods in relation to performance [e.g. Fricke, 1996], we reveal some underlying factors of the perceived impact of using methods. The manner in which designers perceive the effectiveness of their process and outcomes in relation to the way they use methods could influence their performance in the future.
Hence, getting more insight into this context could be of relevance for both education and practice.

This paper is written with the full awareness that personal experiences and opinions of the students and practitioners interviewed cannot be generalized, and that it is from a qualitative perspective based on a small sample. The paper demonstrates a comparison between these two groups of designers, highlighting assumed underlying factors for their perception of the impact that design methods have on several areas around their design processes.

1.2. Education and practice

This section describes how education and practice are related and the role design methods play in each sector. Andreasen [2011] believes that the central behavioural characteristic of a design theory is that, through the created mind-set of the designer and the models, methods and tools, it leads to a more productive design, aiding the probability of results and creating a space of solutions. According to Andreasen, the relationship between education, research and the practice in industry is influenced by different factors. The 'reality practice' is formed by past experiences, best practice and knowledge of the designers (who are often ex-design students), together with ideas and theories. In comparison, the 'arranged practice' as taught at universities is influenced not only by theories and ideas, but also by models of practice which have evolved from the 'reality practice'. Methods are often used as means to represent the reality practice. The arranged practice will be absorbed by the students, who after graduating, go out to the world to be part of and to form actively the 'reality practice' (Figure 1).

This indicates that the factors of education and industry are interrelated and cannot be seen as separate domains. This can be illustrated nicely, considering our sample: Some of the staff members at the IDE are involved not only in research and teaching activities, but also in the industry, and some employees of frog were trained at TU Delft or other institutions that teach related methods.

At IDE there are special seminars and lectures embedded in the curriculum that provide the students with methodological knowledge, and the students are supported and encouraged to use those methods in various design projects. In order to bring the educational context closer to the industry,

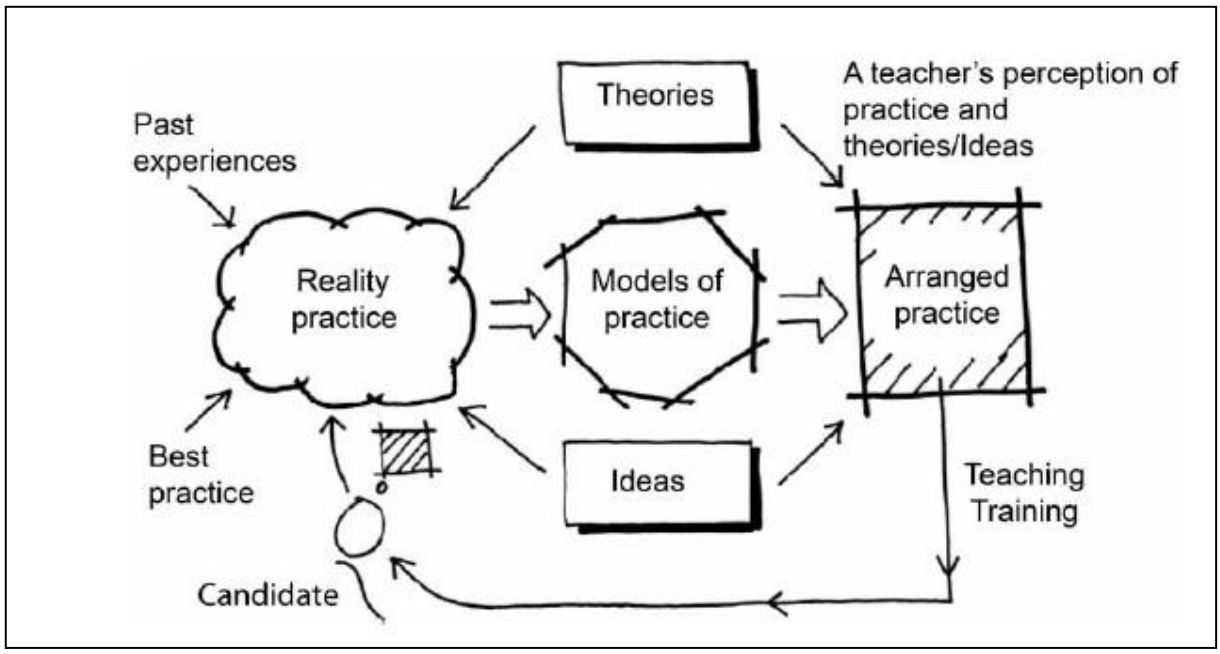

Figure 1. Shaping of industrial practice from theories, ideas and staff members' previous education, derived from Andreasen (2011)

some of the projects are offered in collaboration with real clients. In the first semester of the second year of their Master's program, the students are formed into multidisciplinary teams to execute a complete product development for a real client, including a final prototype as well as a plan for market introduction.

At frog, the design methods we take into account belong to 'design research' (DR), specified as one of the core capabilities of the service portfolio of the company. For the clients, DR is listed together with other services ranging from strategy and interaction design to brand, product design, and technology. Each of the company's worldwide offices has at least one person guiding the DR, a 'design research lead' with a high level of expertise and experience in planning and using design methods in projects.

1.3. Theory regarding psychological factors

From the designer's perspective, it is obvious that the outcome of a design project does not simply depend on underlying psychological factors. Contextual factors, such as expectations of stakeholders, skills and attitudes of team members and other limitations also have significant influence on the performance and the final design, but amongst those several factors, the role of the designer her/himself is often undervalued [Dorst, 2008]. This paper focuses on the psychological factors that drive designers' behaviour and perception which affect the way they use methods. Once more insights into these are available, design research can make use of the knowledge in order to affect design education and practice in a positive way, supporting the agents in fostering better design results.

Design methods are by no means a perfect set of tools that work in any given case; designers need to decide which ones to choose and how to apply them for the design tasks they are working on. It requires designers to be able to act independently and autonomously. This is where the psychological factors of self-efficacy and self-determination come into play:

Self-efficacy is the belief that one can implement on their own certain behaviours that will lead to desired outcomes. Originally developed by Bandura [1977], this concept is claimed to play a central role in task performance. For example, students who believe that they can achieve a high grade in a mathematics course may persist in their efforts to achieve the grade. Conversely, Bandura states in the same paper that, "People who (…) experience low self-efficacy (…) view activities with a sense of futility" [p. 204]. We find it relevant to adapt these findings to designers. If designers believe that using methods will lead them to better design results, they might persist in their efforts and use

methods more often in the future. Studies following theoretical considerations and investigating different professions showed mixed results [Bandura, 1977, Hodge, 2003] regarding whether years of experience play a role in the effects of self-efficacy.

The Self-Determination Theory by Deci and Ryan [1985] represents a broad framework for the study of human motivation and personality. An exemplary description of high self-determination is, "I feel responsible for my actions". The Self-Determination Theory states that autonomy, amongst other variables, plays a major role for motivation. Autonomy provides employees the opportunity to develop self-determination. When given greater freedom, sense of ownership and influence on the outcome of a given task, it is more likely that the employee is more proactive and persistent in her/his approach. [Den Hartog & Belschak, 2011]. Our study takes this into account by observing the effects that different levels of freedom have on a designer.

Self-efficacy and the Self-Determination Theory are relevant for our study from motivational and behavioural perspectives in understanding how designers deal with the level of freedom offered in each organization. Based on the experiences reported by students and practitioners, we were interested in seeing whether methods were perceived as beneficial in their design process, assuming a relevant self-efficacy in this case. Also, we were curious to see whether the circumstance of having a high level of freedom, representing autonomy, would be related to and potentially result in a high level of self-efficacy and vice versa. As the picture regarding the relevance of experience depicted in existing literature remains unclear, we aimed to provide indications on the difference that several years of experience in the design industry (practitioners) would have in comparison to being in the learning process in academia (students).

2. Method

With students and practitioners as participants, a preceding task - a card rating exercise - was undertaken before the actual interviews took place. The interviews were composed of questions about projects with differing levels of freedom regarding design methods. For the qualitative analysis, the transcripts were categorized according to three assumed areas of impact regarding the use of design methods: the design task, communication and adaptability. The results of students and practitioners were individually compared.

2.1. Sample

In order to create a sufficient sample of participants for the study, we selected experienced practitioners and students who all use design methods in their design process. Our sample consisted of four students (2 women) from TU Delft in the second year of the MSc track Design for Interaction (DfI) and five interaction designers (two women) at the German office of frog, all with research based Master's degrees in design and two to eight years of experience in practice (no permanent DR lead). Therefore, their reported experiences were not exclusively based on projects done at their current employer. The study program DfI aims to instil in students a deep understanding of how people interact with products in daily life. Most of the students' reported experiences were based on university projects. The samples' mean ages were 26 (min. 24 and max. 28) for the students and 30 (min. 27 and max. 33) for the practitioners. The participants were not compensated for their involvement in the study.

2.2. Selection of design methods

We invetigated that both populations, the students and the designers, are applying similar design methods in their projects. This creates a suitable basis for a more effective comparison in terms of their perception of design method use. Surveying members from education and practice, we found 43 most recently applied design methods in the two institutions. For practitioners, this was done by sending online-surveys to the 'design research' mailing group of all frog studios worldwide, listing design methods mentioned in their internal knowledge management system for design methods. For education, a similar survey was sent to all Master students of a compulsory design course at TU Delft

based on methods listed in the public knowledge management system for design methods of IDE. Both surveys were limited beforehand by the help of experts in design research at frog and design education at IDE in order not to overload the participants and to increase the likelihood of participation. At frog, the number of completed surveys was n = 17 (out of n = 121); at TU Delft it was n = 39 (out of n = 300). The terminologies of design methods differed depending on the organisation and were intentionally kept in their original form to present both the distinctness and overlaps in their structure. Only a few design methods were somewhat different and/or used exclusively by one of the institutions. Most design methods were used by both. The most often used design methods were: Design Drawing, Storyboard, Product Usability Evaluation, Participatory Design and Expert Interviews.

2.3. Procedure

Prior to the actual interviews, we sensitized the participants on the topic in order to raise their awareness of the broad area of design methods available. This way we also confirmed that the participants had proficient knowledge with regards to the design methods being used in their organization. The participants were asked to perform a card rating exercise in which they sorted design methods according to familiarity. In this task, cards were handed out to let the participants categorize the preselected 43 methods into five categories between "Never heard of", "Would like to try it out", "Do not want to try it out", "Used it before (one to four times)" and "Often used/internalized" (more than five times). In the context of our study - being interested in the perceived impact of design methods - we focused on the design methods that were used by the participants. Figure 2 shows the distribution of answers in the groups of TU Delft students and practitioners at frog for the cumulated categories of "used it before" and "often used". The pattern shows that the practitioners utilise more design methods more often, but still there is a large overlap in design methods which were used by both groups.

The sensitizing activity was followed by a semi-structured interview. After a number of broad questions, each participant was asked to consider two projects that he or she experienced in the past: 1) A project in which the interviewee had a lot of freedom in choosing and applying the design methods and 2) A project in which the interviewee was part of a team to whom specific design methods were imposed and thus had little freedom in choosing and applying. The order of reported projects was randomized. The participants were encouraged to describe each project in general, about the design brief, their role within the project and which DR methods were used. Following each interview, further information about the educational background of the interviewee was gathered. For each project, we explored the participants' perceived impact of the methods used, with respect to the perceived effectiveness of the design process and the outcome.

The interviews were transcribed and analyzed. The answers given by the participants were structured according to three predefined areas of perceived impact. The first area, 'perceived impact related to the design task' consisted of interview questions related to the perceived impact of design methods on the perceived quality of design outcomes during the design process. The second area, 'perceived internal communication' consisted of interview questions related to the perceived impact on the quality of the communication. This area also covered perceived changes in the roles of the team members in relation to using design methods. The last area, 'perceived adaptability of design methods' consisted of interview questions concerning the degree to which design methods were adapted to the specific context. The strictness vs. context-dependency with which the methods were applied was explored in this area.

Exemplary questions for these three categories from our interview guide were: "Did you feel that using the method had a strong influence on product quality?" (for design); "How did the communication between the team members change while applying the method XY in terms of the ability to reason back and forth about the project?" (for communication); and "In case you were involved in applying this method within several projects - to which extent do you feel that it was structured in the same way?" (for adaptability).

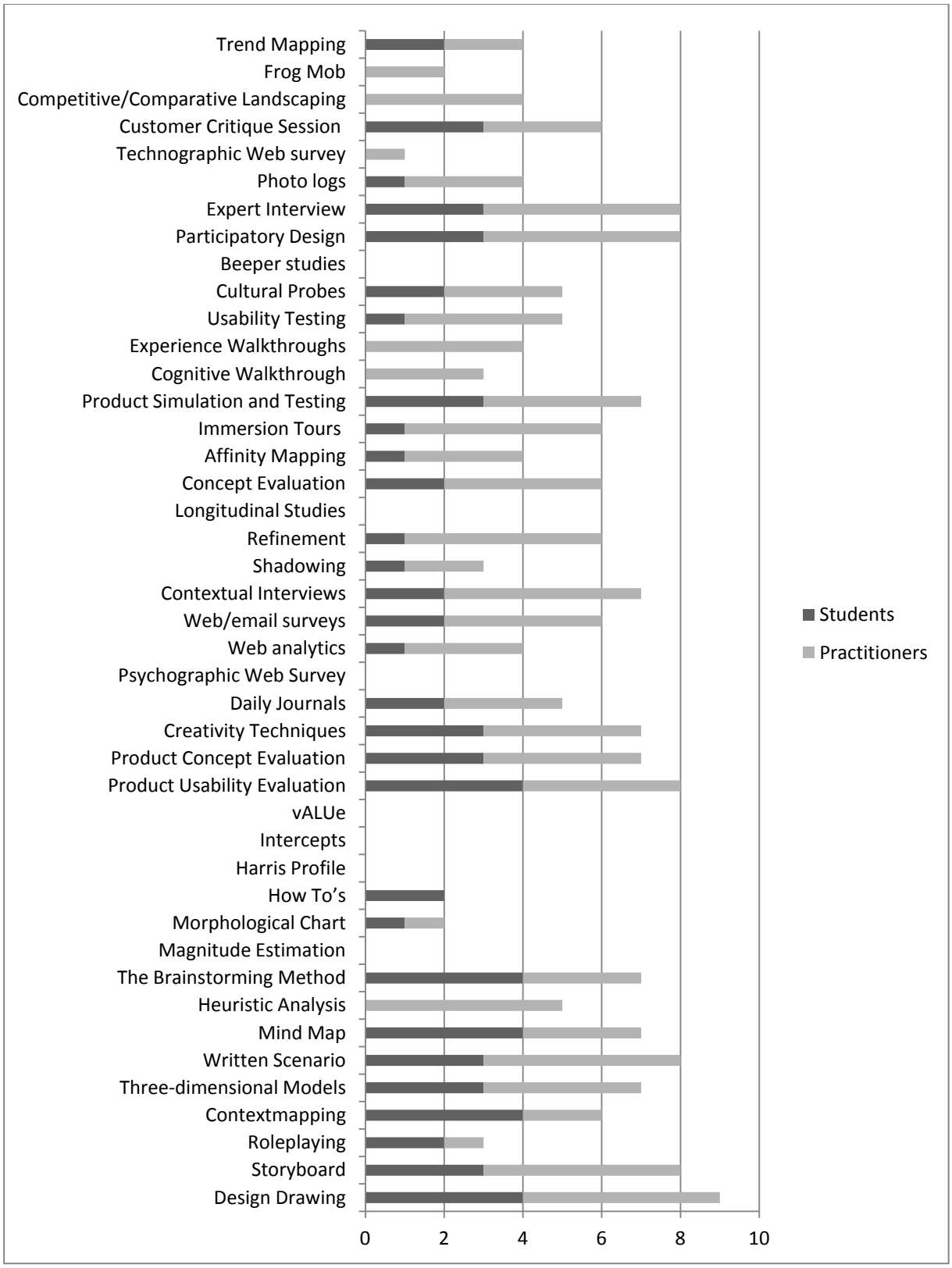

Figure 2. Indicated frequency of use of design methods by both practitioners and students. Cumulative values for both the "used it before" and "often used" categories are presented.

3. Results

The interview protocols of high and low level of freedom were divided into sections according to the areas of perceived impact, as mentioned above. Supporting quotes representing each area were selected. The number of methods used in the projects described by the participants varied between two and twelve, having the students perform more methods within single projects than the practitioners.

3.1 High freedom (HF) in choosing and applying design methods - students vs. practitioners

In this sub-section, the participants were the ones in charge of the design methods, under the given context of client's wishes, budget, time constraints and other limitations. The following is a quote of a practitioner that exemplifies a HF experience: "I did plan the user research and conducted it together with my colleague. Afterwards I handed the results over to the UI (user interface) design team."

3.1.1. Perceived impact on design - HF

The perceived impact of choosing and applying design methods used in projects averaged over different levels of freedom and deduced through a post-interview rating and evaluation of contents was about the same for design students and practitioners. However, rather than taking the statements of the two groups of people as equal, we looked into statements from each group separately, and encountered differences concerning the two circumstances of freedom.

The students reported a higher perceived impact of DR methods when leading the design method related activities, while this perceived impact appeared to be lower for the practitioners. One student participant described that "It (using the method) gave ideas of areas of play (...) The Context Mapping was the most important technique that we used for the design". Another student explained that "It took place at a very early stage and helped me to come up with my design vision (…) I implemented this (finding) in the final design, it was the main part."

We found that students valued design methods more highly - as a very helpful tool for the design process. Under similar circumstances, the practitioners tended to be less enthusiastic. Asked about whether research findings resulting from using design methods were translated into the final concept, a practitioner stated, "No, just details. Not fundamentally." Another practitioner reported, "In the end, when we generated the concepts, I really felt that they were detached from what we've observed, mainly because the area in which we looked into was everyday life things." These statements suggest that practitioner might not view the details of the design implementations as highly important to the outcome of the design.

3.1.2. Perceived internal communication - HF

Regarding the impact using the design methods had on the internal communication of the team, the picture looks quite different. For the projects with high level of freedom, the answers of the two interviewed groups are generally quite similar to each other.

For students, internal communication with other team members of a project was marginally influenced by using design methods, whereas communication with clients was strongly facilitated through it. On reasoning back and forth with other team members, a student mentioned that, "(Using the design methods helped) only for myself, not for the communication in the team." On communicating with the client, a student remarks that, "After explaining all the process, they were really excited. The feedback then was much better than after the strategic first presentation."

No clear pattern could be found in the results of the practitioner's group. On self-planned and applied design methods, one practitioner stated, "It helped us to ask smarter questions to the users but not having smarter discussions in the team." From this we derive that the practitioner saw some value in using the methods, but not on its ability to affect the communication in the team.

3.1.3. Perceived adaptability - HF

For the self-planned use of methods in projects, the level of experience of both groups with the described design methods seemed to be similarly small. For instance, a practitioner said, "I was not as experienced as I am now." Therefore, the statements regarding the adaptability of design methods among projects appeared to be merely based on estimation. When asked about the structure, a student

stated, “It was a simplified version from what I learnt from the course. But the flow and the main activities were the same”. This shows an understanding of parallel implementation, modified for the different context as we construed it. There was a wide range of answers to the question regarding the influence the context had on the way the methods were used. Answers concerning the ease of using methods resembled each other. As yet another example, a practitioner said that "The better the relationship with the user, the better the results will be. If you develop a certain level of trust between the user and yourself in the beginning, then it's easy", referring to the requirements that lead to a simplification in applying user research.

3.2 Low freedom (LF) in choosing and applying design methods - students vs. practitioners

In this sub-section, the participants were not responsible for the selection or could make major decisions in the application of design methods. An experience that is classified as a LF experience is exemplified by the following quote from a student: “The focus group was planned and led by the Strategic Product Design (SPD) student and another DfI student”.

3.2.1. Perceived impact on design - LF

Under the circumstances of low freedom, our analysis led us to derive a reverse picture. The practitioners perceived a higher impact of the design methods on the design than the students. For example, one practitioner explained that, “Based on the contextual interviews, we even came up with a new term for one user group that seemed not to exist before. Based on this knowledge, the design could be much more defined.” This points out that without using the research method, the team would have missed important information which was not accessible through other means. Another practitioner described a case in which someone else was leading the activities this way: “The influence of the design methods was essential because we (the design team) were non-experts on the topic - especially for the information, structures, systems.” In the students’ opinion, the impact of design methods on the different inquired factors seemed to be less strong under the circumstance in which someone else other than themselves is leading the activities. An exemplary quote about findings derived from using methods was: “More general stuff, not specific things.” The student indicated this way that the findings from applying methods influenced the design only indirectly. They helped the team to understand in which domain they work, but did not add to the design contents. Another student stated, “We found what people did not like. It was more a confirmation, no real changes. It was too limited altogether”, hinting at a comparably low impact of the design method used on the later result.

3.2.2. Perceived internal communication - LF

For projects in which the interviewees had a low level of freedom, the students reported even less influence of applying design methods on the communication in the team. Asked about the level of detail in which the communication in the team has changed while applying the methods, a student claimed that it “did not change at all”. On the contrary, the practitioners showed a more positive impression on the role design methods played in internal communication. When asked about the ability to reason back and forth, one practitioner stated, “The research gave the whole project a better basis. The synthesis is not separable from the research. While taking notes during research, we considered the later synthesis already.” We saw this as an indication that using methods has helped structuring the communication within the design team in a systematic way.

3.2.3. Perceived adaptability - LF

Differences to projects in which the interviewees had low freedom in choosing and using design methods were only visible in the group of students; however, the large variance in the answers has led us to determine these reports to be not as strong as the results for the other two categories mentioned above.

4. Discussion

The finding by Fricke (1996), which states that a flexible use of methods by designers leads to better performance, was partially replicated by our interview study about past experiences of designers in the field. We interviewed students and practitioners, and found that the level of freedom in using methods influences the group of students in a different way than the group of practitioners. Factors such as the amount of experience and circumstances in the given situation tend to play a role.

To summarize our findings; in projects where they had a higher level of freedom, the practitioners indicated to perceive the impact of using design methods had on the design task as less strong than the students. In projects with a lower level of freedom, in which another person was the lead, practitioners tended to perceive the impact of using methods on the perceived quality of design outcomes during the design process as stronger, opposite to what the students reported. The effect of using methods on the perceived internal communication was overall low. Students and practitioners seemed not to see a direct connection between conducting methods and the quality of internal discussions. The only exception was the communication with the client, which seemed to be perceived as positively influenced by using design methods in projects – regardless of the freedom the student or practitioner had. The results concerning the perceived adaptability of the methods the students and practitioners have used were very mixed, and hence inadequate for any reasonable conclusions.

The results of our study's indication that experience plays a role for the perceived impact of using methods goes against past findings from other disciplines. For example, years of teaching experience was not found to moderate the relationship between autonomy and self-efficacy [Hodge, 2003]. This disparity is corroborated by Cross [2004], who points out that expertise in design has some aspects which are significantly different from expertise in other fields. Accordingly, a conclusion that can be made for social cognitive theory in psychology is that processes found in different domains should not be generalized without reflecting about their different contexts and professions.

Our study further indicates that other variables yet affect the perceived impact of using design methods, potentially moderating psychological factors. How knowledgeable the person leading activities related to design methods is, tends to play a major role in the perceived impact of the methods, no matter whether it was the interviewee or someone else.

We would like to point to potential implications. Throughout our study, we noticed a conflict: the level of freedom to choose methods is seemingly sensitive for students in particular; however, in design education students are seldom given the choice. This is something we suggest design educators to consider; but first, further research should go into more detail to provide more data that can be generalized.

Another potential implication for design education is to create awareness. We suggest informing students about differences in their perception that come along with becoming more experienced and the impact that psychological factors have on their perception of processes. Pairing them up with more experienced PhD students in projects may allow the students to experience and learn from the differences between the pair. This could potentially encourage the students to reflect more about their role in research and motivate them to learn and practice using methods to achieve a higher level of expertise.

In a recent study, Birkhofer [2011] refers to the work of many influential colleagues such as Hubka and Eder, Pahl and Beitz, Badke-Schaub and Frankenberger, all of whom have contributed with their process models and their analyses of design projects and processes through empirical design research in industry to the large body of design science. Reflecting on the findings from the past 40 years, Birkhofer criticizes the way design methods are often taught. He calls it a "consultant style", addressing an inappropriate use of methods and a degeneration of design methods [2011, p. 23]. He emphasizes that a designer needs to have a concept of requirements before choosing an appropriate method for a design task, and recommends not letting the choice or use of design methods become a mechanical routine. We expand this to the recommendation of creating a flexible working context for students and practitioners as this might be a promising approach to enable higher self-efficacy and better design solutions in the end.

For future research, we recommend the development of a self-efficacy scale measuring a state quality tailored to our sample in order to be able to draw more direct conclusions than it is possible

from interpreting qualitative data as seen in this study. The retrospective nature of the study also limits the reliability of self-reports.

Finally, the authors acknowledge the limitations of the present study. With n = 5 for the practitioners and n = 4 for the students, the size of the sample is small and does not allow quantitative analysis and calculating effect sizes and variances, hence the degree to which these results can be generalized is limited. For future research, we suggest to apply a path analysis with a larger sample to clarify the cause-effect relationship of the psychological factors involved.

5. Conclusion

We conclude that regarding applying methods, the interviewed students tend to be more influenced by the freedom to choose and apply a design method in terms of the perceived performance of the team, process and project outcomes than the interviewed practitioners in industry. The latter appear to be more influenced by the level and quality of expertise of the person in charge of leading design method related activities. The freedom in planning and using design methods therefore might be more affected by psychological mechanisms such as self-efficacy and self-determination in an equal context, meaning that the person who leads activities related to design methods in the project is equally skilled and experienced as oneself. In our study, this was valid for students, not for practitioners, because in the industry often a specially trained and experienced person leads others who are often times comparably less experienced in applying design methods systematically.

Acknowledgements

As the first author, I hereby thank the Faculties of Product Innovation Management and Industrial Design at Delft, University of Technology as well as the Universiteitsfonds Delft for grants that support my participation at the DESIGN Conference 2012. I highly value the support of Elizabeth Roche who enabled me to undertake this research at the German studio of frog. Without your support, this study could not have been realized. All participants of this study, I greatly appreciate your interest and that you contributed your time to the research.

6. References

Andreasen, M. M., (2011). 45 Years with Design Methodology. Journal of Engineering Design. Vol. 22, No. 5, May 2011, pp. 293–332.

Bandura, A. (1977). Self-efficacy: Toward a unifying theory of behavioral change. Psychological Review, 84, pp. 191-215.

Birkhofer, H. (2011). From design practice to design science: the evolution of a career in design methodology research. Journal of Engineering Design, 22(5), pp. 333-359.

Cross, N. (2004). Expertise in design: an overview. Design Studies, 25(5), pp. 427–441.

Deci, E. L., & Ryan, R. M. (1985). Intrinsic motivation and self-determination in human behavior. New York: Plenum.

Den Hartog, D. N., & Belschak, F. D. (2011). When does transformational leadership enhance employee proactive behavior? The role of autonomy and role breadth self-efficacy. The Journal of applied psychology.

Dorst, K. (2008). Design research: a revolution-waiting-to-happen. Design Studies, 29, pp. 4-11.

Fricke, G. (1996). Research in Engineering Design, 8 (3), pp. 151-165.

Hodge, S. A. (2003). Teachers' perceptions of autonomy and administrative support as predictors of self-efficacy: The moderating roles of gender and experience. Dissertation Abstracts International Section A: Humanities and Social Sciences, Vol. 63(11-A), pp. 3852.

O'Donnel, F. J. and Duffy, A. H. B.(2005). Design performance. London: Springer.

Ilona Abena Owusu
MSc candidate Design for Interaction / Psychology
Delft, University of Technology, Faculty of Industrial Design Engineering
Landbergstraat 15, 2628CE Delft, The Netherlands
Telephone: +31 15 2783029
Telefax: +31 15 2787179
ia.owusu@yahoo.com
http://studiolab.ide.tudelft.nl/studiolab/