Designerly Ways to Theoretical Insight: Visualisation as a means to explore, discuss and understand design theory

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Abstract

This paper set out to investigate *how design students learn from visualising theory in design education*. The exploration rests on the assumption that the application of tools and techniques from design practice supports design students with an entrance to the theoretical part of the field.

The paper is based on teaching experiences from an MA course in design methodology at Design School Kolding where we use visualisation as a tool to discuss, explore and understand design theory. To throw light on the question, student evaluations and feedback has been included together with a classification of the material from one visualisation exercise. In addition, theories for how to understand designerly ways of knowing and constructing knowledge have been applied as tools to think with in the discussion.

The educational approach where design students read, analyse, and visualise theory, appears to be beneficial to the students' learning process for a number of reasons, which will be discussed in the paper. The main findings indicate that visualising theory is beneficial because it applies a type of practice that the students are familiar with, and supports the construction of new knowledge, by allowing the students to express information and concepts in ways that are personally meaningful to them.

Key words

visualisation, designerly knowing, design education, design methodology

Introduction

The use of visualisation as a design tool has been discussed in various ways within the field of design research and in textbooks. During many years design researchers have studied, discussed and acknowledged sketching and drawing as a tool for reflection as well as designing in various ways (see for example Schön, 1983; Cross, 1995; Lawson & Dorst, 2009; Goldschmidt 1991, 2013). Visualisation has also been the subject or included in textbooks across different design domains, see for example Buxton (2007) on user experience, Olofsson and Sjölen (2005) on product design or Gaimster (2011) on Fashion design) Also method card collections usually include methods where visualisation plays a central role (IDEO, 2002; DSKD, 2011). Additionally visualisation has been discussed as an 'assisting' tool in communicating design and design processes (see for example Roam (2009) on visual thinking in business innovation, Sibbett (2010) on visualisation as meeting facilitation and Rohde (2013) on visual note taking). Thus, there is a large and diverse body of knowledge and a vast amount of literature, which is concerned with visualisation as a communicative or reflective tool in the design process.

In this paper we are specifically concerned with visualisation as a reflective tool but we take a slightly different perspective than most of the cited literature since our aim is to discuss visualisation as a teaching approach in theoretical courses in the design education. We use this study to claim that there is an educational potential in using a designerly approach when teaching theory in design schools. Therefore, instead of exploring visualisation as a design tool, we discuss ways in which visualisation can be integrated as a tool for exploring and learning theory in design education.

In recent years at Design School Kolding in Denmark we have applied visualisation exercises in various cross-disciplinary courses at all levels as a tool to discuss, explore and understand design theory. Back in 2009 one of the authors introduced students to the use of visualisation as a tool for dialogue when reading and making sense of theory (Gelting, 2009). We decided to further explore the integration of visualisation using examples from an MA course on Design Methodology. The exploration rests on the assumption that the application of tools and techniques from design practice supports design students with an entrance to the theoretical part of the field and holds the promise of improving the students' learning outcome. Feedback and evaluation by the students indicate that they do indeed experience that the visualisation approach helps them engage with theory at a new level, and in this way supports the learning process.

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We use the paper to reflect on the teaching approaches and learning outcome of the course. During the three times that we have run the program, we have received positive feedback and evaluation from the students, indicating that applying visualisation as a tool for exploring and making sense of theory provide them with the ability to grasp and discuss theoretical concepts – see different perspectives and being able to address them together. We use a combination of structured reading assignments, group work and visualisation exercises. What we would like to focus on in this article is the visualisation exercises, how and why that helps the students process the readings. The overall question, which is explored in this paper, is therefore: *How do design students learn from visualising theory in design education?* The overall purpose is to gain a better understanding of why it works well to use visualisations as a pedagogical tool – and how does it work?

Before we lay out the theoretical foundation we introduce the case, which we build upon, namely the course in design methodology, and the empirical data produced by collecting and clustering the visualisations from the first exercise in the 2013 course.

Teaching Design Methodology

The Design Methodology course at Design School Kolding in Denmark encourages the students to work in-depth with design theory in an active and participatory way. The students are expected to acquire an overview of design methodology and in-depth knowledge of selected literature. Furthermore they are expected to reflect on methodological aspects in relation to their personal design practice. It is a mandatory course offered to all MA students in their final year. This means that we teach an interdisciplinary group of 60-80 students coming from Fashion, Textiles, Industrial Design, Graphic Design, Illustration and Interaction Design.

From a didactic perspective the large size of the group is a challenge. How can we secure the individual learning and at the same time encourage the students to contribute to common knowledge generation and learning? Another main challenge is that the students are highly dedicated to design practice and how to act as designers. It can be difficult for some students to understand that their design practice can benefit from theoretical insights. On top of that many students suffer from dyslexia. Finally, if there is any international students present the course is taught in English, which is not the native language in Denmark.

We are a group of three teachers/researchers, who develop and run the course together. The course was offered for the first time in September 2011. In September 2012 and 2013 we had the opportunity to refine the course, building on experiences from the previous year(s). The course is a 2-week course. Teaching is 4 days a week from 9.00 to 2.15.

The students pass this course by attending a minimum 75% of the time. Therefore the learning impact cannot be measured in terms of exam grades or by analysing written assignments but is related to an expected learning outcome for the students. The expected learning outcome is to be able to discuss design process and method from a historical perspective and to possess knowledge on how the field of design relates to methodological research and approaches of other disciplines. It is also important that the students gain an overview of the most important design theorists' design methodological stance and to be able to use this knowledge to understand contemporary prevailing approaches. Last but not least the students must be able to reflect on design methodology in relation to design practice.

The pedagogical key elements in the course are: group work, a process of structured reading assignments and visualisation as a tool to think with. As a preparation for the group work we provide the students with a short introduction to the selected literature and an assignment, which guides them in the subsequent reading process. Each assignment encourages the students to reflect on structure as well as content in selected text(s). The expected outcome is a written summary and a visualisation. The visualisation is expected to communicate the main points in the text(s) using drawing and short statements. Over the years we have learned that the visualisation appear to serve the purpose of further understanding and remembering the theory if it is hand-drawn and in poster size.

The 2013 course consisted of three assignments. Each assignment had a specific goal: 1) to understand a single text in-depth, 2) to conduct a comparative analysis of two texts, and 3) to understand design methodology in a historical context. The group size was two to four students to increase the likelihood of everyone in the group participating actively. The students read in groups, they explored, discussed and solved the assignment together. One full day was allocated for each assignment. Subsequently we arranged discussions and presentations in smaller groups. This was an alternative to plenum discussions, which we reduced to a minimum in order to let each student be as active as possible.

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Mainly text-based visualisations

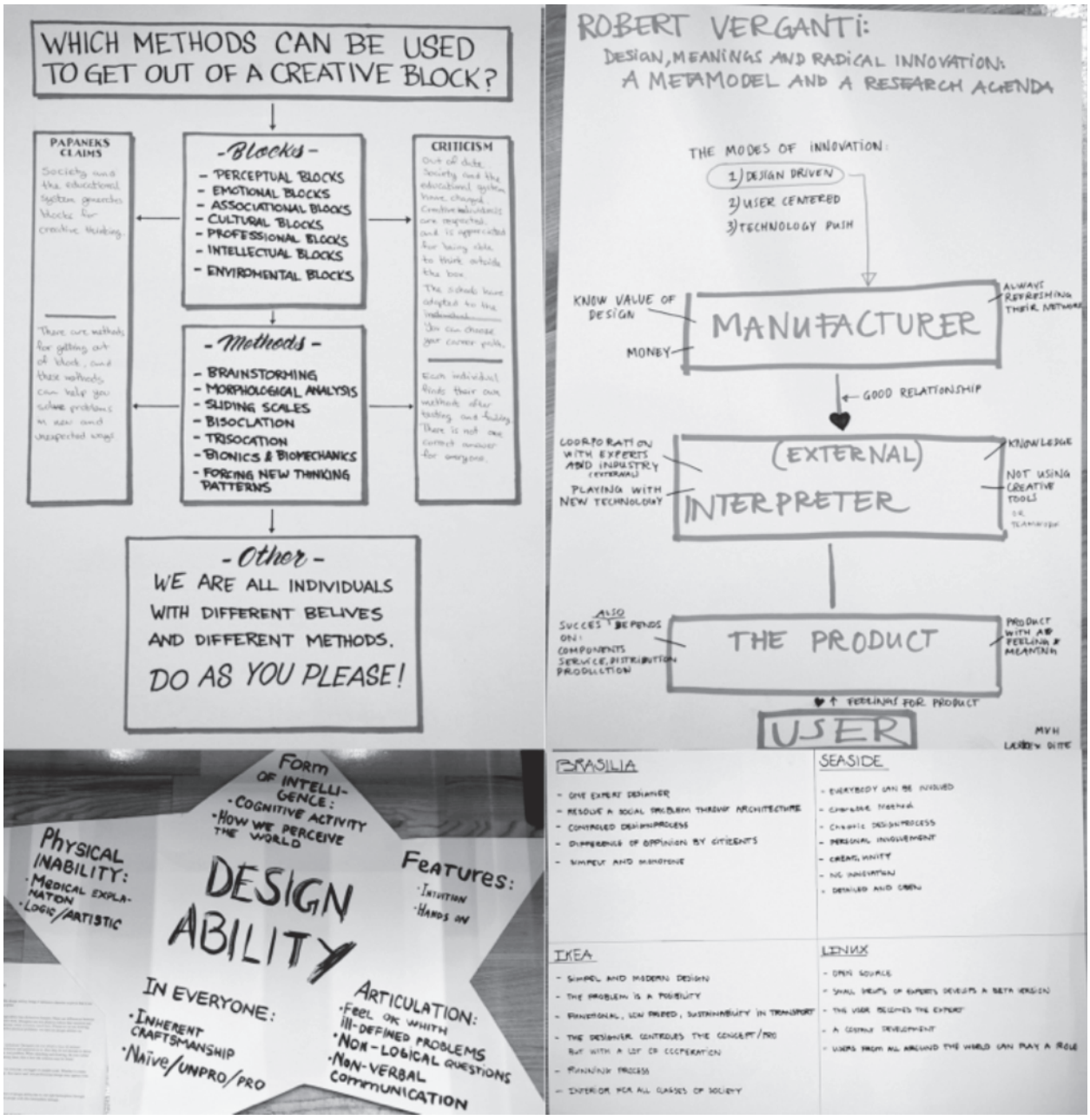

Figure 1: These posters exemplify the mainly text based visualisations (photos: S. A. K. Friis).

Empirical Data and Examples

In this section we use material from the first assignment to exemplify and cluster ways in which the students visualised single texts. In the first assignment the students worked in pairs. They were asked to read one text and subsequently demonstrate the insight in the form of a written summary and a hand drawn visualisation in poster size.

First we present a classification of the different types of visualisation, which we have received. We have registered 26 visualisations, which we have divided into three main groups. Each group reflect a certain type of visualisation: 1) Mainly text based, 2) Mainly narratives and/or symbols based, and 3) A combination of statements and narratives/symbols. Secondly we exemplify ways in which the visualisations were used as a means for knowledge sharing between the groups.

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Mainly narratives and/or symbols based visualisations

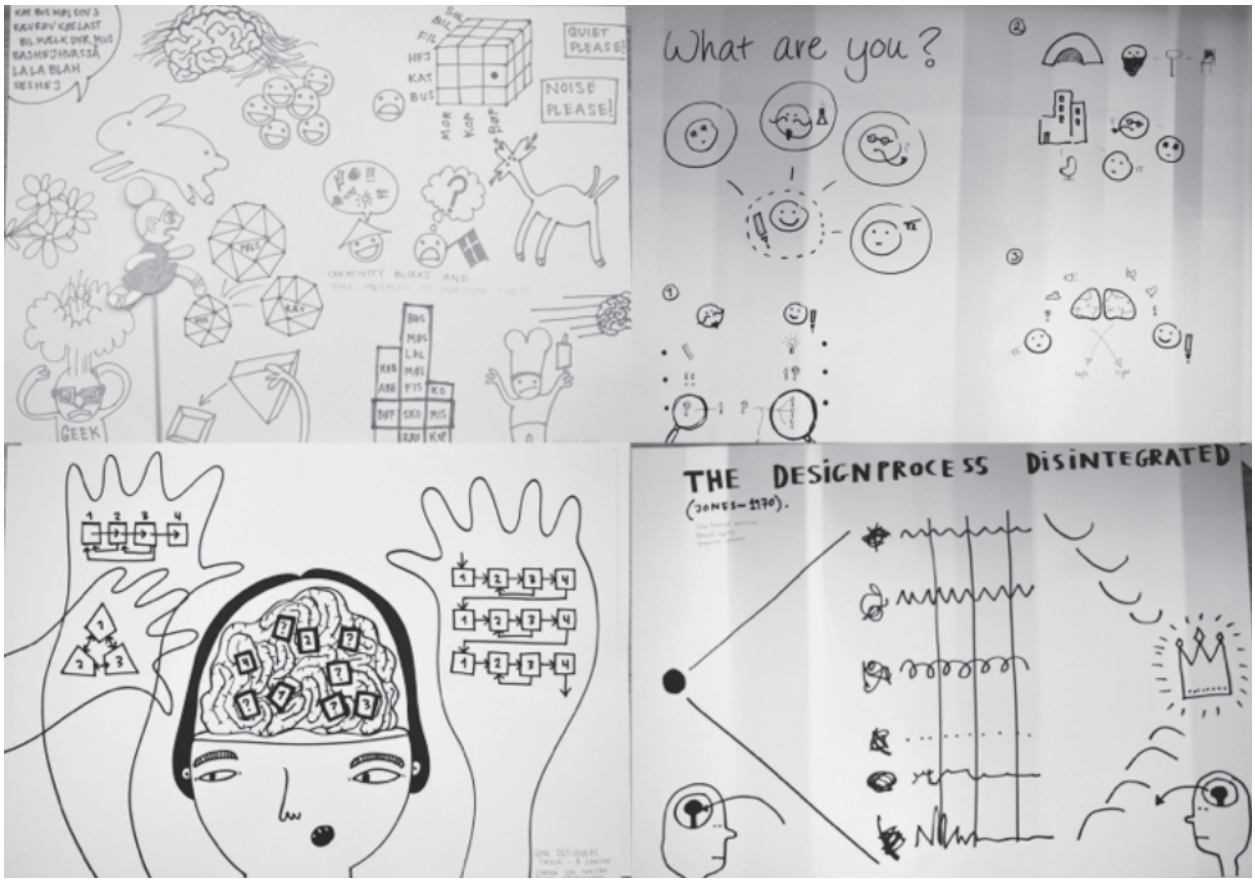

Figure 2: These posters exemplify visualisations mainly based on narratives and/or symbols (photos: S. A. K. Friis).

The smallest group of visualisations is mainly text based (5 out of 26). As Figure 1 shows the text often appears in an organised and structured way, which resembles bullet points organised in diagrams. The diagrammatic character indicates an order or a system of reading and understanding the visualisation. This type of word-based visualisation presents the main points of the text. The reader gets a clear view of the relation between the main points due to the way they are structured and organised on the poster. This type of visualisation appears close to an objective depiction of the text, bringing forth key terms and concepts.

The visualisations that are mainly based on narratives and/or symbols appear to reflect a more subjective depiction of the text (8 out of 26). It is a translation of the text into something personally meaningful. It fits with how designers and architects use a concept as a means for grasping, framing an idea…'if we make it like a…'. Using metaphors, analogies and associations the text is transformed from something difficult and abstract into something more relatable and known. In other words the visualisation based on narratives and/or symbols is a concrete bid on the essence of the text (Figure 2). Some of these visualisations are difficult to understand if one is not familiar with the text or has witnessed the presentation of the visualisation.

The largest group of visualisations is a combination of narratives and/or symbols and short statements (13 out of 26). As Figure 3 shows this type of visualisations is in many respects a mix of the two other types. It is characteristic that the text appears as short statements, which enhances the chosen narrative or symbol(s). Some of the visualisations have a diagrammatic character like the text-based visualisations and some of them are closer to the visualisations mainly based on narratives and/or symbols. Common for this type of visualisations is that words and images supplement each other.

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Visualisations based on a combination of text and narratives/symbols

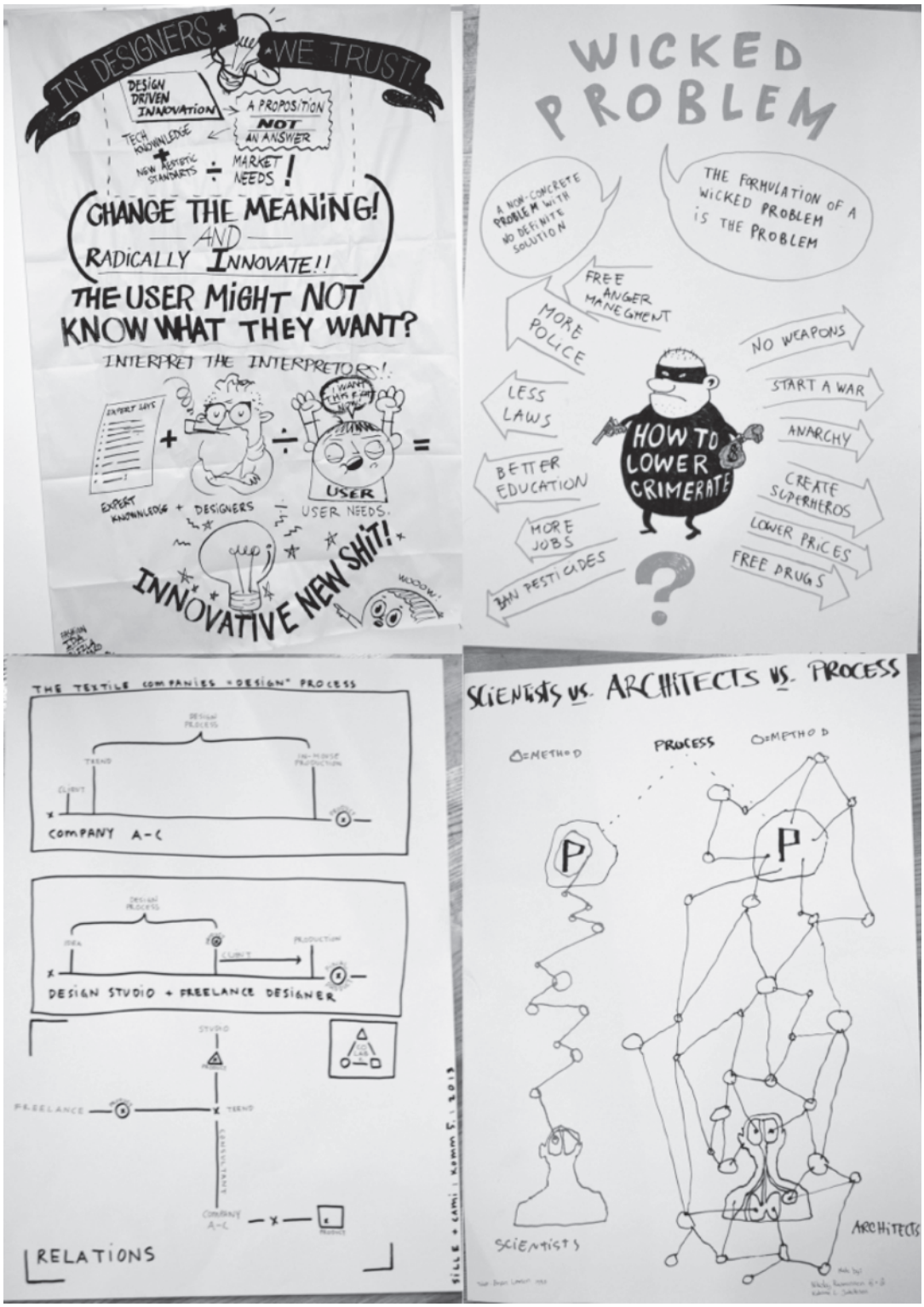

Figure 3: These posters exemplify visualisations using a combination of narratives and/or symbols and short statements (photo: S. A. K. Friis).

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Presentation and Knowledge Sharing

Figure 4: Examples from the knowledge sharing (photo: S. A. K. Friis).

When we first introduced the visualisation assignments in 2011 several students found it odd. The students clearly expected a highly theoretical course with classic lectures and one-way communication from teacher to students even though this is rarely the case at Design School Kolding. They assumed that we included the visualisation assignment in order to 'bribe' them to 'love' theory by letting them use well-known tools from design practice. While we were not out to 'bribe' them, we did want to provide them with a familiar entrance to exploring and making sense of theory. Fortunately, in the course evaluation, the term 'bribe' did not come up and students emphasised how much they actually learned from taking the visualisation assignment seriously. The task of visualising forced the students to discuss and identify the content and main points of the texts. Otherwise they wouldn't be able to decide for a way to visualise it. Said one student in 2013 "I love visualisation. It helps dive into the texts and making it enables you to see if you understood it!" (09.2013). A group of students explained it this way: "It's great to meet up in a small group when you have read the text, to talk about it, make sense of it, and circle the most important points together. And when you have to make the visualisation together, and tell each other about ideas for how to do it, there is another point of discovery: Do we have a shared understanding or are there things, which we have understood differently? Not until you make the visualisation, do you really understand it [the text]" (09.2013). Two students described what happened when they were comparing visualisations of the same text: "It was fun – there were two groups that had read and visualised the same text. But the visualisations made them see that they had understood the text quite differently. The visualisations acted as drivers for a rich discussion, which gave room to new perspectives" (09.2013).

The first reading assignment was followed by knowledge sharing in groups of 2-3 pairs of students. We asked the students to use the visualisations disseminating the generated knowledge to fellow students (Figure 4). Afterwards we had a short plenum discussion, which included a brief feedback on the use of the visualisations. Several of the students mentioned that the visualisations helped in their understanding of the texts presented by fellow students. It was also mentioned that it was easier to

remember the main point of the texts when they were accompanied by a visualisation. Finally the visualisations served as a starting point for discussing diverging understandings of the same text.

Theoretical Foundation

The next section seeks to provide a theoretical foundation for the further discussion of the research question: *How do design students learn from visualising theory in design education?* Design students are special in the sense that they are trained to use the power of conjecture (Lawson, 2006) for instance through sketching and visualising possible solutions (Schön, 1983; Cross, 1995). This is an important factor when trying to understand how MA design students in their final year learn from visualising theory – the training of the students cannot be separated from the teaching methodology that we apply and investigate. We therefore find it appropriate and worthwhile to use design theory – with a special attention to designerly ways of knowing – since the visualisation approach to exploring, discussing, and understanding design methodology is applied in the context of design education. Thus, the present paper builds on theory from the field of design, and particularly the designerly ways of exploring and knowing as described by Cross (2007), Lawson (2006), Schön (1983), Goldschmidt (1991) and Kolko (2010). While the visualisation approach to exploring and understanding theory might also be fruitful in other disciplines, it is not part of this investigation.

Constructive Thinking in Education/Cognitive Potential

According to Cross (2007), there are large areas of human cognitive ability that have systematically been ignored in our educational system. He argues that numeracy and literacy have been favoured whereas the culture of constructive thinking has been neglected: *"This culture relies not so much on verbal, numerical and literary modes of thinking and communicating, but on nonverbal modes. This is particularly evident in the designer's use of models and 'codes' that rely so heavily on graphic images – i.e. drawings, diagrams and sketches that are aids to internal thinking as well as aids to communicating ideas and instructions to others" (Cross, 2007: 28-29). Based on the work of Piaget and Bruner he further argues that cognitive development is a continuous process of interaction between different modes of cognition. "That is, the qualitative different types of cognition (e.g. 'concrete' and 'formal' types in Piaget's terms, 'iconic' and 'symbolic' in Bruner's terms) are not simply characteristic of different 'stages' of development, but are different kinds of innate human cognitive abilities, all of which can be developed from lower to higher levels"* (Cross, 2007: 28).

Solution Focused Strategies

Several researchers have pointed out how designers are trained to explore and understand by conjecture. Lawson (2006) studied design behaviour through a series of experiments and came to the conclusion that while scientists problem-solve by analysis, designers problem-solve by synthesis. He also concluded that the design behaviour is learned by education since 1st year BA students did not display distinct solution focused strategies. Says Cross "*A central feature of design activity, then, is its reliance on generating fairly quickly a satisfactory solution, rather than that of any prolonged analysis of the problem*" (Cross, 2007: 23). "*Designing is a process of pattern synthesis, rather than pattern recognition*. (Cross, 2007: 24). By doing so, trying out solutions, "*they learn about the nature of the problem*" (Lawson in Cross, 2007: 23).

Reflective Practice

Looking at design as a unique way of thinking and acting, Schön (1983) has provided significant insights into how this takes place in practice. Schön explains how the architect/designer uses a complex combination of different materials, medium and language to engage in the creative process. This process creates unintended consequences that feed back into the process and creates a new understanding of the project and process. "*He shapes the situation, in accordance with his initial appreciation of it, the situation "talks-back", and he responds to the situations back-talk*" (Schön, 1983: 79). This process Schön names as having a conversation with the materials of the situation. Just like Cross, Schön understands the designers' approach from a constructivist perspective – knowledge is being formed in the individual human being when new information meets existing knowledge generated from previous experience – "*The solution is not simply lying there among the data, like the dog among the spots in the well known perceptual puzzle; it has to be actively constructed by the designer's own efforts*" (Cross, 2007: 24).

Externalization as a driver for Sense – and Synthesis –Making

Kolko (2010) explores how designers use externalisation of data and thoughts to fuel synthesis and to make ideas external and sharable: "*Common to all methods of synthesis is a "sense of getting it out" in order to identify and forge connections. This is an attempt to make obvious the sensemaking conditions described above; emphasis is placed on finding relationships and patterns between elements, and forcing an external view of things. In all of the methods, it is less important to be "accurate" and more important to give some abstract and tangible*

form to the ideas, thoughts and reflections. Once externalized, the ideas become "real" – they become something that can be discussed, defined, embraced, or rejected by any number of people, and the ideas become part of a larger process of synthesis. Essentially, sensemaking is an internal, personal process, while synthesis can be a collaborative, external process." (Kolko, 2010: 18). Alas, Kolko makes a distinction between 'sensemaking', which is described as internal and personal, and 'synthesis', which can be collaborative and external. This point will be further explored in the discussion in relation to the approaches, which were applied in the present course.

Seeing That and Seeing As

Based on the assumption that the practice of sketching is helpful to architects' thinking, Goldschmidt (1991) is interested in the underlying cognitive operations behind sketching. She describes a protocol study of 8 architects working on a specific building design and how they use sketching to pull thoughts onto the paper but also create new ideas and thoughts in the process. Sketching being a visual conversation and meeting place between paper, pen and ideas. In the analysis Goldschmidt defines two different ways in which architects use sketching: *seeing as* (when thinking in metaphors or figural thinking, synthesising) and *seeing that* (non figural, and analytical thinking). Sketching being used to trigger alternately *seeing as* and *seeing that* thus aiding the architects' development of ideas and creative process. Kolko's findings – that the externalization is a way to make sense and create synthesis – appears to be in line with Goldschmidt's definitions of *seeing as* and *seeing that*. However, while Kolko differentiates between two processes as being either internal and personal or collaborative and external, Goldschmidt points out the cognitive operations supported by different types of sketches.

Discussion

In this section theory from the previous section is applied to analyse and discuss the main question of how and why design students learn from visualising theory in design education. As a part of this we address the role that the type of visualisation plays for the individual understanding of the text and the role that the visualisations play in the presentations of the texts to fellow students.

Lawson's findings concerning how scientists and designers prefer to work (2006) is relevant to the present study, since design students are asked to use both approaches: firstly, they analyse the text, using a series of guiding questions in relation to content and structure, and render the significant points in a summary. This is a straight forward understanding exercise, making the strange familiar in a quite objective way. Secondly, the students are asked to visualise the text, to synthesise their findings in a hand-drawn illustration. This is a transformation exercise, making the familiar strange in a subjective way, allowing the students to reflect while constructing, and bring forth something of them selves in the illustration of the text. However, depending on the type of visualisation that the students make, the activity can be placed on scales between 'subjective' and 'objective', 'concrete' or 'abstract', and 'diagrammatic' and 'narrative' – the transformation being more evident in the subjective, concrete, and narrative representation than visualizations at the opposite end of the spectrums. This relates well to Goldschmidt's findings of different types of sketches supporting different types of cognitive operation, which is further addressed later in the discussion.

In the present case, the situation can be said to be opposite to the one depicted by Cross when suggesting that constructive thinking has been neglected in culture. Master students in their final year are familiar with using drawings, models, and sketches in their everyday work whereas reading and analysing theory is something, which they in general are less comfortable with. However, Cross's point about the different cognitive abilities is still of interest to the present study where the educational approach encourages students to switch between these different cognitive modes. By visualising the text that they have read and analysed, the students thus apply an approach, which Cross would refer to as a designerly way of knowing: making their mode of problem solving solution focused, making their mode of thinking constructive, using 'codes' to translate abstract requirements into concrete objects, and using these 'codes' to both 'read' and 'write' in 'object' languages.

The students in doing a visualisation transformation or synthesis of the text goes into a dialogue with the text in a tangible way. Thus, they create a situation where the visualization "talks back" to them and force them into a conversation with the text (Schön, 1983). The material nature of the handmade visualisation invites the students to physically explore the text. Rather than designing beautiful visualisations meant for broader knowledge dissemination the students use visualization as a tool to think with. Thus, these may not reflect the actual drawing skills design students on MA level are supposed to possess.

Comparing Goldschmidt's findings to the classification presented in section 3, they seem to be in accordance:

Some students use seeing as visualisations where they create a poster, which is narrative and metaphorical (Figure 2) and some students use seeing that sketching were they use a diagrammatic and analytical way of visualising the text (Figure 1). Some students use the visualisations to move between the different ways of reflecting upon the text and getting an understanding of it (Figure 3). Pulling thoughts from a tacit state to an explicit state. In coming courses it may be interesting to increase the attention to the type of visualisations the students come up with or be more precise when giving the student's the visualisation assignments, altering between different types of visualisation for different purposes or maybe even asking the students to make a series of visualisations, for instance starting out with the sensemaking visualisation, *seeing that*, and continuing with the synthesis visualisation, *seeing as*.

Kolko also explores the significance of external representations, however, suggests that sensemaking is internal and personal, whereas synthesis can be a collaborative and external process. When looking at the present course material, it is not readily clear whether sensemaking is only an individual process – or whether it can happen between design students working together on a visualisation. As a matter of fact, a consistent feedback from the students is that working in groups together is supportive in both the exploration and understanding of a theory. However, answering the question goes beyond the scope of the present study.

To summarise the findings of the present study, the educational approach where design students read, analyse, and visualise theory, appears to be beneficial to the students' learning process for a number of reasons.

a. Applying visualisation tools and techniques support design students with an entrance to the theoretical part of the field, because it constitutes a familiar way of exploring and making sense of a situation

b. When moving from reading and analysing to interpreting and visualising, the students make connection across different cognitive ways of operating, such as for instance the verbal and non-verbal modes of thinking. This continuous process of interaction between different modes of cognition supports the construction of connections and the ability to remember what was constructed

c. Working with visualising a text takes the students away from prolonged analysis, which is unfamiliar territory to many design students, inviting them to investigate and understand the text by trying out solutions (constructive thinking)

d. Visualisation, particularly in the case of visualisations that are mainly narratives and/or symbols based, has to do with synthesising and translating the text into something personally meaningful. In the visualisation process, new information (the theory) meets the students' existing knowledge and experiences, and new knowledge is constructed

e. Visualisation, particularly in the case of visualisations that are mainly text based and diagrammatic, enables visual analysis and sensemaking of a theory, enabling abstract and objective representation

f. 'Getting it out' as suggested by Kolko, enables the students to make their ideas, reflections, and thoughts 'real' and they can use the externalised version to further discuss and make sense of the concepts and ideas. It moves the exploration and sensemaking from a largely individual process to a shared process

g. Presenting and seeing other student groups' visualisations enables students to identify and forge connections and produce new understanding together

Conclusion

The present paper set out to investigate *how design students learn from visualising theory in design education*. To throw light on the question, student evaluations and feedback has been included together with a classification of the first visualisation exercise in the 2013 course program. In addition, theories for how to understand designerly ways of knowing and constructing knowledge have been applied as tools to think with in the analysis and discussion.

The research is still in its early phases and the findings are tentative. However, we argue that our experiments with integrating visualisation as a tool for exploring and making sense of theory can be of value to design education as a whole. In a time where many design schools move from arts and crafts based approaches only to also include more academic ways of learning, and where the production of theory is increasing, it seems appropriate to think of ways in which we might tailor theory based programs to design students.

The main findings is that 'yes' – visualising theory is beneficial to MA design students, because it applies a type of practice that they are familiar with, and supports the construction of new knowledge, by allowing the students to express information and concepts in ways that are personally meaningful. 'Getting it out', putting it on paper, enables students – within the groups – to make sense of and synthesise new meanings together. When sharing with other groups and seeing their visualisations, the

student groups as a whole, support each other in creating an overview.

A downside might be that some groups have misunderstood a text or they might only show a fraction of a theory in the visualisation, leading to the fact that other students, who have not read the text themselves, are 'cheated' on important information or directly misled. When running a course for this many students, and presentations are run in smaller groups, the teachers cannot be present everywhere at the same time. However, the fact that several groups read the same texts and get a chance to present to each other and discuss perspectives might in part make up for this.

Further Work

Would visualisation work as an educational lever within other educations as well? It is a good question whether the visualisation approach to text reading can be transferred to other disciplines and fields and it might be a subject for further research. As mentioned above Lawson argues that design students are trained to use their powers of conjecture to find solutions and for example a biology student might not be able to benefit from the visualisation exercise in the same manner as the design student in his/her final year. But all the same, thinking about Cross's argument, that numeracy, literacy, and nonverbal models and codes are all innate human cognitive abilities – all of which can be developed from lower to higher levels, one would think that the visualisation approach to text reading can be transferred to other disciplines and fields. With the proper introduction, the above mentioned biology student might be able to benefit from the visualisation exercise by getting some training in visualisation and applying it to theory understanding.

However, we are teachers and researchers at a design school and it would be appropriate to consider further research worth to discuss within the community of design research and from which the design students could benefit. In this paper we have started to identify different categories of and approaches to visualising. Studying in-depth the roles the different types of visualizations play in teaching design theory might be a fruitful and highly interesting subject for further research.

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