Sketching and idea generation during the conceptual phase

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ABSTRACT
This paper focuses on how sketching can be used to generate ideas and solve problems during the design process. The focus is on design students as there is a difference between experts and novice designers. The following hypothesis is set up: Sketching, as a tool to solve a complex problem, helps to generate more ideas in comparison when only using mental imagery. Two experiments, a comparison experiment and retrospective analysis, were conducted to get a better insight in the hypothesis and provide a possible answer. Sketching has the slight advantage of reinterpretation. Design students have the need for a form of external memory, like sketches or diagrams, when generating ideas. A future experiment can be conducted to dig deeper into the subject.

General Terms
Theory, Design, Experimentation.

Keywords
Sketching, mental imagery, idea generation, creativity, conceptual phase, design process.

1. INTRODUCTION
I personally sketch a lot during my own design process. I noticed there is a difference among students in the way they use sketches in their process and the quality of the sketches.

With this paper I want to look into the usage of sketching as a tool and non-sketching and its relation to creativity and problem solving during the conceptual phase of a design process.

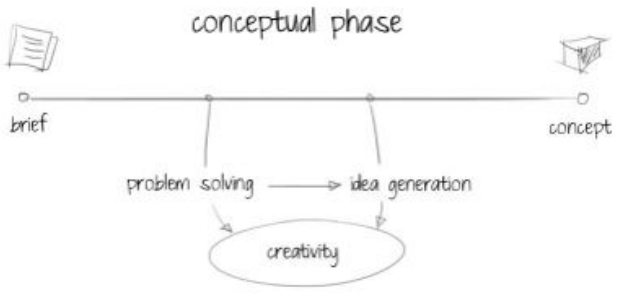

Figure 1. Visualisation of conceptual phase and creativity.

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Does sketching have influence on creativity? Can one become more creative while solving a problem when using sketching as a tool, instead of solving the problem with mental imaginary only? So can one generate more ideas that will help to solve the design problem while sketching?

2. BACKGROUND
A returning subject in the literature about sketching is reinterpretation, when a sketch or diagram is used to inspire for a new sketch or diagram. Van der Lugt [7] quotes Smith in his paper, which is as followed: "Presumably, when visually depicted, ideas are more able to inspire new ones" [7,p102]. So the advantage of drawings and diagrams is that they are associated with reinterpretation or new ways of seeing them [3,4,5,7]. An advantage of reinterpretation, regarding generating ideas, is that it allows lateral transformation to occur more easily. This effect will result in more unstructured ideas according to Goel according to Purcell & Gero [5].

A sketch or diagram can also be used as external memory. According to Purcell & Gero [5], Newell and Simon propose that when the complexity and/or size of a problem exceeds the limit of the short-term memory that the problem will be broken up or decomposed into sub-problems. In addition, external memory aids such as sketches and diagrams are used. These ways can reduce the load on the working memory.

Next to the sketch or diagram itself, there are also some insights on the difference between the usage of sketching among expert and novice designers. Bilda et al. [1,2] has done several studies with expert and student designers and the usage of sketching versus mental imagery. The studies showed that sketching might not be a necessary act for an expert designer under certain conditions during the conceptual phase. There were no significant differences in the density of idea production between sketching and blindfolded design activity for expert designers. Seitamaa-Hakkarainen and Hakkarainen [6] also looked into the difference between advanced students and expert designers. They noticed that expert designers came up with more in-depth ideas while students came up with many different ideas.

3. HYPOTHESIS
Sketching has the advantage of reinterpretation, which also allows lateral transformation to occur. In contrast when using only mental imagery to solve a complex problem there is no access to external memory aids. So there will be

less reinterpretation that will allow lateral transformation to occur easily. This will result in fewer ideas in comparison with a designer that has the ability to sketch.

The following hypothesis is set up to explore in this paper: Sketching, as a tool to solve a complex problem, helps to generate more ideas in comparison when only using mental imagery. This hypothesis is based on the sketching activities of design students.

4. METHOD

Two small experiments were conducted, a comparison experiment and retrospective analysis, to explore if there is a relation between the amount of generated ideas and the usage of sketching versus mental imagery. Both experiments were conducted parallel to one another. The outcome of the retrospective analysis did not influence the setup of the comparison experiment.

4.1. Retrospective Analysis

This experiment is an analysis of the idea generation during the conceptual phase of my own project from the past, in which ideas were generated for a complex design challenge. The advantage of this analysis is that it is regarding a real life situation and a complex design challenge.

The ideas should be of similar quality and serve the same purpose, so not sketches that focus on communication while other sketches are more loose sketches. For the analysis a sample was taken of the ideas that were generated from the first brainstorm session until the selection of three concepts.

In the retrospective analysis was tried to analyse if there were any cases where the design challenge was divided into sub-problems. Sub-problems would indicate that the design challenge is complex, according to Purcell & Gero [5], Newell and Simon propose that when the complexity of a problem exceeds the limit of the short-term memory that it will be broken up or decomposed into sub-problems.

Finally the analysis gave an insight in the amount of ideas that can be seen as lateral transformation or as vertical transformation. Another important insight from the analysis is the amount of ideas that were generated due to the fact of reinterpretation. For reinterpretation the order in which an idea was generated played a role as well.

4.2. Comparison Experiment

This experiment helped to make a comparison between a short idea generation phase where students were able to use sketching and one where students were only allowed to use their mind, mental imagery.

The sample for this experiment consisted out of two design students from the Royal Danish Academy of Fine Arts. This is only a small sample, but is sufficient to get some first insights and offers opportunities for improvements for future related experiments.

An important aspect of the comparison experiment is the complexity of the design challenge. The design challenge should be complex enough, but still be able to be used in an idea generation of only 10 minutes. The students were asked to generate ideas for the following two design challenges:

Design challenge 1: Design a digital camera for people with bad eyesight.

Design challenge 2: Design a bag for a mother with children.

Both participants conducted the experiment individually at a normal working space, to get the closest experience to a real life situation.

The participants were asked to generate ideas for both design challenges, but for design challenge 1 the participants were only allowed to make use of their mental imagery and no other tools. The participants spoke out loud their ideas and the researcher noted these down, but this process was not visible towards the participants. For design challenge 2 the participants were allowed to use sketching to generate ideas.

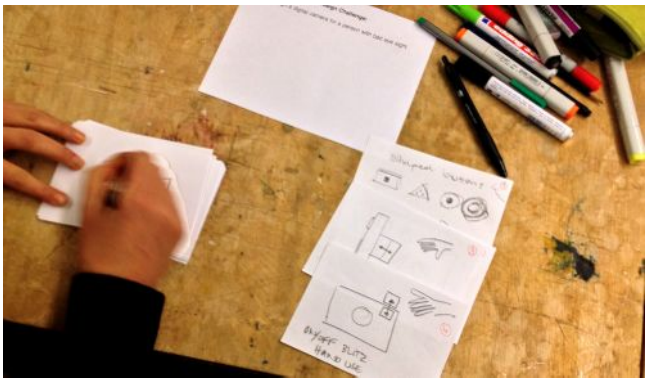

Figure 2. Participant generating ideas with the ability to sketch.

After finishing both design challenges there was a quick interview about the usage of sketching versus mental imagery during the experiment and in their own process.

Finally the participants were asked to rate their own ideas on a 1 to 5 scale from bad to good. This helped to get a qualitative insight next to the quantitative insight from the amount of ideas.

5. DISCUSSION

The goal of both experiments was to get an answer to the hypothesis, but also look at it from a real life situation. So the retrospective analysis was from a real life situation and with the comparison experiment it was tried to mimic a real life situation. Most of the other experiments, from the literature, are conducted in an experimental environment. Both of my experiments were focused on design students where they generate ideas for a complex design problem.

5.1. Retrospective Analysis

The retrospective analysis of my own project showed that there is clearly more lateral than vertical transformation during the idea generation. The goal of the idea generation in the conceptual phase is to generate many different ideas. This could also explain why there would be more lateral transformation than vertical transformation.

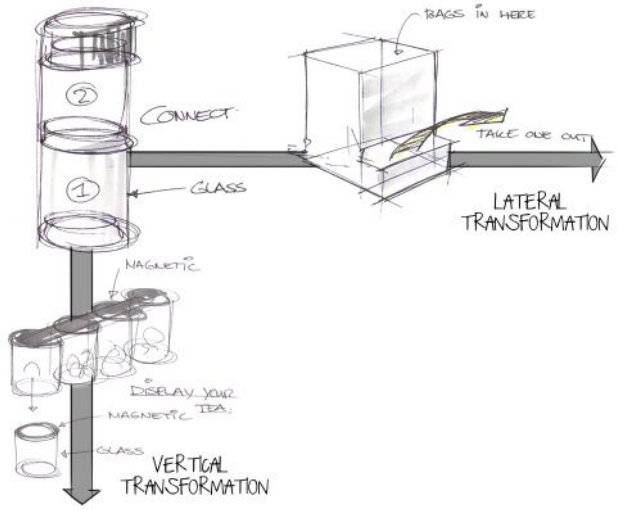

Figure 3. Lateral versus vertical transformation.

Eight cases of reinterpretation were analysed in the retrospective analysis and some ideas have inspired more than once. Mainly the reinterpretation would consist of a feature that is repeated, for example a timer, first designed together with a thermometer, and was coming back in a cup

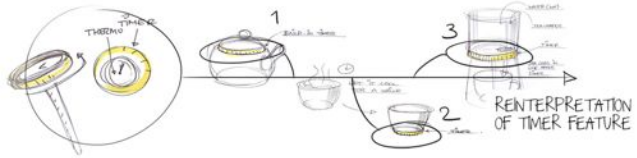

Figure 4. Reinterpretation of timer feature in the idea generation.

and a teapot. There were also cases that an idea is transformed to another form, for example a measure cup to the same measurement indication in a teacup. Most of the reinterpretation found place on the same day and was not spread over multiple days.

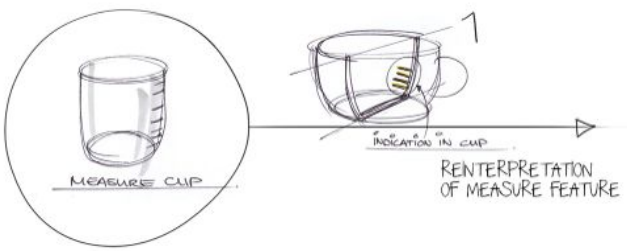

Figure 5. Reinterpretation of measurement feature in the idea generation.

It was suspected that reinterpretation would be the advantage of sketching as a tool, but roughly 10% of the ideas generated were inspired by earlier generated ideas. This is not a high percentage and could indicate that there is only a slight advantage when using sketching as a tool.

5.2. Comparison Experiment

The comparison experiment showed some surprising results. Suspected was that the participants would generate more ideas with the ability to sketch in comparison with mental imagery only. Instead the participants generated more ideas during mental imagery.

There was clearly a difference in quality between the ideas generated for both design challenges. The ideas made with sketching were more elaborated and more detailed. The ideas made during mental imagery sometimes consisted only out of one or two words, for example: “several openings”. One of the reasons for this could be that there is a mix between the thinking process and an idea during mental imagery. The participants start think out loud as well and this thinking process will be noted down as an idea. For example one participant elaborated on aspects of one idea for a bag, in this special case the colour, texture and material were all noted down as a separate idea. This participant had more variety in her ideas while sketching.

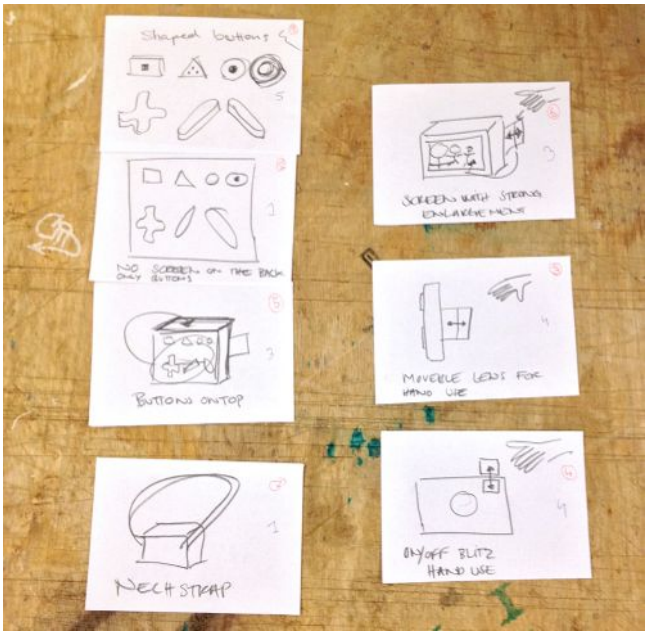

Figure 6. Ideas generated with sketching.

Although the participants generated more ideas with mental imagery at some point they just wanted to write or sketch something. One participant only generated 1 idea with sketching versus 15 ideas with mental imagery, she still found sketching more effective. She mentioned that she normally sketches a lot during her own process and is visual minded. The other participant said to work more with mental imagery, but makes use of word-maps or models instead of sketches. The ability to sketch or write

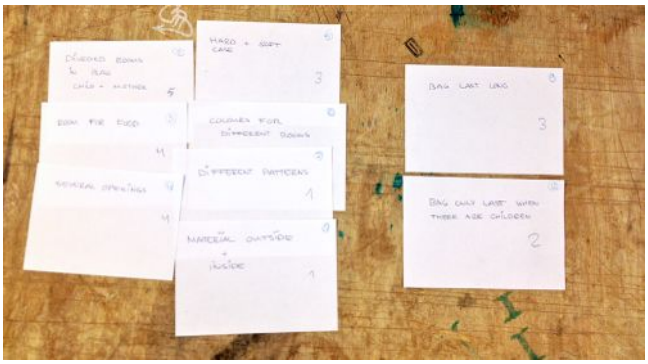

Figure 7. Ideas generated with mental imagery.

had the preference from both participants although the amount of ideas indicated that mental imagery generated more ideas during the experiment.

Another aspect that was noticed during the experiments was time. The participants only had 10 minutes to come up with ideas for one design challenge. Both participants could easily use the whole 10 minutes during sketching, but had some difficulties with mental imagery. One participant indicated that she normally would have stopped, but was forced to continue due to the 10 minutes of the experiment. She also mentioned that she puts more time in her sketches, because she personally likes it to look good as well. The 10 minutes could have been to short to make a good comparison between mental imagery and sketching. It might be possible that mental imagery is in favour for a short period, because it can be executed more quickly. For sketching there is the extra task of putting down your thoughts on paper and give some shape to it.

6. CONCLUSION

Out of the retrospective analysis can be concluded that sketching has the slight advantage of reinterpretation. So sketching helps me to become more creative and generate new ideas. In the comparison experiments there were some forms of reinterpretation, for example an idea based on an earlier idea. It is difficult to say if mental imagery could have reinterpretation in a period longer than 10 minutes. A sketch will stay the same and can be accessed easily while a thought in someone's mind can become vaguely or change when recalling it.

The participants mentioned their normal way of the conceptual phase and their use of sketching. This is also very personal and depending on the education of the designer. One of the participants preferred using word-maps instead of sketching. One thing that both participants had in common regarding their style and preference was that they had the need for a form of external memory. So external memory, like sketching, helps the students to boost their own creativity to come up with ideas in comparison with mental imagery.

The comparison experiment showed that there were more ideas generated with mental imagery, but the overall quality of the ideas seem not to be completely equal. The ideas that were sketched were more elaborated while the mental imagery ideas got more mixed up with the thinking process. It would be good to look into how the ideas generated with mental imagery can be captured without too much distortion from the thinking process to get the quality of the ideas more equal.

Although I cannot completely give an answer on my hypothesis, I think that a form of external memory helps to become more creative and it has a slight advantage of reinterpretation. This can help to generate new ideas. I do not know what the effect of mental imagery will have on generating ideas for a longer period for a complex design problem. The studies of Bilda et al. [1,2] showed that there is a difference in the density of idea production for design students. But the studies of Bilda et al. are conducted in an experimental environment and I would like to see the effect of this in real life situations. This was also one of the reasons to do a retrospective analysis, because this reflects a real life situation. The effect of mental imagery on producing ideas can be explored further with a future experiment. For this the comparison and retrospective analysis can be combined. For example, participants will be working on the same complex design challenge during a project, but will only be able to sketch or use mental imagery. With this kind of study you will get an insight in a real life situation and also see the difference way of how designers work and their personal style and preferences.

7. ACKNOWLEDGEMENTS

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