DESIGN DOING

A study on design doing methodology and the application to a business perspective

Master thesis Enno Cleveringa

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Graduation report by Enno Cleveringa

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The cover shows various concrete cubes that were made during this project, the inspiration came from studio Lernert & Sander

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Integrated Product Design
Delft University of Technology

Preface

The starting point for this project was a personal quest into what kind of designer I am. The term design doing triggered my interest in this project. Although not knowing exactly what that meant, I felt like being more of a design do'er instead of a design thinker.

My mom always said I was the most practical one in the family. Probably a legacy of her father, a skilled carpenter. He had built his own shed in the back yard, which he used to make anything and everything. At my parents there are still several of wooden fruit bowls and a giant book case that he has made. As a kid I was always happy to go there and play in that shed. See all the tools he used, the things he made and smell the sawdust in the air.

When entering the Keilewerf for the first time a similar feeling arose. A feeling of being able to make and being proud of the things you make. As a design student most of my projects were focused on user research and concept design. Some projects resulted in a physical prototype, but most were on a more abstract level. Making was something I did in my spare time and as a part-time job. For my graduation project I was looking for something to combine these.

Design doing to me sounded like a more hands on approach towards design, starting to make rather than over thinking details on paper or in CAD-models. The term sounded to me like the link between making, or craftsmanship, and industrial design.

Acknowledgments

This project would not have been possible without the help and support of many people around me.

First off all I would like to thank Bende for giving me the opportunity to do this project. Hugo, thanks for introducing me to design doing and helping me get through this project. Wouter, for your jokes that were always on the edge and sometimes a little over it. Bart, for teaching me about woodworking techniques and using tools. Lysander, for driving me around in the forklift and Olmo for sitting across from me all those hours in the Bende office. I will always remember the lunches, the laughter and the things we built together.

My chair, Marieke, thank you for helping me get through it all, your interest in my project and the enthusiastic emails which started it all. Most of all thanks for continuously being more enthusiastic about this project than I was myself.

Jacqueline, thanks for all the awesome trips we made through the city during the project. For putting up with me in the times I was stubborn and for pushing me to get the best out of myself.

My parents for supporting me throughout my studies. I know that I should pick up the phone more often and tell you what is going on in my life

Carlo and Thomas for being my roommates. For the failed quiches, the pasta puttanesca, the board games and the games of FIFA we played.

Thank you all,

Enno Cleveringa
Rotterdam 2017

Executive summary

This graduation project was performed at the faculty of Industrial Design Engineering at the Delft University of Technology. This thesis describes the process and outcome of a research into the design doing methodology. More specifically this project is divided into two parts, first part is to research the design doing methodology, the second is to apply the methodology to a business perspective.

The project was performed in collaboration with Bende

STARTING POINT - Design thinking is the most used method of design within the faculty of design engineering. Design thinking methodology has three pillars, technical feasibility, user desirability and business viability. Every designer should design on the limits of new technology, make products that people want to use, all while maintaining a feasible business strategy.

Bende uses the term design doing for their way of working. The company focuses on making at an early stage in the design process. Use making as a means of detailing, in stead of detailing on paper or in virtual models.

"What is design doing?"

"How can design doing be applied in a business environment?"

These were the questions that started this project. The project was divided into three phases.

PHASE 1: ANALYSIS - Both the design methods are primarily problem solving methodologies. The complexity of the problem is something that differs, design thinking has proven to be useful in addressing wicked problems and social issues. Design doing is focusing on more straightforward problems, it offers solutions on working principles and material applications. Problems that are directly related to product design. The goal of these methodologies is to create structure and order in the complex design process.

Every designer has a specific set of skills and no designer has the same skills. These skills are acquired over the years by being involved in a range of projects, companies, materials, technologies and people. Although these skills are all different, there are several skills that each designer should posses in order to design good and useful products.

One of these is the practical knowledge of working with materials. This is knowledge which can only be obtained by actually doing and experiencing it by hand. It is vital for a designer to know the practical properties of materials before applying this in a design. This led to the following vision;

"Design doing is a material-driven approach that focuses on the pxxractical application of materials and the tools used to process them"

The vision together with the outcomes of the analysis phase were used to formulate a framework for the use of design doing. This was used to write a material exploration case.

PHASE 2: MATERIAL EXPLORATION CASE - The main question of this exploration is;

"What is the impact of doing in stead of reasoning?"

In other words, what happens when a designer tries every material combination he/she can think of in stead of reasoning what the outcome will be? The goal is to do

as much as possible and use the results as the criteria for success. When a new material combination is thought off, first thing is to apply it, test it and use the outcome of the test to see whether it is useful/interesting.

A total of 36 different materials combinations were tested during this phase. The outcomes were rated during a workshop. The highest rated experiments were the ones that had properties which are contradictory to what is expected of concrete. Concrete is heavy, hard, cold, geometric and sharp. It does not float, let light through or is shaped organically.

PHASE 3: RELATION TO BENDE - The third part of this project was to relate the findings about design doing back to bende, how can the company best use design doing? One of the most important findings of the case was that the results of the experiments were not the only outcome. The case experiments proved to inspire people to come up with material combinations. For future material explorations, with other materials, the goal is to condense the process into a day or two. There will be less material findings, but the design scope of the company will be broadened and it will boost the overall creativity within the company.

Design doing has proven to be useful in a business environment. Important factor in the use of design doing is to save the results and outcomes of the testing and experimenting and using it in future projects. This is an area where Bende can improve.

For this purpose a format was created which consists of three steps, document, evaluate and consult. The first step is to document all aspects of a project, the first sketch as well the final result. The second step is to condense all the information of the first step to a manageable amount that shows the essence of a project. Third step is to consult this information in later projects and use it to improve the making process.

For this last step a physical material bank was designed, made and installed in the office of Bende. This bank serves three purposes; remind, inspire and inform. The material samples are a reminder of all the projects and materials that Bende has worked with. The second is to use the material samples as inspiration during idea generation and setting up new projects. The last purpose is to use the materials to show future partners what Bende has done, is capable of and can offer in a new project.

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Chapter 1: Introduction

The first chapter will introduce the company which was involved in this project, the topic of this project in the form of a design brief and ends with an overview of the structure that was used for the this report.

Chapters:
1.1 The company
1.2 The design brief
1.3 The report structure

1.1 Company

This project is carried out in collaboration with Bende, a brief introduction into the company.

COMPANY - Bende (See figure 1,2 and 3) is a Rotterdam based company. The company was founded seven years ago with the goal to recycle leftover materials from the Rotterdam central station build site. Later the company became more of a makers' community, where the company would acquire projects and anyone willing to help was welcome. The use of recycled materials became less of a focus point. Since January 2016 one IDE alumnus and a communication specialist took over the company. The company designs interiors, commissioned by bars, restaurants and offices as well as stands for festivals and festival signage. The company mainly uses wood, but have close connections with steel workers, welders and other disciplines for the use of other materials and production methods.

Keilewerf - Bende is located in the Keilewerf. This is a makers' collective housed in a former factory building. The collective houses twenty to thirty companies, mostly freelancers, ranging from carpenters, a material shop, a food truck interior builder, a photo studio and a vintage furniture shop.

Mission - The Bende's mission is to offer creative energy and extraordinary solutions. The goal is to work on unique projects, working with different materials as well as different clients and a wide range of subjects and locations. The company wants to offer more than products or projects, they want to help generate ideas and brainstorm on possible solutions and not only be an executor, but be part of a project.

figure 1:Bende office


figure 2: View from Bende office


figure 3:Bende workshop

1.2 Design brief

The starting point of this project was a mutual interest in design doing by the company and the faculty. What is design doing? What are the characteristics of this methodology? How can it be applied in a business environment? This chapter describes the starting point of the project, the design brief.

DESIGN DOING - Bende uses the term design doing as their approach to design. What is design doing? How does the company see this and what definitions can be found in literature? How can this be used as a design strategy?

RELEVANCE - Design thinking is the most used design methodology at the Faculty of Industrial Design Engineering. Design doing is a different approach to design. This project aims to determine how these two relate to each other.

APPROACH - First step is to research the term design doing. What definition can be found in literature, how does Bende see this term? How does this relate to design thinking? What is the impact on the context and the business they are in? These questions will be answered during the **analysis phase**.

The results of the analysis phase will be combined into a **framework**. This will be used to formulate and perform a **material research**. The results of this research together with the framework will be used to **evaluate** the methodology as well as the impact of this in a business environment.

GOAL - This project aims to answer two questions;

"What is design doing?"

"How can design doing be applied in a business environment?"

On one hand, a theoretical approach to design methodology and on the other a practical implementation of the theory. Throughout the project a distinction will be made between these two levels.

CHALLENGES

What is design doing? What are the characteristics?

How to apply design doing in a business environment?

figure 4: Project outcome

1.3 Report structure

INTRODUCTION

First phase of the report introduced the subjects that concern the project. The company, the design brief and the first insights into the impact of these on the project.

ANALYSIS

Second part of the report is the analysis phase, which further elaborates on the subjects addressed in the introduction as well as the context concerning the project.

CASE

Third part of the report combines the findings of the first two phases into a framework. From this framework a material exploration plan is set up and performed. This exploration is an example case of the application of design doing methodology.

BENDE

The fourth phase uses the findings and outcomes of the material research and applies these to Bende. How can the company use design doing best they can? What are the key points to keep in mind while doing so?

EVALUATION

The fifth and final phase evaluates on the project as a whole. What is design doing? What is the impact of design doing on a business? How can bende use the result of this project in the future?

INFORMATION

Throughout the report these small squares will inform the reader about the most important insights, findings or challenges that were found in that part of the project.


MAKER
MOVEMENT

Chapter 2: Analyses

This chapter addresses the subjects that were introduced in the introduction more thoroughly. It will explain several context trends concerning design doing and bende and will be used as a basis for the vision which will be formulated in the next phase.

Chapters:
2.1 Design thinking
2.2 Design doing
2.3 Maker movement
2.4 Craftsmanship
2.5 Artisinal movement
2.6 Company analysis
2.7 Conclusions

2.1 Design thinking

Design thinking is the most used design method at the faculty of Industrial Design Engineering. What are the characteristics of this methodology?

HISTORY - Design thinking has been around for over forty years(Johansson-Sköldberg, Woodilla & Çetinkaya, 2013) in design literature and practice. A distinction has been made between designerly thinking and design thinking, the first being the academic stream of design literature on the methodology and the second being the adaption of design thinking in practice (Warner & Simon, 1969). In the recent past design thinking has gone beyond design itself and is used as a tool to solved wicked problems as well as address social problems(Brown & Wyatt, 2010*)*. This report will focus on design thinking as a method for product design.

DEFINITION - The 1991 foundation of IDEO was the first adaptation from theory to a business. The definition developed by IDEO CEO, Tim Brown (Brown & Wyatt, 2008);

"Design thinking is a human-centered approach to innovation that draws from the designer's toolkit to integrate the needs of people, the possibilities of technology, and the requirements for business success."

Design thinking methodology has three pillars, technical feasibility, user desirability and business viability (See figure 4). Every designer should design on the limits of new technology, make products that people want to use, all while maintaining a feasible business strategy.

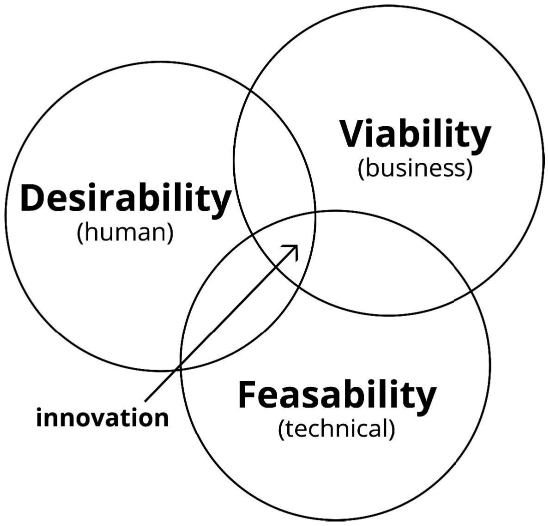


figure 4: Pillars of design thinking

PROCESS - Design thinking is a design methodology that provides a solution-based approach to solving problems. Design thinking is an iterative, non-linear process that consists of five phases, empathize, define, ideate, prototype and test (Friis Dam & Siang, 2008) (See figure 5).

PHASES - First phase of the process is to learn the end-user. Who are they? What are their demands? Understanding the human needs that are involved in a project. The second phase re-frames and defines the problem. Third phase focuses on creating as many ideas/solutions as possible on the problem definition. The fourth phase selects one or several ideas of which prototypes are made. These are tested in the fifth and final phase.

NON-LINEAR - Design thinking is a non-linear process, meaning that during every phase the designer can revert to another phase. For example, the testing phase can provide new insights about the needs of the end-user, or the prototype phase sparks new ideas for the ideation phase (see figure 5).

ITERATIVE - Iterations are inherent to design thinking, a first prototype will never result in a finished product that is ready for production. The first prototype will result in a second prototype which will result in a third etc. The process of design thinking relies on iterations as a means of refining and detailing to improve the quality of the final design.

INSIGHTS

- Design thinking is a problem solving methodology

- Design thinking is a structured approach to an often fuzzy process

- The process is non-linear and iterative

- The goal is to create meaningful products

- It is a human-centered approach

- It has adapted itself beyond the discipline of design

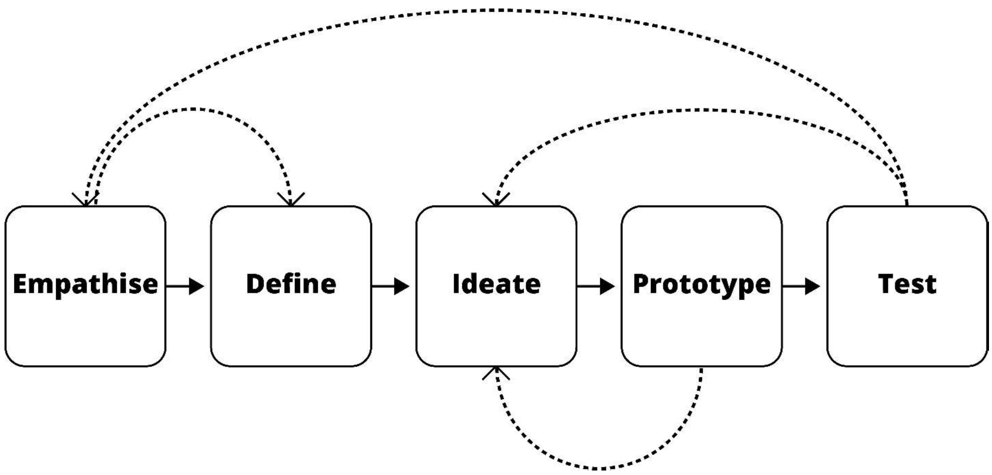


figure 5: Phases of design thinking

2.2 Design doing

Bende uses design doing as their method of design. What is the definition of this term and what are the characteristics of the methodology? How can a business apply this method?

NEW TERM - Design doing is a term that has not been addressed extensively in literature. The term does appear, but with a wide variety of definitions. The term is most commonly used as a combination of learning by doing and designing. Putting the theory of design thinking into practice (Fajardo, Rehm & Joffres, 2012)

“Written materials alone cannot capture all the nuances of design thinking because the approach involves a structured approach with a lot of unstructured elements. Design thinking, like jazz, requires an appreciation for improvisation; learning how to apply it is an experiential and social activity.”

There are numerous examples of workshop, lectures and symposiums that teach design thinking by involving, usually, non-designers to help them understand the basics of design thinking.

LEARNING CYCLE - The theory of doing as a means of learning has been around for centuries;

“I hear and I forget, I see and I remember, I do and I understand”
Confucius, 500 BC

A more recent adaption of the learning by doing can be found in the learning cycle, as described by Kolb (Kolb, 2015) (See figure 6)

His definition for learning is;

“*Learning is the process whereby knowledge is created through the transformation of experience.* “

The model consists of four stages (See figure 6). Any of the four stage can be the starting point, but the sequence remains the same. The cycle shows that doing is an integral part of learning.

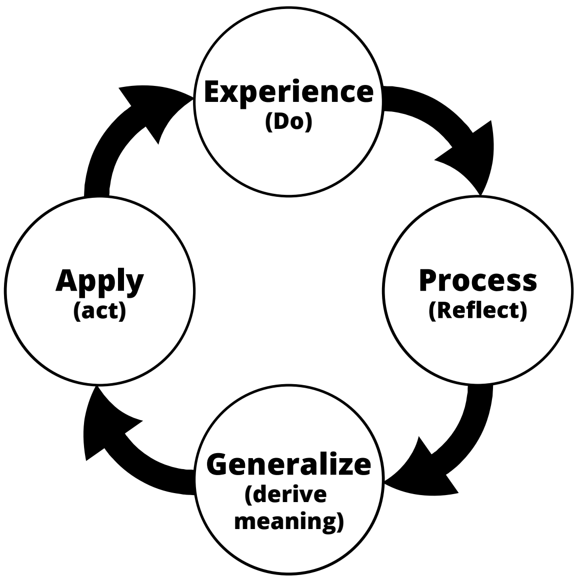


figure 6: Kolb’s learning cycle

BENDE METHOD - Although there is no conformity about the definition of design doing, bende use it to describe their method of design.

The company focuses on making at an early stage in the design process. Use making as a means of detailing, in stead of detailing on paper or in virtual models. Problems are more easily identified in a tangible model than on paper or in a virtual model. Generating solutions can be done more efficiently in tangible models as well.

Not only scale models are made in this manner, several projects were realized with a sketch as the starting point. The main body of, for instance, a bar was made before deciding on the finish of the product.

FUTURE REFERENCE - One of the main challenges that Bende is facing is to preserve the findings of a project for future reference. Scale models can be helpful in learning about a certain solution or working principle. This is not only valuable knowledge in that particular project, but also for future projects. How can this knowledge be saved and made available for future reference?

INSIGHTS

- Design doing is an iterative process

- It is a problem solving method

- The goal is to start making at an early stage in the process

- Problems are found and solved in physical objects

- It relies on learning by doing

- A challenge is to use the findings in future projects

2.3 Maker movement

The maker culture, or movement, is a global trend in which individuals are making and creating. This chapter explains on this trend and the applicability to the project.

"Maker culture emphasizes informal, networked, peer led, and shared learning motivated by fun and self-fulfillment" (Sharples et al, 2013)

The next phase of the digital revolution will go beyond personal computation to personal fabrication (Mikhak et al, 2002). Personal fabrication is what characterizes the maker movement, individuals getting access to digital fabrication tools and enabling them to make and create. Where peers were able to share and communicate with the rise of the internet, they are now able to share designs and plans for making (Gershenfeld, 2012). MIT professor Neil Gershenfeld calls this a change from bits to atoms, from on screen discussions and forums to tangible products and prototypes.

FABLAB - His theory led to the creation of Fablabs (digital Fabrication Laboratories). The idea behind these labs is to enable anyone and everyone around the world to make and create and to support local entrepreneurship. Originating at MIT, there are currently nearly a thousand (Anderson, 2010) different locations all over the world, from the north of Norway to the south of South Africa and from Japan to Australia. These are the ones that carry the name of Fablab. There are other similar locations, such as the keilewerf, that are providing the same solutions for local ideas.

Fablabs are usually situated in small abandoned factory buildings. The labs offer a range of tools which almost always include a CNC-mill and a 3D-printer. Two or three people are running a fablab, mostly on voluntary bases, and they help people with learning to use the tools and provide them with materials to work with. Anyone with an idea is allowed to turn it into a prototype.

LOWERING COSTS - One of the major changes that the maker movement has brought forward is the lowering cost of prototypes. One or two decades ago it would have been costly to make a prototype and it was a privilege for large corporations and multinationals. Making a plastic prototype, for instance, would be done using injection molding and for that a mold was needed, which could easily cost five thousand euro for a simple version. Apart from the it would take time to be milled. Using 3d printing it is now possible to print is time consuming to mill this mold plastic prototype within a fraction of the cost and the time. By providing equipment locally, such as 3d printers, anyone with an idea is able to test this and maybe start looking into producing it and starting a small business. It is no longer necessary to invest large sums of money. Some savings and a little spare time can already be the start of a business.

figure 7: Print workshop

SHARING - The maker movement is built on sharing. Sharing your ideas, as well as your 3d-models and blueprints of the things you are making.

"The real strength of a fablab is not technical; it is social"

Sharing not only to show what you have made, but for help as well as showing the problems that were overcome during the making process. There are endless videos and websites, such as instructables.com, that offer how-to's about everything you want to make. It has become difficult to try and make something of which there is no example online. This sharing is not only happening online, but in physical places such as fablabs as well.

MAKERSPACE - An example of such a place in Rotterdam is the bouwkeet, (See figure 7, 8, 9 and 10) this is a makerspace that focuses on children between the age of 10 to 15 to make and create. The makerspace relies on volunteers who teach the children about making and creating. It is free for anyone to use the bouwkeet. The only request is to share your knowledge, by setting up a workshop or anything you can come up with to help. The bouwkeet has a wide range of tools, from digital manufacturing tools such as 3d-printers, CNC mills and computer guided sewing machines to traditional tools for woodworking, pottery or welding.

figure 9: Digital fabrication

figure 8: Metal workshop

figure 10: Wood workshop

THE MAKER MOVEMENT MANIFESTO - The maker movement manifesto (Hatch, 2014) is a manual for the first timer in the field of making. What is the maker movement, why and where has the maker movement started and how can you become part of the maker movement? To guide the reader, the manifesto has listed nine pillars of the maker movement;

"Make, share, give, learn, tool up, play, participate, support, change."

Not all nine will be explained in detail, but below is an explanation of the pillars that focus on the why of making, why do people enjoy to make things? (See image #)

MAKE

"Making is fundamental to what it means to be human. We must make, create, and express ourselves to feel whole. There is something unique about making physical things. These things are like little pieces of us and seem to embody portions of our souls. "

SHARE

"Sharing what you have made and what you know about making with others is the method by which a maker's feeling of wholeness is achieved. You cannot make and not share. "

PLAY

"Be playful with what you are making, and you will be surprised, excited, and proud of what you discover. A maker doesn't need to know what is being made in order to make something. The most interesting things are a results of playing and coincidence. "

figure 11: Play, make, share

ROLE OF THE DESIGNER - The maker movement is changing the role of the designer. Traditionally a designer is the person behind a product, someone who has designed it from the ground up. The user is only involved at the end, or the use. The maker movement is placing the design of products in the hands of the user. A designer is designing the tools that are used by the makers. A 3d printer, for example, is a unique tool to produce prototypes and products, but the printer itself is designed to enable the maker to use it. The program used to instruct the printer on what to print has been designed. In the case of the 3d printer the designer has shifted away from the final product and is supplying the maker with a potential for making.

IMPACT ON BENDE - The former factory building in which the keilewerf is located is could be seen as a makerspace. Is Bende part of the maker culture? Maybe not literally, it is tapping into one of the needs that lies at the bases of the culture however, the desire to make and create. The maker movement manifesto gives numerous examples of individuals who are fed up with sitting behind a desk all day and decided to start working on an idea they have had for a long time and see if it is able to earn money from producing it and starting a business.

RALLY FIGHTER - An example of how this desire can help is found in the Rally Fighter[13] (See figure 12). This all American muscle car is a result of a community of automotive designers, most working on a voluntary basis to help and design an open source car. The reason for the voluntary nature of this project lies in the fact that there are many automotive designers who do not work in the automotive industry. This industry is highly competitive and only the best have the limited number of jobs that are available. This leaves a large group of designers that have the skills and the desire to design cars, but no project. This means; if the project is interesting enough, the best people will find it and offer to help.

INSIGHTS

- Maker movement is a social movement, there is a desire to make and create.

- No need to know the end result before starting to make, play, try and find out

- If your project is interesting enough the right people will come

- The role of the designer is changing

figure 12: Rally fighter

2.4 Craftsmanship

A dusty barn filled with numerous half-finished tables and chairs and with an old gray man sanding away at a piece of wood (See figure 13). This is craftsmanship, but there is more to it. This part describes what craftsmanship is and how it applies to Bende.

DEFINITION - In the most literal form, craftsmanship is the skill in a particular craft. The book of Richard Sennett (Sennett, 2009) defines craftsmanship as;

"The desire to do one job as best you can"

This is applicable to any discipline and/or profession. The man in the dusty barn has probably spent a large part of his life in that barn to learn exactly how to use wood and make furniture out of it. But an aircraft engineer designing a new wing to improve air flow and reduce drag can also be seen as a craftsman. Or, in this case, a designer who is working towards a product.

TACIT KNOWLEDGE - One thing that all craftsmen have in common is tacit knowledge, knowledge they have learned through years of experience. A woodworker knows what the best tool is to shape a piece of wood, but has learned this through repetition. First using the wrong tool and learning what the best method is by doing, trying and learning from the experience. This knowledge is difficult to transfer to someone else.

"We know more than we than we can tell"
(Sanga, 2006)

The woodworker as mentioned above knows how to shape a piece of wood, but is probably unable to explain why and how this is, let alone teach someone else about the best way to do this.

PITFALL - A downside of the desire to do something the best you can, can be found in the Manhattan project. The project was about creating something no else thought possible, a group of scientists went to great lengths to achieve the impossible. Only then to realize they had created the atom bomb. The focus on doing on job as best you can, blurs the potential impact that the end results may have.

INSIGHTS

- Acquire and apply and preserve tacit knowledge

- Do a job best you can

- Bende is Somewhere on the boundary between craftsmanship and industrial production

figure 13: Craftsmanship

2.5 Artisan movement

The artisan movement is a global trend in which users are demanding locally produced goods. Consumers are looking for beer from a local brewery and prefer to eat bread from the bakery (See figure 14) around the corner. This part explain this and how it applies to Bende.

HANDMADE - This trend doesn't only apply to primary needs, but also to more luxury items. Parents would rather let their children play with wooden toys made by the local carpenter that with plastic dolls that are made in china. Mass production has almost become a taboo and people want products which are handmade and have not been transported by oil tanker.

DRAWBACK - One of the drawbacks of this trend is that the demand for local products is so high and the potential market for companies is so large that most of them overshoot their goals. Most start with a desire, quitting their job as an office worker to follow their lifelong dream of becoming a baker. It is hard to continue doing this and not succumb to the potential money and success and become a business man instead of a baker. In essence, the reason for consumers to be attracted to these companies is also the reason for the companies to turn into what the consumers are trying to avoid, mass production.

Challenge: How to not outpace yourself, for bende this is a real challenge.

INSIGHTS

- Trying to prevent yourself from overshooting your goals

figure 14: Jordy's bakery

2.6 Company Analysis

This project was performed at the company, being present on a daily basis. During this project several projects started and finished. These provided insights in how Bende approached and performed projects.

PROJECT OWNERS - There are on average two or three projects running simultaneously at the company and these overlap, in who is working on them as well as who is in charge and what is supposed to happen. There is no clear project owner per project or a person in charge who tells others what to do.

A clear example of this was the use of an anti slip material on stairs in a project. The first choice was to use a type of gravel which was later discarded because of the use of anti slip strips. The person who showed up first the next morning was not informed on this and the material was already bought, he therefore installed the gravel. This had to be sanded of, which was a time consuming task which could have been prevented.

PROJECT OVERLAP - As said, there are two to three project running at the same time, this means that deadlines of one project are in the middle of another project. One of the main downsides of this is that project results get overshadow by others. When one project is finished, there is no real closure, as the work on the next project continues. Proper project evaluations are uncommon and project results are not documented properly.

Several projects are temporary, in particular stands and festivals. One project was a stand for the annual motorcycle fair. A wall of death inspired stand with a twenty five meter diameter was designed and made. The fair ran for five days, during this time no professional pictures were taken of the final result. The use of this project in the portfolio is therefore difficult, as there are only images of the build process and the cad-model, but non of how it looked in the end.

TESTING - Almost every projects relies on testing and experimenting. Partial solutions are tried out in scale models and material combinations are made to see and feel the results before it is applied in a project. This is already an application of design doing in the company. There should however be more focus on saving the results of these tests. The ones that work out as planned are used in a project and are thereby remembered. There are also test that fail or do not prove to be useful for that particular project, but could provide valuable information for the next project.

INSIGHTS

- There are no clear project owners

- There is often a lack of documentation of the final results

- The company uses testing and experimenting as a means of design, but does not save the outcomes

- Project evaluation is uncommon and limited

35

2.7 Conclusions

This concludes the analysis phase, the most important findings are explained in this chapter. The chapter is divided into two parts, the first compares design thinking and design doing, the second the context and trends.

DESIGN DOING AND THINKING

PROBLEM SOLVING - Both the design methods are primarily problem solving methodologies. The complexity of the problem is something that differs, design thinking has proved to be useful in addressing wicked problems and social issues. Design doing is focusing on more straightforward problems, it offers solutions on working principles and material processing. Problems that are related to product design. The goal of these methodologies is to create structure and order in the complex process of designing a product.

LEARNING BY DOING - Both methodologies use learning by doing as a technique to iterate and improve on a design. The stage in the process where it is applied is different. In design doing the focus is on doing at an early stage in the process as well as in later stages, doing as a tool for ideation and problem solving. In design thinking, doing usually increase in the ideate and prototype phase. In design thinking the doing is used as a tool for detailing and improving a design.

FOCUS - The first phase of design thinking is empathizing; learning and familiarizing with the end user. The methodology is therefore human-centered. Design doing focuses more on materials and working principles, a material focused design method. Taking a design sketch and applying it, testing to see if it is useful and using or discarding it for the next step.

INSIGHTS

- Design thinking is a problem solving methodology

- Design thinking is a structured approach to an often fuzzy process

- The process is non-linear and iterative

- The goal is to create meaningful products

- It is a human-centered approach

- It has adapted itself beyond the discipline of design

INSIGHTS

- Problem solving methodologies with different levels of complexity

- Learning by doing is an important aspect in both methodologies, the stage on which these are applied is different

- The focus is different, design thinking start with the user as the bases for design. Design doing focuses more on material limitations and working principles as a bases for design

TRENDS AND CONTEXT

PLAY, MAKE, SHARE - The maker movement is a development that relies on technical possibilities for design. The movement however is more of a social development, as can be seen from this quote;

"Maker culture emphasizes informal, networked, peer led, and shared learning motivated by fun and self-fulfillment"

Important factors in making is to having fun, learning from it and helping others with what you have learned. The goal or product of making is sometimes even subordinate to this. Starting with making without a final goal or idea can have the most interesting result. Surprise yourself by making and creating.

TACIT KNOWLEDGE - This type knowledge is an important part of Bende. A lot of projects have interesting working principles or material applications. These are easily forgotten. Especially when a certain material application was tested but never applied in a project. The pitfall here is that this knowledge is lost forever and that would be wasteful.

Besides this it is clear that there is still a lot to learn about the use of materials. Individuals need to experience materials, go through the same problems and face the same issues as everyone else in order to learn how to work with a tool or a material. It is however interesting to see how this individual work can be used to serve the collective. Some mistakes have to be made by everyone in order to learn from it, but some only need to be made by one person in order for the collective to learn from it.

INSIGHTS

- Trying to prevent yourself from overshooting your goals

INSIGHTS

- Acquire and apply and preserve tacit knowledge

- Do a job best you can

- Somewhere on the boundary between craftsmanship and industrial production

INSIGHTS

- Maker movement is a social movement, there is a desire to make and create.

- No need to know the end result before starting to make, play, try and find out

- If your project is interesting enough the right people will come

- The role of the designer is changing

Chapter 3: Vision

This chapter combines the findings and outcomes of the analyses phase to formulate a vision on the use of design doing. This is done by using an analogy on making and several examples of making.

Chapters:

3.1 Cooking analogy
3.2 Example 1
3.3 Example 2
3.4 Example 3
3.5 Conclusions
3.6 Vision

3.1 Cooking analogy

Design doing is a practical design methodology. Making at an early stage in the design process and iterating on the outcome to improve the quality of a design. This chapter explains the vision that was formulated for the use of design doing.

COOKING ANALOGY - This analogy was used to compare cooking and making. Cooking is a skill that takes time and effort to master, much the same as making.

Learning to cook starts with the use of a cookbook and recipes, Exact quantities, cooking times and preparation methods are provided in a step by step guide on how to prepare a dish. From here someone can start experimenting with small adjustments to a recipe, changing an ingredient or adding different spices. Over time the affinity with cooking is increased. Skills with preparation methods and knowledge about ingredients grows over time. Now someone can make their own dish, relying on experience, and try out new methods and styles. Finally someone can continue to become a chef, earn a Michelin star and maybe change the perception of food in general.

MAKER TYPES - Four different types of makers have been identified (Hagel et al ,2014) similar to the different levels of cooking. Zero to maker, maker to maker, maker to market and the maker advocate.

ZERO TO MAKER - The first level is an inexperienced maker, much like the first time cook. Someone who benefits most from detailed plans and step by step guides to learn skills and techniques for making. This maker relies on other makers to help them and learn about different aspects of making and creating.

MAKER TO MAKER - The second level of making consists of makers that are beginning to collaborate and use the expertise of others to create projects and teams for making. Together they are contributing to the maker community by creating new knowledge they want to share and give back to the makers.

MAKER TO MARKET - The maker to market level entails makers that have found their knowledge and findings appeal to a broader audience and see a commercial application for this. This is not the destination for all makers, most continue to improve their own knowledge and contribute to the making community.

MAKER ADVOCATE - The fourth level of making consists of people or companies that are not necessarily makers themselves but support the making community. Keilewerf is an example of a maker advocate, they provide space and tools for others to make and create.

MAKING LEVELS - The maker types were used to formulate four levels of making.

1. Making using a step by step guide
2. Making based on a detailed design
3. Making based on an image
4. Making based on an existing material/ object

The first level of making is in many aspects the same as using a recipe while cooking. An example is instructables, a website that offers step by step guides, written by makers. The list of guides is growing every day and when making something it is almost certain that the website has a guide about it or something similar to it.

The second level focuses on designing a product before making it. Before making, the design is detailed on paper. In essence the maker is writing his own guide before starting to make.

Third level takes inspiration from an image as the starting point for product. The goal is to make something similar to that. The first step is to determine how that product is made and how this can be imitated. From here the goal is to make and improve the design while making.

The last level relies on an object or piece of material as the starting point for a product. The goal is to use the object to determine what type of product can be made and how the object is best used. Again the goal here is to design while making and iterate on what has been made.

These making levels are focused on the first level of maker types, zero to maker. The goal of these levels is to introduce a novice to making and improve the knowledge and skill by going through these levels.

3.2 Example 1

The making levels were tested by making several lamps. This chapter explains on the set up and the findings from this making process.

DESIGN - The first lamp that was made, was based on a picture found online (see figure 16). The design of the lamp is made to look like a strap was keeping several strips of wood together. For making this lamp, these strips had to be sawn, as these were not available in the workshop of Bende.

MAKING - In order to do this planks had to be cut to size. This required a technique called rip cutting. This means cutting a piece of wood along the grain. A table saw is used for sawing planks into square strips. The design of the lamp is, as said, made to look like the strips are held together using a strap. Although this might be true, for this prototype the strips were glued together and screws were driven in spots that were out of sight.

SUPPORT - A reef knot was used to attach the strap to the lamp. The ends of the straps needed a small loop at the end, in order to slip around the small hooks in the ceiling (see figure 15). Bende does not have a sewing machine around, but there is an upholsterer located close in the keilewerf, which offered to help with sewing the loops. This is a nice example of how the tenants of help each other out.

figure 15: Final design

figure 16: Inspiration

3.3 Example 2

FLOOR LAMP - The second design was a floor lamp, this lamp was also based on a image found online (see figure 18), but before making the lamp, it was elaborated and detailed on paper and later in Solidworks.

figure 18: Inspiration

CHALLENGES - This design has several challenges, mostly concerning joining pieces of wood at different angles (See figure 19). This design was first thought out on paper before making the first cut. The angles for this design had to be quite exact for everything to fit tightly together.

BISCUITS - A test fit of three pieces of wood was made (See figure 19). The miter saw was used to cut the pieces to the right angle, after which the biscuits were used to join the pieces together. This technique uses a biscuit jointer, a tool that cuts a slot in the wood. In this slot a wood biscuit is glued using wood glue. This adds strength to the joint.

figure 19: Three joined beams

*figure 17***CLAMPING** - Gluing the parts together was done using a jig to clamp everything together (see figure 20). A normal clamp could not be used, as this will only apply force in one direction, applying this to angles pieces of wood will pull the part apart in stead of together.

FINAL DESIGN - This design proved to be quite challenging, mostly because of all the different angles in the original design. For this project the decision was made to focus on other aspects of design doing and the lamp was not finished.

figure 20: Joint clamp

3.4 Example 3

DESK LAMP - The third lamp that was made was a desk lamp. This is an archetype lamp and was based on a simple sketch (see figure 21) before building the first prototype.

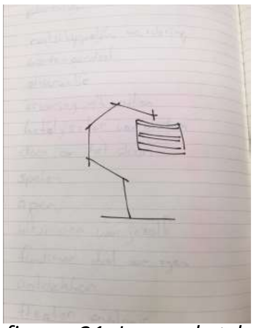


figure 21: Lamp sketch

ITERATIONS - This lamp went through several iterations (See figure 22), as the design was not elaborated at all, several design decisions were made during the build. The first lamp for instance, had a lampshade made of sheets of wood, this caused the light to be directed towards one spot, this was done differently in the later designs.

figure 22: First iteration

FINAL DESIGN - The images below show the final design of the desk lamp. The layers of the lamp shade are slightly skewed (See figure 23), giving the lamp a more interesting look.

The lamp can also be used in different positions (See figure 24) than originally intended, this shows that a design can have a surprising effect on the designer. This effect would not have been discovered without the lamp being made. If a lamp was made in, for instance, Solidworks, this effect would not have been discovered.

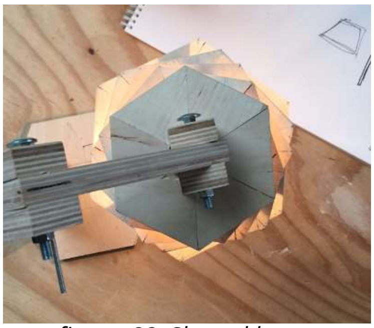


figure 23: Skewed layers

figure 24: Unintended use

3.5 Conclusions

Although not all four levels of the cookbook analogy have been tested, some generic conclusions can be made from the results of making these lamps.

DOING - Reading about rip cutting will give and understanding of the technique. But it will not show you how much dust it results in, or how long it takes for one cut to be made across the length of a plank. Designing a lamp which involves several hundreds of these cuts will definitely make it time consuming, although this might not directly be clear from learning the technique from a book. This is valuable knowledge which can only be obtained by doing.

TRAIL AND ERROR - Learning to apply these techniques will not go without any problems. Rip cutting is a techniques which is quite dangerous, as the saw blade is spinning freely and touching it will most likely result in losing a finger. Using such a technique for the first time should be done together with someone who has experience in using it. This person does not only help with safety, but can also explain on the limitations of a tool and what it is typically used for.

3.6 Vision

This chapter explains the vision that was formulated for the application of design doing.

TOOLKIT - Every designer has a specific set of skills and no designer has the same skills. These skills are acquired over the years by being involved in a range of projects, companies, materials, technologies and people. Although these skills are all different, there are several skills that each designer should posses in order to design good and useful products.

MATERIALS - One of these skills is the knowledge of the materials that a designer uses in a design. A design of an aluminum frame without knowing the properties of aluminum or how the material is processed is impossible.

MATERIAL KNOWLEDGE - Information on material properties can be found in books or databases, for instance the Cambridge Engineering Selector (CES) edupack which is widely used in the academic world to teach about materials and manufacturing processes. This software shows all properties of a material, ranging from the tensile strength and melting point to production costs and environmental impact.

PRACTICAL KNOWLEDGE - There is however information lacking in such databases. The practical knowledge of working with materials. A designer could, for instance, come up with a design in which thin strips of wood are incorporated. The database will not show that these strips will split in half when trying to drive a screw in. This is knowledge which can only be obtained by actually doing and experiencing it by hand. It is vital for a designer to know this before designing a product made of wood. This led to the following vision;

“Design doing is an approach focused on learning the practical applications of materials and the tools used to process them”

Chapter 4: Framework

The fourth chapter combines the findings and outcomes of the analysis phase and the vision and uses it to formulate a framework for design doing. The framework is in its turn used to write a material exploration plan.

Chapters:
4.1 Design doing framework
4.2 Material exploration plan

4.1 Framework for design doing

From the findings of the analyses, cooking analogy and vision, a framework is formulated for the application of design doing.

DOING - As describe in the previous chapter, the focus of the design doing methodology is to learn about the practical properties of tools and materials. The framework helps create knowledge by doing in stead of reading and learning from books and other sources.

APPLY - To best apply design doing, is to take a material or tool of which a designer has little knowledge and learn about the properties of this material by applying, trying and doing.

KOLB - Design doing relies on learning by doing. As described in chapter 2.2 by the learning cycle of Kolb. The process starts with an experience, then reflects on what has been done, derives meaning from it and acts upon what has been learned, (See figure 25)

In stead of reflecting and deriving meaning before applying, design doing applies before evaluating (See figure 26). Not asking what the result could be, but applying it and using the results to reflect on the impact and meaning of what has been done.

ORDER - Apart from this design doing uses applying as the first phase of the process, where the learning cycle of Kolb states that the learning cycle can start at any of the four phases, as long as the order in which the phase occur remains the same.

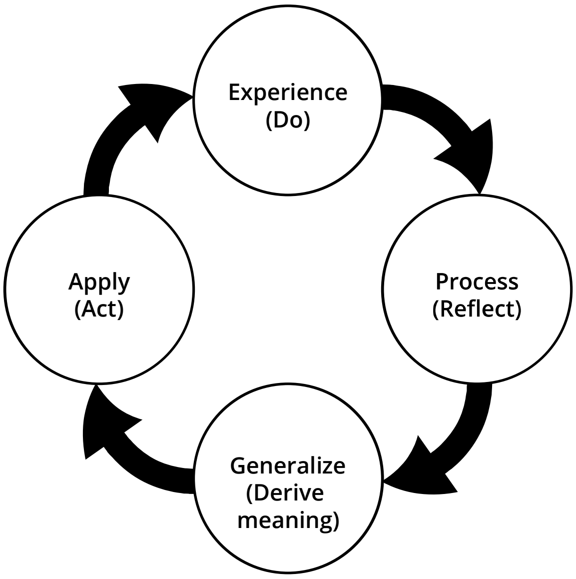


figure 25: Kolb learning cycle

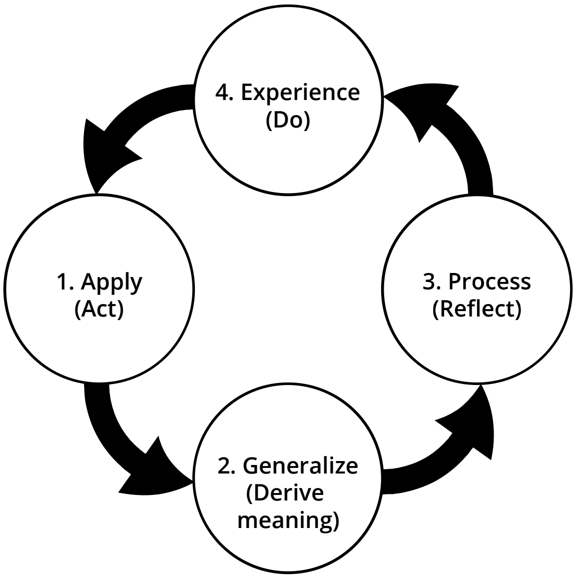


figure 26: Design doing cycle

The idea of doing before evaluating coincides with one of the findings of the analysis phase;

"A designer does not need to know what is being made before starting to make. Play, try and play to discover and amaze yourself."

BASES - This is the bases for the design doing framework. The object or product that is being made is not the main goal, the goal of this method is to learn about materials and tools. The knowledge that is gained will become part of the toolkit of a designer and can be used in future projects.

RESEARCH - The next phase of the project is to take this framework and apply it. As described in the design brief, this will have two focuses;

"How can you use design doing to learn about the practical properties of a material?"

"How can design doing be applied in a business environment?"

First the methodology will be tested, in the form of a material research. The next step will be to take the results from the material research and use this for the start of a design phase for a Bende product.

4.2 Material exploration plan

After having analyzed the company, the theory and the context, a vision and a framework were formulated. These explained on the aspects of design doing, what the methodology is and how it can be applied. The next phase is to use the vision and the framework to set up a material exploration plan and perform this. This chapter explains the set up of this plan.

MATERIALS - The best materials to use for this exploration are materials that have not been used and of which there is little knowledge within the company as well as the designer. For this exploration the choice was made to use three materials and combine these.

STYROFOAM - The first material was Styrofoam, this was because of a tour through the studio of the Dutch artist Joep van Lieshout.One of things he is known for are large polyester sculptures. The sculptures are made using Styrofoam molds. This inspired Bende, as this material is relatively easy to manipulate and can results in both huge statues as well as small products.

CONCRETE - Second material was concrete. This was chosen because the shared interest in working with this material and the expectation that this would combine well with Styrofoam. The Styrofoam can be used as a mold for concrete and create form freedom for the molds.

LIGHT - The third material used in the exploration is light. Although this is not a material that can be shaped and molded and used to make physical objects, it is interesting to treat it as such and see how it combines with the other materials.

METHOD - The main question of this exploration is;

"What is the impact of doing in stead of reasoning?"

In other words, what happens when a designer tries every material combination he/she can think of in stead of reasoning what will be the outcome of this material combination?

GOAL - In this exploration the goal is to do as much as possible and use the results as the criteria for success. When a new material combination is thought of or proposed by someone else, first thing is to apply it, test it and use the outcome of the test to see whether it is useful/interesting.

Chapter 5: Material exploration

The material exploration that was performed in this project is explained in this chapter. The chapter starts with listing all the different material combinations and applications that were used in this exploration, an overview of all the experiments is given and the chapters ends with the selection of the most promising outcomes for future use within Bende.

Chapters:

5.1 Styrofoam
5.2 Concrete
5.3 - 5.11 Material experiments
5.12 Material experiment overview
5.13 Experiment selection
5.14 Conclusions

5.1 Styrofoam

The first material that was explored was Styrofoam. This chapter explains the steps taken during the exploration of this material and the outcomes.

STYROFOAM - The choice for Styrofoam was because it is relatively easy to manipulate using a wire cutter, box knife, saw and rasps and files. The first tests with the material were mainly focused on using a wire cutter (see figure 27) for the first time. The wire cutter used in this project is often used in making detailed models in architecture. The wire cutter has several attachments, such as a guide, a circle cutting jig and the floor of the cutter has a numbered grid. This tool is quite precise and can be used to make exact cuts in Styrofoam as well as hardened foam.

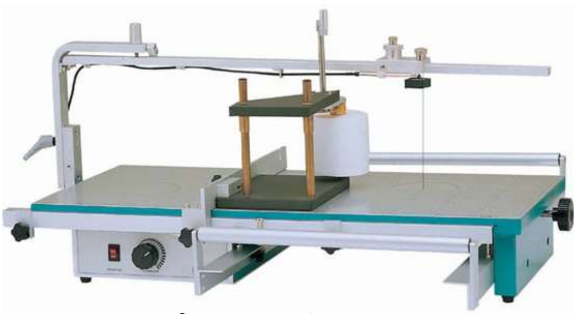


figure 27: Wire cutter

GEOMETRIC SHAPES - First steps in the exploration were focused on learning to use the wire cutter. To see how precise the cutter was, several geometric shapes (See figure 28) were made. Starting with simple shapes as cubes and circles, the shapes quickly became more complex, such as a dodecahedron and a icosahedron.

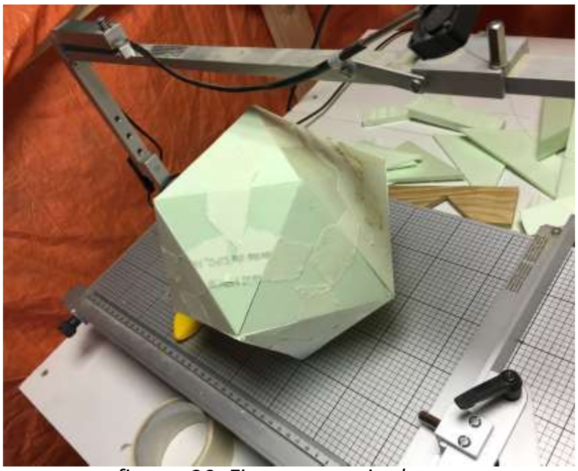


figure 28: First geometric shapes

Styrofoam is a trademarked brand of expanded polystyrene, is a plastic which is used in a wide variety of applications, but mostly in packaging and construction. The materials has a low density and is therefor used for protecting valuable goods, without adding weight. The material has a cell like structure. It is available as sheet materials, but also as beads.

LAMPSHADES - The shapes were first made as solids, but as the shapes grew more complex, the faces were cut separately and joined together using glue and tape. These hollow shapes resembled lampshades and light bulbs were used to test the effect of light to the geometric shapes (See images below)

CELL STRUCTURE - Using Styrofoam as a lampshade, the cell structure of the material is highlighted. Especially when the material is cut into thin layers.
There are several types of foam, with for example different cell sizes and higher densities. These were put side by side to see the difference in effect.

figure 29: Round lamp

figure 30: Geometric lamp

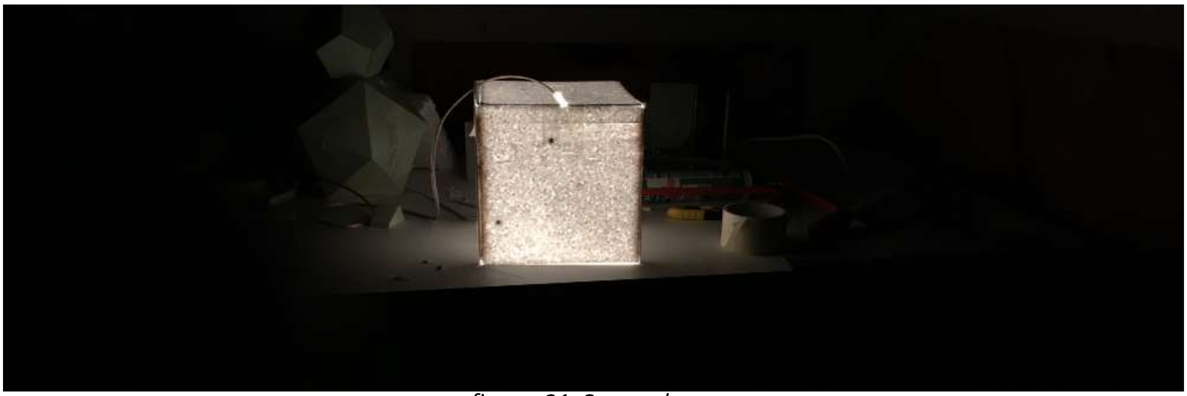


figure 31: Square lamp

OPTIONS - To connect pieces of Styrofoam together, there are several options available on the market. One option is to use tape. There are special foam glues available on the market. Polystyrene foam glue is one of these. Another option is pur foam to connect the pieces together.

CHOICE - Tape is an easy method, but has a limited lifetime, as it will come lose quite quickly. The foam glue that was used had a long dry time, so was not very suitable for quick prototyping. PUR foam is a good option, the only downside is that it is causes a chemical reaction and when using it, a mask is required when using this material.

FINDINGS - For the first tests, tape was used because it was easy and quick. Later the foam glue was used for making more aesthetically pleasing prototypes. During the making it became clear that the selection of this material did not only apply to the use, but also to the end result. The tape has a sort of blurring effect on the Styrofoam (see figure 32). The foam glue leaves a brown marking on the Styrofoam (See figure 33). The material itself is brown and especially shows when shining light through it.

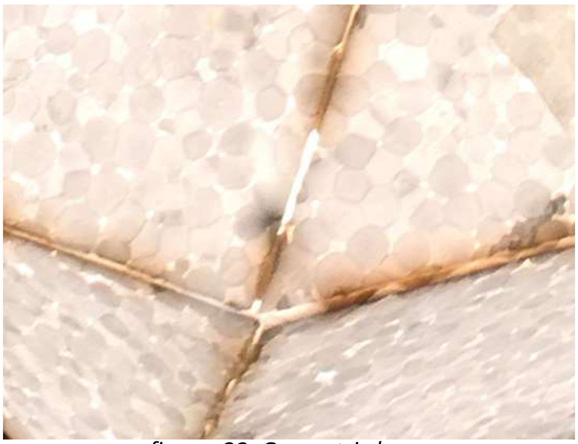


figure 33: Geometric lamp

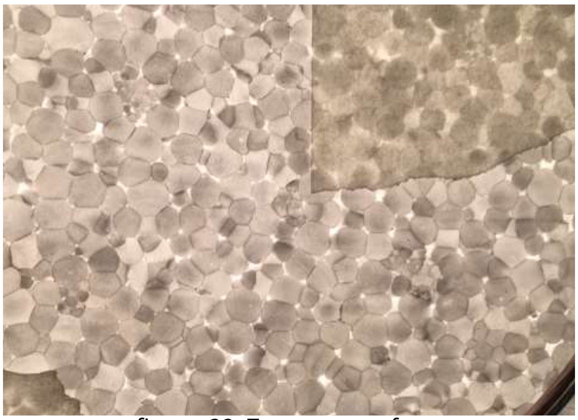


figure 32: Tape on styrofoam

CONCLUSION - This shows that every choice for a design has impact on the end result. Although having chosen a certain type of connection, the fact that the prototype would have brown markings on it was unexpected.

In this project it is of extra importance, as this brown marking can be seen as an important finding, It might be disappointing at first, as the expectation was a clean shape. On the other hand it might be taken as a given and be over exaggerated to show the principle by the way that the product is assembled.

For this project the questions arises of how to deal with the unexpectancies. A designer can never fully know how something will turn out, so unexpected effects like this example shows will always happen, but how to deal with this? Not every effect will be good, but it is also not a definite problem every time, so when is it a problem that needs to be fixed and when should it be embraced?

5.2 Concrete

After the first explorations with Styrofoam the next material that was analyzed was concrete. The main factors for this choice were the personal inexperience with the material in combination with the expectation that it would easily combine with Styrofoam. This chapter explains on the first steps with concrete.

CONCRETE - The first step in exploring this material was to compare different types of concretes. There are numerous kinds of concrete, ranging from sand cement to high strength industrial types and asphalt.
In its simplest form, concrete is a mixture of paste and aggregates, or rocks. The paste, composed cement and water, coats the surface of the fine (small) and coarse (larger) aggregates. Through a chemical reaction called hydration, the paste hardens and gains strength to form the rock-like mass known as concrete.

The differences between concrete is the type of aggregate and the type of paste that is used. Asphalt for instance uses bitumen as a pasta and has coarse aggregates.
For this project the choice was made to use a concrete with a small aggregate, sand. The paste is normal cement. This concrete is usually used for flooring, because is has a fine finish.

FIRST CASTINGS - As said the personal experience with this material was low, so first step was to learn how to mix and use concrete. Using a scale, a measuring cup and a square mold the first castings were made. The did not turn out very well. The mixture was to wet and caused the mix to not set properly. This resulted in brittle brick. Although looking at the previous chapter this might be an interesting outcome, this was far from the desired effect and therefor not interesting for continuation.

After several attempts a better ratio was found for the mixture that resulted in better looking forms.

From here a first product like object was made, a lampshade (See figure 34). This lampshade was hollow and had several thin pieces of Styrofoam on the sides that could show light.
Again there was a problem with the mix ratio and the shade did not turn out as expected. This was the starting point for several experiments with a wide range of materials. These will be listed in the next chapter.

figure 34: Concrete lamp shade

TYPES OF CEMENT - The images below show three different samples of cement. The top is a sand cement, the second a normal cement and the bottom a lightweight version. The lightweight is achieved by adding carbon beads mixed in with the cement.

SURFACE FINISH -The first two test showed a much less smooth surface finish as bottom cube. After several attempts the finish was still not smooth at all. The reason for this could be anything, a wrong solid to liquid ratio used or not waiting long enough before removing the mold. The sand concrete seemed to stick to the wood used for the mold.

MOLDS - Molding concrete not only leaves a pattern on the casted part, there is also a concrete residue left on the mold itself (See figure 38). This shows that not only the product or prototype that is being made is an outcome of the design process. The elements used for making something can be valuable by themselves.


figure 35: Sand cement


figure 36: Normal cement


figure 37: Lightweight cement


figure 38: Mold texture

5.3 Concrete and Styrofoam

The first material combination that was tested was concrete and Styrofoam. This chapters explains on the reasons, expectations and outcomes.

REASON - The first tests with this material used polystyrene beads mixed in with the concrete itself. The interest rose from the idea to create a lightweight concrete.

WEIGHT - To test what the effect was of polystyrene beads to concrete and how different percentages of beads per volume compared to each other, a cube was made. The cubes all had the same dimensions, 80x80x80 mm.

The four cubes (See figure 39) with the top left having the lowest percentage of beads and the bottom right the highest. The image in the bottom right is of a cube without beads added to the mixture.

The weight of the different cubes is displayed in the table below.

Concrete block (No beads)	518 gr
Least beads	371 gr
“	322 gr
“	237 gr
Most beads	211 gr

FLOATS - The addition of beads to the mixture in this case leads to almost 60 percent decrease in weight. Another interesting findings is that the lightest cube actually floats in water.

figure 39: Polystyrene and concrete

FINISH - The addition of beads has an effect on the finish of the concrete. Note here is that the cube made without beads had a mold made of multiplex while the others had a mold with a laminate surface. This is the reason between the smooth surface of the top right and the roughness of the beadles cube. Most notably when adding more beads to the mixture, is that there appear more voids in the surfaces. This is probably because the addition of beads effects the flow properties of the concrete an will therefor not fill the gaps.

figure 40: No added beads

PLATE - After having tested the addition of beads to the mixture in cubes, a larger plate (see figure 41) was made to see what effect the finish would have and if the material properties would change, in terms of strength and brittleness.

figure 41: Concrete panel

The finish surface of the plate was good, there were still some voids, but most of the surface was clean. The mold for the plate was different from the cubes, the plate was sandwiched between two planks ,while the cubes were open on the top. The cubes show that the beads float in the concrete mixture and float to the top and this shows, especially in the top right cube. Because the plate was clamped, the beads did not float to the top.

STRENGTH - to test the strength, the plate was placed on two beams on either end and weight was added to see what would happen. The plate already broke quite easily. It is hard to say how this compares to a normal concrete plate. What was interesting however was the inside of the plate (See figure 42). The beads are equally divided over the mixture. In this case a already lightweight concrete was used, which has carbon beads in it. This causes a pattern of white and black beads in the inside of the plate.

OUTCOMES - For this first test the most interesting findings were the fact that concrete could float with the addition of polystyrene beads. Adding the beads does not only reduce the weight, it can also have an aesthetic function in, for instance, a kitchen counter top with the beads structure showing .

figure 42: Cell structure

5.4 Concrete and light

One of the 'materials' in this exploration was light. How does light react with concrete and Styrofoam? This part explains the reasons, expectations and outcomes of these material combinations.

REASON - The combination of light and Styrofoam proved to be it interesting while doing the first tests with Styrofoam alone. These test were done to see whether the three would combine good together.

EXPECTATIONS - There were several different options to try for this test, thin walled Styrofoam, larger Styrofoam pieces poured with the concrete, plastic granulate, glass fibers wires and acrylic plates. For the combinations with Styrofoam the expectations were that it would create a similar effect as with normal Styrofoam, for the others it was hard to say beforehand what would happen, the plastic granulate looked promising.

OUTCOME - The thin walled cube (See figure 43) proved not very interesting, as the light did not shine through and it was so thin that it was very brittle.

figure 43: Thin walled test

The cube with larger Styrofoam parts (See figure 44) cast in with the concrete did not surprise very much. It showed the cell structure when a light was put underneath the cube. It was already pretty much a finish lamp shade.

figure 44: Large Styrofoam parts

GRANULATE - The experiment with the plastic granulate (See images below) was a little disappointing. The expectation was that it would let light through, but this did not happen. The small beads did not connect to each other and therefore there was not connected piece of material that could transport the light from one side to the other.

figure 45: Plastic granulate

figure 46: Concrete and granulate

ACRYLIC - The acrylic sheets (See figures below) in the mold showed disappointing at first, most of the pieces of acrylic were covered in concrete and were not visible. Only after sanding and removing concrete did they show. This does give an interesting effect on the end result.

figure 47: Concrete and acrylic

figure 48: Concrete acrylic and light

OPTIC FIBERS - The most interesting outcome of the combination of light and concrete came from the fiber optic wires (See figure 49). These wires can sort of transport light through the material. A light shining on an end point of the wire lights up the whole wire. By casting this in concrete, light it transported through the material. This is made even more interesting because the wire are not visible in the block itself. It looks like a normal piece on concrete, until a light is put on it.

figure 49: Concrete and optic fibers

5.5 Warped concrete stool

Next experiment came from watching a youtube video about a warped concrete bench. This part explains on the reason, the expectations and the outcome of this experiment.

REASON - The bench made in the youtube video used several additives in the concrete. The product was cast in a silicon mold. This mold was first laid flat (See figure 50), the concrete was poured in the mold and was allowed to harden for about half an hour. After this the mold was bent into the final shape (See figure 51), With this technique it is possible to make thin walled objects that have rounded edges. This experiment was done to see how difficult it would be to reenact this technique.

ADDITIVES - For this technique to main additives are used, glass fiber and flow plasticizer. The first is used to give strength to the final product. The glass fibers are mixed into the concrete mixture, When the mixture hardens the fibers add tensile strength, which normal concrete lacks. The addition of plasticizer is in order for the mixture to harden properly. Concrete has a set ratio of liquid and solid ingredients. The plasticizer changes this ratio, there is less liquid needed for the same amount of solid material. The mixture flows less, it is a more clay like substance. When bending the mold in the final shape, normal concrete would still flow and there would be more concrete in the bottom of the mold and less in the top. With the plasticizer, the mixture does not flow and the final product has an equal wall thickness over the whole bench.

EXPECTATIONS - Using concrete in combination with these additives makes the process more complicated, as it requires exact proportions of every ingredient and the waiting time before bending the mold is hard to determine. Waiting too long will cause cracks in the surface and bending too early will cause the mixture to flow.

OUTCOME - The two images below show the mold before and after bending. The mold has two hinges incorporated. The mixture is poured on a sheet of flexible hardboard that bends with the mold.

figure 50: Mold before bending

figure 51: Mold after bending


figure 52: Detail of curved area


figure 53: Inside surface area

The images on this page shows the final stool that resulted from this experiment. The final outcome of the experiment has an interesting look. The curves on both sides match and the outside surface is smooth. This stool shown in the pictures is the second attempt, as the first was bent too late and broke into small pieces. Interesting effect on the inside of the stool is that the carbon beads that were in the lightweight concrete mixture came floating to the top. The glass fibers in the mixture created a tight web like structure which left no room for the beads.


figure 54: Outside surface area


figure 55: Warped concrete stool

5.6 Concrete and cloth

Next experiment used a piece of cloth as the mold for pouring concrete. This part explains on the reason, the expectations and the outcome of this experiment.

REASON - The reason for this experiment was left over concrete from making the large concrete panel, the idea behind this experiment was to make an organic shape out of concrete instead of the geometric shapes that were made before

EXPECTATION - This experiment was more of a side experiment, the expectation was that it would probably fail and end up making a mess.

OUTCOME - The outcome (See images) of this experiment was therefore unexpected, the shapes was very interesting, the pattern of the cloth used for making the shape clearly shows on the outside of the surface and the whole object did not look at all like it was made of concrete. The side were quite brittle and it had to be handled with care to prevent it from breaking. Overall this experiment turned out real nice.

figure 56: Concrete and cloth bowl


figure 57: Concrete bowl inside


figure 58: Concrete bowl outside

5.7 Miscellaneous

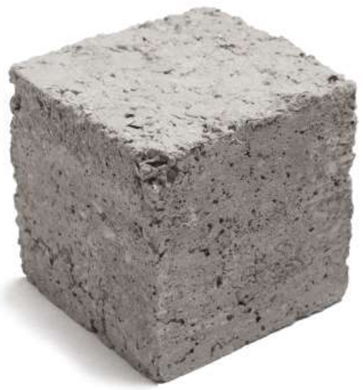


figure 59: Concrete and sawdust

figure 60: Concrete and coloring liquid

This section covers some small side experiments the were performed during the material exploration.

SAWDUST - The cube above has sawdust mixed in with the concrete. This was done to test whether this could be used for weight reduction of concrete. Saw dust is abundant in the Keilewerf and would be a very cheap option. The cube worked out well, but it was hard to get the mixture to the right consistency. Wood takes up a lot of moisture, and the concrete mixture needs a lot more water to still flow. The cube also has some weak spots, as the saw dust does not distribute very well over the mixture, it tends to lump together.

COLORING LIQUID - The image above shows a cube that was mixed with Mixol, or a coloring liquid. Although almost double the amount than described, the effect of the coloring is almost invisible. The goal was to make a gradient from dark gray, or the normal color of the concrete to white/light gray.

CORK - The image below shows a combination of cork and concrete, this was done because of the contradiction in texture. The hard and smooth concrete in combination with the soft and grainy cork. This experiment did not turn out as expected, the cork and concrete don’t bind at all.

figure 61: Concrete and cork

5.8 Concrete and acrylic

This material combination was more or less found by accident. This part explains on the workings behind this material combination.

FINISH - The cube on the right shows a piece of wood on one side, but in the middle there was a piece of acrylic. This acrylic was put there to test of light would shine through the material from one end to the other, This did work, only the concrete did not bind with the acrylic. The cube broke a part, which was disappointing for the experiment. But what appeared was nice, the surface finish (See figure 63) left behind by the material was perfect, as the image in the bottom right shows, it had a mirror like reflective finish.

A larger panel (See figure 64) was made to further test this. Again the surface was very smooth, it did however show some in clarities. This was because the acrylic plate that was used had some markings on them and these would shown on the concrete. This can probably be used, by cutting a logo or a name in a piece of acrylic and pouring concrete on that will most likely leave this same logo or name in the final cast of concrete.

figure 62: Concrete and acrylic cube

figure 63: Acrylic surface finish

figure 64: Large panel with acrylic finish

5.9 Large concrete panel

One of the projects bende was working on during the material exploration phase was using Viroc. This is a material that resembles concrete, but is sheet material with a concrete look. This means that the material can be processed in the same manner as normal sheet material, using a table saw for instance, but gives a different look. This part explains how this experiment was carried out.

REASON - A large concrete panel (See figure 68) was made to test if it was a viable option to make these panels ourselves. The viroc panels are quite expensive, 300 euro per sheet of 2440x1220. Besides this the material is quite brittle, it is easy to chip of a corner or edge. This can cause a panel to be useless and thereby increase the costs even more.

A downside of concrete panels is that it is difficult to fasten to a construction. Usually concrete is poured into a mold that is built on a construction. For this experiment a wooden core was added to the panel for making it more workable. This core can be used to drive screws in the panel and fasten it.

The bottom picture is a small test to see the effect of a wooden core on a concrete panel. This worked out well,

The difference between the large panel and the test is that the large panel was poured over a sheet of wood, this means that the panel is still visible from the bottom and does is not completely covered in concrete.

OUTCOME - The surface finish of the panel was smooth, there are four small dents on each corner, but this was due to an error in the mold. The drying process (See figure 66) was interesting, the picture shows that the center of the panel dries quicker than the outside. The wood in the panel probably sucks some of the water out of the concrete mixture which causes this. Downside of this is that the panel slightly warped as the wooden panel became moisturized.

USE - Because of the warping effect this method was not used in the project that Bende was working on. Besides this the questions arose if this would be a cheaper option. The pouring concrete takes quite some man hours, and the quite a lot of material is needed for one panel, with the risk of it warping and having to be redone.

figure 65: Large panel with acrylic finish

figure 66: Influence on drying process


figure 67: Panel during drying process


figure 68:Large concrete panel

5.10 Concrete canvas

A relatively new material is concrete canvas, this material is a concrete impregnated fabric that hardens when hydrated. This part explains the working principle behind this material and how this can be used by Bende.

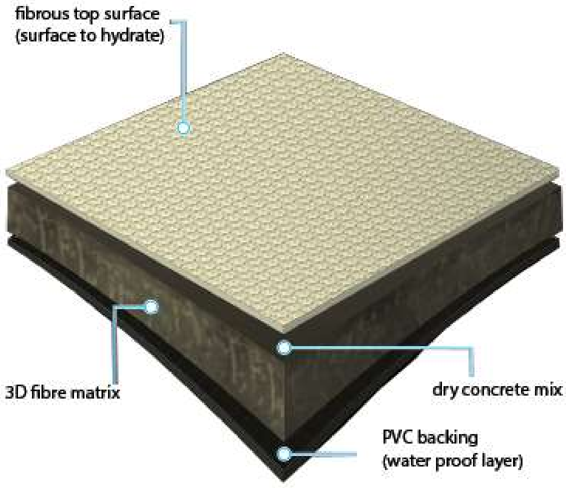


figure 69: Layers of Concrete Canvas

WORKING PRINCIPLE - Concrete canvas was invented in the early 2000's. The material is essentially three layers (See figure 69), one layer of porous material, one layer of a tight knit fiber matrix containing a dry concrete mix and a layer of water proof PVC. When water is poured over the porous layer it will be absorbed by the concrete mixture, the water proof layer prevents the water from pouring out on the bottom. The material will harden to a concrete like hardness. The material is available in 5,8 and 13 mm thickness.

The first application of the material were emergency shelters. A large balloon is inflated under a layer of concrete canvas. Then water is sprayed over the canvas. Within 24 hours the material is hardened and the shelter can be used. It offers better protection against environmental impact than standard tents.

REASON - For this project the interest in this material rose because of the concrete and cloth experiment. This material seemed to offer the same properties of formability, but easier to process. The expectations were that this material could be used to make curved objects and maybe even organic shapes.

OUTCOME - The material was hard to obtain, as it is relatively new to the market, there is no official distributor in the Netherlands. A part from this the material is currently being used in industrial quantities.

Some sample material was available for doing some small experiments. The material is easy to process, as expected, it can be cut to size using a box cutter.

The material was not as flexible as expected, it is quite tough and does not easily stay in a shape. The first test was set up to make a bowl. This proved to be difficult, because the material tends to bend back to its original flat shape. Another downside was the by bending and then adding water, some parts of the material stay dry and do not harden, so the bowl ended up half hardened and half still soft and bendable.

figure 70: Water on sample of canvas

5.11 Concrete stool straight

This experiment was already going more towards a product. Could a combination of concrete and metal reinforcement (See figure 73)result in a usable product?

REASON - The goal was to create a stool that was both light enough to be moved by one person and be stiff and strong enough to support one person. To keep the weight down, Styrofoam was added to the concrete mixture.

OUTCOME - The strength proved to be easily achievable (See figure 72). The weight of the stool however was difficult. The overall dimensions of the stool were kept to a minimum, but the stool still weighed over 25 kilograms. Another downside of the experiment was to inaccuracy in the pouring of the concrete. The thickness of the stool was 4 centimeter, the concrete was poured from the side (See figure 71). The concrete did not cover the mold equally, resulting in gaps in the surface of the stool.

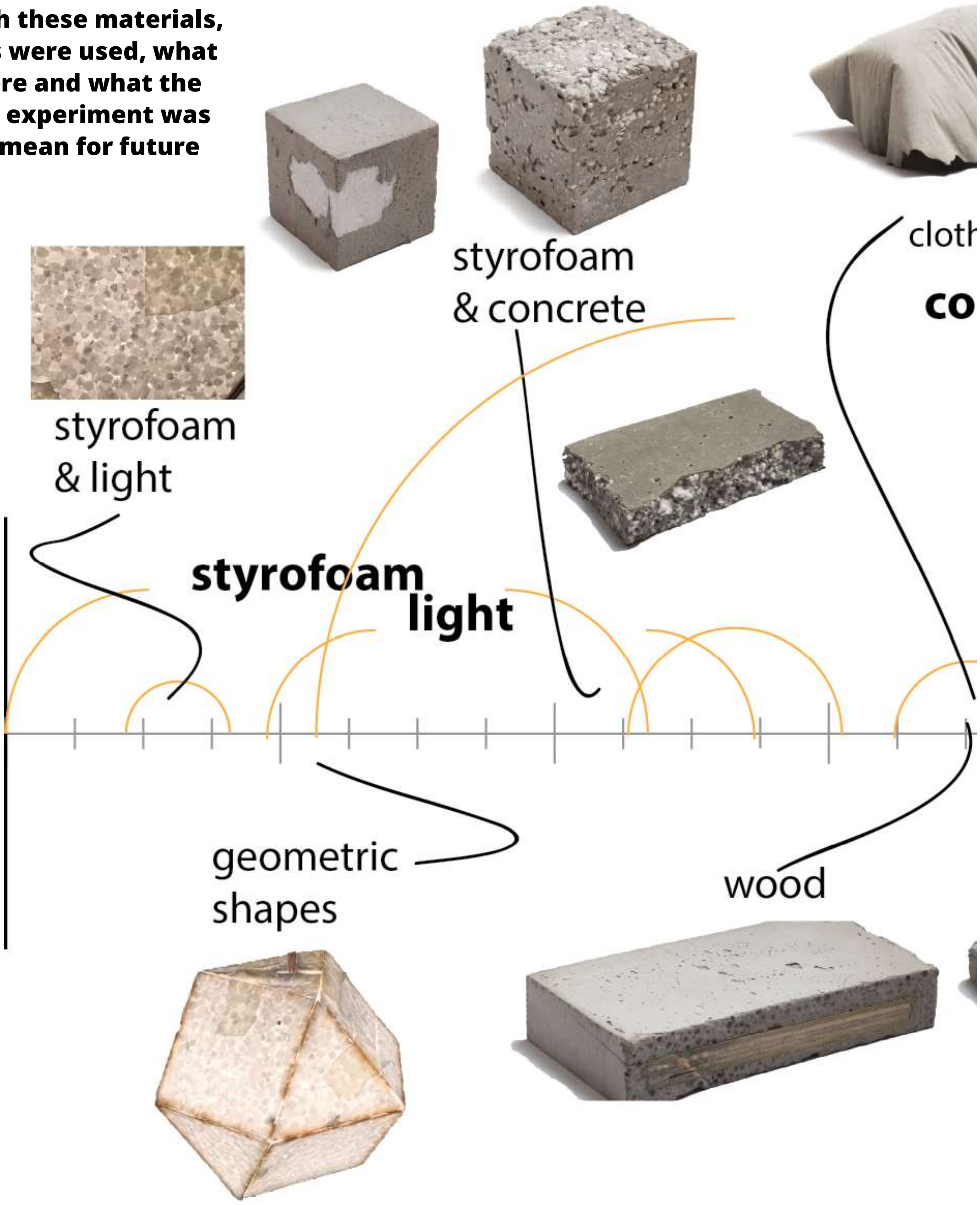
figure 72: Strength test

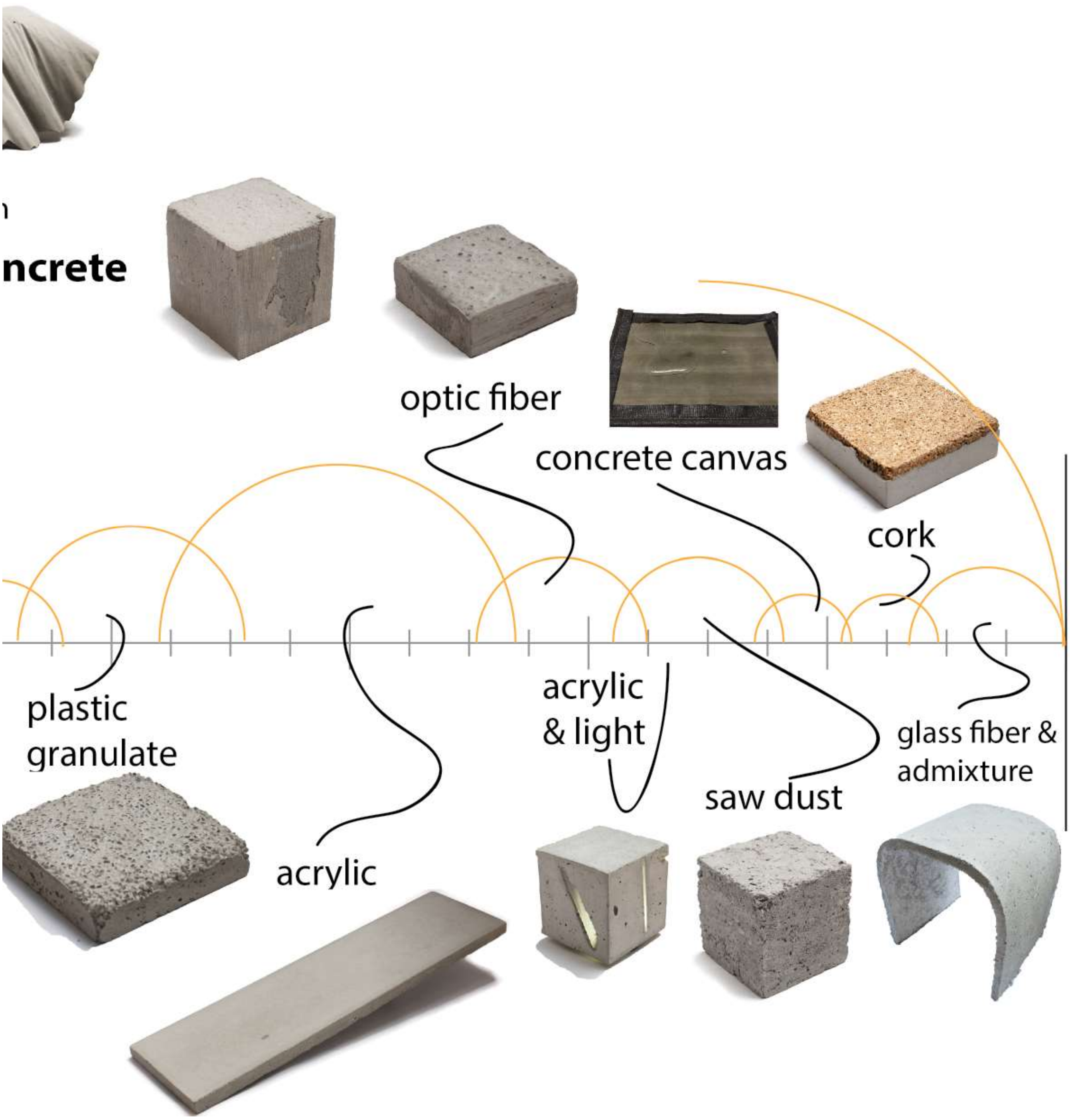
figure 71: Inaccuracy in the mold

figure 73: Metal reinforcement

5.12 Overview of experiments

The time line on this page represents the material exploration process and all the materials that have been addressed. The next pages will explain on all the different experiments that have been performed with these materials, why these materials were used, what the expectations were and what the final outcome of the experiment was and what this could mean for future experiments.




ncrete
optic fiber
concrete canvas
cork
plastic
granulate
acrylic
acrylic
& light
saw dust
glass fiber &
admixture

5.13 Experiment selection

After having performed all the different experiments described above a workshop was organized to select the findings that could be further tested and researched could be a starting point for the design of a Bende product. This chapter describes the selection procedure and the outcome.

WORKSHOP - To select the most interesting/promising outcomes of the material exploration a workshop was set up in which all the Bende members were asked to rate all of the experiments. Most of the members had already seen parts or elements of the experiments, but this was the first time that they were all put together.

CRITERIA - The members were asked to rate the experiments on usability, surprise effect and if it could be something they thought would fit Bende and their identity. Besides that they were asked to draw or describe their first product ideas concerning every experiment.

OUTCOME - The experiments were all rated on a scale of one to five on each scale. Six of the experiments were rated with an average of four and higher, the optic fiber experiment, the warped concrete stool, the concrete and cloth, the acrylic concrete and light, and the concrete on acrylic.

CONCLUSION - The highest rated experiments were the ones that had properties which are contradictory to what could be expected of concrete. Concrete is heavy, hard, cold, geometric and sometimes even sharp. It does not float, let light through or come in organic shapes.

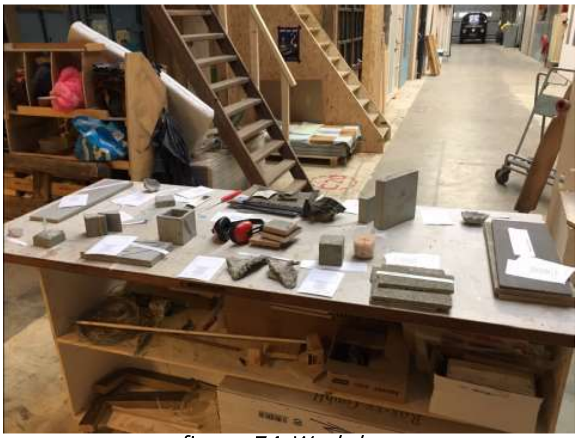


figure 74: Workshop

figure 75: Workshop

5.14 Conclusions

The material exploration phase showed that doing, making and testing can generate a lot of interesting findings. When a material combination came to mind or someone made a suggestion about a combination the goal was to make or test it and reason why it should not work or what would be a better option. During the material exploration a total of thirty six different cubes, panels and other objects were made.

MOTIVATION - It is difficult to make something rather than reason about what could be done better or what could go wrong.

It became clear that it was hard to continue doing and making during the day. Usually the day started with opening a mold that was left to set overnight. The results of this experiment had a large impact on the rest of the day, when the expectations were high and the results was disappointing it was hard to motivate yourself to start a new experiment or make an improved version of the ‘failed’ experiment. If the results was above expectations however, this was a motivation to continue on that direction and experiment more with the material combination.

UNEXPECTED - The effect of an unexpected outcome was interesting to see, when the acrylic plate and concrete experiment showed a mirror like smooth surface finish, the second experiment was immediately made and poured to see if this effect could be achieved a second time. When this dried over night and showed similar results the next day, it felt like a real discovery.

CREATIVITY - During the exploration it became clear that other members of Bende were interested in the concrete experiments and wanted to know the outcomes and results. Often they would propose other material combinations of which some are described above. This shows that this type of research can add value to Bende beyond the outcomes of the experiments performed in this case. The overall creativity within Bende got a boost, Bende members saw the possibilities of using concrete in on-going projects. New material combinations and applications were proposed.

INSPIRATION - In order to come up with new experiments and directions the Bende members were already helpful, but sometimes other means of inspiration were used. Interesting example is the warped concrete stool. The youtube video that was used as inspiration for this video was found at an early stage during the case. It was discarded, as it seemed too challenging at first, as there was little experience in using concrete. After having performed more experiments, it became more likely that this experiment could succeed. After having done some research online about the different ingredients that were used the experiment was started. This proved both that it was possible to create concrete products that were first deemed to difficult and that a lot of knowledge about a material can be generated in a material exploration case as described in this chapter.

OUTCOMES - As said above, the actual outcomes of the performed experiments are not the only outcomes, but these can be valuable and usable in future project or even result in a Bende product. Saving these results is important, especially when consulting these after some time. How can these outcomes be saved and how can it be made so that Bende will actually use it in the future?


B·E·N·D·E

Chapter 6: Relation to Bende

There are three levels of design doing in this thesis; the case, the project with its findings and outcomes and a recommendation on how Bende can best apply this in their business

Chapters:

6.1 Document
6.2 Evaluate & Consult
6.3 Material database

6.1 Document

The first step in using design doing to generate more value for a business is to document and save all of the outcomes of a project.

DATA - Every part of a project needs to be documented, the first sketch, the materials that were used, the supplying companies, tests that were performed etc.

DRIVE - All this information needs to be saved in a clear and structured manner. Every project should have the same folders and sub-folders (See figure 76), so when looking for a video of a certain project, this can always be found in the same place. Some information should be saved in a general folder or document, for instance suppliers. Supplier name and the materials they supply, a contact person and login information for the website. A clear overview to help with ordering new materials.

STRUCTURE - Every Bende member should document their actions and findings.
This will be the most important factor for success of this setup. It will take time before everyone is used to this. The first step is to introduce it in a new project. From the start focus on documenting. Create a structure in the project where everyone gets used to documenting their actions. From here on it will be part of the general actions of every member and will be applied in all future projects.

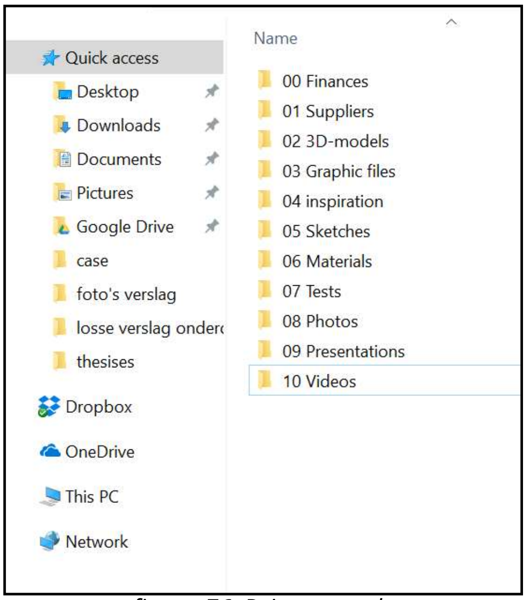


figure 76: Drive example

6.2 Evaluate & Consult

After having documented every part of the process, the next step is to evaluate on the findings, outcomes, results and process.

SETUP - The evaluation of every project should be done using the same format. A 30 minute evaluation in which every Bende member who worked on the project gets 2 minutes to explain their findings and thoughts on the project. The rest of the evaluation's purpose is to decide on what aspects are the most interesting and can be used to show essence of the project.

GOAL - the goal of the evaluation is to condense the data that was saved and documented into a small and manageable document. This will be a physical document that can be used both for consultation during future projects and for portfolio use, showing possible future partners what Bende is capable of.

SAMPLES - Next to the document as described above, the materials that were applied in the project should be present in the form of samples.

CONSULT - This the most important aspect of using design doing in a business environment. Using the findings and outcomes of previous projects to improve future projects and overall quality. Apply materials and applications that have proven themselves in different situations and in different fields. Use the knowledge that is generated by design doing to create value for a company.

PROCESS - The figure below shows the loop of design doing in a business. The goal is to make, document the making and all its aspects and consult the outcomes and results to improve the making process.

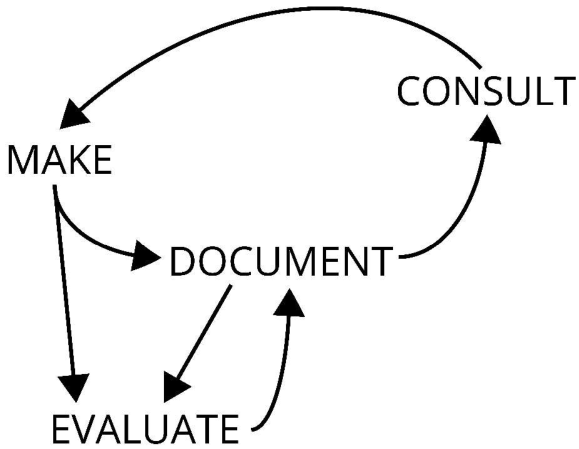


figure 77: Design doing process

6.3 Material Database

The final outcome of this project is a material database that consists of all the materials that Bende has worked with in the past. This database is a reminder, a source of inspiration and a tool to show future partners what Bende is capable of.

REMINDER - The material database is a reminder of all the projects, materials and applications that Bende has worked on, used or applied in past projects. The problems that were overcome, the things that were accomplished that the company is proud of and the knowledge that was gained on using materials.

SOURCE OF INSPIRATION - Next to this the material database can be a great source of inspiration. During idea generation for new projects that database can help inspire new material combinations or new applications for materials that have already been used in another project. Having a physical database helps greatly with this. Having two materials in your hands and laying them next to each other to see and feel how they combine is very valuable. This speaks more to the mind that trying to imagine how they would look together.

PORTFOLIO - Finally the database can be used as a portfolio for future partners, showing what has been done, what could be done next and where Bende already has knowledge on. This in combination with the document that is compiled during the evaluation phase, can show the essence of past project and give and insight into what a future partner can expect from a Bende project.

Chapter 7: Reflection & Evaluation

There are three levels of design doing in this project, the material exploration case, the overall projects outcomes and the application of the project to the business perspective of Bende. This chapters evaluates on these levels and ends with a personal reflection on this graduation project.

Chapters:

7.1 Case
7.2 Project
7.3 Overall conclusions
7.4 Personal reflection

7.1 Case

How can Bende apply this case in their daily activities? What would be the added value of this way of working and how can it be used to gain competitive advantage?

SCOPE - The main idea behind this case was to broaden the scope of Bende. This case was performed with concrete, Styrofoam and light as the main materials. The goal was to gain knowledge and experience and investigate the possible use of this material in future or on-going projects. Future material explorations could be done with other materials, for instance glass, metal, plastic or clay. The knowledge and experience in using these materials will broaden the scope of Bende, at the start of a project several different materials can be considered, used and applied in projects.

TIME - This case was performed in roughly two weeks. This is not achievable in the normal routine of Bende. The cost for having someone perform such a material research would outweigh the outcomes of such a research.

NEXT STEP - For future material explorations, a better option would be to condense it into a one or two day session and by involving several or maybe even all Bende members. As described in the previous chapter, the material exploration case proved to be more valuable than only the outcomes of the performed experiments. The overall creativity of everyone who was involved grew and people saw the possibilities of applying the new materials in a project. By organizing a exploration once every one or two months, several materials can be added to the scope of Bende while organizing a creative day that while boost the overall creativity within the company.

INSIGHTS

The main goal of material explorations is to broaden the design scope of Bende in general.

This setup of this case was time consuming, for future use of material explorations the goal is to use less time for this.

The case provided to be more valuable than the results of the experiments only, the case proved to inspire Bende members and boost overall creativity.

7.2 Project

The case showed that design doing can results in interesting material properties and applications which can be used to broaden the scope of Bende as well as results in starting points for a Bende product.

RESULTS - There is however one main challenge in getting the most out of design doing, saving the results, findings and solutions for future reference. This does not only apply to the results of the material exploration, but to the on-going and future projects that Bende is performing as well.

"***How can Bende log all of the findings and results?***"

And maybe even more important,

"How can these findings and results be made available and be of added value in future projects?"

The logging and use of the findings is divided into three phases;

Document, evaluate, consult

Document - Take photo's, make videos, document every step. The first sketch as well as the final result. Information about suppliers, materials, costs, failed test that were not used, general findings, problems that were overcome. All these outcomes are saved to the general drive.

Evaluate - After each project an evaluation with every Bende member involved in the project will explain on the most interesting findings, things to prevent in the next project, and the quality and satisfaction of the final result. This evaluation will result in a summary of a project with the most important and interesting result.

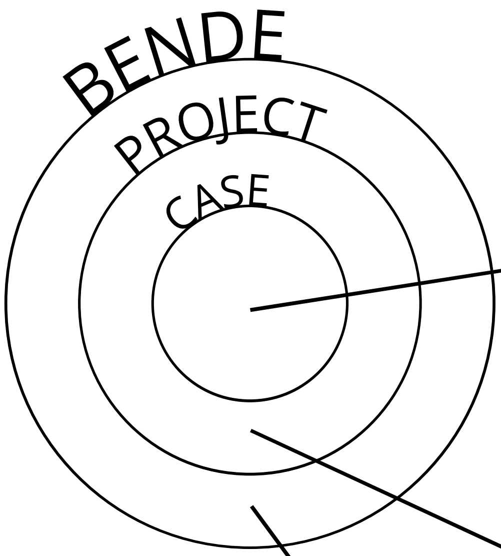
Consult - Use the findings of previous projects in current projects. During the ideation phase to generate new ideas or to show future clients. Make several different databases, one on materials findings and applications, one about working principles, one about detailing, one about suppliers, one about failed tests, one with the most surprising material combinations.

The next pages will address each phase of this set up and explain in detail how this is best achieved.

CHALLENGE

The main challenge of this set up is to create a database that will actually be used. The documentation phase will generate an enormous amount of data, the goal of the evaluation is to select the important data and save this in an accessible and more importantly, a practical database.

7.3 Overall conclusions



CASE INSIGHTS

The main goal of material explorations is to broaden the design scope of Bende in general.

The case proved to be more valuable than the results of the experiments itself, it inspired Bende members and boosted overall creativity.

PROJECT OUTCOME

The most important aspect of design doing in a business environment is to save the results and outcomes of the tests and explorations. Successful exploration can be used, improved and applied in future projects. Failed test can be reviewed and can improve insights on why it failed and what could be done better.

BENDE CHALLENGE

The main challenge of saving results in outcomes is to create a database that will actually be used. The documentation phase will generate an enormous amount of data, the goal to select the most important and inspiring data and save this in an accessible and more importantly, a practical database. This database is useful in both ideation and idea generation as well as a useful tool to show future partners about past projects, materials and applications.

7.4 Personal reflection

The underlying goal of this project was to make as much as possible, use the graduation project as a cover, or excuse, to make and create, use my hands and learn about tools and materials. This was what attracted me in the first place. It is however hard to make for the sake of making, a goal or a more concrete, no pun intended, product direction would have helped me during this project.

The material exploration case was started with a lot of enthusiasm and interest. The first outcomes and experiences with concrete were fulfilling. But the need to turn them into products or product directions grew. In the end I did not succeed in turning them into products, the findings were maybe to abstract, but none of the ideas or directions really spoke to me and convinced me to use it to design a product for Bende.

The choice for using concrete and sticking to this material might be a reason for this, there was a certain mismatch between Bende and concrete. Hard to put my finger on it, but in the end this material was maybe not the best fit for coming up with a product.

On the other side I have been making a lot in this project. Especially at the first months of the project several new techniques and materials were appropriated. Especially the warped concrete stool was something I am proud of, this method was found at an early stage and I did not expect to make something with that, as it seemed far too difficult.
That it worked out in the end felt like a real achievement. It was nice to see that others who heard about my project, asked for advice on using concrete when making something themselves. A friend of mine, who I had not spoken to in quite some time, messaged me to ask tips for using concrete in a project he was working on. I was able to give him some valuable tips on what to do and what to avoid, this made me feel like an expert on a subject I did not know much about a few weeks prior.

The first steps in the design doing methodology were hard. I think i have at least gone through six different definitions during this project. What is part of design doing? What is not? I still feel I have not really reached the essence of what design doing is. It would be interesting to see another student use my findings and outcomes for further research into design doing. I feel like the potential of design doing is much larger than what I have achieved in this project.

Making decisions in this project did not come easily. Most meetings during the project resulted in my chair or coaches proposing directions I had not thought of myself and pursuing these. The meetings were very motivating and helpful for me, as I felt like I could often not see beyond what I presented at the meetings.

In the end in can say that this project has learned me a great deal about myself and about making. Besides this graduation project I helped with several other projects for Bende and was even in charge of breaking down the wall of death that was made for the motor show. I feel proud to have been part of Bende.

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