IMPLEMENTING DESIGN FOR SUSTAINABILITY IN PRODUCT DESIGN PRACTICES: A CASE STUDY

HALFDAN KELLER JUSTESEN HJALTE GREGERSEN

Sustainable Design, AAU, København Hjalte.g@gmail.com // 42 72 45 02 Halfdan.justesen@gmail.com // 27 82 29 00 Antal anslag: 137.604 Dato: 07/06-2019

A C K N O W L E D G E M E N T S

We would like to express our deepest gratitude to our supervisor Birgitte Hoffmann for guidance through our project. Your help has been indispensable. and Andrés Felipe Valderrama Pineda for assisting us both in the initial process of developing a thesis and as a helping hand throughout. We would also like to say a big thanks to all of our collaborators; Christina Halskov (Halskov & Dalsgaard), Boris Berlin (Iskos/Berlin) and Brain Frandsen (The Danish Design Center). Thank you for letting us haunt you with all sorts of weird interventions and thank you for your great inputs for our project. We would also like to say thanks to the amazing lector staff at Sustainable Design, Aalborg University for getting us through this lovely education. It has been some great year and we learned a lot.

We would also like to extend my thanks to the technicians of the laboratory, in particular, to "Lotte Smed" for always giving us good advice and making sure we cleaned up after ourselves in the lab.

We would also like to thank each other for keeping a good spirit even when times were pressured and deadlines were approaching rapidly. Nice going buddy!

Finally, wish to thank our parents for their support we and encouragement throughout the studies. And in life.

We would like to dedicate this thesis the Greta Thunberg, for her amazing job around the world. You have done more for this planet in the last 10 months than we have done in the last five years. Change comes from action. We believe in you!

SIGNATURES



Hjalte Gregersen // 20135146

Halldan fistesen

Halfdan Justesen // 20145759

SUMMARY

This thesis is the result of a design project conducted in participation with two product design studios. The design project investigates the potential for sustainable impact in product design, and how product design practitioners could interface with higher levels of design for sustainability. The researchers have used a Science and Technology studies approach and pushed the product design practitioners in this transition. During the project, two case studies are developed on the bases of interviews and participant observation. The cases map out a set of different design processes to find ways to include more sustainable choices in them. A framework for sustainability in product design has been presented and based on current establish knowledge, and the case studies, a design specification for a design solution been constructed. Through a systematic and iterative design synthesis, the authors, in participation with the project collaborators, constructed a framework for teaching sustainability in product design on three-tiers, called Sustainable Thinking.

Key Words: Design For Sustainability, Product Design, Case-studies, Design Process

TABLE OF CONTENT

ACKNOWLEDGEMENTS 2
INTRODUCTION
PROBLEMATIZATION7
RESEARCH DESIGN
THEORETICAL FRAMEWORK: SCIENCE AND TECHNOLOGY9
PROJECT DESIGN 11
LITERATURE REVIEW
DESIGN METHODOLOGY 16
"SUSTAINABILITY" 17
SUSTAINABILITY IN PRODUCT DESIGN
OUR PERSPECTIVE
PARTICIPATORY PROCESS
DELIMITATION23
OUR PARTICIPATORY JOURNEY23
QUALITATIVE INTERVIEWS24
DESIGN GAMES27
GAME 1 - THE NON-CHAIR29
GAME 2 - NOBODY
BRAIN FRANDSEN FROM THE DANISH DESIGN CENTER
CASE DESCRIBTIONS
CASE DESCRIBTION: H&D

CASE DESCRIBTION: BORIS BERLIN
DISCUSSION
SCIENCE AND TECHNOLOGY STUDIES
THE PRODUCT INNOVATION LEVEL
CREATING VALUE WHILE TAKING RESPONSIBILITY
THE CHOICES BENEATH THE PROCESSES
DESIGN SPECIFICATION
DESIGN SYNTHESIS
BRAINSTORM
MORPHOLOGY
ESTABLISHED DESIGN STRATEGIES
SELECTION OF FINAL SOLUTION CONCEPT
SUSTAINABLE THINKING
LEVEL 1: CIRCULAR PRODUCTS71
LEVEL 2: PRACTICE ORIENTATED DESIGN
LEVEL 3: CIRCULAR BUSINESS MODELS71
CIRCULAR PRODUCTS72
CONCLUSION
PERSPECTIVATION

CHAPTER I INTRODUCTION

This thesis serves as documentation of a design project carried out in the spring of 2019 at Aalborg University Copenhagen's Master program "Sustainable Design". The design project's focus has been to work with product designers and push them towards including more sustainability in their product designs. In this chapter, we present the problematization and vision for the project.

PROBLEMATIZA-TION

Our modern society and our positivistic locked-in views on technological change are creating unsustainable living patterns. In order to change this, we must find ways to break these patterns and the modern consumption paradigm "feeding" the society with unsustainable choices all the time (Ehrenfeld, 2008).

Sustainable design engineering and especially Design for Sustainability (DfS) is evolving, running towards more systemic changes (Ceschin, 2016). In this project, we want to focus on a bottom-up perspective to the systemic change; What about the designers out there that are still working with product design in a more classical sense? - Designers who are still concerned with shades of green and material choices before even thinking about the life-span of the product or how these materials impact the planet. How we can offer these more traditional designers with tools for both understanding, but also implementing more sustainability into their products?

However, this idea of implementing more sustainable design practices, into the traditional design domain, raises a series of issues: First of all, we need to understand the way the designers work. Secondly, we need to address the current understandings of sustainability in product design. And lastly, how can we push such a transition?

Our research questions:

How can we, as sustainable design engineers, understand sustainability in product design? And how can we then push

product designers to include sustainability in their practices?

With this project, we want to contribute to the field of Sustainable Design Engineering by offering a practical approach to push the designers to take part in a systemic transition.

Based on two case studies, we provide an understanding but also challenge the current practices of designing products, in small traditional design studios in Denmark. Based on the current research on sustainability in general and transitions within the DfS-movement, Science of Design and empirical participatory research, we will synthesize a framework for both implementing and understanding sustainability in product design. Using a systemic understanding and an Actor-Network Theory (ANT) approach, we create a design solution to push this transition.

The project is based on a literature review where we go through some of the research that we find relevant to address this problem. We show how the design processes are situated and complex and argue for why we understand them as something that can only be presented as a narrative; one concrete example (Achten, 2008; Cross, 2001; Ehrenfeld, 2008; Lawson, 2005). We show how the DfS-movement is changing towards a more systemic approach to design and why it is crucial that we do not leave out the designers (Ceschin, 2016). Based on a presentation of four different established conceptualizations of sustainability, we develop a framework that makes sustainability in product design tangible. This framework is the result of a discussion where we use both state-of-theart literature and our own participatory research.

CHAPTER 2 RESEARCH DESIGN

The second chapter covers the design of our research approach in the project. Using a Science and Technology studies approach, we have designed our research. Three approaches are presented, and their relation to the project is explained. Based on the problem formulation, we have formulated a set of sub-questions. Each sub-question is then used to explain why and how we seek to address different aspects of the project.

THEORETICAL FRAMEWORK: SCI-ENCE AND TECH-NOLOGY

We approach the problem field through a systemic approach. As designers and researchers, we have adopted the ways of science and technology studies to collect empirical data, analyze, synthesize and approach implementation. The particular approaches we are using in this project are; Participatory Design (PD), Socio-Technical Systems in conjunction with Actor-Network Theory (ANT), which will be described below. We also work with Case Studies (CS), one of the reasons being they generate knowledge of a practical nature (Flyvbjerg, 2006), and are essential to Science and Technology Studies research (Sismondo, 2010).

Product Designers act in a social world in which they develop and refine technological artefacts (Sismondo, 2010). We as researchers come from a different social world from which we are observing them through a Science and Technology Studies perspective. Thus, we see them as 'constructing' non-human actors with the potential agency to create change. Furthermore, we accept that the designers may have vastly different understandings of the object and its relation to the social world, then we have (Sismondo, 2010). This is why we seek to understand their views through a participatory process.

When working science and technology studies, we seek to understand and push systemic transitions and the different relevant actors that function within them. This is done through the study of the interrelations between relevant social groups, regulations, users, norms, cultures and other social institutions, so we can find ways to enable positive transitions (Geels, 2004). This socio-technical approach is useful because we seek to not only develop tools but also further the diffusion, translation and the use of those knowledge tools.

Socio-Technical Systems

Socio-technical systems is an approach to understand how technical systems interact and relate to societal structures (Geels, 2004). The approach pertains that social and technical aspects are all interrelated (Geels, 2004), and it is in these relationships, we find the key to transition these systems (Smith, 2005). STS theorists suggest that transitions in these systems happen in co-evolution, meaning that multiple parts of the system change together, because of the dynamics and the interrelated nature of the system (Geels, 2004).

Actor-Network Theory (ANT)

ANT sees actors as heterogeneous in the sense that they include both humans and non-humans (Sismondo, 2010). Both humans and non-humans have interests that cause them to act, and that can be managed and used (Sismondo, 2010). This is why we both look at the designers' role and the agency of the artefacts that they construct.

ANT helps us to understand the role of the designers and their relations with other actors. While we only use it indirectly, it has shaped and the project our perceptions. Actor-networks are, as the name suggests, descriptive networks of humans and non-humans actors, and their interrelations (Latour, 2005). ANT pertains that everything exists in interrelation, and these interrelations are ever-shifting (Latour, 2005). Actor networks can be said to undergo 'moments of translation' when they change from one stage to another (Callon, 1986). In a translation, the interrelations of the actors swift when they negotiate and adopt changes.

Callon (1986) suggests there are four moments of translation:

- **Problematization**: The nature of the problem is defined within a specific situation.
- Interessement: Actors are locked into roles and defined in a program.
- Enrollment: Actors negotiate their roles and how the roles interrelate in the programs.
- **Mobilization**: Ensuring the spokespersons who represent the relevant actor groups are aligned with those groups.

Until recent years ANT has primarily been used in a descriptive manner, but it can be a useful approach for designers (Stoni, 2015). As designers, we can use ANT to approach to problem-based design. Firstly, it can be used to understand the problem area and a situational mapping of actors relevant to future design-solution as a translation (Latour, 2005). Secondly, actor-networks can be designed as part of a solution, and we, as designers, can frame our own role as facilitators in the design translation (Stoni, 2015).

Participatory Design

Participatory Design (PD) is a tradition of research-based design, in which design activities are done with relevant actors (users, subject-matter experts, and other stakeholders) (Spinuzzu, 2005). In PD 'designers' relinquish a large part of their control of the objects of design (Robertson, 2012), making the act of designing one of collaboration and shared decision-making (Robertson, 2012). It can be discussed whether PD is a general approach or a specific methodology (Spinuzzu, 2005), in this project we have used methods from it, in efforts to gain an understanding of the tacit knowledge in design work.

Case Studies

Throughout the design project, we have worked with two case studies. Case studies are a research strategy, in which researchers investigate a single instance of the subject matter. These studies are often very concentrated and go into great detail about their specific case. When using case studies, it is important to acknowledge the locality of one's findings (Merriam, 1988).

Case studies become increasingly relevant when it comes to contemporary research, as they are used to present a concrete example of the research field (Flyvbjerg, 2006). Especially when the researchers have little or no influence on events they investigated (Rowley, 2002). While researchers should be careful to generalize on the findings they produce when they undergo case-based research (Rowley, 2002), examples can lay the foundation for scientific development (Flyvbjerg, 2006). One way of lifting a case study to this level, it is crucial to display that it has been informed by established theory, and through exemplification contribute to that theory (Rowley, 2002).

In his paper, Flyvbjerg (2006) presents different ways to select cases to study. Tabel 2.1 display his descriptions of the different strategies for selecting information-oriented cases on the grounds of their expected content. These are selection frames can be used when seeking to maximize information from small samples or single cases Flyvbjerg (2006).

TYPE OF SELECTION	PURPOSE
1. EXTREME/DEVIANT CASES	To obtain information on unusual cases, which can be especially problematic or especially good in a more closely defined sense, for instance pol- icy fiascos/successes.
2. MAXIMUM VARIATION CASES	To obtain information about the significance of various circumstances for case process and out- come; e.g., three to four cases which are very different on one dimension: size, form of organi- zation, location, budget, etc.
3. CRITICAL CASES	To achieve information which permits logical deductions of the type, 'if this is (not) valid for this case, then it applies to all (no) cases.'
4. PARADIGMATIC CASES	To develop a metaphor or establish an exemplar for the domain which the case concerns.

Table 2.1: Exempt from "Table A: Strategies for the Selection of Samples and Cases" (Flyvberg, 2006, p. 128)

PROJECT DESIGN

To approach our project work in a strategic manner, we have mapped the sub-problem (see below) and how we address them through different design activities. The project work has been directed by the Double Diamond, a simple model which describes "the design process" (Design Council, 2007). The model presents 4 phases of design; discover, define, develop, and deliver beginning with a problem, having a definition between define and develop, and ends with a solution (Design Council, 2007). In the project work, we have actively directed our process using the double diamond as a framework for decision making and progress tracking to handle deadlines. As we will show later, there is no such thing as a single representation of "the design process", but rather a set of unique abstract ways of being creative. The double diamond guided us through four phases of design activities:

- Research (Discover) The process of collecting empirical evidence with the purpose of gaining knowledge about the problem field.
- Analysis (Define) Processing of the empirical data and relevant information through theoretical frameworks, with the purpose of creating knowledge and understanding of the problem field.
- Synthesis (Develop) A knowledge-based development of design solutions, with the purpose of exploring the solution space.
- Implementation (Deliver) Selection between the potential design solutions and strategic steps to deploy diffuse and domesticate the solution in the problem field, with the purpose of solving the problem.

Problemformulation

How can we, as sustainable design engineers, understand sustainability in product design? And how can we then push product designers to include sustainability in their practices?

In order to structure and design our project work, we have divided the research problem into five sub-questions. The sub-questions presented have been arranged in accordance with interdependencies; some answers are required to understand the relevance of subsequent questions.

- What is sustainability in product design? (And what is wrong with the current ways?)
- 2. What do we need to understand about product designers and their design practices?

- 3. What is the role of product designers in sustainable transitions?
- 4. Where in their design processes can sustainable design strategies be introduced?
- 5. How can product designers be equipped to include sustainability in their work?

To illustrate the strategic structure of our work, illustration 2.1 shows the different steps we go through in our project and how they relate to the sub-questions. In each of these steps, we have identified different theories and methods, frameworks and public strategies. To see the process in relation to our problem, we have our problem statement in the centre of the mapping and placed the sub-questions in relation to the design activities. The dashed line around the illustration is representing



Illustration 2.1: Initial project scope - This illustration shows how we are going to address different aspects of our project. the illustration shows, witch and when different theories and methods are used and where the sub-questions are assessed. the theoretical framework. This map has evolved throughout the project and been used to discover how we could move forward in the project work.

1. What is sustainability in product design? (And what is wrong with the current ways?)

Through the research of various views of both product design as a profession, design processes, and sustainability. We will synthesize a definition of what sustainability is within the domain of product design. We will then continue to define what is sustainability and unsustainability both in product design and everyday practices. We want to create a framework for understanding and including sustainable development in product design, and though this framework, we want to explore and define how designers can create value while taking responsibility.

2. What do we need to understand about product designers and their design practices?

In our design project, we want to work with product designers and their design practices. Early in the project, we chose a profile for potential collaborators, where the designers have a degree of independence and autonomy: "Units within micro and small-sized enterprises (50 > employees), which has a function of designing everyday products for mass markets."

To establish who we are designing for, two case studies will be constructed. We want to enrol a sample of designers as collaborators in the project. We will then proceed to create cases based on each of the designers. The aim is that these cases are representing vastly different approaches to product design. These cases are then used to establish an understanding of product design practices.

The case studies will be based on a series of interventions with the different actors, semi-structured interviews, design games, and informal conversation. In these, we will look into, the way they work with collaborators, their product portfolio, the way they approach design work, and their understanding of sustainability. These case studies will be presented as the results of our research and are then used to represent the product designers in the remainder of the project, including our discussion and design synthesis.

3. What is the role of product designers in sustainable transitions?

To understand the role of product designers in relation to sustainability, we will use our findings from the case studies and, in contrast to the current research on design practices and sustainability to identify how such a role should look. This will be the result of our analysis, which will seek to create an understanding of how we can bridge the gap between the current product design practices and sustainability efforts on a systemic level.

4. Where in their design processes can sustainable design strategies be introduced?

Through iterative participatory design activities with our collaborators, we will locate which parts of their design processes would be most relevant to include sustainable design strategies. Based on these activities and an analysis of the design process will be conducted in the two cases studies, where we will identify and how such changes could be addressed.

5. How can product designers be equipped to include sustainability in their work?

Based on the case studies and the participatory design activities, a set of potential solutions will be synthesized. These solutions will draw on the theories and knowledge of sustainable design engineering and cover topics such as; designing for circular business models, and practice-orientated design as well as an exemplification on how you can work with sustainability in product design.

CHAPTER 3 LITERATURE REVIEW

In this chapter, we are going to present the literature and research made in the different topics that we are concerned with in this project. We will first present some of the established views on sustainability and sustainable development; then we will provide the background knowledge we find necessary for understanding the designers that we work with, in this project. And lastly, we will present the current trends in the "design for sustainability" movement.

INTRODUCTION

When approaching this project, we choose to focus on the designers as our main actors. The designers pointed out that they wanted to incorporate more sustainability in the products that they design. We saw this as a potential not just to help the designers to implement more sustainability into their process but also as an exciting project, where we as sustainable design engineers could gain hands-on experience and knowledge about key aspects of our field and how it has evolved.

To give a better understanding of the field of design and the role of the designer, we will present some research concerned with the science of design. We will present insights into how designers work and present how the nature of design problems influences their design process. To explain why it only makes sense to map the design process as chronological narratives.

To give a better understanding of the term "sustainability", we will present three fundamental concepts. First, we will present some of the views from the so-called Brundtland report: "Our Common Future" (1987). We will introduce the foundation for our conceptualization of sustainability in product design by challenging the triple-bottom-line perspective through a more recent view on the term "sustainability" from Kuhlman and Farrington's "What is sustainability?" (2010) and Ehrenfeld's "Sustainability by Design" (2008).

The last part of this chapter is focused on the already established efforts to make sustainable design. We will show how some of the tendencies of Design for Sustainability is moving away from the product innovation level and towards a more socio-technical approach to sustainable

design. Lastly, we want to introduce "Circular Economy" as a more practical approach to sustainable product design with an economic perspective.

DESIGN METHODOLOGY

In this section, we will present some of the key takeaways from the Science of Design literature. As Cross (2008) explains it: "So let me suggest here that science of design refers to that body of work which attempts to improve our understanding of design through "scienctific" (i.e., systematic, reliable) methods of investigation (Cross, 2008; 53)"

"A designer makes things. Sometimes he makes the final product; more often, he makes a representation— a plan, program, or image— of an artifact to be constructed by others. He works in particular situations, uses particular materials, and employs a distinctive medium and language. Typically, his making process is complex." (Schön, 2016; 78-79)

A design process can be understood as a non-sequential series of steps/actions that are performed by the designer in order to synthesize a solution to a given design problem (Lawson, 2005). Thus, it is not a one-step process, nor is it an entirely creative process without any form of control. The nature of the designs problems forces the designers to have to return to the given problem several times and iterate their own ideas to make choices that enable them to improve the design (Achten, 2008; Lawson, 2005).

However, many others have operated within the science of design (Cross, 2001). Many have tried to put up a model for how the design process looks and works and many have defined the act of designing (Cross, 2001). But there is a fundamental problem in doing so, due to the nature of the design process it only makes sense to "map" in hindsight (Cross, 2001, Schön, 2016). As Simon (1969) poses it in his "The Sciences of the Artificial":

The natural sciences are concerned with how things are...design, on the other hand, is concerned with how things ought to be. (Simon, 1969; 114).

In the practice of science, models are crucial in order to validate one's results. The science of design refers to the body of work, which aims to improve our understanding of design (Cross, 2001). Thus, Science of Design might even be more for science to learn from design and not a positivistic simplification mapping of how designers think. Designers work with the artificial, their knowledge and practices are embedded into the things that make and therefore, the problems that they solve (Cross, 2001).

Wicket problems lead to wicket processes

Design problems are 'wicked' thus, the problems do not have a single fixed solution and are ill-defined (Achten, 2008). Thus, the practice of 'designing' is driven by the 'wicked' nature of the problems. Designing is then, as much about the problem as it is about the 'actual design' (Achten, 2008).

Design problems are, therefore, something that the designer can learn from not only at the beginning of the process (briefs, information from clients, previous relations, etc.) but throughout the whole design process (Achten, 2008).

"One of the essential characteristics of design problems then is that they are

often not apparent but must be found" (Lawson, 2005, pp. 56).

Design problems are open-ended puzzles without a single correct answer; thus, it is impossible for the designer to determine just one correct solution to the 'puzzle'. Therefore, the designer strives more for a satisfying result rather than a correct one (Achten, 2008). The wicked nature of the design problems is that until a solution is attempted the designer cannot determine which information or parts of the problem is going to be useful for a potential satisfying result (Lawson, 2005 and Achten, 2008).

The design process can, in many ways, be seen as being driven by the problems that they solve (Archten, 2008). This means that the designers need to not only utilize the information given to them by, e.g. clients, inspiration, material knowledge, etc. but the designers but also generate knowledge from the design problem through-out the whole process (Archten, 2008).

"SUSTAINABILITY"

Studying sustainable design engineering in 5 years have taught us that the term "sustainability" is a complex concept and what constitutes it is very relative to the context of the field of one's work. In this section, we will explore the different perspectives on the conceptualization of sustainability and how that is relevant for product design. Having displayed an overview of the science of design, we will now turn to present different conceptualization of sustainability. First, we will present the first policymaking definition and then move on to a couple more recent understandings.

Sustainable Development has since the publication of "Our Common Future" has been a subject of debate. With the release

of Our Common Future in 1987, it became evident that climate action and a new road for development and growth was needed (Brundtland, 1987). Sustainable development was defined in Our Common Future as:

"... development that meets the needs of the present without compromising the ability of future generations to meet their own needs." (Brundtland, 1987, p. 16)

With a definition with this heavy emphasis on needs, we look a bit further into the report to understand these, mainly what these needs are. It states that the set of needs for the continued human existence on the planet is what later becomes the foundation of "the pillars of sustainability": economic growth, environmental protection, and social equality (Brundtland, 1987).

Wellbeing over time

Kuhlman and Farrington argue in their much later article that the pillars of the social- and economic sustainability can be conjoined (Kuhlman and Farrington, 2010). The basis for this argument is that economic sustainability can be perceived as an aspect of social sustainability that has to do with access and availability of materials and services, such as food and healthcare, known as welfare (Kuhlman and Farrington, 2010). And they name the conceptualization of this juxtaposition wellbeing. Furthermore, the authors present a call to make a distinction between environmental action and the enhancement of wellbeing. Detaching the wellbeing from the concept of sustainability, so it solely focuses on the environment (Kuhlman and Farrington, 2010).

SUSTAINABILITY IN PRODUCT DESIGN

Sustainability and unsustainability in product design practices

Escaping this self-perpetuating consumption paradigm is no simple task. Ehrenfeld (2008) suggests that in order to do so, we need to stop the current and start creating a new reality, a paradigm shift, a revolution. We need to start addressing the wrongdoings or unsustainable *cultural behaviours* of the current regime that rule in every western or even modernized society, and we need to do this on a systemic level (Ceschin, 2016; Geels, 2004).

While we are acknowledging that: "Producing sustainability takes much more than simple problem solving and incremental improvements in the present socio-economic system." (Ehrenfeld, 2008 p. 65) We, however, believe that we can not only focus on this from a bird-perspective, topdown systemic level but we also need to work from the bottom-up and give the designers tools to redesign parts of the system by carefully designing new choices, new products or services, fitting the hopefully new paradigm to come (Ceschin, 2016). Designers, in this sense, are the human beings that are designing and developing many of the consumer choices (products) we, as consumers, are presented with, in our everyday life.

Our society in the western world is driven by consumption, and we see unsustainability as the consequence of the extraction, production, use, and disposal of these material goods (Ehrenfeld, 2008). The problem with this notion is that we too often see a confusing connection between consumption of material artifacts and our well-being as humans. Consumption is often seen from an economic perspective as using resources or quantitative representations of the resources, and when talking about sustainability, we should note that this notion is lacking a qualitative understanding of the practice or 'want' the goods are fulfilling instead of the consumption itself. This is one of the reasons why we are stuck in these unsustainable patterns where new technology is seen as the only solution to the problem (Ehrenfeld, 2008).

Actors on the "Product innovation level" are important actors in this transition (Ceschin, 2016). We perceive the designers as being in the middle of this change, we do so because we see them both as part of the problem (supplying the system with new artifacts, pushing away the responsibility) but also as a potential part of the solution by rethinking the way they design artifacts so that these new products will. We see the designers as having a leading role in bringing forward new technologies and potential that these new technologies can contribute actively to new and more sustainable consumption patterns.

Design for Sustainability (DfS)

Sustainability in itself is a complex phenomenon, and as we just described, so is the field design which then makes designing towards more sustainability an even more complicated matter and forces the designers to think in new ways about products. As we later will show, we see sustainability as a relative term and therefore consider design for sustainability as a matter of creating value while taking responsibility. Thus, sustainability is not something you achieve; instead, it is a constant fight for improving the existing.

Sustainability is no longer perceived as a static goal that we can set for our society. Sustainability evolves and, with it, the strategies and approaches for designing for sustainability (Ceschin, 2016). Ceschin (2016) suggest that in order to reach this constantly evolving target, requires a radical, multi-level change on a systemic level.

"This radical change is accepted to require not only technological interventions but also social, cultural/behavioural, institutional and organisational change". (Ceschin, 2016; 119).

In his article, Ceschin (2016) explores the evolution of Design for Sustainability (DfS), and divide the different strategies into 4 categories/levels:

- 1. Product design innovation level
- 2. Product-service system innovation level
- 3. Spatio-social innovation level

4. Socio-technical system innovation level (See figure 3.1).

While it is essential to acknowledge that a systemic approach is crucial if we want to live in a more sustainable society, we must also acknowledge that there are a lot of professions that still work at the product design innovation level and that they are part of why socio-technical systems can thrive. We need product designers to become part of or at least contribute to the Socio-technical system innovation level. Thus, the potential changes created of these systems are codependent on the products that we put into them, and we need to address product design as being part of a bigger whole. The designers need to understand that the products that they design need to be designed to have

a positive relationship with the systems (Ceschin, 2016).



Illustration 3.1: "Figure 2: The DfS Evolutionary Framework with the existing DfS approaches mapped onto it. The timeline shows the year when the first keypublication of each DfS approach was published (Ceschin, 2016; 144).

CIRCULAR ECONOMY

Seen in relation to the framework (see figure 3.1) found in the "Evolution of Design For Sustainability" (Ceschin, 2016; 144), Circular Economy, as a design approach would enable the designers to interact with some of the other levels, especially the "Product-service system innovation level". Circular Economy (CE), describes an economic model where the goal is to maximize the material used over the longest period of time by rethinking the way we perceive materials in general. We need to understand materials as something of value, where the material flow is "designed" into the products from the beginning (Charter, 2018; Bakker et al., 2015).

Circular Design

Charter (2018), see's CE as a potential "huge" business opportunities, but in the same sentence, Charter notes that this will require us to rethink the way we do business. Charter (2018) also states that new (circular) design methods will become an inevitable part of every business. Bakker et al. (2015) also propose "A Product design framework a circular economy."

These circular design strategies are: "Design for...":

- Attachment & Trust
- Durability
- Standardization & Compatibility
- Maintenance & Repair
- Upgradability & Adaptability
- Dis- & Reassembly (Bakker et al., 2015).

CE is an economic movement that first started in the 2000s in the aftermath of the global economic crash (Charter, 2018). It got further attention in the early 2010s because of the start-up of the Ellen McArthur Foundation (Charter, 2018).

Although few researchers explicitly consider CE as a framework sustainable development and CE in its basic idea is an economic model, its qualities can also be considered as a direction towards a more sustainable society (Kirchherr et al., 2017). CE also touches on some of the UN's SDG's, more specifically, number 6 (Responsible Consumption and Production) (Charter, 2018).

OUR PERSPECTIVE

There are many different ways of understanding sustainability; when we seek to create practical solutions, we must find ways to make sustainability more tangible. We see the circular economy as a tool and framework that can give an economic argument to the design industry and the designers we work with, but it can also be used to increase the sustainability of future products with a circular profile. We see a good argument for including circularity in the design process, and this can be done by implementing various circular design methods such as Circular Design which we will also describe later in our report.

Above we have presented different perspectives on sustainability, most of which do not tackle issues in a way that creates sustainable solutions but instead breaks the creation of unsustainable products. A circularity or other does tangible concepts does not inherently enable sustainable development, but they can create a good point of departure.

CHAPTER 4 PARTICIPATORY PROCESS

In this chapter, we describe our work with the project collaborators. The journey will be described in a quasi-chronological order. For each intervention we will describe the method used, then proceed to present how the intervention was carried out in practice, the key takeaways will be presented together with our own reflections, and we will then proceed to the next step of our journey.

In our design project have we worked with product designers and their design practices. The aim of this work is to create two case descriptions — one for each of the designers. The case descriptions contain our understanding of how the designers work. The case descriptions are based on the results we have conducted during our interventions. The cases will then function as the main focus of our analysis.

DELIMITATION

We have succeeded in enrolling two designers and one expert in the field of the design in our project. While having one or two designers more would have been beneficial for the project; we did not succeed in enrolling any more, despite a lot of effort. We even tried to challenge the current cases by enrolling more prominent design companies such as HAY or MUUTO and also some "positive"-cases with similar design profiles but actors that already are implementing some sort of sustainability in their design process, but none of the designers we contacted had the time to participate.

Right after our initial interviews, we chose a profile for potential collaborators, where the designers have a degree of independence and autonomy: "Units within micro and small-sized enterprises (50 > employees), which has a function of designing everyday products for mass markets."

The limitation was based around the notion that we wanted to create case studies and needed some ground for comparing. As a starting point, we took what we already knew, and at this point, we only knew Halskov and Dalsgaard and their ways of working, so we laid down the boundaries for the rest of the design profiles based on H&D.

OUR PARTICIPATO-Ry Journey

We started our journey, based on a problem that was observed during Gregersen's internship at a Design studio called Halskov and Dalsgaard. During the internship, Gregersen (2019) uncovered the fact that the designers want to include more sustainability in their products, but that they need more knowledge about sustainability. We started to investigate this problem further with different approaches. The internship is ground for many for our initial hypothesis' and sadly also assumptions, as we will show later. Some parts of the cases are also based on information acquired during Gregersen's internship.

In our initial journey, we mainly focus on enrolling relevant actors in our project, and if that succeeded, we would then proceed to follow up with a semi-structured interview.

The Initial Journey

To structure our knowledge early on, we developed the structure for our semistructured interview (Appendix A - Interview Guide). We constructed this interview guide because we know how important it is in a general sense but also because a clear methodology is one of the critical points when working with case-study based research (Rowley, 2002).

Desk research:

After the interview structure was done, we started to reach out to different relevant actors. We began by searching for companies with similar company activities as H&D. In Denmark, there is a registry of companies and their activities. These activities are structured with numbers for each industry sector. The code that H&D belong to is 741010; this sector covers company activities regarding industrial design and product development. We then choose to reach out to some of the companies that we found interesting, mostly larger corporations we did this because we wanted to see the difference between working in a studio and as a part of a brand.

We ended up contacting 5 of the companies; all of them were more prominent design companies such as HAY and SEBRA (Appendix B - Reaching Out). We also looked into The Danish Design Council; we did this because Christina from H&D is a member of the council, and it might be an excellent place to find relevant actors. From the council, we contacted a number of small design studios that all seemed to have similar business activities to H&D. We got in contact with some of the designers, and many found the project interesting, but as many times before, the lack of time was a factor, and most of these actors simply did not have the resources to engage in our project. We ended up getting an interview with an industrial designer called Boris Berlin, which is behind a number of companies such as Komplot Design, Boris Berlin Design, and Iskos-Berlin.

Now that we had some relevant actors to work with we started to investigate some of the critical points of our work. The purpose of the interview was to: "Establish a connection to the company, gain an understanding of their approach and also to figure out if they are relevant to our project." (Appendix A - Interview Guide). Qualitative Interviews

'Qualitative interviews' is a method used for collecting information from relevant actors. During interviews, the interviewer and informants engage in dialogue. The purpose of such an interview is to make the informants share their opinions, perspectives, and experiences so that the interview can be used to get more in-depth qualitative insight and a detailed understanding of a specific case, or situation from the actor's point of view (Spradley, 1979).

Informants - When we as designers engage with actors they go from being a source of observation to be a source of information who speak on their own, in their own "language" (from their own culture and perspective) (Spradley, 1979).

The semi-structured nature - In most cases, qualitative interviews are supported by an interview-guide that facilitates a flexible structure. The interview guide consists of themes and questions that are relevant to the investigation and research topic, but without having a rigid frame or chronologíc schedule of the questions allowing room for the interviewer to explore points made by the informant in a more detailed manner. (Bryman, 2016).

Disadvantages and advantages of interviews

When using interviews, it is essential to acknowledge information is coming from the perspective of the informant. Interviews do not present a picture of reality, but rather a subjective presentation. Here are a few things to watch out for when conducting and processing interview data:

• The culture and language of the information might neglect information that is implicit to them (Bryman, 2016).

- Formalities and agendas might make Informant hide or neglect information do not want to talk about (Bryman, 2016).
- While semi-structured interviews do allow for some flexibility, it still doesn't give structure limits exploration (Bryman, 2016).

However, the subjective perspective and personal experience do also afford advantages:

- Informants with a lot of experience and can provide assessments of relevant issues information that are not amenable through other research methodology. And do so early in the research process (Bryman, 2016).
- The informants retro-perspective can create a solid foundation for understanding why things are the way they are (Bryman, 2016).
- The negotiation of interviews facilitates a natural ground to gain informed consent from the informants and using the information they provide in research and are not likely to intrude in people's lives (Bryman, 2016).
- Qualitative interviews excel in research situations where the interview wants to explore a specific topic (Bryman, 2016).

Interviews in the design process

A successful interview situation serves as an excellent opportunity to get your foot in the door and establish a connection to relevant actors you want to work with. This makes the interview ideal as an initial intervention, as most human actors have some kind of understanding of what an interview is. They can relate to it. So in a project where there are no pre-establish partners, they can also serve as a tool to get potential actors interested. In this project, we decided to initiate our work by interview potential partners, not only to gain an initial understanding but also establish a connection. Interviews allow for a natural follow-up, which is convenient in research processes (Bryman, 2016), and this opportunity can be advantageous when we as sustainable design engineers engage in the facilitation of transitions and build meaningful relationships to our collaborators.

Initial interview with H&D and Boris

The first interview was with Christina from H&D to investigate our problem field. The interview was based around our interview-guide but with a few changes. As previously mentioned, the alterations to the interviews were made because we already had some of the information we desired from the internship.

After the interview with Christina, we also did an interview with Boris. This time we followed the interview-guide. Both interviews were considered to be successful. We got useful insights for our cases and gained knowledge about the companies, their views on sustainability, and what they felt like the role of the designer were supposed to be. Lastly, we got a confirmation that both of these actors would indeed be relevant to our project.

Christina from H&D said that they would like to part of the project but that they finite time to contribute with. We agreed that H&D would be able to help us with the testing of a potential solution. Boris was also excited about the project, and the agreement with Boris was that he was willing to participate in our process and that he would like to meet with us again.

Findings from the initial interviews

H&D:

- Christina has experienced a rise in the focus on Circular Economy.
- Clients are sometimes expecting sustainability to be a part of the designs
- "Our collaborators expect sustainability as part of our designs
- H&D sees the materials to be the main factor in a more sustainable product design
- Sometimes the designers don't have the power to make a sustainable solution come to life. The client has the power.
- Everybody has a role to play in terms of sustainability
- H&D feels the pressure from society to create a more sustainable design. However, it is hard to find time to gain knowledge about sustainability and sustainable product design

Boris Berlin:

- Boris work with a broad range of products in his design process. He gives it the designation: "Lifestyle Design."
- He chooses his materials from what lasts
- Boris only includes the users in his design process by "sitting in their place". He imagines how end the user would use the product or how manufacturers think.
- He thinks that every designer includes users in their design process and, if not, they should.
- Boris' understanding of sustainability is more or less the same as Christina:
 - Sustainability is about the materials and their impacts on the environment

Reflections

It is essential to notice that we did not ask any questions about their design process. This is clearly a mistake and something that we later would see as being an obstacle when trying to facilitate a design game with Boris Berlin. The mistake was due to the fact that we "black boxed" the design process of the different designers assuming that all designers followed the same sort of structure that Gregersen (2019) had observed at H&D.

We decided to do semi-structured interviews because they would allow us to get around the same sort of questions for different actors while at the same time being flexible enough to account for the differences.

Failing to enrol more actors but keeping Boris in the loop

The status was that we had one fully engaged actor enrolled in the project, one actor who is interested in the project but was not able to invest much time. Other than Boris and Christina, no one from The Danish Design Council had the time to meet up with us or even answer our emails. The bigger design companies that, we also tried to reach out to via the industry code for industrial design and product development (741010) did not get back to us at all.

At this point, we decided that we wanted to continue to try to enrol relevant actors into our process, while at the same time keep Boris and Christina in the loop. We looked at the information we got from the interview and came to the conclusion that we needed more information about the actors around Boris, and how they interacted with his designs and their relation to both his design process. We thought that now would be a good time to take another method into use and decided we wanted to introduce some participatory ANT mapping into the project through a design game.

Design Games

Design games are tools which can be used to create dialogue and share knowledge between "playing" participants (or participating actors). Utilizing game-like elements, e.g. "turns", "representative pieces" and "game boards" the design games creates a magic circle, where typical conversation-culture do not apply. They are excellent tools for making reluctant actors open up. They are often employed by designers in participatory design processes to facilitate collaborative exploration of a subject matter and gain design contributions from several actors (Vaajakallio, & Mattelmäki, 2014).

Design Games work best when they are explicitly designed for the intended subject or topic, they are meant to explore, and the actors who have to engage in dialogue (Brandt, 2006). However, design games are not ideal for facilitating negotiations and reaching compromises, as their explorative nature and playful elements can hinder these activities (Brandt et al., 2008). Furthermore, the physicality of the representative dialogue elements may hinder the broadness of the conversation, as too many game pieces can make the play process messy and confusing (Brandt et al., 2008). The design and construction of design games as a tool are resource heavy and time-consuming (Brandt, 2006).

The Design Game with Boris

Developing the design game:

Our process with the design game that we did with Boris was rapid. This rapid process also ended posing some problems for us both in the facilitation and later when analyzing the results. We created the design game from start to finish in 1,5-2 work-days. We allowed ourselves to fail fast and decided that we would get what we could from the design game. After an initial brainstorm, we came to the conclusion that the purpose of the design game was to find out:

Witch actors, does Boris see as part of his design process, what is the internal relations? and what is their relation to the design? and how does the design change when is in contact with different actors? Who takes decisions regarding the design and lastly, where can we (Boris and us in collaboration) see the possibility to introduce sustainability into the design process. After we had the purpose of the design game laid out, we then used it as a foundation for a series of short brainstorms. The brainstorms were 3 minutes each and focused on the different elements of the design game. We then mapped all the part solutions in a morphology scheme. The morphology scheme helped us to create the final design of the design game (Appendix C - Design Game Morphology) When we had decided the final design of

When we had decided the final design of the design game, we started to construct it.

The design game was intended to be divided into 4 phases. For each phase, we would ask Boris to place game-pieces on a blank piece of A3-paper. The idea was that the pieces together with exploratory questions could assist us in creating a sort of Network of the actors and their relations to Boris' design process. Lastly, we would like to explore Boris' views on sustainability. We would do this exploration by having a collaborative discussion looking for areas of the network where we could locate room for improvements, in terms of sustainability. We had different game pieces to assist Boris in mapping the Actor-Network:

The game pieces had different functions during the design game.

- Product pieces
- Actor pieces
- Design Action pieces
 - The life cycle pieces included: form and function, Production, distribution, use and disposal
- Design activity pieces
 - The Design activity pieces included: Sketching, briefs and meetings

Phase 1

The first step of the design game was that we wanted Boris to choose a real-life scenario based on a product he designed. He would do this by writing the name of the product and then place it on the paper together with a "product-piece". The product should then function as the base for the rest of the mapping.

Phase 2

In this phase, we then asked Boris to map the actors he found to be relevant to his process of designing this product. Here he should use the "Actor" game pieces.

Phase 3

The third step was about the relations between the actors, Boris and the product. Who makes decisions? and how do these decisions change the design? Here it is the "Product" pieces that are used.



Illustration 4.1: Examples of the different design pieces

Phase 4

The last step was to map where and how sustainability could be added to this map. Here we use the "Design Action"-pieces.

Facilitation:

The facilitation of the design was divided so that one member of the group (Hjalte Gregersen) was facilitating the 4 phases and guiding Boris in playing the design game. The other half (Halfdan Justesen) took notes and assisted with additional questions. We ran into some problems during the facilitation; Boris was not that fraud about this intervention. He criticized different parts of the game from the beginning. He found the game elements to be poorly designed and also criticised some of the formulations on the pieces included in the game. However, we do not see this intervention as a failure; we still gained knowledge we can use when constructing the case descriptions. A sort of unexpected extra results of how Boris sees things differently from our understanding. He agreed to play the game with us, still not understanding the purpose or why it would be of any importance to the project. We played the game twice and where we went through the phases of the game talking and discussing the placement of different pieces.

Game 1 - The Non-chair

Phase 1 - Boris chooses his Non-chair to be the base of the rest of the design game. The Non-Chair is a monobloc chair made of PU-Rubber. When we wanted to go to phase 2 and start to map the actors, we ran into a problem. In the reflections, we will give our take on why we think we ran into this problem. According to Boris, no other actors have been involved in the process of designing this product. We found this notion interesting, especially taking H&D's design process into account, and continued to investigate how the product came from idea to finished product.

Phase 2 & 3 - Boris continued his narrative about the Non-Chair. He starts with the producer of the manufacturer. The manufacturer is an important actor for the rest of the process the reason being that Boris is strategic in his way of enrolling actors into his process and he uses a number of objects to enrol actors in the process. Boris has, in this case, made a prototype of both the chair and a model of how it should be manufactured. Boris enrols the manufacturer for three main reasons; 1) he wants to get a brief idea of how much the manufacturing is going to cost. 2) How big of an investment is he going to need to realise the idea and 3) because of the innovative approach to the production method of the chair (monobloc), is the design feasible as it is right now?

After some tries Boris found a manufacturer in Sweden that would be willing to make the design, he got a price, and therefore it allowed him to go one step further in his process. The next step for Boris was to find a brand that would be willing to make the investment needed. Boris needs to first get an investment for creating a prototype tool that can prove for potential buyers that this design can be realized. And after that, he needs even more significant investment actually to put the chair into production. Armed with his manufacturer, the price for the unit and his models of the chair, Boris contacts different actors that Boris finds relevant. First, he talks to Sven Lundh from Källemo, Sven declines the offer, but we will return to him shortly but tells Boris that he should make a company, just for

this chair. After Sven, Boris talks to Peter Larsen from Montana. Peter agrees to give Boris the money, but he also tells Boris that the non-chair should be a brand by itself and not a part of the collection at Montana. The agreement is that Boris will have the prototype made while Peter finds a CEO for the hopefully new company. Time goes, and Boris gets the prototype done, in the meantime, Peter could not find a CEO for the company, and Peter Larsen leaves the project. Boris then goes back to Sven Lundh, now armed with his manufacturer, the price for the unit, his models of the chair and a full working prototype of the manufacturing tool, proving the concept of the chair. Sven is in, and together they put the chair into production.

MONOBLOC - Monobloc is a type of product that is both created from only one material, and that is assembled in one process to form a product that does not have any screws and other signs of assembly. Boris sees Monobloc as a design challenge.

Phase 4 - In phase 4, we had a brief discussion with Boris about the potential for optimizing the chair in a way that would make it more sustainable. Boris informed us that the rubber type he used could be changed for a natural rubber type. At this time, we saw the chair as one material, one process of manufacturing and overall as an excellent example of a chair that without many changes could function is a more circular system. Boris then informed us that the chair was in fact not an actual mono-bloc but was just looking as such. The chair was actually two materials, the rubber and a steel frame. This information raised some concerns in terms of disassembling the chair. Boris then insured us that the chair should not be taken apart because it would not be thrown out.

Game 2 - NOBODY

In the case with the Nobody chair, we followed the same phases as the first game. We instructed Boris to find a product that was a result of a brief. We did this because we wanted the narrative that Boris was presenting to fit more with the game pieces. This resulted in a narrative that is more similar to the process as we see it at H&D.

- The brief from a client (in this case the manager from a Swedish prison facility, responsible for the prison inventory)
- The design phase where the designers sketch and iterate on their solution to find the best answer(s) for the design problem
- 3. A presentation that in this case, failed because the manager had passed away while the product was being designed. In many cases, the project would have ended here. But in Boris' case, a manager from the Danish design company HAY came by the studio. He saw the design, and Boris then sold it to HAY (Appendix D - NOBODY Brief)

So in many cases, the process looks a lot like the one we see at H&D. However, there are some exceptions: Boris makes a lot fewer sketches than what we see in the case with H&D. Boris' knowledge of unique materials and manufacturing processes, lead him to choose a material for the chair early on, even before he started sketching the design of the chair. Boris chose to make the chair out of a bi-component non-woven made of PET. He made this choice based on the design brief (Appendix D - NOBODY Brief). After this choice, he again went for a mono-bloc type of design where the chair was produced in one material and one single process. We consider the narrative to give us some valuable insights into the cases. However, this insight is not due to the design game. The reason is that Boris' narrative about his products tells a lot about his relation to design and the process of designing. His perspective is significantly different from our perspective.

Results from the Design Game With Boris:

The results from our design game with Boris will be presented in our case description. The results from this design game resulted in the design process presented in the case description, and as part of Boris' understanding of sustainability there, it has also resulted in our general understanding of how the designers work.

Key takeaways:

- Boris' approach to designing products is that he strives to, always, challenge his thoughts on design
- Boris' design process is vastly different from the one we see in H&D
- Boris designs his products as an idea, sketches it and then work towards finding a client for the design
- He approaches different actors to test the different aspects of his design such as; Production costs, feasibility and proof of concept
- We also understood that not only is Boris' approach to design different from H&D's but also vastly different than what we first assumed:

• Form and function are not codependent. The function is depending on the use and form is a result of the overall process

Reflections:

The intent of the game was that Boris would chose a product and place it on the board, map the actors associated with this product development. Then through our questions, Boris would map the relation and explain how the design changed during the process. And then Boris, in collaboration with us, pinpoints the places where sustainability could be added to the process. But the intent had one major flaw; our assumptions about Boris' design process.

- We assumed that Boris started with a brief (Like we see it in the case with H&D)
- 2. We also assumed that the vision of the design was made during a long process of drawings, 3d-cad, and renderings (Like the H&D-case)
- 3. Lastly, we assumed that the actors made changes to the design during the process. This assumption is due to the fact that we thought that the production facility would make changes due to what the production could handle. And that the brand Boris targeted would make changes to the design due to how they perceived the design as part of their brand.

These steps were not apparent in any of the two runs of the design game with Boris. Which is not to say that we did not get anything out of the intervention, but we acknowledge that our assumptions stood in the way of some of the processes in the game and that the game did not work as intended.

Brain Frandsen from The Danish Design Center

During the facilitation of our design with Boris, he pointed out that it might even not be our responsibility to make this type of project, meaning that; he felt like someone else should have done it already. He felt like some already established institution such as the Danish Design Center (DDC) should be the ones that carried this task of offering tool for the designers to be more sustainable in their product design. This perspective made us think, what if we could enrol DDC into our process? - We decided to "roll the snowball", so to speak and contacted DDC. We went through their webpage and found a project manager by the name Brian Frandsen. We called Brian, explaining our project and work so far, and asked if DDC would be interested in the project. We also emailed Brian our project description so he was informed by what we had done so far and our thoughts about the project. (Appendix E - project description for Brian). Brian accepted our request, and we agreed to meet up so we could do an interview with him about the role of DDC and their take on the project. We found DDC to of significant influence of our project. They could not only give us new knowledge on the subject; they might be a possible carrier for a potential solution. And they already work with topics such as; product design, sustainable development and design processes. Our intent with the meeting was to 1) establish a collaborative connection to Brian and DDC. 2) Gain access to knowledge/insights through interviews. 3) Possibly roll a snowball into more of the design community.

The interview with Brian:

The meeting with Brain was structured around a semi-structured interview (see Appendix F - Meeting With Brian). Our interview was structured around our three goals with enrolling DDC into our project. The interview went as planned and gave us a lot of useful insights into the work of DDC, some ideas to other actors that could be relevant in include into the project and Brian also found the project interesting, and he agreed to help us with the project. The results of this interview can be found in Appendix F - Meeting with Brian.

HANNE DALSGAARD



CHRISTINA HALSKOV

CHAPTER 5 CASE DESCRIBTIONS

In this chapter, we will present our case descriptions. We will, based on a narrative, describe the way the two design cases work in their design processes. The cases will be a collection of different empirical materials such as interviews, design games and observations. The case descriptions will then be the foundation and representation of the designers in the rest of the report, e.g. the discussion and our design synthesis. In the H&D case, we have included work from an earlier internship report based on an internship in the company (Gregersen, 2019). The cases will be presented with a background, a "designer profile", the process and the views on sustainability.

CASE DESCRIBTION: H&D

Background

The background for this case study is based on multiple sources of different kinds. Most prominent is an article which is based on an internship at Halskov & Dalsgaard. This article is written by Hjalte Gregersen (2019), who also are 50% of this thesis team.

We have also included an interview we made with Christina Halskov from H&D and some desk research based on the company's webpage. We have included this data to present knowledge of the case. The case study is a combination of both participatory observations, semi-structured interviews, desk-research.

All of these information resources have been used in conjunction with the previously mentioned article to create an evidence-based case. The article is based on narratives and qualitative data and is built around two main stories that deal with two different design processes in the design company. The article is marked confidential by the author because he has been subject to an NDA (non-disclosure agreement). The NDA protects the sketches, renderings, and ideas for the business of the design company. "Therefore not said that all information is off limits: work methods, interviews, and statements from the staff will be disclosed in order to give a qualitative description of how the company is working and what we can learn from that." (Gregersen, 2019; 1).

Designer Profile

Halskov & Dalsgaard Design (H&D) is a design studio based in Copenhagen. The company works with clients and design products for them as contracted designers. H&D is operating on a globally and works with a broad range of consumer products (Christmas decor, furniture, and an array of general items such as candle holders and vases).

H&D consists of two designers: Hanne Dalsgaard and Christina Halskov, who bring in interns, such as Gregersen, to carry out graphic renderings and other minor design tasks (Choosing colours, making models and participating in meetings with clients). Hanne and Christina are both from an industrial design background and has graduated from the Academy of Fine Arts Architecture Department of Industrial Design. Hanne in 1986 and Christina 1988. H&D have constructed designs for clients including IKEA, Stelton, The Danish Design Museum, Kibodan etc.

H&D has existed since 1990 and has been awarded a variety of design awards including The Danish Design Prize, Euroluce Milan Design Award, and SIM Innovation Prize.

The Design Process of H&D Brief:

As a typical design process at H&D starts with a design brief formulated by a client. The brief stated that the client wanted small furniture to go along with their existing product collection. They stated that they wanted it to be 'Nordic' in its overall style. The furniture had to be multi-functional but other than that nothing else was stated. **DESIGN PROCESS AT H&D**



Illustration 5.1: H&D's Design process

Sketching:

H&D starts sketching a lot of new furniture fitting the description, mostly tables and chairs but also some mirrors and other small furniture were sketched. Most of them are planned to be made out of either wood, metal or a combination of the two. Many of the sketches are discarded due to the trial and error nature of the process. The sketches are discarded because the designer does not feel an attachment to the idea. This can be because of form or because it looks too much like something that already exists.

Refinement:

If a sketch is selected for further development, they will hand it over to another table where an intern would make a 3D model of the given product. The designers and interns would then proceed to discuss the 3D models and see how they could be improved. Sometimes the 3D models would be discarded. Sometimes the model would be reiterated as a sketch, or if the designer was satisfied, the intern would take the idea a step further and make a rendering of the product. Note: A rendering is a photorealistic computer-generated model of a given product, showing a life-like example of the product. The process with the renderings is the same as with the 3d models, a lot of small incremental changes and iterations. Sometimes the rendering is discarded and sometimes it is selected for the final step: the presentation. In the presentation stage, the rendering is being turned into presentation material. The products are presented in different colours, materials and in different life-like scenarios; it could be inside an artificial living room or standing on a shelf with other small products.

Sustainability in Halskov

& Dalsgaard

Based on Hjaltes internship and internship report (Gregersen, 2019), we had a hypothesis of a potential problem area in the design studio: H&D's lack of access to sustainable knowledge and tools. In order to investigate further, we set up a semi-structured interview with one of H&Ds partners, Christina Halskov.

Key Takeaways:

 Christina has a clear understanding of product design and what it involves; Materials, Shape, and Color.

- Christina has experienced a rise in the focus on Circular Economy.
- Clients are expecting sustainability to be a part of the designs H&D delivers quote: "Vores samarbejdspartnere forventer bæredygtighed i designet." Translated: "Our collaborators expect sustainability as part of our designs."
- H&D sees the materials to be the primary factor in more sustainable product design.
- Sometimes the designers don't have the power to make a sustainable solution come to life. If the customer can't see it as part of their branding, they won't choose that design.
- H&D feels the pressure from society to create a more sustainable design.
CASE DESCRIBTION: BORIS BERLIN

Background

The Empirical Data has been collected via:

- A Desk research via the internet,
- The semi-structured interview with the designer
- The design game played with the designer.

Desk-research was mainly based on the Designer's own content (website, works, etc.) But also a few articles from outside sources have been taken into account.

The structured interview was part of an initial meeting with Boris and served as a foundation for understanding what kind of Design Studio he is running. The Interview also approaches subjects such as "What is sustainability" in an effort to learn about Boris's current understanding of sustainability. We also asked questions about user involvement, and about specific designs, he has created.

The design game was brought in to with the purpose of collaboratively mapping actor-network of Boris' design processes. However, it failed a little when Boris obviously didn't need the design game to talk about "who" and "what" was involved in the process.



BORIS BERLIN

Designer Profile

Boris Berlin is a Russian designer who has been based in Denmark since 1983, where he founded Boris Berlin Design. Boris is educated as an Industrial and Graphic Designer MDD, graduate of the Institute of Applied Arts and Design, St. Petersburg

1975. After his graduation he got employed by VNIITE, Leningrad and worked freelance, designing both industrial products and graphics.

1985-87 Working for Penta Design, a computerized work station for Danish Post and Telegraph.

In 1987 he then co-founded KOMPLOT Design, where he remains a partner. Being part of KOMPLOT Design, he has received several Design Awards, and his work has been represented Design Museums all over the World.

In 2010 he became a co-founder and partner of ISKOS-BERLIN Design. Now he seems to be working mainly on his own projects. Design Process: Boris Berlin

Boris has taken us through two different stories of design processes, which he has done previously. Going through two cases, each of these approaches is explored. The first case is the case of the NON-chair, a vision based process when Borises own drive and ideas drives the process. The second case is the NOBODY, which happen as a result of a design brief, a commissioned project from a client.

Story 1:

This is the story of how Boris Berlin designed his Non-chair. The story was told by himself, in a setting of an unstructured dialogue / failed design game. ing in with the surroundings and have a "timeless" character (simplicity and timelessness).

After Boris is done with the vision of his design, he starts his negotiation process. Boris does not design his products from briefs as H&D does, he creates his designs from a vision and then negotiates his design through a process that Boris facilitates. Thus, Boris designs both the facilitation process and the product.

He is equipped with a model of his product, a model of how he thinks that it could be produced and some drawings of the product, Boris starts his journey. The journey starts with the manufactures.



BORIS' STORY NO 1

Illustration 5.2: Boris' story 1

Boris' starts with a design vision in his head. The vision is driven by different factors such as; material studies and design challenges. The design challenges are creative limitations Boris sets for himself to push the boundaries of what can be done within the domain of design. In this case, the vision is to create a piece of furniture; a chair, that is created in one material, without any assembly visible to the user (monobloc). On top of that, Boris also wants the chair to be anonymous in the sense that is blendThe reason behind this point of departure is that Boris knows that he needs arguments in terms of production-prices and feasibility in further negotiations. Having a solid idea of the expenses are essential for the brands when they make a decision about investing in Boris' designs.

Here it should be noted: the production method has not been used in this the way before. This type of chair is a first of its kind, and that is also why we see some of the potential manufacturers reject the project and tells Boris that "it is not possible to produce". But one Swedish manufacturer gives Boris a yes or at least maybe, and that was enough for Boris.

He is now equipped with a model of his product, a model of how he believes can be produced, some drawings of the product and (maybe) a manufacturer.

The journey continues, and Boris is now in the process of finding a brand who wants to invest in the chair. First, he needs a prototype tool, that can function as further proof of concept. to help Boris with the project. Boris has to create a prototype tool, and Peter Lassen has to find a CEO for the new brand. While Boris is done with the prototype tool, Peter Lassen could not find a CEO and therefore leaves the project, but he still gives Boris the 70.000,- for the prototype tool. Boris then goes back to Sven Lundh now equipped with prototype tool, and Sven Lundh now agrees to invest in the chair project.

Story 2:

Story two emerges from some questions we had during the design game on the use of briefs.



Illustration 5.3: Boris' story 2

Boris has in his design of the process also some brands in mind that he thinks would be able to carry his design. First, he goes to Sven Lundh from Källermo. Because of the complexity of the project Sven Lundh even though he saw the potential in the design could not see him and Källermo as part of the project because of this complexity. Boris then took his design to another actor, Peter Lassen from Montana. Peter Lassen also liked the design and wanted to create a brand only for this chair. He agrees

Seen in hindsight, we were biased by our perception that the design process looks like the one from the case with H&D. Nevertheless, we can now see that having a case where the design process is started by a brief defined by an external user gives us perspective on what we already know from the H&D-case and allows us to compare the two cases.

This process starts with a brief made by The Department of Swedish Prison Institution. Due to the nature of a prison an environment, the brief was mostly made out of points Boris calls "[...]a list of impossible and contradicting demands" (Appendix D - NOBODY Brief).

The Brief:

"It had to be **impossible** to:

- Use the chair as a weapon in a fight;
- Produce any weapon out of the chair (knife f.ex.);
- Hide anything(!) inside the chair (no hollow tubes with access through glides,
- no screw mounted details, etc.);
- Use the chair to produce loud sounds (by smashing into the door or into the wall, etc.)

On the other hand, it **had** to be:

Somewhat comfortable, better more residential than institutional;

- Universal (neither specifically dining nor easy chair);
- Easy to clean;
- Easy to move;
- And so on, and so forth..." (Appendix D - NOBODY Brief)

After Boris received the brief, he used his knowledge about materials to form a design. He decided that the best material to produce the chair would be a soft and light material; in this case, PET bi-component non-woven fabric material also used for automotive interior (see picture). "We were already experimenting a lot with moulding/thermoforming of PET felt while working on GUBI Chair II Collection and it was natural to look for the solution by trying to make a "textile monoblock" - no frame, no tubing, no assembly, no noise, no upholstery, NOBODY...". (Appendix D - NOBODY Brief)

Accumulating Knowledge

Boris seems to always be exploring new

materials and knowledge about design. Even before the active design actions begins his interest in experimenting with materials are playing into the process. As is the case with the NOBODY when he attended conferences and did experiments with the non-woven PET felt mat, even before the design case hit his door.

The Idea

In the two cases, there is a fundamentally different approach to how the core idea of the design comes into being:

Boris own vision

An idea pops into his head, and he decides to move forward with it. In the case of the NON-chair, the idea was grounded in a self-imposed challenge; "Can I design a monoblock chair in a single material using polyurethane." Notice here the material component of the chair, Boris seems to be driven by his material knowledge. He mentioned to us this entire project was mainly based on his previous experience with polyurethane.

A design brief

A client hires Boris and provides him with a design specification to solve. Boris then draws on his experience and creates a design that meets the specification. In the case of the NOBODY, he had been given a case from a Swedish prison warden, who wanted a chair that was prison safe. The brief contained a long list of what the chair shouldn't be. Having hiding place, being turned into weapons, making noise, etc.

Material and Shape

In both cases, this step is quite similar. Boris draws upon his experience to give shape to the design; this mainly happens by the drawing table. Based on the material and the other requirements, he draws idea sketches and makes them become tangible. In this "phase" he also begins to think about the production method. Boris explained that the shape of is a result of culture, materials, functionality, production and messages coming together.

Proof of concept

Boris' includes actors in his design process is to build up the agency of the product. As we can see in the process of "story 1"; Boris' uses the manufacturer as a means to prove that his product can succeed. He also proves the unit-costs, and by that, he already knows which size of investment he needs to get the product into production.

Sustainability in Boris Ber-

lin Design

When asked about product life cycles, Boris started with "Once upon a time there was plastic bottle" and then continued to take us through the initial steps in the product life cycle of the NOBODY. However, he quickly dismissed this entire part of the conversation as trivial. When Boris talks about sustainability, it is often about materials and production methods. He has made it very clear that he sees a problem surrounding his knowledge on sustainable development. In the interview, he displayed his frustration with the abstraction of the concept and the amount of arey matter noise in the field. His wish is to get concrete solutions and find a way to build tools.

CHAPTER 6 DISCUSSION

In this chapter, we will discuss the different perspectives we have found in our research, both regarding the literature research on the topic and the collaborative empirical process. We will sum up the different findings from our work and with the perspective of our theoretical framework, create a design specification. Thus, the design specification is a collective representation of both state-of-the-art research within the field of sustainable design engineering, the designers understanding of sustainability and their current design process.

SCIENCE AND TECHNOLOGY STUDIES

Science and technology is a social construction (Sismondo, 2010). Hence, we see design as the creation of artifacts; we also see the artifacts as being a social construction, with the agency (Sismondo, 2010). In this project, we want to understand the act of designing as the possibility of constructing artifacts that have of relations to the social worlds they exist in, i.e. we want the designers to realize that their products have agency (Sismondo, 2010) and that this agency should be well thought out.

THE PRODUCT INNOVATION LEVEL

As proposed by Ceschin (2016) the development of DfS can be viewed as 4 levels of potential for sustainable impact and that in order to reach this ever-changing goal we need to work on all levels, not just the socio-technical level nor only the product innovation level. We find this interesting for our project, especially seen in contrast to what we see from our interventions with the designers. The designers clearly state that they feel the pressure from the industry and concerns of the end-users to make more sustainable solutions but also states that they need tools and a better understanding of what sustainability is, and how to include more sustainability in their design work. Ceschin (2016) shows that the more systemic we go, the more potential for sustainability we get, while at the same time acknowledging that the product innovation level also has great importance in this transition.

Matters of concern

DfS calls for action across all the levels of potential sustainable development (Ceschin, 2016). Through our empirical research, we have found that the designers themselves are asking for knowledge that will lead them toward more sustainability in their solutions. We find it both encouraging and validating that both the academic side of DfS and the more practical side of product design calls for this action. and for the designers or any other actor at the product innovation level to be transitioned into a position where they have the possibility to interact more the other levels.

Role of the designers

The importance of the actors within the product innovation level, hence the designers, is not questioned by the designers themselves nor the DfS movement (Ceschin, 2016).

This translation, however, is not without complexity and calls for a new definition of the role of the designers. Looking at the DfS movement with the perspective of Socio-Technical System theory it is clear that, if we want a more socio-technical approach to DfS, thus, working towards more potential sustainability, we need designers at the product innovation level to follow (Geels, 2004). Such transition is in a Socio-Technical perspective seen as a co-evolutionary process where actors on all levels of the DfS system needs to change and embrace the designers as part of the system (Ceschin, 2016; Geels, 2004).

We argue that the traditional product designers should be an integrated part of the DfS movement and that we need designers who can, through a new approach to product design, interact with the other levels of design for sustainability.

We need to make a strategic change in the way that the designers work and designs products, and we need to make this strategic change in a way that is both taking the designers ways of working and the current movements in DfS into account.

The translation of the designers

We want to both design and facilitate such translation of the designers through our solution. Thus, we are not just designing a product we are designing a translation of the designers (Stoni, 2015). We want the designers to translate from a role where they "just" design products to designing sustainable products that fit into the evolution of the other levels of DfS. In the words of Callon (1986) we want the actors to go through the four 'moments of translation'; Problematization, Interessement, Enrollment, Mobilization. As presented earlier in the discussion, we see that both the DfS movement and the designers themselves are, to some extent, already Interested in this translation. Our solution should then both offer new tools to the designers, while at the same time function as an 'program' where the designers can negotiate their role in the DfS network.

CREATING VALUE WHILE TAKING RESPONSIBILITY

A FRAMEWORK FOR UNDERSTANDING AND INCLUDING SUSTAINABLE DEVELOP-MENT IN PRODUCT DESIGN.

Kuhlman and Farrington (2010) present an understanding of sustainability in which it is detached from social well-being and solely focuses on the environment. There is a need for differentiation between "well-being of humans" and "environmental action" (Kuhlman and Farrington, 2010). However, we suggest that rather than detaching well-being from sustainability, we, instead make it central to the understanding of sustainability. We must accept the fact that humankind needs to co-exist with the environment, and that humans are the ones to take this responsibility on them. Thus, the last argument, in which Kuhlman and Farrington (2010) de-attach the social and economic aspects form the definition of sustainability is, in our opinion, a step too far.

The primary reason humankind is working towards environmental stability is so that we can continue to create wellbeing over time (Kuhlman and Farrington, 2010).

As Ehrenfeld (2008) suggests, sustainabil-

ity cannot solely be about preservation and avoiding unsustainable development. Designers are relevant because 'design' is distinct from regular problem-solving (Ehrenfeld, 2008). But also because the designers we work with, in this project are designing everyday objects. They are designing new artifacts for our modern society, and without any acknowledgment of sustainability, they tend to contribute to a more unsustainable future. The designers need to understand design in a new way where they can create value while taking responsibility.

Humankind has grown to be dependent on progress and inconsiderate patterns of consumption (Ehrenfeld, 2008). However, we can not stop technological innovation and solely focus on the preservation and restoration of the ecosystems. This calls for action, where we combine the design of new products with a sustainable focus. When we mention sustainable development, it is about efforts to secure a society in which humans can sustain, thrive, and continue to develop. To display this, we have conceptualized two forms of responsibility for creating value.

Sustainability is creating value while:

Taking Environmental Responsibility is efforts that lead to preservation and restoration of the natural environment, and Taking Social Responsibility is efforts that lead to social well-being: distribution of welfare and resources.

THE CHOICES BENEATH THE PROCESSES

When we look at the two cases, we see their design processes as being vastly different. Even within the cases, from one design problem to another, it changes significantly. We see the design process as being a complex, creative and iterative (Achten, 2008; Lawson, 2005; Shön, 2016). This nature of the design process makes it hard to synthesize in a way that makes it possible for us as sustainable design engineers to both understand and design a solution around it.

When mapping out the design process, we seek to gain an understanding of how the designers work, seen in hindsight. This is important for our work because it assists in the validation of our results (Cross, 2001, Schön, 2016). We are on the other hand, also very aware of not using this design process as an instrument of drawing any unjustified conclusions. It is a representation of the narrative we have conducted in our interventions with the designers.

Due to their creative nature and the problems they solve, design processes are lacking universal structure (Achten, 2008; Lawson, 2005). Therefore we have to look past the structure if we seek to create a universal solution. We see the designers, in contrast to our own design process, as controlling the process, where we, on the other hand, chooses to be steered by a structured design process.

Our interventions with Brian from the Danish Design Center and the designers added a lot of useful insights into how we could approach this problem. Brian stated that "designers only really shifts between two stages in their process". The synthesis of the design is where the designers have the agency to choose. They make choices. "They shift between being curious to explore and having the courage to make choices" In other words, shifting between divergent thinking and convergent thinking. (this is not to be confused with the "double diamond"). We find this very interesting for our design process because this gives us an entry to where we can create a universal solution in what seems to be a very situated world. If we can influence these choices and substitute unsustainable choices whit a more sustainable alternative, we can start to see the designers as agents of change.

DESIGN SPECIFICATION

The design specification is a description of requirements to design solution, derived from the problem discovery and definition. In this project, the design specification is the result of the research, and analysis of the case studies.

To avoid confusion; in the list below "our design solution" refers to the outcome of this project, and "products" refers to the outcome of a design process done by the product designer from the case studies.

Boundaries of the solutions space:

- The designers from the case examples are working with product innovation; our design solution needs to offer them ways to interface with higher levels of potential impacts, such as product/ service innovation or socio-technical system innovation.
- The product designers lack an

understanding of design for sustainability, so our design solution needs to include a tangible description of sustainability in product design.

- Design processes are very different, there are many different ways of designing, so our design solution needs to work regardless of structure (or lack thereof) in the given process.
 - Whether designers are letting their work be steered by a process, or if they are controlling it, they continuously make design choices about the end product; our design solution needs to offer them ways of including sustainability in those choices.
 - A sustainable design choice is a choice in which your primary evaluation frame take responsibility in regards to social and environmental factors
 - Major design choices are made in two areas of "the negotiation of the design brief" and "the synthesis of the product design", while both are important, the scope of our design solution is located where we have observed the designers have opportunities to change how they make choices.

CHAPTER 7 DESIGN SYNTHESIS

In this chapter, we will describe our process of synthesising a solution for the design specification we just presented. This presentation tells a linear story of our design activities in a structured creative process.

BRAINSTORM

The design synthesis started with a brainstorm-session based on the design specification we presented in the last chapter. Our brainstorming exercise was based on the traditional concept of getting all design ideas out of your head and into a tangible immutable stage. Such as a drawing or a sentence on paper.

The overall question was, how can we include sustainability in the choices made in the two areas derived from the design specification.

- 1. "the negotiation of the design brief", and
- 2. "the synthesis of the product design".

In the first part of the exercise, we set a timer for 15 min and brainstormed for the duration. Then we presented ideas for each other, and based on an informal discussion of these, we synthesized a series of different functional categories and then listed elements from our ideas within each of the categories.

This exercise was done for both the negotiation and the synthesis areas.

MORPHOLOGY

Morphology is a method for generating design solution alternatives founded in engineering design (Cross, 1989). In morphology, the designer creates a chart with two axises, on the horizontal axis the subfunctions categories, the boundaries of each category is defined by the desired functionality. An example could be different ways to turn the water on and off when designing a water tap. Then you combine whole design alternatives based on different ways to combine sub-functions. The morphology method was initially created for engineering design; we have adapted it to fit conceptual design instead. The primary adaption is in regards to the rigid sub-function categories, in our work they pertain to broader concepts such as "ways to present learning

material" or "business structure".

Based on the brainstorming, we created two morphology charts, and in collaboration discussed our way to a set of potential design solutions.

The Morphology led us to developed 11 solution concept alternatives to the design solution.

Concept Catalogue

Having chosen the functionality of the different concepts, we then refined each of them in a way where they had equal representation. For each of the concepts, we develop the following parameters, three key characteristics and 150-word description, each explaining the three aspects of the concept: the focus, the role of the designer, and the platform for implementation.

Functional Categories	THE SYNTHESIS OF THE PRODUCT DESIGN						
Challenges & Sustianable Concepts	Cradle to Cradle	Beautiful Sustainabi- lity 6,11	Circular De- sign Strate- gies 8,9,10	Sustainable Selection Criteria 7,9,11	Redesign for look and feel 6		
User Involve- ment	End-user Persona Panel 7	Expert Per- sona Panel 7	Obligatory User Tests 8,9,11	Product Questions from the users. 7,9,11			
Eductaion & Inspiration	Courses in Engineering Design Met- hods 8, 11	Sustainabili- ty Glasses 9	Positive Ca- ses	After education of the desig- ners 7,8	Sustainable Material Courses 8,10		
Conferences & Campaigns	Material Confrence 10	"Are you ta- king respon- sibility" 10,11					
Changing the demand for sustaina- bility	Raise endu- serand client awareness of the designers responsibility 11	Sustainable designer 6					

Table 7.1 - Morphology scheme 1: Design Tools: The number indicates which of the functional element have been used to create each of the concepts.

Functional Categories	THE NEGOTIATION OF THE DESIGN BRIEF					
Knowledge Communication	Design for Sustai- nable Design Goals	Sustainable News Feed	Edible Goal			
	3	1,4	5			
Company Policy/Structure	New BMC	Extern Sustainable Capa- city	Radical Pratice Change			
	5	1,3	2			
New Resources	Interns	Sustainable Consultant				
	2	1				
Publication	Intial Meeting Protocol 1, 4					
Layered Solutions	Online Platform o ffering Sustainable Product Design Brief 3,5,2	A movement for Sustianb- le Product Design "Danish Sustainable Design Council" 3, 4				

Table 7.2 - Morphology scheme 2: Negotiation Tools: The number indicates which of the functional element have been used to create each of the concepts.

CONCEPT CATALOGUE

In this section of the report we will present our concepts. The concepts will be presented in a concept catalogue. Hence the change in format.

All of these concepts are in the early stages and are meant to be used as boundary objects for further development in Participatory Design activities, rather than rigid solution options. Each of them has a different representative focus that reflects a space in the solution space we are considering.

Final solutions might well be a combination of two or more of these concepts.

TABLE OF CONCEPTS

1. SUSTAINABLE BRIEF CONSULTANT	52
2. PLATFORM FOR SUSTAINABLE BRIEFS	53
3. DANISH (SUSTAINABILITY) DESIGN ORGANIZATION	54
4. KNOWLEDGE ORGANIZATION	55
5. SUSTAINABLE BUSINESS MODEL	56
6. OUTSOURCING THE SUSTAINABLE PART OF THE DESIGN	57
7. PERSONA PANEL	58
8. FURTHER EDUCATION OF PRODUCT DESIGNERS	59
9. EXTENDED DESIGN BRIEF	60
10. A SUSTAINABLE CONFERENCE	61
11. RESPONSIBLE DESIGN	62

1. SUSTAINABLE BRIEF CON-SULTANT

- A THIRD PARTY IN THE NEGOTIATION OF THE DESIGN BRIEF
- EXTERNAL RESOURCE IN THE FORM OF
 A SUSTAINABILITY EXPERT
 - INTRODUCE SUSTAINABILITY FROM THE BEGINNING OF THE DESIGNERS PROCESS



DESCRIBTION

Understanding what constitutes a sustainable product can be hard in itself. For new products to be sustainable, their entire life cycle and role in business models must be put under the loop. This conceptualization can be done by an external resource such as a sustainable design engineer. The resource would join the initial meetings when the design briefs are developed and assist in negotiating a specification that is taking responsibility towards the environment and other sustainable factors. The consultant could be brought in at different stages of the design process to follow-up on product development.

Focus

An agreement between client and designer that the product in question needs to be sustainable.

The role of the designer To focus on giving shape and design products that fits the brief.

Platform for implementation

This concept would be facilitated by a third party/consultancy who specializes in sustainable development and would be financed as part of the design cost paid by the designer's client.

2. PLATFORM FOR SUSTAIN-ABLE BRIEFS

- A PLATFORM WHERE BRIEFS CAN BE SHARED
- SEPARATION OF CLIENT AND DESIGNER
 - DEDICATION TO SUSTAINABLE PRODUCTS



DESCRIBTION

Instead of having to look for new products and negotiate with clients, this platform aims to let the designer do a lot of design work. No longer having to sit in meetings, the designers will after they have enrolled, simply receive design specification from sustainable developers who have already done the pre-work (research and analysis) with the clients.

Focus

Separating designers from the clients and putting in a third party actor who facilitates the creation of a design specification that has taken sustainability into account.

The role of the designer The role of the designer would be to design products according to this brief and dedicate themselves to the platform.

Platform for implementation

This platform would facilitate and mediate sustainable product development by analysis of the needs of clients and deliver products design briefs to designers.

3. DANISH (SUSTAINABILITY) DESIGN ORGANIZATION

- CERTIFICATION THROUGH IMPLEMENT-ING AND TAKING RESPONSIBILITY INTO THE DESIGN PROCESS
- A PLATFORM WITH DESIGN PROJECTS
 WITH A SUSTAINABLE FOCUS
 - A MOVEMENT WITH NEW PRODUCT DESIGNERS THAT TAKE RESPONSIBILITY FOR THEIR DESIGNS
- NECESSARY KNOWLEDGE TO DESIGN FOR THESE NEW DEMANDS

DESCRIBTION

This concept is a combination of an organization that provides a new certification for the designers to strengthen their position on the market as "sustainable" product designers. The certification is given to the designers when they agree to implement new and sustainable changes to their design process. The changes the designers must implement relate to taking responsibility throughout their design process. These changes must be related to the UN's SDGs.

In addition, the organization must be established. It must provide the necessary knowledge to the designers who will ultimately enable them to change their practice and design products that fit these new demands.



Focus

To disseminate sustainable practices in product design through knowledge sharing and design projects with a sustainable focus.

The role of the designer

The role of the designer is to change their practices into new, more sustainable ones. They do this by implementing a new set of constraints in their design process; actively saying yes to take responsibility for their product design.

Platform for implementation

A sort of council or organization which provides knowledge that the designers can use in connection with their design process.

4. KNOWLEDGE ORGANIZA-TION

KNOWLEDGE AND ARGUMENTS THAT SUPPORT SUSTAINABLE PRODUCT SOLUTIONS AS GOOD BUSINESS

BASED IN AN ESTABLISHED ORGANIZA-TION WITHIN THE DESIGN INDUSTRY

SUPPORT THE DESIGNERS AS THE AGENTS OF CHANGE

DESCRIBTION

This concept is based on an organization rooted in either the Danish Design Center or the Danish Design Council, which are already established knowledge providers in the design industry. This addition to the organizations should focus on making knowledge about why, including sustainability in product design is good business. The knowledge should be easily edible for the designers, so they can use it as an argument when negotiating with other actors. The organization should act as a support for the designers who want to offer their customers a more sustainable product but do not feel they have the necessary knowledge to convince clients that it is both a responsible choice and also can be good business.



Focus

The focus of this concept is to provide the necessary arguments and knowledge to the designers, in an easily edible way.

The role of the designer The role of the designer here is to function as an agent of change by bringing new sustainable products over the table.

Platform for implementation

All of the above must be run by a knowledge organization, and we think that it would optimally be an already established organization. So either the DDC or the GDR would be a reasonable bid for an organization that could carry this development of knowledge sharing.

5. SUSTAINABLE BUSINESS MODEL

FOCUS ON A NEW BRAND

BE THE NEW POSITIVE CASE

A COMPLETE RETHINKING OF THE BUSINESS MODEL



DESCRIBTION

The business model we have observed in most positive cases is one focused on a single line of products: they specialize in optimizing a small number of products and make it part of their brand. The concept is working on the premise that the mass market designers at their core reinforces consumer culture and have to be cut loose. The alternative is to specialize in a particular area and work exclusively with it. That could be "Chairs" and then develop an elaborate understanding of what constitutes a sustainable chair.

Focus

Focus on the continued development of products that are branded and developed as sustainable. Become a brand.

The role of the designer The role of the designers is to refocus their business towards a single line of products and continuously improve these products.

Platform for implementation

Consultants who will help with the business development of the new brand.

6. OUTSOURCING THE SUSTAIN-ABLE PART OF THE DESIGN

- KEEPING THE ROLE OF THE DESIGNER AS WE SEE IT NOW
- A CAMPAIGN ABOUT TAKING "RE-SPONSIBILITY" IN PRODUCT DESIGN
 - UTILIZING THE SKILLS OF THE DESIGN-ERS AND OTHER ACTORS INSTEAD OF CHANGING THEM



DESCRIBTION

"Outsourcing the sustainable part of the design" is about the designers having their role as it is now, it is up to other actors to define the sustainable tasks. The other actors or users do what we would call the design research. Examine the problems, observe users and come up with a design brief. The brief is passed on to the designers, and it is the designers' job to do what we have observed that they are experts in, making it ready for the consumer market. In this way, the designers can maintain their role as it is. In addition, we want to add a layer to this solution by making a campaign about adding "responsibility" to product design. The campaign will function as an additional argument to make sustainable design.

Focus

The focus of this solution is to take responsibility away from the designers and give it to other actors who already have training in identifying where sustainability must be considered in a given solution.

The role of the designer

The role of designers should, as far as possible, not change.

Platform for implementation

The platform for implementation can be many things; existing companies specializing in sustainable development or a new company that manages to convey sustainability problems in a way that the designers could design products that are sustainable.

7. PERSONA PANEL

USER FOCUS

- WHO ARE THE USERS OF THE PRODUCT
- ONLINE EASY TO ACCESS RESOURCE



DESCRIBTION

Personas are descriptions of fictional users. The designer can use a persona to help them empathize and put themselves in the place of the users of their products. The "Persona Panel" would be an easily accessible set of personas relevant to product designers; the resource would be updated and maintained. Each persona would be equipped with a demographic description, a list of accessibility needs, preferences on different areas (wants), and a set of crucial questions that the users could ask in relation to a product. Some of these personas could be a sort of sustainability specialist, asking questions like "how do I repair it?" or "how do I sort it during recycling".

Focus

The focus here is on displaying the diversity of users and that sustainable development must take this diversity into account during the design.

The role of the designer The designer would be a researcher,

seeking to understand the users of their design.

Platform for implementation

This platform would be an online resource with descriptions and videos explaining the wants and needs of a wide array of users.

8. FURTHER EDUCATION OF PRODUCT DESIGNERS

CONTINUING EDUCATION OF THE DESIGNERS

CIRCULAR DESIGN

CO-DESIGN PRACTICES

CHANGING THE POSITION OF THE MARKET OF THE DESIGNERS

DESCRIBTION

This solution is about continuing education of the designers. An education course, video course or another form of knowledge-creating material must be constructed. This material should enable designers to create solutions based on circular design and Participatory Design. The circular part is there to give the designers some concrete tools for making sustainable solutions. And the Participatory Design part is included because we believe that if the designers potentially create solutions that have to change people's practices, the designers must also be able to identify these practices.

Focus

The focus here is on giving the designers a thorough knowledge of design methods and tools for creating circular and sustainable design. There is a clear focus on both circular design and Participatory Design.

The role of the designer The role of the designer is to change their position on the market to go from having a primarily aesthetic and functional to being user-driven and sustainable.

Platform for implementation

This concept could be facilitated by an established organization or company such as Danish Design Center or an educational platform. Or it could be a new establishment or company that specialises in educating these designers.

9. EXTENDED DESIGN BRIEF

- CRITICAL QUESTIONS TO IMPLEMENT DESIGN FOR CIRCULARITY
- FORCED USER-DRIVEN DESIGN
- A DESIGNER DRIVEN APPROACH
- PRACTICE CHANGES OVER TIME

DESCRIBTION

In this solution, we want to create some extra options that designers can add to their design process and design brief. These options must be formulated as critical questions that the designers must relate to in their design process. The Critical Issues must be based on Circular Design and assist the designer in making choices that take into account the entire product's life-span.

In addition, we will implement some options that force the designers to test with users and thus involve the users in the design process. Initially, we want to introduce a relatively solid structure towards the designers. The idea is that the designers can, over time, naturally implement these initiatives in their design process.

Focus

The focus of this solution is to implement changes in the design through critical questions. These questions need to be implemented into the design process, and with time, the questions should be a natural part of the design process.

The role of the designer The role of the designer is, in this case, acting like those who have to carry this development.

Platform for implementation

The platform here is also the designers themselves and their design practices.

10. A SUSTAINABLE CONFER-ENCE

- CONFERENCE FOR SUSTAINABLE PART-NERSHIPS
- COURSES IN CIRCULAR DESIGN
 - SUBSTITUTING MATERIALS FOR MORE SUSTAINABLE ONES
 - CREATING RELATIONSHIPS BETWEEN PARTNERS IN THE PRODUCT DESIGN INDUSTRY

DESCRIBTION

In this concept, the idea is to create a space where designers, material creators, and other design professionals can meet, and the common theme of the conference is sustainability. We want to create a conference where new connections can be formed to create new sustainable partnerships between both the designers, material creators and other people from the industry. We want to add value to all parties involved, so parts of the conference would be talks about circular design, courses in substituting materials for more sustainable materials, and to create awareness for the conference we want to make a campaign that focuses on Creating value while taking responsibility, in product design.



Focus

The focus of this solution is to create connections and give the entire industry an insight into how they can jointly create new, more sustainable solutions.

The role of the designer The role of the designers here is to be curious and seek new partnerships and discover new, more sustainable materials.

Platform for implementation

The platform here is a conference where we want to create connections between different parts of the product design industry. It could be done as a start-up, creating the conference from scratch or to utilize some established actors in the industry as hosts for this conference. These actors could be organizations like Material Connexion, DDR or DDC.

11. RESPONSIBLE DESIGN

- A PUBLIC CAMPAIGN, TARGETING BOTH CONSUMERS, PRODUCERS AND DESIGNERS
- PRESENTATION OF SOCIAL AND ENVI-RONMENTAL RESPONSIBILITY
- DESIGN CRITERIA IN THE FORM OF CHALLENGING **RE**STRAINTS
- COURSES IN CIRCULAR DESIGN

DESCRIBTION

Calling for consumers, designers and producers to take **re**sponsibility and choose to be sustainable. This platform advocates **re**sponsible design. This training platform is grounded in the inherent responsibility; we humans have towards the planet and our fellow people. The platform will centre around the responsible restraints: "Can the product be **re**paired?". These restraints are meant as a design challenge - a creative challenge for the designers.

The focus here would be on a known methodology for sustainable development, such as circular design (Design for durability, dis- and reassembly, etc.), using the mantra of the responsible restraints to remind them in their design practice.



Focus

The focus of this concept is to empower designers to develop more sustainable products by providing them with an exciting challenge that will spark creativity. The role of the designer

The designer here will first be a pupil of sustainability and later an agent of change.

Platform for implementation

This training platform would be driven and developed as a start-up, that would offer resources such as video series, workshops, seminars, webinars, talks. This work should be financed through grants rather than user payment; getting the designers to invest their time is going to be hard enough, user-payment will meet a lot of resistance.



Established Design Strate-

gies

We knew that we also had to present a tangible framework for sustainable product design to find that we looked to established knowledge. Using our research and sustainability experience as sustainable design engineers. We choose a number of established engineering design strategies that fit the requirements of the understanding of the sustainability we want the designers to adopt.

The selected design strategies were:

- The 6 design strategies for circular design as presented by Bakker et al. in Products that Last (2014):
 - Design for Attachment and Trust
 - Design for Durability
 - Design for Ease of Maintenance and Repair
 - Design for Standardization and Compatibility
 - Design for Dis- and reassembly
 - Design for Upgradability and Adaptability
- Lifecycle Design
- Material Flow Design
- Stakeholder & User Representation
- Stakeholder & User Tests
- Stakeholder & User Involvement
- Practice-Oriented Design
- User Observation

We also developed one ourselves:

• **Re**sponsible **Re**straints, founded in the understanding of responsible design choices we presented in the last chapter and the idea of creative challenges sparked during our interview with Brian Frandsen.

Short descriptions of each of these can be found in Appendix G - Intervention Cards.

DESIGN INTERVENTIONS

Seeking to develop different ways to include the strategies and concepts in participation with the users and experts, we undertook a design intervention. A simple creative exercise where we asked the users and experts we have worked with previously to join us in developing a solution. In this design intervention, we presented the 11 concepts from the concept catalogue and the design strategies (mentioned above) on a set of cards. The cards were intended to assist the facilitation of the discussion between the designers and us.

The Cards

In order to create an engaging conversation, we wanted to create a common ground between us as sustainability experts and the designers, as owners of their own process. Therefore we created a set of cards with short descriptions. The primary functions were to physically represent the concepts and strategies in the conversation and give us tangible objects to engage with. All the cards can be found in Appendix: G – Intervention Cards'.

The cards were meant to function as Boundary Objects. They were intended to be adaptable to the way they are perceived, and still immutable in their identity. Boundary Objects function in the space between social worlds, when actors from different worlds relate to the object facilitated in a way where they create a shared understanding (Star and Griesemer, 1989). In this case, our social world of sustainable design engineers and their world social world of established product designers.

Facilitation Guide

Using the informal facilitation guide, the design intervention included

- A presentation and discussion of the sustainable design strategies cards
- A presentation and discussion of the concepts cards
- A process where the designers could create new solutions based on the cards

The Interventions

We held three design interventions following the same procedure as described above. One with each of the designers from our case studies, and one with Brian Frandsen from the Danish Design Center. We decided that we wanted all of the intervention to have the same content and not change anything because we wanted different their perspectives based on a similar point of departure.

Key-takeaways from the interventions

- Christina already knows about the circular design strategies and expresses that other designers do as well.
- Christina also expresses concern that she doesn't know how to use the strategies.



Illustration 7.1: Design intervention result Christina

- Boris confirms that he knows about the circular design strategies, but points out that it is a question of how well he knows them.
- Boris explicitly asked for a way to see the circular design strategies exemplified.
- Both Christina and Boris are in the opinion that they have a good understanding of the end-users of their products, and are already practising user involvement in their design.
- Boris continues to show reluctance towards the solutions where he, as a designer, needs to learn "engineering" skills and has a hard time seeing his own role using these strategies.
- Christina and Brain both pointed towards a solution that included a prioritized list of the circular strategies.
- Brian instantly discarded all concepts in which the designers role did not include learning about sustainable design strategies.



Illustration 7.2: Design intervention result: Brian

Key-quotes from the design intervention

Christina:

"Men det er lidt ligesom når du ser nogen danse på et dansegulv. Professionelle dansere ik?. og det ser pisse nemt ud, og de smiler. (HA: Selvom, de er ved at dø indvendigt...), og det er pisse svært. men det er et spændende kort." [Attachment and trust]

"Vi skal både lave genanvendelige ting og vi skal lave noget helt om igen. men man kan sige begge veje skal man jo gå ad."

"... den kedel den skal være så hammer fedt designet så man kan holde ud at se på den i 20år..."

Boris:

"Man skal bare smører ærmerne op og gå i gang"

"Som designer, hvis der er noget jeg ikke ved, så finder jeg en der kan fortælle mig det"

" Som designer er man i vold af tilfælde bekendskaber ... rygter eller meninger"

" Skal i lave et konkret eksempel, såsom et eksisterende produkt? Hvordan det kunne have været, hvis man havde anvendt de her strategier?"

"Hvis det hele var sådan, så behøver vi ikke designeren" [When talking about the engineering acspect of the solutions]

Brian:

[When speaking about a prioritized list of the Design Approaches] "Alle designere i kommer ud til vil, ihvertfald hvis de er nogenlunde sane i forhold til hvad der sker i verden, sige det vil jeg også gerne være en del af" " "Det her det er ligesom niveau 1" [In a potential solution]

"Jeg ked af de her og den her [Points at the "out-sourcing"-cards] Jeg tror ikke på vi opnår noget af det vi gerne vil opnå her, hvis vi siger 'Designers opgave er at sætte form' på noget pre-definerede ideer om hvad bæredygtighed er, for det er faktisk designere der kan lave det her på en måde hvor det bliver en hel løsning." [When talking about the solution where the designers keeps their role as it is now]

SELECTION OF FINAL SOLUTION CONCEPT

Based on the discussion and the solutions generated in the intervention, we decided to go forward with a framework for working on different levels of impact. We decided to go with a three-tier solution that would gradually introduce the designers to design strategies for operating on the different levels of potential sustainable impact, which we have included in the design specification. Each of the tiers is built up by the ideas from the solution concepts we presented in the catalogue and a set of design strategies.

1st Level: Circular Products

This level is meant to prepare designers to use product design strategies that will prepare the products to function in more sustainable systems, so they can interface with the higher tiers.

Concepts: Responsible Design Campaign, Further education of the designers. Strategies: The circular design strategies.

2nd Level: Understanding the Use-Environment

This level is meant to help designers understand how to include the end-users in their design process, so they can create products to further the well-being of their recipients.

Concepts: Further education of the designers, Persona Panel as case examples. Strategies: Stakeholder & User Tests, Stakeholder & User Involvement, Practice-Oriented Design, User Observation.

3rd Level: Products in systems

This level is meant to teach the designer how to include the systems; their products are a part of, in their design.

Concepts: 5. Further education of the designers, new business model. Strategies: Lifecycle, Material Flow.

This final solution will be refined and detailed in the following chapter.



Illustration 7.3: Selection of Final Solution Concept

CHAPTER 8 SUSTAINABLE THINKING

This chapter presents our final solution. Sustainable Thinking is a three-level learning plan for product designers. It is meant to elevate the designers from product innovation level to the product service system, and socio-technical level of innovation and potential sustainable impact.



Illustration 8.1: The conceptualization of our final solution, "Sustinable Thinking"

LEVEL 1: CIRCULAR PRODUCTS

The first level is the product innovation level as presented by Ceschin (2016) this is the level we see the designers are at now (Ceschin, 2016). Here we offer the designers ways to design products that interface with circular systems and business models. The first level serves as a gateway to the rest of the model, as the designers already have some familiarity with the learning content.

Primary Learning Objective: How to use Circular Design Strategies.

LEVEL 2: PRACTICE ORIENTATED DE-SIGN

Understanding the potential sustainable impacts of the Use-Phase is essential when

designing for sustainability, the second level of the model is focusing on the products use-environment. The designers must understand the practice their product function in if they want to design solutions that avoid unsustainable behavior.

Primary Learning Objective: How to use Practice Orientated Design.

LEVEL 3: CIRCULAR BUSINESS MODELS

This level offers the designers an approach to higher levels of sustainable impact. Here we would like to offer the designers some tools that enable them to interact with the product service system level or the socio-technical level.

Primary Learning Objective: How to design Circular Business Models.

CIRCULAR PROD-UCTS

In this project, we will only go into depth with the first level. We choose to do so because these tools are crucial in order for the design solutions til interact with the "higher" levels. The designers need to be able to interact with some of the levels with a higher level of potential sustainability. This solution and especially the first level is critical for this transition. The first level is all about taking what we know about the designers ways of working and combining it with our knowledge about sustainability, through already tested and applied design strategies. These strategies have been tested with the designers and then modified to fit into the designers' practices and understanding of the terms. The first level is a refined and modified version of the "circular design strategies" found in the Bakker et al. (2014).

The Circular Design Strategies as prioritized steps To provide the designers with a tangible way to interact with the strategies. We have constructed the strategies into a prioritized order:

- DESIGN FOR ATTACHMENT AND TRUST
- DESIGN FOR DURABILITY
- DESIGN FOR EASE OF MAINTENANCE
 AND REPAIR
- DESIGN FOR DIS- AND REASSEMBLY
- DESIGN FOR STANDARDIZATION AND COMPATIBILITY
- DESIGN FOR UPGRADABILITY AND ADAPTABILITY

It is crucial here to notice that the list starts at a point where we already see the designers as experts. The second point "Durability" have after the interview been modified so that it is not "durability" that is the end goal but rather a better understanding of the durability seen in the context of the expected life-span of the product. The goal is not to force changes into the designs but rather to offer the designers with a creative challenge of considering a possible solution for each of the steps. Thus, we see the steps as design challenges. Here we have formulated some questions the designers can think about, in the more unfamiliar steps.

Design for Ease of Maintenance and Repair

- How can the user get the product repaired if it breaks?
- Will you need any spare parts to repair essential parts of the product?
- Does the product need maintenance it entire expected product life?

Design for Dis- and reassembly

- How will the product be disassembled and be sorted when it gets disposed of?
- Is there any permanent closing between materials, if so how could we get avoid them?
- How can you open the product, access the most critical component, and close the product again, withing harming its look and feel?

Design for Standardization and Compatibility

- Is there an industry standard for any of the products functional components, and could the product be adapted to follow them?
- If the product is part of a collection, could the product line then share some of their components?
Design for Upgradability and Adaptability

• What happens when new technology hits the product's market?

4 EXAMPLES

In the next section, we will present four examples of how Circular Products could function in a "real-life"-scenario. The examples are based on products from the design portfolio of the two design studios presented in the case descriptions. The products are then being redesigned for circularity, as it is intended with the solution. Not all the steps have been used in each example; only the ones that made sense for the given product. However, all of the steps have been taken into consideration.

These examples functions as a prototype of displaying the solution in practice. The examples are also a prototype for a piece of learning material. Other types of learning material, such as instructional videos, or posters, could be tested. For now, we are keeping it as simple as possible, and only trying one type of learning material.



KÜLLA BY HALSKOV & DALSGAARD

KÜLLA is a lamp designed by H&D for IKEA. The lamp is made from very durable metal lamp-shade, metal stand, LED-bulb, and a dimmer switch. Researching on the product online we found out that the dimmer mechanism on the KÜLLA would quickly break. Sometimes after only 6 months. The dimmer mechanism is made out of a switch and the dimmer electronics located in the base of the lamp.



STEP

DURABILITY

REPAIR & MAINTENANCE

The lamp is known online for its faulty dimmer mechanism. Either it breaks or it is simply unstable and "has its own life". This is a problem because the overall design of the lamp is a very durable metal design. We suggest that the dimmer compartment would be taken out of the lamp design so it would be easier to repair. In this way the switch and the electronics in the same compartment.

STANDARDIZATION & COMPATIBILITY + UPGRADABILITY

The lamp is already designed for dis- & reassembly. The rod, the shade, the bulb, and the base can all be taken apart. This makes it possible to upgrade and change the lamp. The shade could be used together with other lamp-systems. The lamp could be upgraded by adding more rod to make it taller or smaller. And by using standard fittings for the bulbs new LEDbulbs can be added to the lamp as the development of LED-bulbs continues to improve.

2



new dimmer compartment

GUBIII BY BORIS BERLIN

The Gubi II is a chair made in two-layered polyester fibers. The polyester is extracted from recycled plastic bottles and transformed into a felt-like material. In one process the two sides of the chair are molded around the steel frame. We do not see the durability as an issue because the chair is designed to last for a very long time, both for the eye and for the strength of the materials.





REPAIR & MAINTENANCE

Due to the fact that the chair is made into one single piece and the user (or any other person for that matter) cannot take it apart without breaking the chair. Thus, it is really difficult for the user to maintain or repair the chair in a non-complicated manner. We think that allowing the user to disassemble the chair would improve the chairs life-span or at least its ability to be more "circular".



DIS-ASEMPLED VERSION

DIFFERENT MATERIALS OR COLORS



STANDARDIZATION & COMPATIBILITY + UPGRADABILITY

Being able to take the chair apart would also allow the design to compatible the standardized waste system. This would also make it possible to even change the seat to new colors or even another material, such as wood.

PENOL PEN BY BORIS BERLIN The Penol Pen is made of an aluminum casing with plastic parts. Our concern with this product is that the life-span of this product is determined by the ink or maybe THE ORRIGINAL PRODUCT the tip of the pen. We want to offer a new take on this product using the step from our solution. We do not see the durability or dis- and reassembly as a problem, so these steps will be skipped. STEP **1**... **REPAIR &** NEW TIP FOR REPLACING MAINTENANCE A WORN DOWN TIP

The most of the maintenance of this type of pen is rooted in the use of ink and the wear and tear of the tip of the pen. If the pen cannot write in a manner that fulfills the needs of the users, they will throw it our and buy a new one. We surgest that if would be a good idea if the users could refill the pen and even change the tip.

INK-CARTRIDGE FOR REFILLING THE PEN

DIFFERENT TYPES OF

"BRUSHES

This would also increase the possibility of more changes. One could create a standardized pen that the writing tip could be adapted to. In addition, one could develop various types of brushes. Then you could have one pen for multitasking tasks instead of buying and replacing many pens.

STANDARDIZATION &

COMPATIBILITY + UPGRADABILITY

STEP

2



CHAPTER 9 CONCLUSION

In this chapter, we will present our conclusion and perspectivation. In our conclusion, we will answer the questions and problems stated in our introduction. We will sum up the report and present our key-findings. In the perspectivation, we sum up the relevance of our solution. And lastly, give our advice on the next step needed to excel "Sustainable thinking" as a learning framework.

The use of our theoretical framework

During the last couple of months, we have worked in a close participatory process with two prominent product designers. We have used a theoretical framework to steer our work and decision making; a socio-technical systemic understanding to see the designers as part of a bigger transition and showed that the designers indeed should be part of this transition happening within the DfS movement. Through this understanding, we argue how and why we work with product designers. Based on ANT, we have approached the transition and proposed a solution for how we can offer the product designers (product innovation level) a way to interact with the other levels of DfS. Furthermore, we have throughout the whole project used participatory design methods to gain knowledge about the designers, their work processes, and their views on sustainability. This knowledge has been described in two case studies.

The use of case studies

The use of case studies has had a significant influenced the way we have approached this project.

To establish who we are designing for two case studies have been developed. The case studies are based on the designers, we have been able to enrol as collaborators in our project. While these cases are limited, they represent two vastly different approaches to product design.

The case studies are based on a series of interventions with the different actors; semi-structured interviews, design games, and informal conversation. In these interventions, we have looked into; the way they work with collaborators, the range of products the designers work with, their approach to designing, and their understanding of sustainability. These case studies are the result of our research on product designers. We have used the cases to present a concrete example of our work, and these examples have then been used to lay the foundation of our research, discussion, and our final design process.

Sustainability in product design

Through the research of various views of both product design as a profession, the Science of Design, and sustainability. We have synthesized a definition of what sustainability is within the domain of product design. Based on this definition, we have created a framework for including sustainability in product design, and though this framework, we have explored and defined how designers can create value while taking responsibility.

To understand the role of product designers in relation to sustainability, we use our findings from the case studies and, in contrast to the current research on design practices and sustainability, we identified how the role of the designers, in this transition, could be. This corresponds to the result of our discussion and analysis, which shows an understanding of how we can bridge the gap between the different levels in the DfS movement.

Implementing sustainable product design practices

We have proposed a set of potential solutions. These solutions are the results of our analysis of the case studies. The alternative solutions have been presented both in this report and for the designers. The solutions have been synthesized based on both qualitative empirical data from our participatory process and research grounded in the theories and knowledge of sustainable design engineering and cover topics such as; designing for circular business models, the UN's SDG, and practice-orientated design.

The synthesis establishes requirements for a

set of learning objectives. The objectives then turned into tools for design. Lastly, we have presented a final solution, "Sustainable Thinking". Sustainable Thinking is a further conceptualization of the prior concepts, based on our results from design interventions. Lastly, we have given four examples of how this solution could influence product designs made by the designers from the case studies.

PERSPECTIVATION

We believe that this solution is a step in the right direction. We can not stress enough that we need to get these designers to interact with the other levels of potential impact. The product designers need a more systemic understanding, and pushing this transition starts by getting them to include sustainability in their product design practices. We need designers who can understand user-practices to create new products with inscribed new and more sustainable practices. The designers are calling out, asking for tools and knowledge. They want to be part of this transition, they want to change the way they work or think.

The Future

However, we are not there yet. We need to continue this work and start to implement our solution, one step at the time. Our next step is to go out and test our final solution again, refining it. When the answer is ready, we should then start to implement it. First of all, we need to create instructional material for the designers we have worked with in this project. We would also propose to keep refining the other steps of the solution and figure out how to do it in practice. Figuring out how to construct level 2 and 3 of Sustainable Thinking is the next step in our effort to push product designers towards working with higher levels of sustainable impact. And then, we will look for ways to enrol more designers in Sustainable Thinking so they can join in the transition towards Design for Sustainability.

R E F E R E N C E S :

Achten, H. H. (2008). Design processes: Between academic and practice views. In Design processes: What architects & industrial designers can teach others about managing the design process, Delft University Press, 14-27,

Bakker, C., den Hollander, M., Van Hinte, E., & Zljlstra, Y. (2014). Products that last: Product design for circular business models. TU Delft Library.

Brandt, E. (2006). Designing exploratory design games: a framework for participation in participatory design?. In Proceedings of the ninth conference on Participatory design: Expanding boundaries in design-Volume 1 (pp. 57-66). ACM.

Brandt, E., Messeter, J. & Binder, T. (2008) Formatting design dialogues – games and participation, CoDesign, 4:1, 51-64, DOI: 10.1080/15710880801905724

Brundtland, G. H., Khalid, M., Agnelli, S., & Al-Athel, S. (1987). Our common future. New York.

Bryman, A. (2016). Social research methods. Oxford University Press.

Callon, M. (1986) 'Some Elements of a Sociology of Translation-Domestication of the Scallops and the Fishermen of St-Brieuc Bay', Power, Action and Belief: A New Sociology of Knowledge?, pp. 196–223.

Ceschin, F., & Gaziulusoy, I. (2016). Evolution of design for sustainability: From product design to design for system innovations and transitions. Design studies, 47, 118-163. Charter, M. (Ed.). (2018). Designing for the Circular Economy. Routledge, 1-11.

Cross, N. (2001). Designerly ways of knowing: Design discipline versus design science. Design issues, 17(3), 49-55.

Cross, N., & Roy, R. (1989). Engineering design methods (Vol. 4). New York: Wiley.

Czarniawska, B. (2014). Social science research: From field to desk. Sage.

Design Council, 2007. A study of the design process. UK Design Council, 44, 1-144.

Ehn, P., & Bannon, L. J. (2012). Design: design matters in Participatory Design. In Routledge international handbook of participatory design (pp. 57-83). Routledge.

Ehrenfeld, J. R. (2009). Sustainability by design: A subversive strategy for transforming our consumer culture. Yale University Press.

Flyvbjerg, B. (2006). Five misunderstandings about case-study research. Qualitative Inquiry, 12(2), 219-245.

Gregersen (2019). A PRAGMATIC VIEW ON THE 'CLASSIC' DESIGN APPROACH. Unreleashed internship report. Available on request.

Geels, F. W. (2004). From sectoral systems of innovation to socio-technical systems: Insights about dynamics and change from sociology and institutional theory. Research Policy, 33(6-7), 897-920. Kirchherr, J., Reike, D., & Hekkert, M. (2017). Conceptualizing the circular economy: An analysis of 114 definitions. Resources, Conservation and Recycling, 127, 221-232.

Kuhlman, T., & Farrington, J. (2010). What is sustainability?. Sustainability, 2(11), 3436-3448.

Lawson, B. (2006). How designers think 4th edition. Routledge.

Merriam, S. B. (1988). Case study research in education: A qualitative approach. Jossey-Bass.

Merriam, S. B. (1988). Case study research in education: A qualitative approach. Jossey-Bass.

Robertson, T., & Simonsen, J. (2012). Participatory Design: an introduction. In Routledge international handbook of participatory design (pp. 21-38). Routledge.

Rowley, J. (2002). Using case studies in research. Management research news, 25(1), 16-27.

Schön D. (2016), The Reflective Practitioner: How Professionals Think in Action, Routledge, 76-104

Simon H. A (1996), The Sciences of the Artificial (111-138), Cambridge, MA: MIT Press.

Sismondo, S. (2010). An introduction to science and technology studies (Vol. 1). Chichester: Wiley-Blackwell. 1-11, 57-71, 81-92 Smith, A., Stirling, A., & Berkhout, F. (2005). The governance of sustainable socio-technical transitions. Research Policy, 34(10), 1491-1510.

Spinuzzi, C. (2005). The methodology of participatory design. Technical Communication, 52(2), 163-174.

Spradley, J. P. (1979). The ethnographic interview. Waveland Press.

Star, S. L., & Griesemer, J. R. (1989). Institutional ecology, translations' and boundary objects: Amateurs and professionals in Berkeley's Museum of Vertebrate Zoology, 1907-39. Social studies of science, 19(3), 387-420.

Storni, C. (2015). Notes on ANT for designers: ontological, methodological and epistemological turn in collaborative design. CoDesign, 11(3-4), 166-178.

Vaajakallio, K., & Mattelmäki, T. (2014). Design games in codesign: as a tool, a mindset and a structure. CoDesign, 10(1), 63-77.