Interactive Textile Library

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Final Master Project Proposal

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VISION

Figure 1. *Pieces from Elephantasia collection for By-wire.net, Utrecht 2016*

Over the course of my academic career I increasingly became more interested in the fabrication and implementation of electronics in textiles and its implementation in design projects. Initially, this domain was sparked by my interest in fashion, consequently by doing an internship at by-wire.net, a fashion / technology company, I learned that there is a market for intelligent textiles. This demand is generated by both technology focused companies and fashion focused companies. After attending Fabricademy hosted by The Waag Society I realised that most of the electronic textiles presented today are very experimental, low fidelity, and therefore failed to communicate its value to design companies. I decided to do an internship at Mercedes-Benz to be able to create a better understanding on how the development of new technologies within the car interior is handled, specifically in its soft (textile) materials. This experience reinforced the previous statement of companies not being able to implement the intelligent textiles because of their immature development state or for them to have a too "artsy" appeal. An (indirect) result is that they're inclined to look for screen based interface innovations.

This all together allowed me to establish a vision and purpose as a designer. I envision a future where interactive textiles will allow for seamless interaction with interfaces in our environment, such as car interiors and furniture, and to provide the opportunity to bring them closer to our bodies, in the case of fashion. In this final master project (FMP) I would like to bring interactive textiles closer to designers in the form of high fidelity samples, for them to be able to understand and use this new type of interactive material in their work, eventually bringing it closer to us in our everyday lives.

Figure 2. *Interactive Textile Breeze for Interactive materiality from TU/e, Eindhoven 2019*

Figure 3. *Digital Craftsmanshipcollection for Textile Academy, Eindhoven 2018.*

IDENTITY

Figure 4. *Bio-dying yarn for Textile Academy, Amsterdam 2017*

Figure 5. *Laser cutting textile butterflies for Textile Academy Amsterdam 2018*

Figure 6. *3D printing on textile for design project TU/e Eindhoven 2018*

To be able to execute my vision I have to be able to work with textiles as well as creating (with) them. At first, I was most interested in incorporating interactive textiles within garments. During my internship at by-wire.net I helped fabricating electronics into garments as well as creating a mini-collection. During this time I learned what it entails to create a collection of garments as well as how to construct them. To gain more professional skills I attended the class Sewing Techniques elective at the HKU fashion design department. After completing my bachelor Industrial design I wanted to combine the more traditional fabrication methods with digital fabrication methods and therefore I attended Fabricademy. Here I learned how to combine traditional fabrication methods with more innovative fabrication methods using, among other things, the laser cutter, Adobe Illustrator and grasshopper. I further developed my fabrication skill during my master using 3D printing as a visual communication medium and to support textile shape changes.

An interesting concept used within the field of interaction design is using aesthetics as a means for communication in terms of interaction (Ross, et al., 2010). Rather than seeing aesthetics and interaction as two different fields, we can look at them as two co-dependent aspects of design (Petersen, et al., 2004). Aesthetics is an initiation tool, to attract the user to interact with the material in a specific way, as well as a way to provide feedback to the user. I get inspired by different aesthetic philosophical theories such as Anthony, Earl of Shaftesbury, which I believe to be one of the firsts who would link beauty with functionality and purpose, who together with, Plato, who vouched to distinguish between replication (or interpretation) and innovation, perhaps defined what we call design today. During my bachelor and master I have followed elective such as The Art of Design, Basic Form Giving Skills and Interactive Materiality to further understand how aesthetics can impact interactivity and ones perception. In case of my FMP, I will be aiming to use aesthetics for this very purpose.

To be able to execute the fabrication of interactive textiles it is also important to understand and to gain skills within the electronics domain. Throughout my bachelor Industrial design I acquired knowledge regarding the construction of electronic circuits in projects and electives such as Creative Electronics. During my current project I am carrying out research regarding different technologies that can allow for conductivity and shape changes in textiles for wearables. In my previous project, I used conductive fabrics to create a composite leather sensor. By continuously using technology to enhance textiles I've been able to detect possibilities for it to be more integrated into the textile for rich interactions. An example of this is Breeze, a project executed within the elective Interactive Materiality. In this project I used electronics, 3D printing and textiles to create an interactive textile surface. This surface was able to show its breathing rhythm, but as you started to approach it it would try to create a deeper connection by revealing its heartbeat.

I continuously seek to improve my skills within different domains that allow to create meaningful interactive textile experiences. This skill set is my identity, at the same time, my identity is continuously evolving and with it I gain more and more specialized skills. This Final Master project will allow me to bring everything I learned together to get a step closer to fulfilling my Vision.

INTRODUCTION

Figure 7. *Textile shape change exploration for By-wire.net, Utrecht 2016*

This final master project aims to create an interactive textile library for the company Handmade, my current internship company. This library provides samples that will allow Handmade to incorporate and further develop interactive textiles in their own projects.

Since the beginning of the technological era we are finding ways to integrate technology into our surroundings, interweaving it with our everyday lives. These new technologies allowed for human input to then automatically carry out some predetermined functions, creating what we know now as interfaces. Starting from analogue input, buttons, rotation knobs, sliders, etc., to digital screens that merely required touch and gestures. With the developments in the twenty-first century we are slowly finding ourselves surrounded by more and more digital screens. Screens allow for a lot of information to be shown at once and it allows for efficient communication, a downside of this technology is that we are slowly becoming less in touch with our other senses while overloading our visual sense (Rideout, 2010). There are different developments in the field of design and engineering that are starting to allow for richer interfaces that use multiple senses. An example of this is the fact that sound design is becoming increasingly important as well as haptic feedback, which are being integrated within screen based interfaces more frequently. Because of my experience with textile and fashion design I see an opportunity to integrate interfaces within the soft surfaces we encounter in our everyday lives, these textiles will be able to provide information as well as intuitive haptic experiences.

The main area that has been most interested in using smart textiles is the fashion industry. The making of smart wearable textiles has been in constant development since approximately 1997, starting with the exploration of a touch pad sewn onto clothing (Rekimoto, 2001)(Saponas, 2011). In this initial era, these electronic textiles, or e-textiles, were made out of composite materials, combining regular textiles with conventional electronics adapted to maintain the flexibility of fabrics (Buechley, 2007). From this the industry looked at creating electric circuits on textiles to be able to add more sensors and to carry data across the textiles. An example of this is e-broidery, which uses conductive threat to embroider the circuit onto textile to then add components onto the circuit (Post, 2000)(Buechley, 2013). More recently, researchers have started to look at ways which would allow the technology to be more integrated within the textiles, using for example; conductive yarns (Van Langenhove, 2007), thermochromic ink, Shape memory alloys (Castano,2014) and coatings (Thilagavathi, 2014). My project seeks to further developed these types of technologies in textiles aiming to combine in- and output to create interactive textile interfaces.

I mainly gained insight into how designers use smart textiles into their design processes during my internships. At by-wire.net, clients would have a textile/technology based question which was then resolved and prototyped by Marina Toeters. In the Color and Trim department of Mercedes-Benz suppliers would present materials that the designers then used to design their car interiors. Since interactive textiles are rarely available for production almost no electronic textiles are presented and even less picked out for their designs. At Handmade the designers look for information regarding the fabrication methods of certain textile sensors or actuators to then make and adjust them according to their projects. While this seems like a good and effective approach, there are many different sources that are not very specific and lack the fundamental knowledge about textiles which has an impact on the prototyping efficiency. The main insight that these experiences provided is that there is a need for specific, clear, producible and desirable samples for design companies. These have the potential to support further smart textile developments as well saving a company time and money.

GOAL

The goal is to create a sample library that is composed of interactive (composite) textiles. These textiles be able to translate an input into an output. These in and outputs will be designed using different variations of their:

- *Material Characterizations: Strech, water absorption, fatigue,*
- *Experiential Proporties - Haptic and tactile qualities, perceivable shape changes,*

The sample library will be presented in a physical format as well as in a digital format. To be able to communicate the value of these interactive textile samples I will focus on ensuring a high fidelity that aesthetically and interactively communicates it potential and secondly generating application concepts for different domains.

The application concepts will generated through design cases carried out in collaboration with the company Handmade. These design cases can then be used by Handmade to communicate the potential of interactive textiles to their clients in the respecting domains. The aim is to carry out a total of 5 design cases. In each design case multiple samples are addressed and will mainly focus on the following domains:

- *wearables*
- *Automotive*
- *Furniture and interior design*

The reason for using these domains is that these already use soft materials and textiles as their main material. Therefore imaging an enhanced textile interface is easier.

RELATED WORK

As defined by the paper Phase change materials for smart textiles, an interpretation of smart textiles is when the material shows a "clearly defined reaction as a result of a clearly defined stimulus" (Spillman, et al., 1996). Within my project and the field of design and electronics, we refer to the reaction as the actuator and the stimulus the sensor. Since the definition of interactive also refers to the combination of sensing and activation, "smart-" and "interactive-" will both be used in the context of this project. A differentiation can be made between different smart textiles depending of their level of intelligence. The smart textile made for this project can be placed into the sub category called active smart textiles, which refers to the reactive capability of the material to the stimuli of an integrated sensor (Stoppa, et al., 2014). A way of textile activation can be achieved by the usage of 4D textiles. 4D textiles are defined as textiles that can change shape or function over time (Pei, et al., 2005). These are interesting to consider in this project since they can be made by 3D printing on textile and are highly customisable and adjustable (Schmelzeisen, et al., 2017). This is relevant considering the equipment at my disposal and the aim to connect each sample to multiple domains (such as the automotive and fashion industry). Most research focus either on activation of textiles or soft materials (Franinović, et al., 2019), (Coelho, et al., 2008), (Webb, et al., 2019), (Yao, et al., 2013) or on the sensor technology in textiles or soft materials (Poupyrev, et al., 2016), (Olwal, et al., 2018), (Mattmann, et al., 2008). I aim to create interactive textiles com combining and showing the codependency between three aspects: fibers, sensing, actuation, fabrication techniques, and aesthetics.

There are designers and companies who are showing more specifically integrated smart textile concepts. These are different from my proposal because they often showcase their new technologies in a very artistic manner or still use screens as an output. Examples of these are:

Figure 8. *Jacquard in 2020. Reprinted from*

Google x Levi Jaquard is a Levi's truckers jacket which allows you to manage certain phone functions, such as answering calls, playing music and taking photos, by swiping or tapping your left sleeve. Conductive yarn is woven into the denim and an additional wireless device must be inserted in the sleeve to communicate with one's phone ("Jacquard by Google - Levis®")

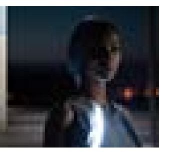

Figure 10. *(lefr)Solar shirt in 2015. Reprinted from paulinevandongen.*

Figure 11. *(right)Phototrope in 2015. Reprinted from paulienrouts.*

Paulien Routs and Plauline van Dongen are both design researchers (that often work together) that uses a science driven approach to design soft materials or fashion garments with new emerging technologies.

Figure 9. *Iridescence in 2019. Reprinted from Behnazfarahi.*

Behnaz Farahi is a designer that uses technology in her work. She uses fashion, architecture and interaction design to create statement pieces.

Figure 12. *3D printed hairin 2016. Reprinted from DesignAward.*

Jfei Ou with MIT developed a printable fine hair structure. This structure is completely programmable using their own software and machine. They created this technique and are now exploring the material's capabilities and possibilities. (Ou, et al., 2016). In contrary to my project where I will start do design from what material properties and behavior it should have and then determining how it would be best to fabricate this.

Looking at the current scope we can find other similar formats. Similar in the way that they present an online platform where the fabrication methods as well as the final output of an interactive material is presented. Yet different because most do not focus on textile as their sole medium or/and different because the presented output is of a low fidelity and lastly it is different because it does not directly link design propositions to the created samples. Though the main difference is that I will be creating and curating the sample library with and for the company Handmade. This way the library presents focused value and is more likely to be incorporated into their future design developments.

Figure 13. *Web interface MorphUI. Reprinted from MorphUI.*

MorphUI *is a platform that collects papers about Human Computer Interaction and Material Science and classifies them into different subcategories for people, to promote the collaboration between the two fields and easy access for further developments.*

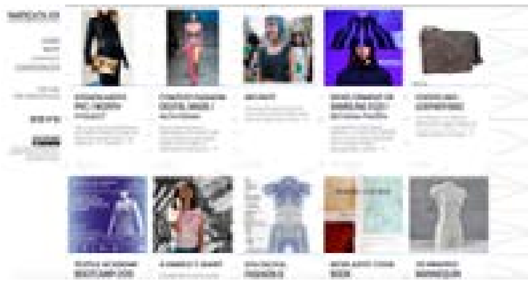

Figure 13. *Web interface Materiability. Reprinted from Materiability.*

Materiability *is a research group that publishes their research, new materials and tutorials. Their purpose is to stimulate a common language and communication flow between the scientific and creative field.*

Figure 14. *Web interface How to get what you want. Reprinted from Kobakant.*

Kobakant *is a platform that publishes wearable technology experiments, often with textiles, and shares the production methods as a basis for further developments and contributions.*

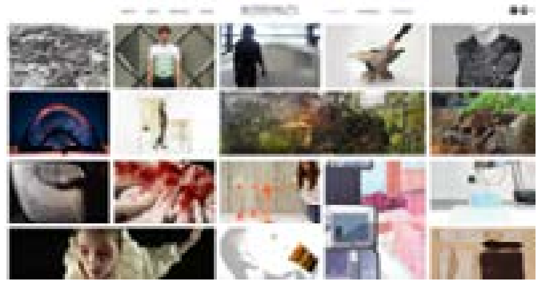

Figure 15. *Web interface Fab Textiles. Reprinted from Fab Textiles.*

Fab Textiles *is an open source platform that strives to innovate the fashion industry by sharing alternative production methods and new techniques.*

APPROACH

The project can be divided into four main stages, of which some will run simultaneously. The main project goal is to produce interactive textile samples for the library. For this library to be focused and meaningful first a detailed curation of the interactions and technologies used is necessary.

THE CURATION

Together with Handmade I will answer a few questions to determine the scope of the library. The aim for the curation session, next to answering the questions below, is to determine a set of success criteria to later evaluate the outcome.

What is the (future) vision of Handmade?
What values do we want to communicate though the interactive textiles?
What (new) technologies are showing to be promising for these type of interfaces?
What type information do we want to provide as an outcome of the interactive textile?
What interactions with the material would we want to carry out?

SAMPLE PRODUCTION

The production of the samples will happen over the course of two months. Different facilities are aimed to be used depending on the nature of the textile that needs to be produced, such as the TU/e materiality lab and Handmade's office. The exact nature of the process creating these interactive sample will become more evident after the curation.

THE EVALUATION

We will use the criteria formulated during the curation session to access whether the interactive textiles fulfil its purpose. I will carry out this evaluation session first alone, then together with Hannah Koch and Handmade.

SAMPLE LIBRARY

Lastly, a physical and digital interactive textile library will be designed and producesd simultaneous with the production of the samples. A physical box will be designed and made to allow the client to experience and interact with the textiles. A digital library will be made and will contain more detailed material characterisation descriptions. In order to provide the right information for producers I will collaborate with Hannah Koch.

DELIVERABLES

The deliverable will consist of a set of approximately 30 samples. These samples are textiles with technology that allows sensing or actuation, for example shape-memory alloys, conductive fibres, thermo coatings, etc). These interactive textiles will be delivered in three ways:

Figure 17. *Moodboard for physical sample box. Reprinted from Pinterest.*

Sample box, with the aim to physically interact and experience the materials. Basic technical information will be provided through an additional card accompanying each sample.

Figure 18. *Moodboard for digital sample box. Reprinted from Pinterest.*

A web based sample library containing photos and videos of the sample. This platform will aim to provide additional in depth mechanical characterization and the sample's construction process.

"The best way to predict the future is to create it"

— ALAN KAY —

CLIENTS AND EXPERTS

There will be different parties involved in this FMP project. The main purpose of these clients and experts is to connect the production developments and technical capabilities of interactive textiles with the design industry more closely.

The client of this project is Handmade. Handmade is a product invention lab who work closely with big corporations to invent, develop and prove new concepts. Together we will be curating what type of interactions and what application domains we want to design for. An important criteria for me to realise my FMP is to value the physical samples to the same degree as the digital representation of the samples, since Handmade provides digital as well as physical prototypes to their clients, I believe that they share a similar value and appreciation towards the tangibility of design concepts.

The expert who will collaborate on this project is Hannah Koch of RWTH Aachen. She is a researcher, designer and coach, her expertise is fabrication of adaptive textiles and 4D materials ("Hannah Koch", n.d,). She is relevant to this FMP becaus she can provide knowledge regarding the technicalities of the textile production methods ensuring the feasibility and quality of production of each sample, as well as the documentation that is necessary when communicating with production industry.

The second expert on this project will be Miguel Bruns, who is an associate professor of the Future Everyday research group at the TU/e. His expertise are Interactive Materials focusing on haptic and shape-changing interfaces (source). He will mentor me during entire course of the project to ensure that both the industry (in this case Handmade) and Universities (though a paper and collaboration with the RWTH Aachen) will benefit from this project.

1ST ITERATION

I started this first iteration aiming to better understand where and how there are opportunities to sense input and where and how actuation can take place in textiles. Starting by researching the different components and structures that make up a textile I found that it is defined as anything that is made from fibrous materials. This includes fabrics and any material that is constructed though knitting, braiding or other fabrication methods (Castano, et al., 2014). As said by Lomov et al."Fabrics are hierarchically structured fibrous materials"(Lomov, et al., 2001), meaning that there are different levels that eventually construct a textile. Fibers are interlaced to form thread, which get twisted to form yarn. Yarn turns into fabric when using different techniques depending on whether we are creating a woven or a non-woven. Woven materials make use of techniques such as braiding and weaving (Castano, et al., 2014), while non-woven material use techniques such as adhesive bonding, thermal bonding or the compression of yarns (Dubrovski, et al, 2005). Finally when combining different fabrics we get composites. The nature of the fibers used to construct a fabric determines a lot of its characteristics such as water absorption (Gioello, 1982). Yet other features, such as flexibility, can also depend on the construction technique used to fabricate the fabric, for example through knitting. To better understand what a fabric is constituted of and where there are opportunities for the integration of sensing and/or actuating I created an overview (see figure x). In addition to the previously mentioned levels I added two additional layers that consider coatings and other structures, such as 3D printing or screen printing, as part of the fabrication process. The next step is to generate an overview that shows in more detail different fibers, yarns, fabric structures, etc. An application, other than the initial aim, could be using such an overview in the textile library box and platform to communicate the fabrics' composition to designers and producers.

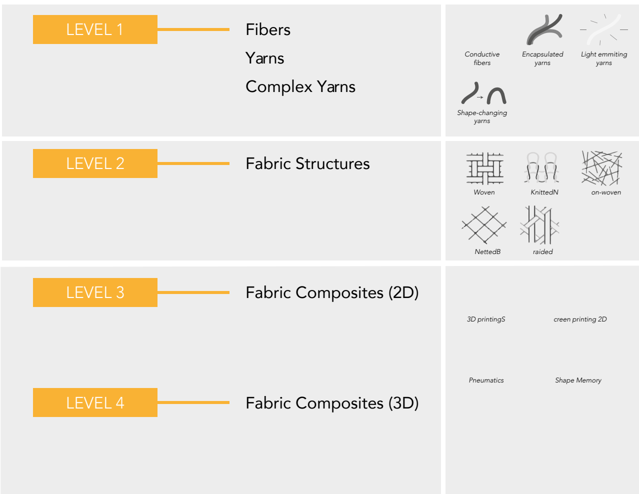

Figure 18. *Overview textile construction layers.*
Note: Adapted from Smart fabric sensors and e-textile technologies by Castano & Flatau, 2014, p. 2

Next I created a set of guidelines that I will follow throughout the final master project:

Color of textile samples:

The colour of all samples will be white and alternatively black, to not only avoid bias but also because the human eye sees sharper defined edges and detail in white (or absence of white in the case of black.

Figure 19. *White textile structures example. Reprinted from Pinterest.*

Size of textile samples:

To be able to demonstrate intentions and functionalities throughout the project they will all be made the same size to minimize the bias during evaluation. All samples will be squares of 20x20 cm, in case this requirement cannot be met due to technical or fabrication constraints they will be realized in 10x10 cm.

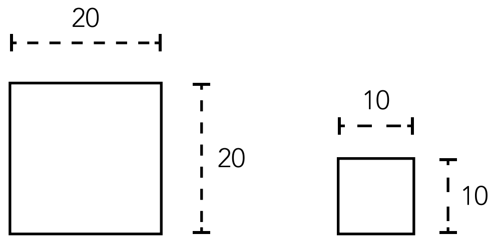

Figure 20. *Sizes of samples.*

Video:

To show the interactive features of each sample a high quality video will be made and placed adequately on the digital library. This video must be able to communicate all interactive features of the textile. To ensure each video does, they will be shown and assessed by an independent party before uploading.

Pictures:

To maintain consistency throughout the documentation of the different textile samples, each sample will be photographed from four different perspectives: textile close up, front view, over head angle and 3/4 angle. Additional photographs may be taken and shown always following the previous perspectives.

PLANNING

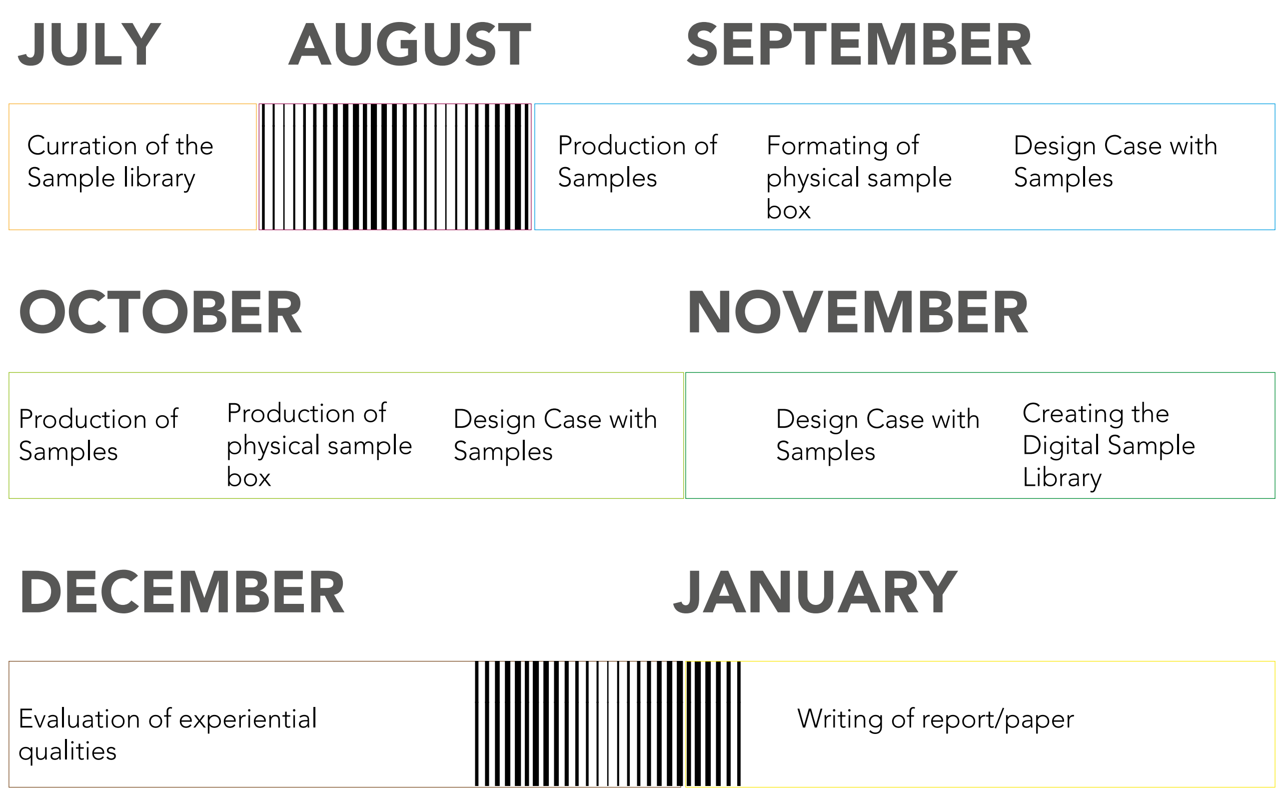

Figure 21. *Planning.*

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Thank you.