

Master thesis

“Non verbal expression of emotions through  
desirable Techno-Fashion”

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Hugo Out

JASNAROK

# “Non verbal expression of emotions through desirable Techno-Fashion”

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Hugo Out  
4208196

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# Preface

Welcome to my master thesis, in which I present my graduation project. The project is part of the master discipline "Design for Interaction", faculty of Industrial Design Engineering at the University of Technology in Delft.

This project is done in collaboration with Jasna Rok. I feel proud to be associated with Jasna Rok, as I consider the company to be a strong player in the area called Techno-Fashion.

A number of different disciplines are part of this master thesis. First and foremost there is Interaction Design, but also the design method Vision in Product Design, Fashion Design, prototyping, programming, electronics, context mapping, visual presentation and many more.

The main driver behind this project is to make a statement in opposition to the modern day fashion industry. With this project, I wish to offer a new phenomenon and present a new view on this industry, to surprise people with an innovative product, and that could be part of a countermovement to the way we interact with the fashion industry right now.

I hope you enjoy reading this design report, and that it will inspire you to look differently to the impact clothing has on you, society and the industry.

I would like to take the opportunity to thank a few people without whom I couldn't have successfully completed the project. First of all the board from the TU Delft, Prof. Dr. ir. Kaspar Jansen and Erik Jepma, who have been a great support and guidance to my project and my personal approach. Also the team from Jasna Rok, Jasna Rokegem, but foremost Tom Demuynck, who joined me every single week to make sure I stayed on track with my approach to Techno-Fashion, helping me with programming and staying inspired.

The team from the Applied Labs, and in particular Martin Verwaal, who helped me day in day out with prototyping my vision and provided the technical support of the dress. I also want to thank Linda from the Applied Labs staff, who helped me with her expertise in designing and tailoring garments, and with her interest in wearable lighting elements.

Im also thankful for the team from the PMB, the workshop of the IDE faculty, for their great expertise and smart suggestions on ways of prototyping my vision.

Finally, all my friends, family and people who took part of the interviews and testing sessions, gave me feedback, showed great interest in the subject and in the project itself, inspired me and who helped me in taking my project to the next level. In particular i would like to thank Alex Santos Lima for the great pictures, Huub Verburg for the production of the video, Danial Sadeghi for the music and Lieke Venema for being the model.

Enjoy!

# Abstract

The project starts with finding a valid implementation of Techno-Fashion based on our current clothing expressive behaviour. Using emotions as one of the main drivers, the goal was to design a desirable Techno-Fashion garment that non verbally expresses the emotions of the wearer. The long term goal is to create a deeper connection between the garment and it's wearer, to initiate a more sustainable approach to using fashion.

## The design context

With the use of the design method 'Vision in Product design', a design context is found, and is used to give a credible design direction. By searching for context factors in the domain of "the expression of body language and emotions through garments and lifestyle", factors are found, like "technology enables us to present the self that we want to be" (Turkle, 2012) and "clothing concerns all of the human person" (Commandeur & in 't Hout, 2019). These factors are combined into clusters, where the clusters show certain relationships with each other. These relationships show phenomenon happening in the world, all together presenting a worldview storyline.

This storyline is something that is happening in the world right now, and shows phenomenon like a large psychological value in expressing yourself, but we are socially presenting and reflecting ourselves online, i.e. not person-person. This creates mental health issues, as social expression, person-to-person, offline, is one of the fundamental needs of humanity (Waldinger, 2015). But there are fewer restrictions for what we are allowed to express socially and culturally.

That storyline evolves in a future worldview context, in which the designer presents his vision of a context that results from the phenomenon of the current world. The future worldview context shows a world in which garments with integrated technology assists the wearers in expressing themselves socially, offline. The technology can also monitor issues like the mental state, and the clothing can be dynamically expressive and in this way give comfort in expressing style. It helps and increases one's sense of value in interacting with others. This is the context in which the design will find its implementation.

User research interviews provide insights such as the wish for an outfit that can change according to the mood of the wearer, and, together with an emotion behaviour research, shows desirable expressive emotions like joy, confidence and relaxation.

All these elements are part of the design context, and are presented in the design vision (page 34). What is possible to be achieved in the context of this graduation project is presented in the project goal (page 36).

# The design phase

The future worldview context, the design vision and the project goal show guidelines about what needs to be designed and why. The project goal promises a technology integrated garment that is dynamic in its expression, to be able to let the user express different amounts of the emotions Joy (happy) and calm (confidence and relaxation). As first steps in the design process, visual elements are explored to find design characteristics that represent the two emotion groups. These visual elements are part of the dynamic expression the garment should provide. It was found that the visual emotions present a separation of expressions: calm calls for subtleness and joy for expressiveness. That division of expressions are used to explain the dynamic expression of the garment. Also, animal expressions were used as design inspiration, and Techno-Fashion benchmarking provides the knowledge of what is technologically possible, and inspire the technical aspects of the garment.

To show first designs of dynamically changing visual elements, three form principle concepts are designed and created. The concepts present elements that can change expression between subtle and expressive to be integrated into a garment. The first concept presents a set of light emitting fiber optic wires that can change its pattern and colors. The second concept shows an silicon dome with supporting LED's that can be blown up with compressed air. The final concept shows a 3D pattern design that can become more or less gradual, also with supporting LED's. Together with dress designs (a dress was chosen as the final garment due to its large canvas and it being a garment that evokes expressiveness), the fiber optic wire concept was chosen to be transformed in a dress prototype.

# The final design

The final design is a dress that can change its expression dynamically, with the use of fiber optics, LED's and other mechanical components. A large prototyping exploration phase went prior to the final design and explored the final design elements. The dynamic expression represents two states: subtle expression and expressive expression. The user is able to chose between the two different states according to his or her desire of expression, which should enable the user to express more comfortably. In this way the user can choose to be less expressive during modest, but informal social environments, but more expressive during environments that are more outgoing, like dancing parties. The design makes use of the first of the above form principle concepts, using fiber optic patterns and LED's that are woven in the dress. Miniature motors are used to reshape the silhouette of the dress, and an electrical circuit and a programmable Arduino controller, that controls the LED's, and lets the user choose the different light and form/silhouette expressions.

Finally, a validation test was organized at Het Nieuwe Cafe in Rotterdam, with a questionnaire that was send after the event to participants. The 28 responses are used to validate the suitability of the dress for a social event, and whether the design characteristics match the perceived emotions. It has been positively received and understood, but a fair amount of people have interesting design suggestions. Also, a professional video and a photoshoot has been organised in order to provide the desired presentation of the concept behind the dress and it's different expressions. Especially the video should help in showing the concept behind the dress, which is creating a statement about a different view on fashion, what is possible with Techno-Fashion and what dynamically expressive clothing can do for the users and the industry.

# Conclusion and future implementation

After validating the design elements of the dress, the characteristics are understood as representing the intended emotions. Moreover, the dress is found to be suitable for a social event like the one that was organized. But, the expressive state aesthetics are found to be a little less appropriate for the moderate social environment, whereas the subtle state is found to be more matching. This has been already shown in the suggested user scenario, so it is well understood. Many suggestions have been made about design iterations, where most of the suggestions talks about the light patterns and the changing silhouette. The light patterns should not change that much from state to state, but the light intensity and hues should show the different levels of expression. Finally, the vibrant shape on the chest part of the dress is said to be a little unfamiliar. The design is suggested to become more vibrant on the bottom half of the dress, being inspired by classic iterations of dresses.

With this project, an example of an integration of fashion and technology that can become more wearable and acceptable is shown. It also shows a way of creating a deeper connection between the wearer and the garment, that suggests a more sustainable approach to the use of fashion. With the help of creating a future worldview context in which the dress finds its implementation, that is based on current world phenomenon, it is tried to show a credible world in which Techno-Fashion becomes accepted, integrated and successful.



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# Introduction

This design report presents the master thesis. The thesis covers a graduation project executed in about 6 months, and marks the finale of the 'Design for Interaction' master program.

This report consists of 10 chapters, that each present a significant part of the project. They chapters are chronologically ordered.

The report start with the original assignment, that had been set-up before the start of the project. Completing the definition of the assignment therefore marked the start of the project.

'Defining the world', which technically presents the analysis phase, continues with the assignment definition. With the use of the Vision in Product design method, a project direction will be shown that is meant for defining design directions.

It continues with the exploration phase, being the start of actually defining physical design characteristics. Credible design characteristics are presented in form principle concepts that show possible designs that can be integrated into clothing.

When a final form principle is chosen, the journey of prototyping chapter presents an exploration fase of prototyping the physical elements of the final dress design. The credible design and mechanical elements, and a user scenario that shows an implementation of the design comes together in the final design chapter. The final design will be validated in the validation chapter, continued with a visual presentation of the design and a story about the future of the presented dress design.

Finally, the project will be reflected in the final two chapters. The first one, chapter 8, concludes the design and it's impact, and shows what future lays ahead. Chapter 9 shows a personal reflection that reflects on the personal ambitions behind the project. These two chapters both reflect on the statements made in the original assignment. That completes the project full circle

# 1 The assignment



# 1

The first chapter of the graduation reports kicks off with the initial assignment and its premise. This gives a clear introduction on the topic and shows the premise, goal and methods that form part of the assignment. This chapter will result in a clear view on what the graduation project will be about. The chapter that follows will present the research part that forms the start of the design process.



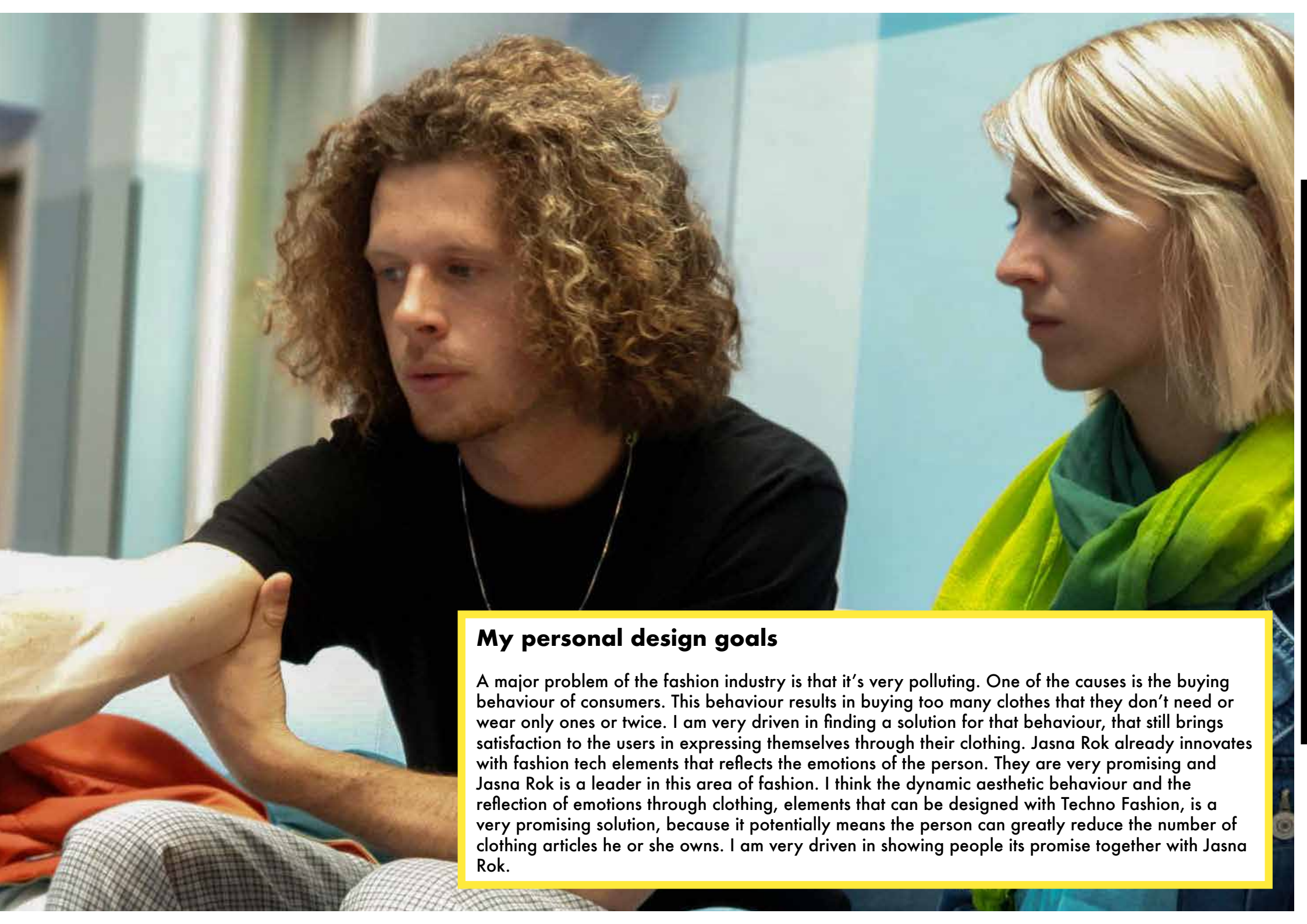
# 1.1 Premise

When I was 15 years old, I developed a large interest in clothing and physical expression through garments. Together with some other interests, like automotive design, this really drove myself to become a product designer. After a few years of studying the Industrial Design Engineering discipline, I started to search for ways to match my love for clothing with product design. I was very much interested in how clothing matches someone's identity and how it affects someone as a person. These psychological aspects of using a product is what got me into the master discipline of Design for Interaction.

In Design for Interaction, that is focusses on the interaction between the product and its user, I am most interested in how a person behaves around a product and what his or her personal motivations are in certain scenarios and contexts. I would very much like to add something to that situation that surprises the user, something he or she wasn't aware of in the first place.

When I had the chance to select an internship, I searched for one at a small clothing label to get to know every aspect of what it takes to run a business in the fashion industry. During the internship, I saw the progression towards innovation being very slow. Together with the fact that the industry is one of the most polluting industries in the world, I started to search for possible ways in which I could combine my skill as a designer and my affection with the fashion industry to search for solutions. That is what got me into finding a suitable graduation project that does that. I watched a lot of documentaries and read many articles, and finally got myself introduced to the phenomenon called Techno-Fashion.





### **My personal design goals**

A major problem of the fashion industry is that it's very polluting. One of the causes is the buying behaviour of consumers. This behaviour results in buying too many clothes that they don't need or wear only ones or twice. I am very driven in finding a solution for that behaviour, that still brings satisfaction to the users in expressing themselves through their clothing. Jasna Rok already innovates with fashion tech elements that reflects the emotions of the person. They are very promising and Jasna Rok is a leader in this area of fashion. I think the dynamic aesthetic behaviour and the reflection of emotions through clothing, elements that can be designed with Techno Fashion, is a very promising solution, because it potentially means the person can greatly reduce the number of clothing articles he or she owns. I am very driven in showing people its promise together with Jasna Rok.

# 1.2 Topic

## Techno-Fashion

The project will concern an application of the innovative clothing phenomenon called Techno-Fashion. Techno-Fashion, according to research (Toussaint, 2018), is about “wearable designs that combine technological functionalities with the aesthetic, expressive, critical and/or communicative power of fashion”. According to her research, she states that “Techno-Fashion so powerfully transforms wearers’ relations to themselves and to the world around them, precisely because of its embodied and material character”. This means, in my opinion, Techno-Fashion can have unlimited possibilities and applications in modern society and in the modern day fashion industry

## Jasna Rok

Finally, the project will be executed in collaboration with the Belgian fashion label Jasna Rok. Jasna Rok specializes in emotion tracking and experiments with expressing emotions through technologically advanced materials. Their website states: “Jasna Rok is on the cutting edge of fashion & technology, going against the fashion grain (runway, season, real sustainability, ...) with its visionary yet pragmatic outlook on the role of fash tech in our daily lives”. Together with Jasna Rok, I am committed in finding a/extending the limits of the practical application of Techno-Fashion, that implements emotive expressions of wearers of fashion, and clothing in general.





# 1.3 Design approach

## Designing with Techno-Fashion

The founder of the label, Jasna Rokegem, states her ultimate goal: "My ultimate goal is for us to only own one garment, the ultimate garment, that can change its shapes, forms and colors, and that always stays clean. The garment adapts itself continuously according to the needs and feelings of the wearer". That garment can satisfy the need of the consumer and replace the large amount of clothing being owned today. They state on their website: "Our team explores and implements the latest research and technology in the field of wearables, sensors, robotics, and electronics, combining these with futuristic haute couture and high-end design. Because fashion is more than a gadget or a cover for ourselves, fash & tech can become an interactive extension of our inner selves and create a new kind of nonverbal communication using real-time feedback".

These promising words will be used to find an application of Techno-Fashion that can be a solution to the slowly innovating fashion industry in terms of sustainability, which makes the industry very polluting. Jasnarok is on the forefront of innovation. I will make use of her knowledge to find a implementation of Techno-Fashion in our modern day society.



# ViP (Vision in Product Design)

To find an innovative design implementation of Techno-Fashion in the industry, the design method called Vision in Product Design (ViP) will be used. This method creates a frame of reference for future product development, by asking: What is this world I am designing for? What matters in this world? It helps the designer to find out what is changing in this world and the people living in it. This gives an open mind towards what the product actually is going to be, instead of defining the requirements first.

The research part of the ViP method starts with finding a search **domain**, in which you will search for **context factors**. These factors show things that are happening in the world right. The factors are gathered from many different disciplines, like psychology, sociology, culture, economy, demography, biology, evolution and technology.

After finding a useful range of factors, they will be **structured** and show so-called world phenomena. The relations between these clusters will show a worldview storyline. That storyline also shows where our world is heading to, so from that worldview, a future context will be formed in which our world is heading towards. This is the future world in which the product design will play its role.

From this future world view, a **statement** will be formed, which shows what you want to offer people in the future context. And finally, the relationship between the product and the user, called the **human-product interactions**, and the **product qualities** matching those interactions, are determined.

Both the human-product interactions and the product qualities are the basis for the future design, and will form a complete design vision. This will be used as the start of the design process. During the design process, continuous reflection on the design vision is needed to be sure the design will be complete it's goal.

# 1.4 The assignment as approved by the board

## Introduction

Currently, the fashion industry is the second most polluting industry in the world, next to the oil industry. The reason why this industry is so polluting is because the consumers buy too many clothes that they don't need or only wear just ones or twice. Because of this, 1/3rd of the owned garments are not being used and in the Netherlands alone, 688 million pieces of clothing are being thrown away annually. Also, the industry seduces the consumer to wear the garments for a short time to let them eventually buy new ones.

Techno-Fashion is the next generation of clothing. In the current digital age, adding technology to a product is nothing special anymore. Therefore, clothing is yet another daily life staple in which technology is added, to enhance people's lives. That is called Techno-Fashion.

Clothing originally is meant for functional benefit. But, over the years, clothing has become a very important way of expressing one's identity. Techno-Fashion has been theoretically proven to be able to extend emotions and identity unlimitedly. Together with new clothing manufacturing techniques like 3d-printing and electricity conducting threads, and labels such as Jasna Rok, this means it has many opportunities to be beneficial to its wearers and for the clothing industry. By finding ways of using Techno-Fashion for creating a greater deeper connection between the wearer and the garments, this can result in a more sustainable use of clothing.

## Problem definition

At this point of time, Techno-Fashion can be very experimental and conceptual, and present their unlimited ways of expressions. This looks unfamiliar to people and most of its functionalities are undesired. There is a need for an application of the possibilities of Techno-Fashion, besides the conceptual work presented right now. What exactly do the wearers appreciate about ways of expressing themselves, and what does their environment appreciate?

How do we express and experience body language, and how can we translate that into an application of Techno-Fashion that is desirable and understandable? How can we translate that phenomenon into Techno-Fashion in order to replace the need for multiple outfits?

# Assignment

"How do we express and experience body language, and how can we translate that into an application of Techno-Fashion that is desirable and understandable, for the wearer and his/her environment? How can this application provide an alternative for the current use of regular clothing?"

I am trying to find out what physical expressions through clothing are most important when expressing body language. My goal is to find patterns in expressing body language through garments, and map this according to the following 5 emotion groups, based on the research of Jasna Rok: Neutral, calm, sad, angry and happy. These emotions will be mapped through and captured for both haptic and visual feedback. The goal is to find what emotive patterns are the most promising and how these can be best expressed.

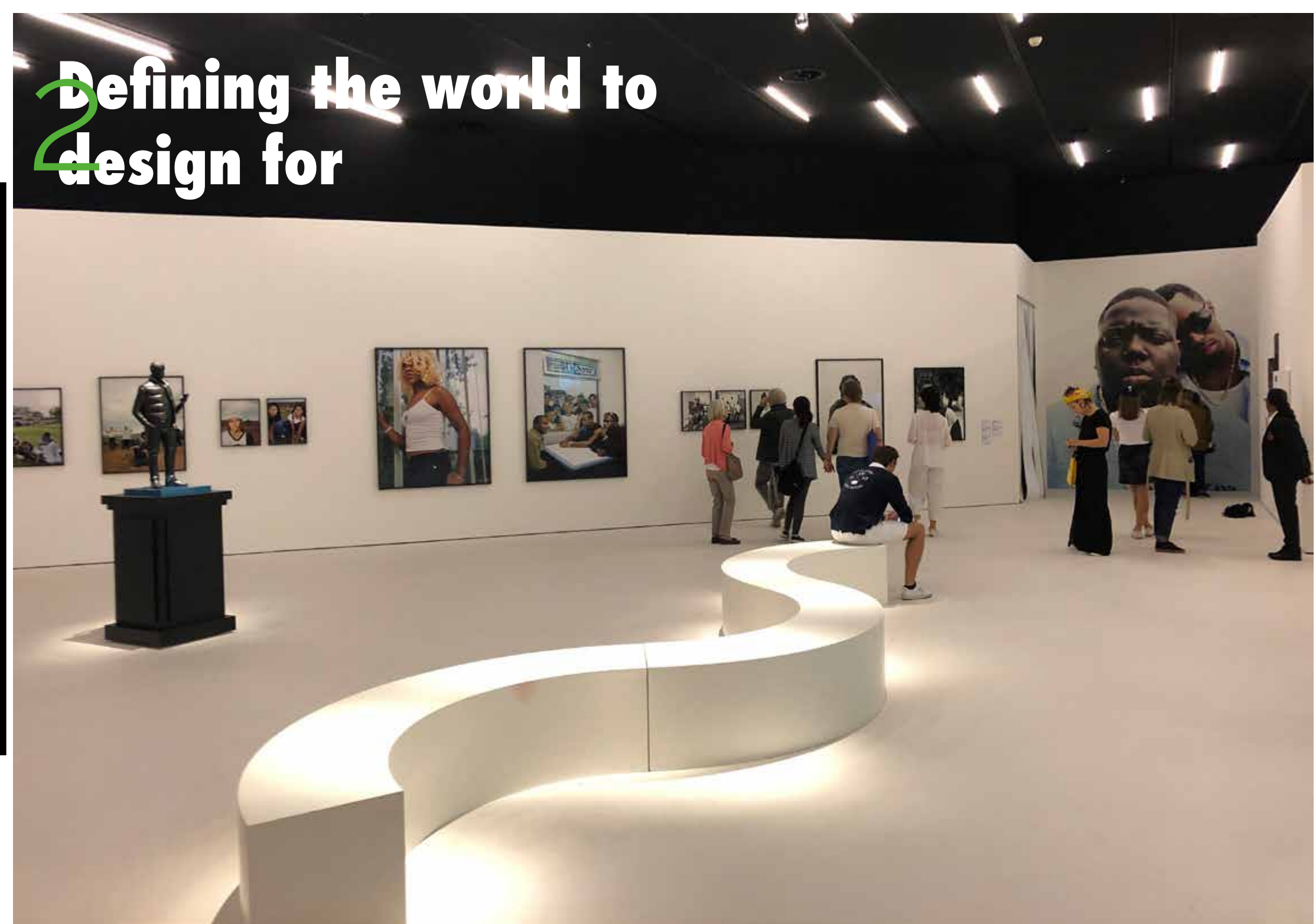
Next, I want to know what the effect is of expressing these emotions, on the wearer and on the surroundings. What role does body language and emotion expression play right now when wearing regular clothing? The application of Techno-Fashion should provide an alternative for that. I want to end up with something that give the industry and its consumers a groundbreaking idea they can actually use, and that they look at as being credible and realizable in a few years

## Approach and relevance to the IDE domain and master

At the start of the project, in the analysis phase, the VIP method will be used to gain insights in and principles of the world. This method will be used because, as seen in other examples of using the method, the insights are very promising and out of the box. Together with a literature research, and the insights gained from that, a personal project vision and design goal will be formulated.

Finally, I want to involve a lot of user tests in order to verify the different design ideas, and to make credible iterations. To be able to involve the wearer as much as possible, multiple user test sessions will be very important to get user insights. The first session will be planned in the analysis phase, to gather these insights as soon as possible. These user insights will be used in the conceptualization phase. In the embodiment phase, another context mapping session will be used to verify the concept ideas. Finally, a last big user test will reflect on the final design.

# Defining the world to design for



2 This chapter presents the explorative research, being the first part of my graduation project. In the previous chapter, the initial design assignment was presented. In this chapter, the goal is to identify topics relevant to that assignment. To that end, the ViP design method will be used, that will result in an initial starting point for the design phase.

Furthermore, after using ViP to find the initial starting point, this chapter continues with researching the user side of the story by organizing interview sessions with clothing wearers. Also, a deepened research into the expression of emotions through clothing presents more understanding in affective design elements relevant to the design phase starting point

At the end of this chapter, the result should answer the following question: What is it exactly that the design should do, and why is it important for the original assignment? This is presented in a project goal and a design vision, and marks the end of the explorative research.



### **The ViP design method**

This Vision in Product Design method, created by Paul Heckert and Matthijs van Dijk, creates a frame of reference for future product development, by asking: What is this world I am designing for? What matters in this world? It helps the designer to find out what is changing in this world and the people living in it. This gives an open mind towards what the product actually is going to be, instead of defining the requirements first.

## 2.1 Design worldview and context

The explorative research starts with searching for factors that have a certain match with the original assignment. Finding a search domain is important to get a more defined search area.. The search domain comes from the initial assignment, presented in the previous chapter, and states "The expression of body language and emotions through garments and lifestyle".

In this search area, research will show certain context factors that might be interesting for the assignment. Based on the designers interest and expertise, certain factors are gathered. These factors show things that are happening in the world right now, and are part of many different disciplines, like psychology, sociology, culture, economy, demography, biology, evolution and technology. A few interesting factors are presented on this page. The full collection of factors are presented in Appendix 1.

Body language have been shown to convey emotional information

Metallinou et. all. (2011)

***Technology enables us to present the self that we want to be. We can delete and retouch everything we want to say.***

Sherry Turkle, TED talk (2012)

Popular culture manufactures "portraits" of who it wants us to be.

Taylor, 2011

**Technology is becoming more intuitive than ever, with new products and devices that can instantly adapt to their surroundings.**

The future 100

What beauty represents is being redefined and brands need to take note of the "imperfect" aesthetic highlighted by a subculture of experimental artists

The future 100

**Clothing concerns all of the human person, all of the body, all of the relationships of man to body as well as the relationships of the body to society**

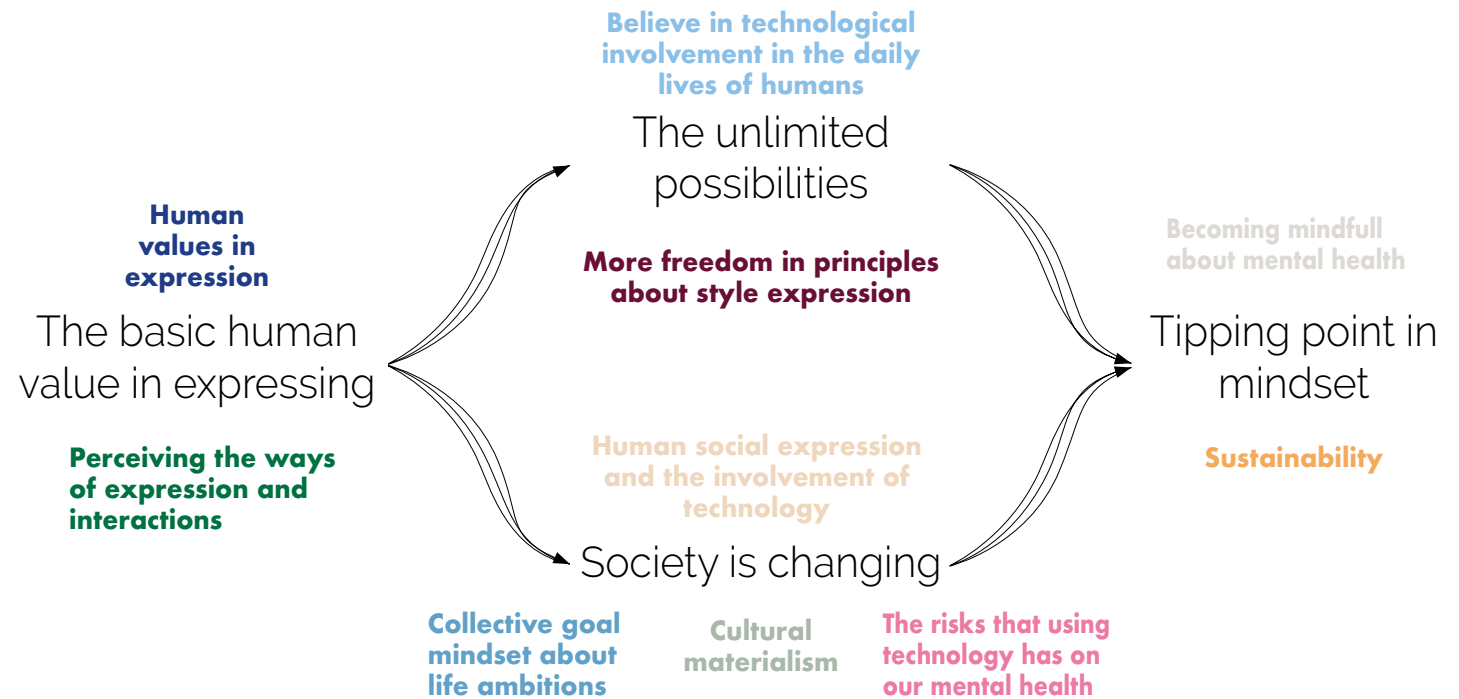
Commandeur, 2019

**We're lonely but we're afraid of intimacy**  
Sherry Turkle, TED talk (2012)

# Context cluster relations

After finding a useful range of factors, they will be gathered and clustered, to find interconnection relations. The clusters combine many different factors that have something in common. Together, they show so-called world phenomena. The relations between these clusters and phenomena tells a worldview storyline, that shows in what world we are living in, based on the search domain. But, it also shows where our world is heading to, which is interesting for design development. This already gives a clearer view of a suitable context for implementing a design solution.

Context factor clusters are highlighted in colour, around their interconnecting relations. Below, the full worldview is presenting as a result of the interconnecting relations.



## Worldview

There is a large psychological value in expressing yourself individually and socially, through body language and style. With the quick development of technology, the internet and social media, we are driven to personally present and reflect ourselves online, because it is an easy escape from personal struggles like solitude and expressing intimacy offline.

Paradoxically, we are in need of social expression to feel good about ourselves, and the expression online isn't the solution for our mental well-being. It may even make things worse. People are realising this more and more.

But, the degree to which we can express ourselves evolves, and there is more freedom and less restrictions for what we are allowed to express socially and culturally.

## 2.1 Design worldview and context

What world I am going to design for? Again, the factor relations, phenomenon and the resulted worldview storyline also shows where our world is heading to. That world is interesting, because it highlights possible design problems. Where our world is heading to is presented in a future worldview context on the next page. This context is a continuation of the world view described on the page 23. The context described on the next page sketches the world in which the final design will appear, and that will support or change the societal phenomena happening in that context. This context dictates what the product I will design will actually bring about.

### Future worldview context

In my future context, integrated technology in garments assists individuals with expressing themselves dynamically, within a range that makes sure the individual can express himself the way he or she likes. There are no practical boundaries or limits in what to express, and how, but the expression itself fits the individual's intuition and emotions.

Also, by tracking one's emotions, mental well-being can be monitored and the technology assists when the individual needs a change in expression. Online social interaction is past its peak, and offline social interaction returns, making sure the individuals provide themselves with all the social expression they need.

Previously online expression was the easy way out, but didn't fulfil. But, technology enables clothing to be dynamically expressive, so as to make people feel more comfortable when expressing themselves, offline, and helps with the human value in interacting.





## The ViP analysis report

Chapter 2.1 is a summarized version of a completely executed ViP analysis report.  
The full analysis report is presented in a separate document, called "The ViP report"



(E)motional mask, by Jasna Rok

## 2.2 User behaviour research

The future worldview context shows a context that I imagine, based on found context factors and worldview phenomena. That context shows some claims about how people are behaving and other social phenomena. Examples are that individuals can express themselves the way they like or that people feel more comfortable when expressing themselves. Another element for example shows that their expression fits the individual's intuition and emotions. How would people actually like to behave themselves regarding these behaviors and phenomena, and how do they express themselves in the current context and why? This worldview needs more concrete research.

Interviews were held with wearers of clothing that had different relationships with the clothes they wear. Some saw themselves using clothing to express their personal values, others had a less close relationship with the expression of their style. The goal was to find out about the emotional motivation behind the clothes they wear and their expressive behavior, and where their motivation comes from. The main insights will be used to give ideas about what human behavioral aspects need to be put into the design vision and what the project goal needs to complete from the user side.

Below, 5 insights show what seems important for people when they express themselves and their motivations. The full transcripts can be found in appendix 3.

### 5 main interview insights

- Much of the wearers personalities are reflected in their way of clothing
- Specific activities trigger specific moods. Certain expectations and emotions go together with these moods. Outfits are matched with these expectations and emotions
- Regardless of what their day will bring, wearers of clothing start their days with specific moods. Examples are feeling blue or feeling free or eccentric. That triggers a certain way of dressing up.
- Again, moods bring the wearers towards certain outfits. But, certain situations force the wearer to dress a certain way, like when you go for a day of studying, where you have to sit comfortably. That situation does not take the full day, so the moods can bring nuances in dressing practically.
- Wearing clothing are dictated by positive emotions. because people want to feel good when wearing their outfit. These emotions are reflected in their garments, and gives the wearer those feelings. When it gives anger or sad feelings, the wrong outfit is worn.



“Finally, when your outfit triggers angry and sad feelings, you have to wear another outfit!”



“On the 5 emotions scale, this outfit is very happy. I am already happy, and the outfit makes me even more happy, so it’s very much on the top of the happy scale. It’s all out crazy and happy, and reminds me of the fun stuff I am going to do.”

“Sometimes a mood does not always match what is comfortable to wear on that particular day. For example, when a girl wants to feel sexy during the day, but they go for a day of studying, it is not always desired to wear revealing clothes. When having a break, it is desired to wear sexy clothes, but when actually studying and going to the toilet, it is not always desired.”



## 2.3 Emotion behaviour research

Another part of getting deeper into researching the future worldview context are the emotions that are part of the expressive behaviour through style and clothes. From the insights gained in the interviews, emotions are found to be a returning aspect in the current and future worldview, and were first named in the initial assignment. People show signs of their emotions when expressing themselves, also found in a few context factors (the factors from Metallinou (2011) and from Commandeur (2019)). The interview insights talk about moods and emotions, and the fact those emotions are reflected in their garments.

Research done by Jasna Rok is used as a starting point to see what emotions are most important when a person is expressing him or herself. Also, Prof. Pieter Desmet, full professor of 'Design for Experience' at the Department of Industrial Design Engineering, is an expert in Design for Emotion. His research will be compared with the research of Jasnarok and Desmet himself will be consulted about the topic.

Finally, the research will give an idea about what emotions are mostly used when talking about style expression, compared to the style expressions found in the interviews. That result will play a major role in presenting the design vision and the project goal, marking the final outcome of this chapter.

### Research theory

Initially, the research of Jasna Rok uses five basic emotion groups in their research: happy, calm, anger, sad and neutral. But, the interview insights show that people want to feel good when wearing their outfit. The 5th insight and the quote on page 26 state that preferably only the positive emotions are desired to be reflected through their garments. This means only the positive emotions like happy and calm should be put into designing a product that makes people feel comfortable when expressing themselves.

So, the positive emotions happy and calm need to be researched in order to understand how design characteristics should trigger them. That results into a design that fits the future worldview. Research of Pieter Desmet, expert in Design for Emotion, is used to get clear definitions about the emotions happy and calm. The positive emotions happy and calm are found to be manifested in the emotion groups joy, confidence and relaxation in his research. The emotion groups and their descriptions are presented on the next page, and are gathered from Desmet (2012).

# Emotion groups

## Joy

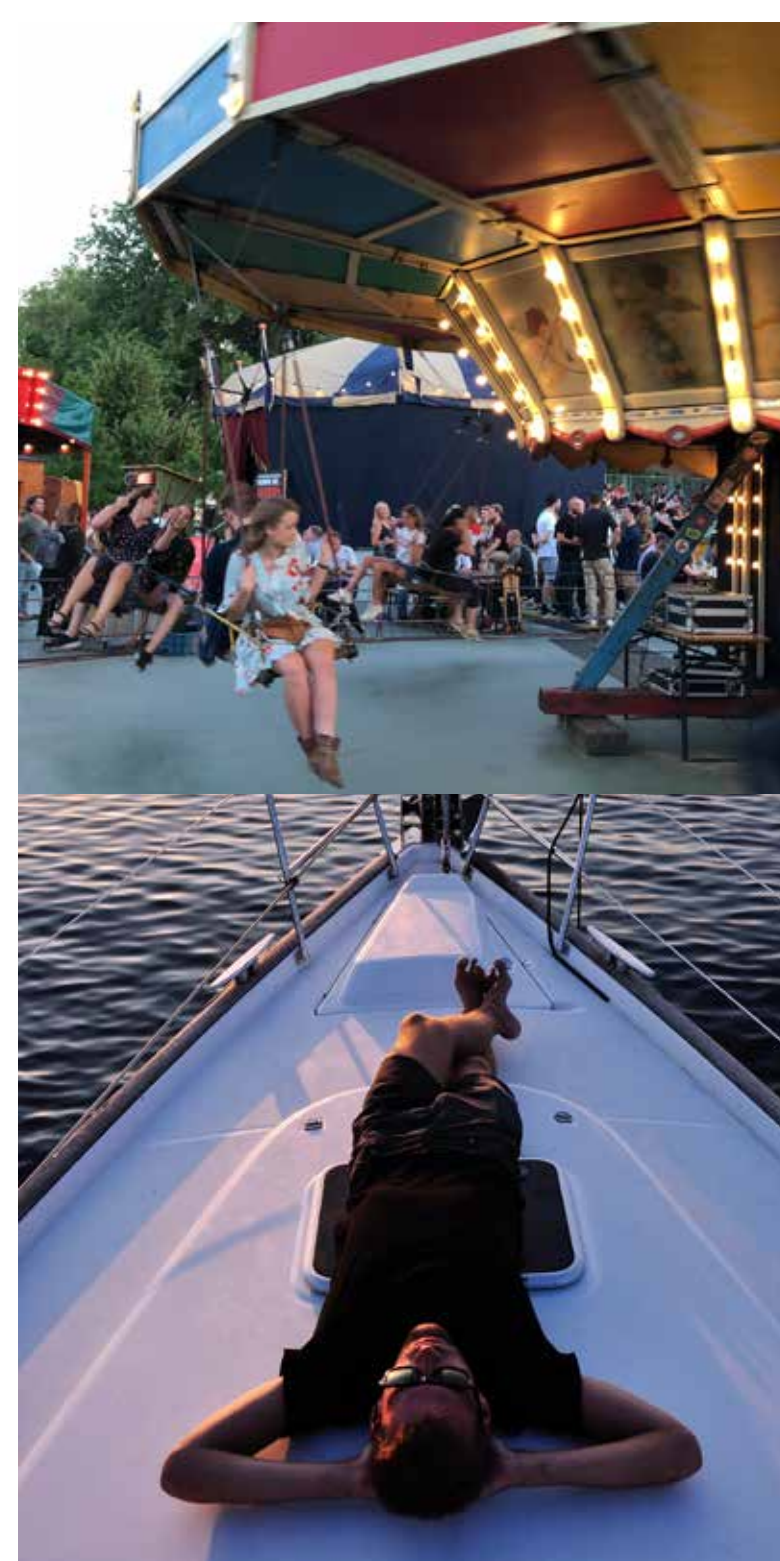
- Joy is the experience of being pleased about (or taking pleasure in) something or some **desirable** event
- People can experience joy when a product is **pleasurable** to use, fulfils its function well, or facilitates a joyful activity. In addition, a product can also represent or remind someone of a **(past) joyful activity**.

## Confidence

- Confidence is the experience of faith in oneself or in one's ability to achieve something or to act in the right way. The related feelings are **self-assurance**, **security** and **certainty**, and the related tendencies are **control**, **competence**, **resolution**, **determination**, and being **free from doubt**.
- People can feel confident about products that are **trustworthy** or easy to use. Products can make people confident because they support **independence** or because they help them look good. Moreover, products that prevent injury or damage and products that support one's expertise or profession also provide confidence.

## Relaxation

- Relaxation is the experience of enjoying a **calm** state of being, **free from mental or physical tension or concern**.
- People can use comfortable products as "tools" for relaxation. Examples of such products are a **fireplace**, a **bed**, a **pillow**, a **bathtub**, a **comfortable chair** and a **massage tool**. People also can feel relaxed when using products that support activities that set them **free from daily worries or from work** (such as **skating in the park**, **listening to music**, or **doing sports**); these activities can also be little moments, such as **drinking a cup of tea**. A special category are products that **force the user to slow down** because they **take time to use** (like a coffee brewing machine).



## 2.3 Emotion behaviour research

The three emotion groups found in Desmet's work match the two positive emotions based on Jasnarok's research. From the same research in which the emotion groups on the previous page are found, multiple sub-emotions being part of those groups were presented that give a more nuanced definition. The single sub-emotions that are represented by those groups are presented on the next page. These emotions can be used when thinking about design characteristics.

But, after knowing what role expression plays in the desires and needs of the user (user interviews) and what emotions are part of those desires and needs (emotion behaviour research), what does the design need to express in order to meet these desires, and to be able to meet the phenomena presented in the future worldview context? Consultation with Prof. Pieter Desmet should give a clearer idea about the role of my future Techno-Fashion design.

## Consultation Prof. Pieter Desmet

After summarizing and presenting the found research outcomes, presented in chapter 2.1 and 2.2, to Desmet, he showed the roles of emotions and expressions in my future design by stating the following 4 phenomena:

- Clothing as a regulator of your mood (I'm sad and I will try something happy)
- Clothing that adapts to your mood, or adapts to my expressive needs that follows from my mood (when I'm grumpy, I'm not feeling like getting expressive)
- When my mood is positive, I want my clothing to act as an expression of that mood
- Certain clothing and situations bring certain experiences of emotions and moods. This is something that can become expressive of not.

This results in the following roles that needs to be fulfilled by the design:

2 inputs:

1. What do I want to feel?
2. What do I want to express?



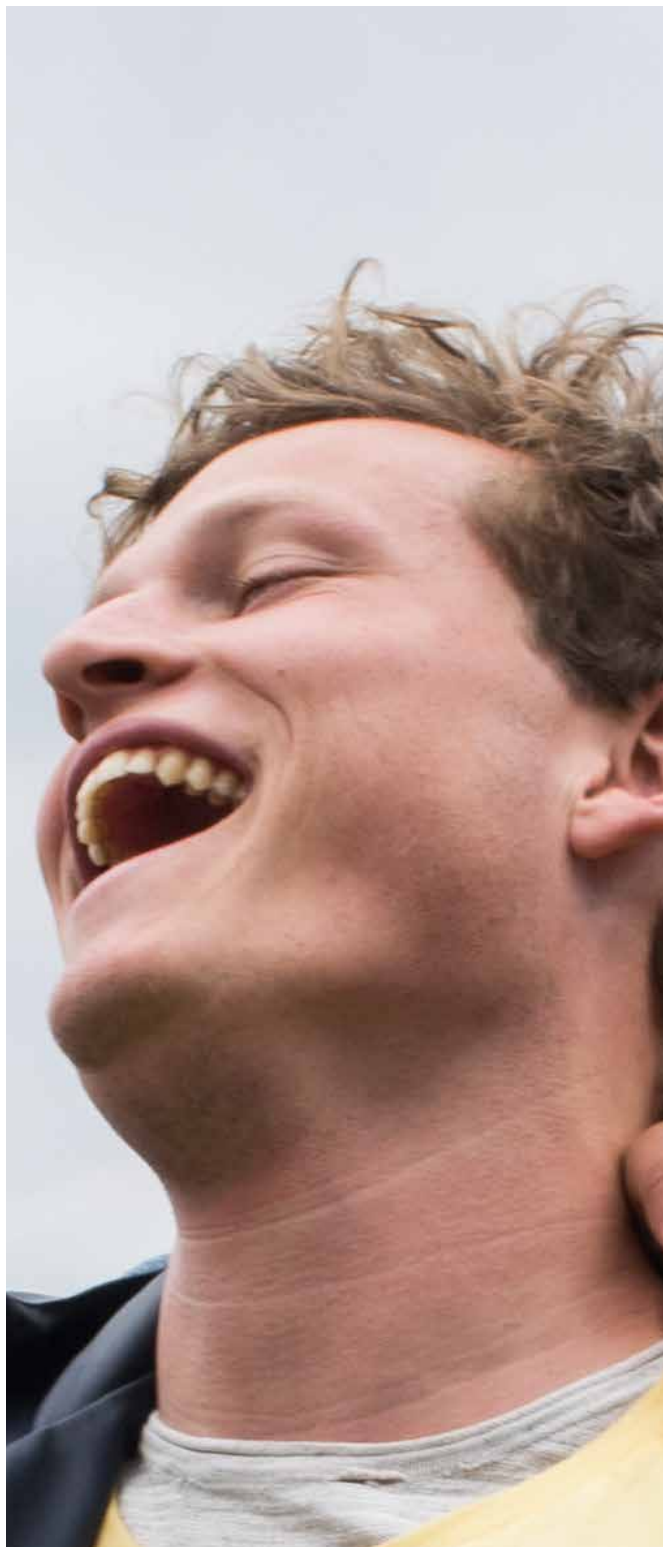
2 outputs:

1. Expressing and experiencing calm
2. Expressing and experiencing joy

# Happy

## Joy

- Joy
- Bliss
- Overjoyed
- Pleasure
- Happy
- Good
- Delighted
- Wonderful
- Rejoice
- Smile
- Cheerful
- Enjoyment



# Calm

## Confidence

- Confident
- Assurance
- Secure
- Trust

## Relaxation

- Relaxed
- At peace
- At ease
- Comfortable
- Peaceful
- Light hearted
- Carefree
- Placid
- Serene
- Tranquil
- Easygoing
- Calm

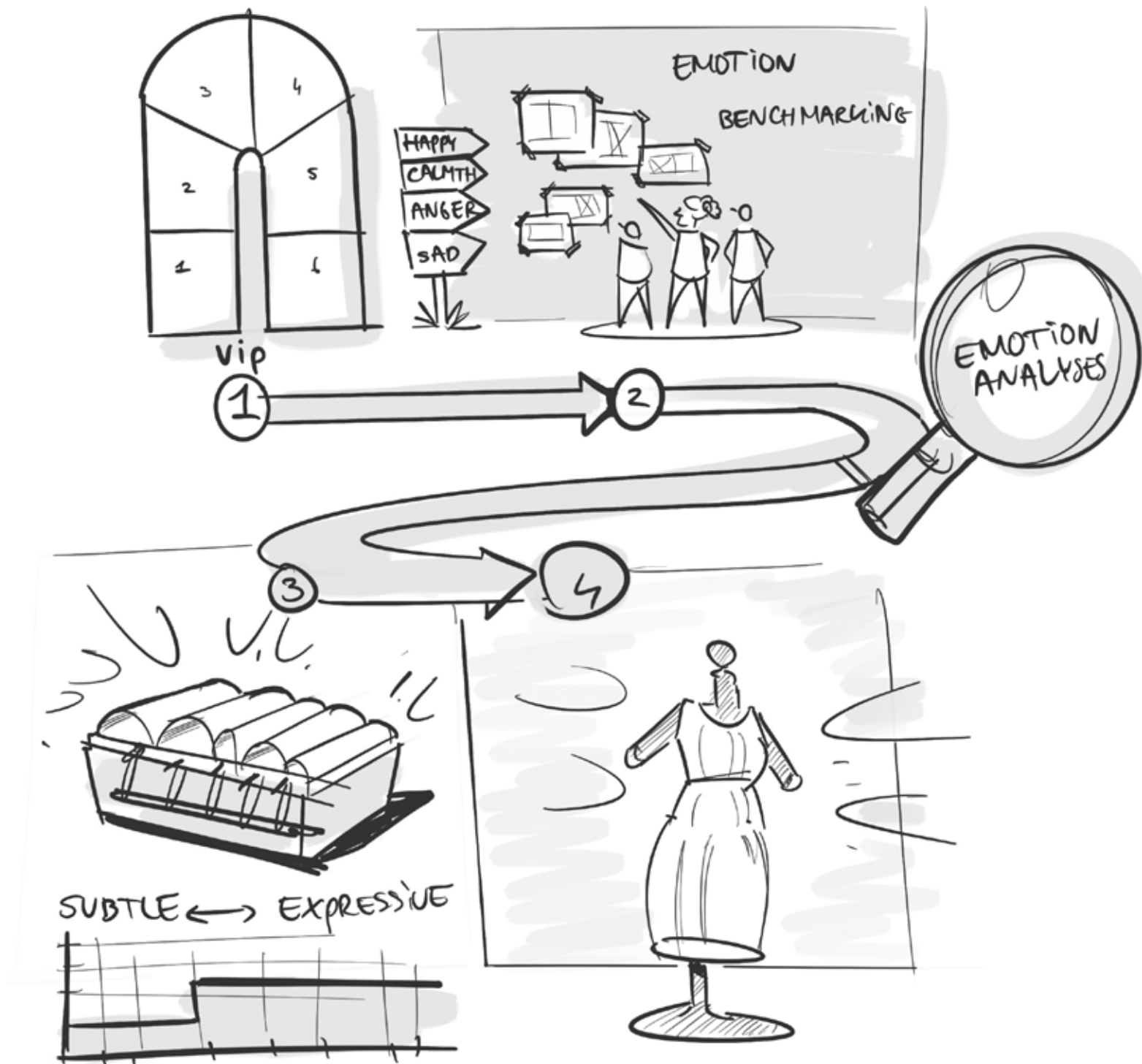
## 2.4 Design vision and project goal

As been promised before, the future worldview context research, combined with the user behavior interviews, the research about the desired emotions and the consult from Desmet, all join together in the design vision and the project goal. The design vision shows what the designer wants to offer people in the future context, together with aimed interactions and product qualities. This is the vision of the designer, and highlights the ultimate goal and implementation of the to be designed product.

Though, this might not always be possible in a project like a graduation project, for example because of time limits or because of too many different phenomenon that need to be taken into account. To be able to show what is feasible and what will be tackled in the project, the project goal is presented. Again, this shows what will be part of the goal the project and what it's final design tries to complete.

Both the vision and it's narrowing down project goal are the basis of the design decisions that will be made during the next phases. The vision and the goal are a union of the previously done research, and mark the end of the explorative research.





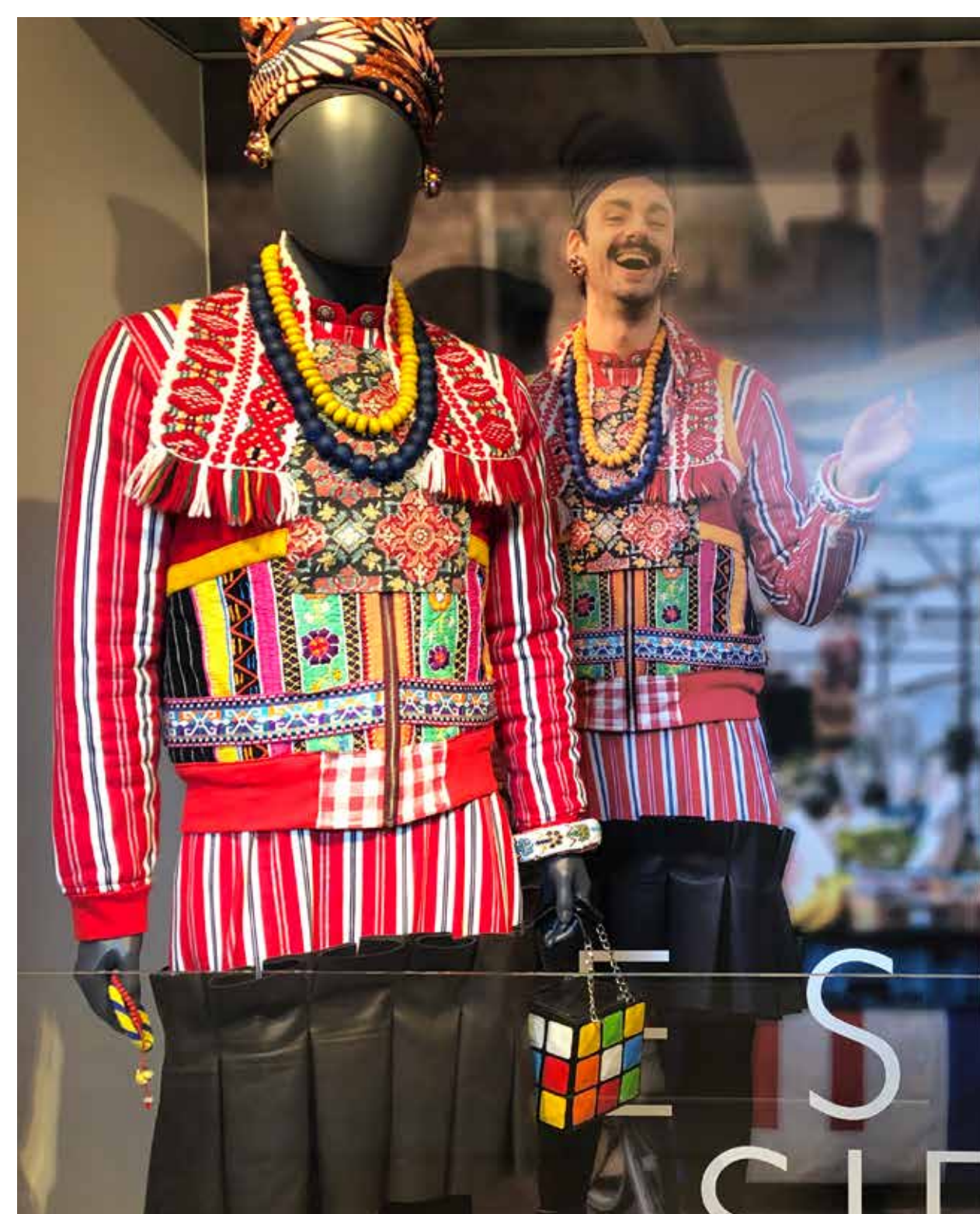
## 2.4 Design vision and project goal

### The design vision

In my future context, driven by offline interactions and a healthy state of mind, I want people to express themselves freely and intuitively, with a focus on offline, real-life expressions, by providing garments with integrated technology in textiles that are dynamic in appearance and expression, and that enables the user to create nuances in expressing the emotions happy and calm through the same garment.

The product will show engaging, decisive, eager and strong characteristics, and beneficially affect the user by enabling interactions such as inviting, vividness, striking, motivating and openness.

*All the human-product interactions and the product qualities, both part of the design vision, are presented in "The ViP report"*



# "LIFE IS BEAUTIFUL, DRESS ACCORDINGLY!"

Theodorus Johannes: "Ik kan niet anders dan expressief zijn. Toen ik mode ging studeren ging er een knop om: er moesten hoge hakken komen, kleur, prints, jurken en broekpakken."

"Al mijn saaiere oude kleren gingen naar het Leger des Heils. Nu, bijna tien jaar later pas ik mijn outfits als fashion statements toe om lans te breken voor de queer community. Iedereen heeft de vrijheid om af te wijken van de traditionele kledingnormen die bij hun geslacht horen. Je mag je laten zien zoals dat voor jou het prettigst voelt."

Theodorus Johannes (Thijs Adriaans) is communicatie expert in mode en werkt als filmmaker en onderzoeker aan de online documentaire serie Community Dressing. Hij onderzoekt daarmee de Nederlandse modecultuur om te kunnen laten zien hoe ons kleedgedrag is veranderd in de laatste honderd jaar. Theodorus Johannes maakt al zijn kleren zelf.

*"Life is Beautiful, Dress Accordingly!"*

*"I have no choice but to be expressive. When I started studying fashion something changed. I had to have high heels, colour, prints, dresses and jumpsuits. All my boring clothes went to the Salvation Army. Almost ten years later, my outfits are fashion statements that break a lance for the queer community. Everyone has the right to disregard the traditional sartorial norms dictated by their gender. You can present yourself however you feel comfortable."*

*Theodorus Johannes (Thijs Adriaans) is a fashion communications expert who works as a film maker and researcher on the online documentary series Community Dressing. His research explores local costume traditions in the Netherlands to find out how clothing has changed in the last hundred years. Theodorus Johannes makes all his clothes himself.*

## 2.4 Design vision and project goal

### The project goal

People are in need of expressing nuances of style and emotions through their garments. The emotions of people are the main non-functional drivers of what to wear and what style to express through clothing. They desire their clothes and style to reflect the two positive emotions: happy and calm. Those people take part in activities, with different moods, that trigger different emotions. These different moods and emotions desires them to create nuances the amount of expression through their garments.

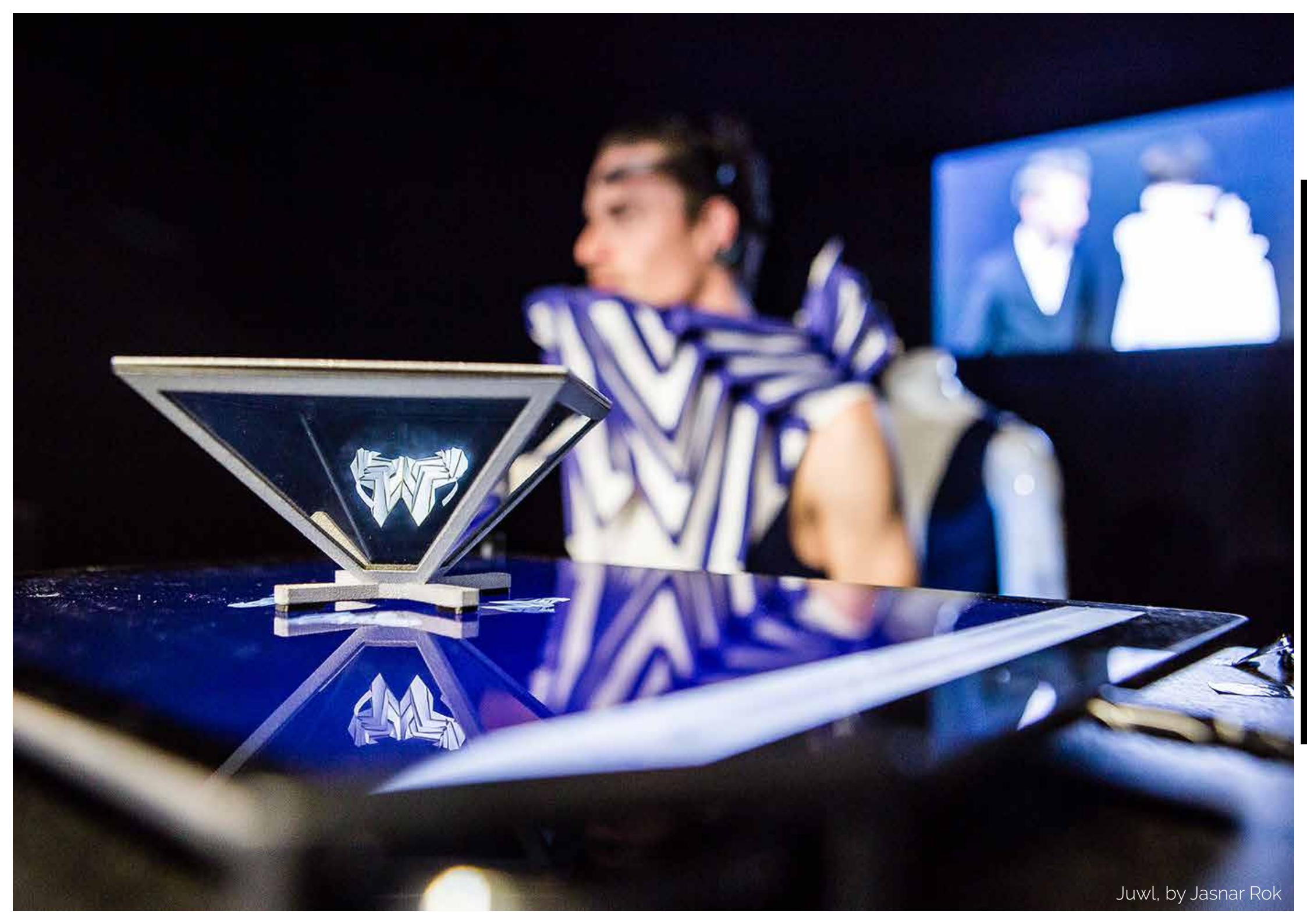
The goal for this project is to design a garment, made from integrated technology in textiles, that is dynamic in appearance. That garment gives the user options of expressing degrees of the two positive emotions, and to create nuances in how they dress during specific activities, like studying, socializing or attending a formal meeting.

The users control those nuances, and decide what nuances in style and emotions they want to express for a period. The dynamic garment enables the user to express themselves more freely to their social real-life environment. In the long run, this creates a more intuitive approach to expression and invites people to interact in a social environment. The owner of the garment builds a stronger connection with the garment, that creates a more conscious and sustainable use of clothing.

My final design will show how these positive emotions and moods can be expressed through dynamic Techno Fashion, These desired expressions trigger the aesthetics of the dress, and the wearer is able to chose the aesthetics so it matches their activities and accompanying moods. The aesthetics of the dress, that are matched with the desired expressive behavior of the wearer, are based on and inspired by general visual characteristics (like a blue sky) that evoke the two positive emotions.

Finally, the final design will show a full body of visual expressions through integrated garments, that will enable the user to create nuances in their expressions during the activities. The goal is to create an intenser expression, to more effectively highlight the desired effects of the garments.

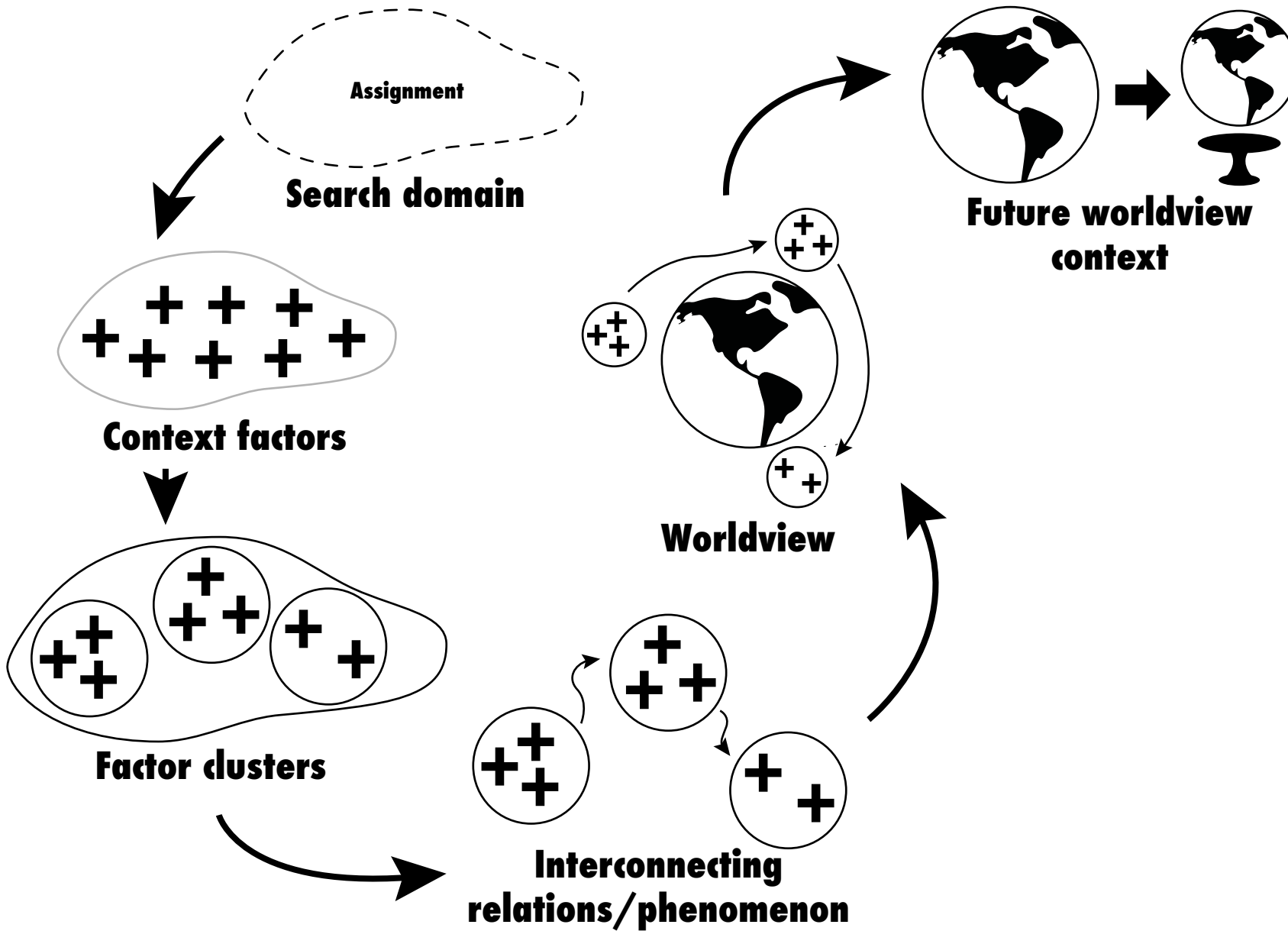
The garment becoming sustainable, which is one of the long term goals the project, will not be a primary requirement of the design elements. Though, the purpose and use of the garment should create a new and more sustainable approach to fashion.



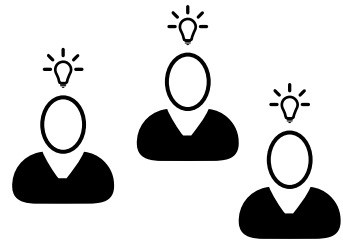
Juwl, by Jasnar Rok

## 2.5 Chapter summary

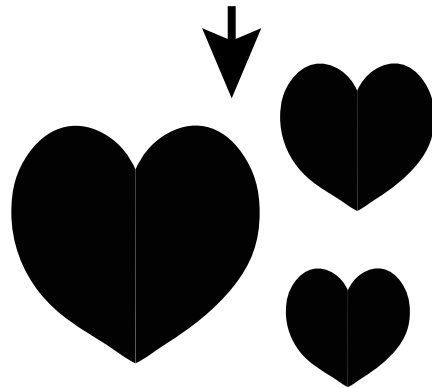
**ViP**



# Worldview research



**User interviews**

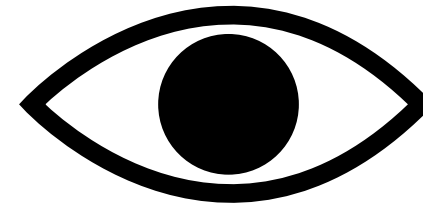


**Emotion research**

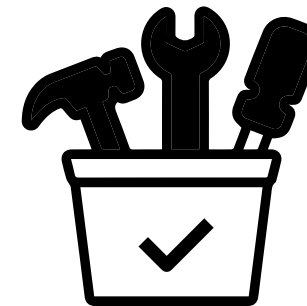


**Expert consult**

# Design defining goals



**Design vision**



**Project goal**



- A world where technological clothing enables comfortable offline expression
- Users desire their clothing to reflect their positive emotions and adaptable to their mood during the day. Desired emotions are Joy, confidence and relaxation and the garment should be able to express these emotions dynamically
- The design vision, presents the ultimate goal of the design
- The project goal presents the feasible outcome of the design and project.

# 3 Exploring the visual design elements

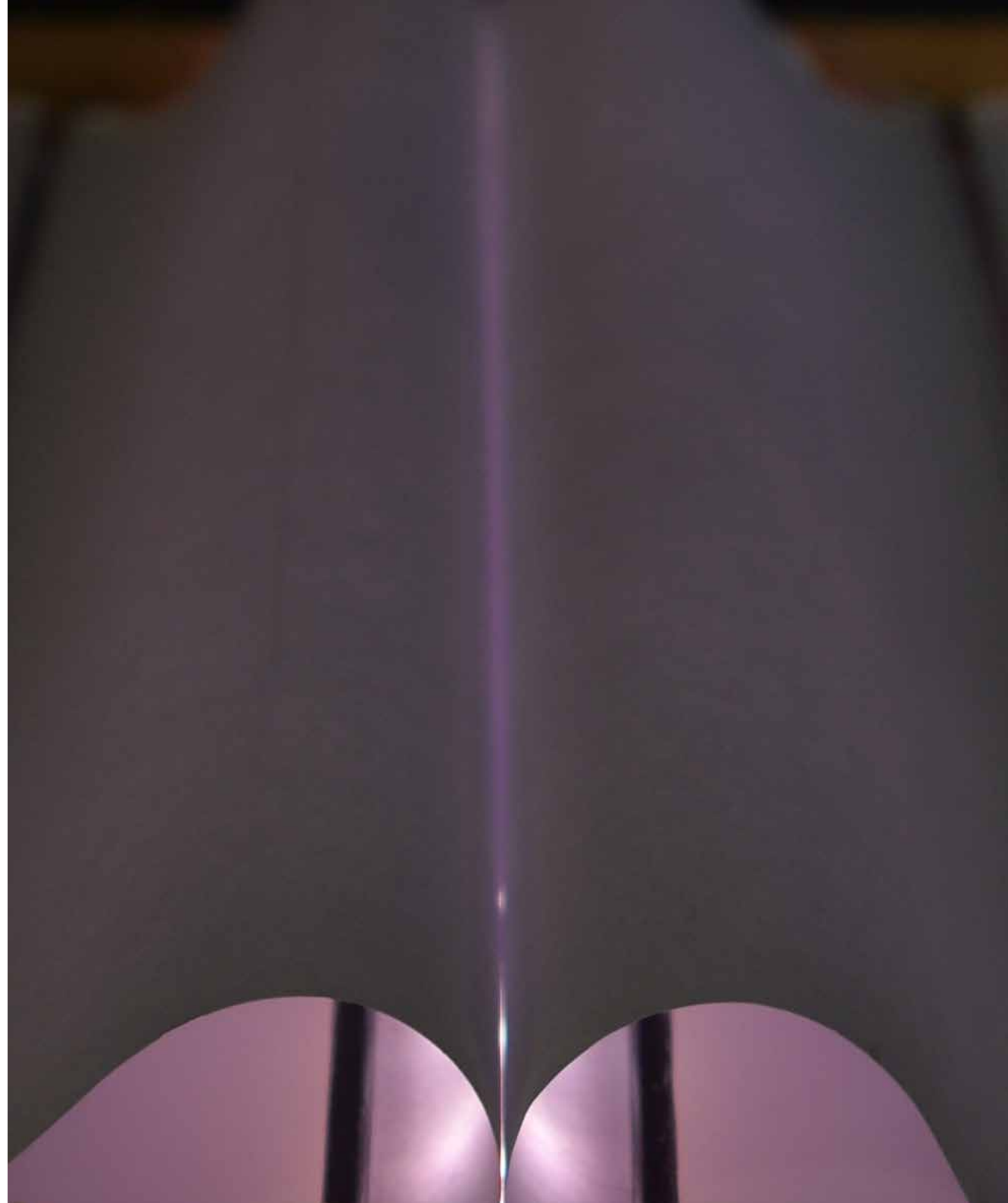




3 The previous chapter showed the first part of my graduation project. It presented a research that defined the world that shows what it is exactly that the design should do, for what purpose and why it is important for the original assignment. Next is starting with the design part of the project, by defining the visual elements and characteristics of the design, so that it completes its defined purpose from the project goal.

In this chapter, an orientation on visual design elements is done to search for what appearance the design should present, and to find out what dynamic contrast it should express to change from a joyfull to a calm state. Together with a technical benchmarking of techno-fashion innovations, this should give an idea about technical feasibility of realizing the found design elements.

Finally, 3 form principle concepts will present 3 dynamic expressions of forms, shapes and patterns. It is a prove of physical design elements that can visually dynamically change.



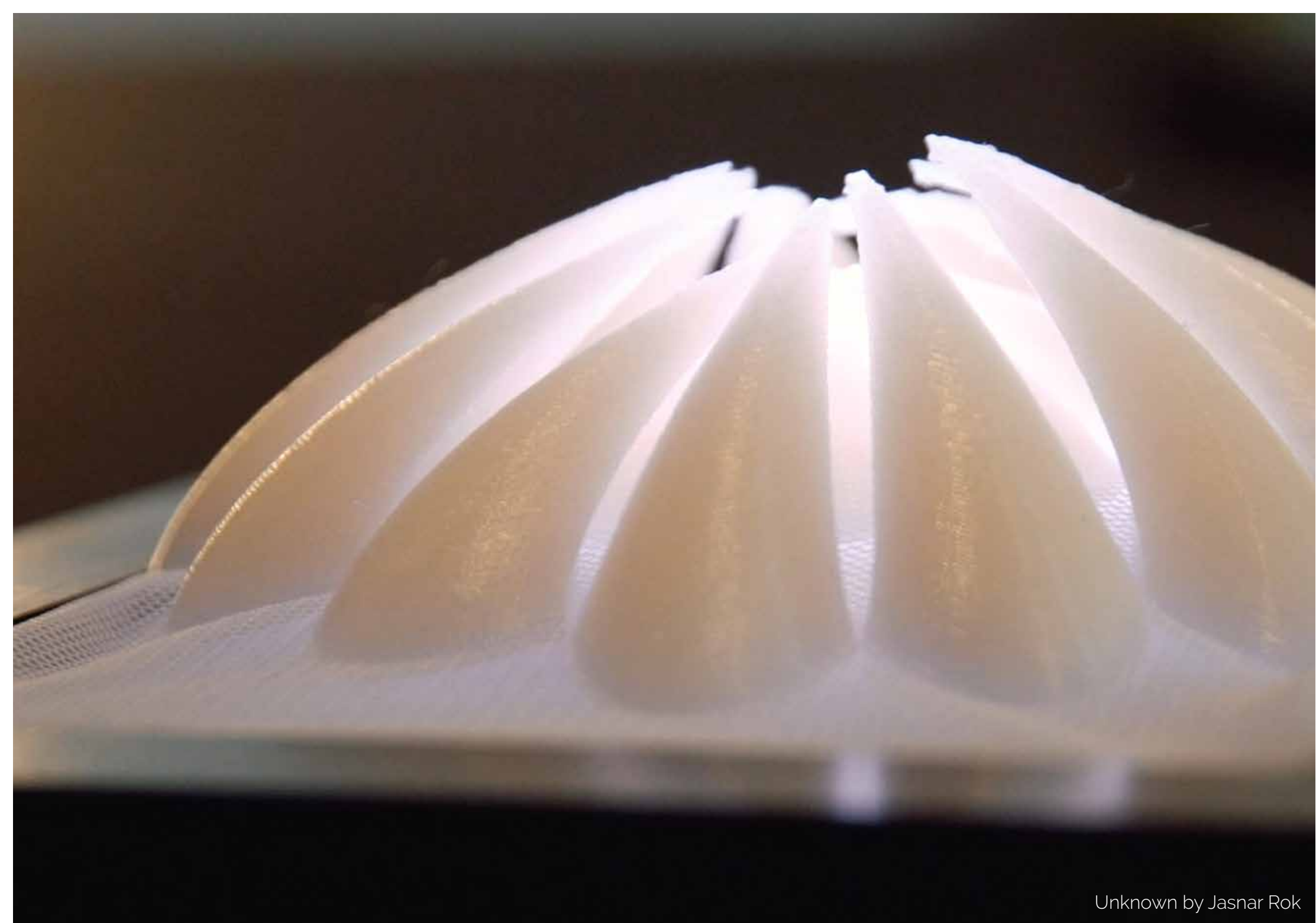
# 3.1 Design characteristics research

The desired result presented in the project goal stated that there is need for gathering visual characteristics that match the emotions happy and calm. These emotions need to be matched with physical characteristics found in the daily lives of people in order to start making decisions about the product's design and expression. Certain characteristics of products or phenomena evoke certain emotions in the memories of users, which can be used as inspiration for physical and visual product characteristics. With the use of the Product Emotion Inspiration Booklet, by the Delft Institute of Positive Design, visual characteristics are gathered that contain the two emotions: Happy and Calm.

Furthermore, more design inspiration will be searched for in how animals express themselves, because they already use dynamic expressions for different purposes, like mating and camouflage.

Finally, technical possibilities will be gathered from existing techno fashion benchmarking to get inspired how to physically make the found visual design elements.

Combinations of different elements are searched for that show promising inspiration for the form principle concepts.



### 3.1 Design characteristics research

## Calm emotion characteristics

The calm characteristics presented on this and the next page all represent soft hues of colors, smooth transitions of shapes and slow paced moving dynamics. They all show strong connections with the emotion groups relaxation and confidence, because of the non abrupt but affective impact. After researching these visual characteristics, it was found that they all have something in common: they all present a subtle state, subtle movements or subtle lighting. This might be an interesting generalized design characteristic that can be used when designing a physical prototype. The selection of characteristics presented here are used for design inspiration. The full collection is presented in appendix 2.1.



Visuals of an aquarium

The hues and the movement of the water gives a content and calm feeling



Mood lights

This mood light brings a feeling of calmth, because it represents nice moods and it presents a dimmed hue, which colour can be changed, according to the need of the user



### Cold nature surroundings

Cold nature gives a visually calming effect, because the scenery is wide and open, without a lot of urban distractions. The nature and the cold also reminds of the desire to get active, which gives a calm, healthy and fresh feeling.



### Taylored garments

Taylored garments can give people a calm feeling, because the clothing fits exactly the way the wearer wants it to fit so they don't have to worry that much about if it looks and fits right



### Clouds

Clouds in a blue sky can give a visually calming effect. because it reminds of the airy character, and because of the soothing shapes and colours.



### "Van Gogh Path" by Daan Roosegaarde

This bike lane, designed by Daan Roosegaarde, bring a feeling of calmth, because it enlights the dark surroundings, it gives guidance, but foremost it reminds people of the stars

### 3.1 Design characteristics research

## Happy emotion characteristics

The happy characteristics, in contrast with the calm ones, represent more vibrant colours and dynamics. Strong lights and more abrupt movements create more energy that matches for example with the emotions joy and cheerful. Some other characteristics evoke playfulness, sometimes even coming from childlike experiences or nostalgia.

Compared with the more subtle characteristics of the calm visual elements, the happy emotion visuals all present a more expressive state. Just like with the generalized characteristic of subtlety, expressiveness can also be a suitable element for designing the physical joyful state. This selection of characteristics are used for design inspiration. The full collection is presented in appendix 2.2.



Exotic fishes

The colours of these exotic fishes gives a happy and joyful feeling



Soap bubble

A soap bubble, especially with kids, brings a very happy feeling because of its shape and colours. For older people, it can evoke the same feelings, but foremost nostalgia.



Stage lights

The flashiness and colours of these stage lights gives an euphoric, energetic and happy feeling



### Disco ball

The disco ball, and its reflection of light, evokes a feeling of happiness



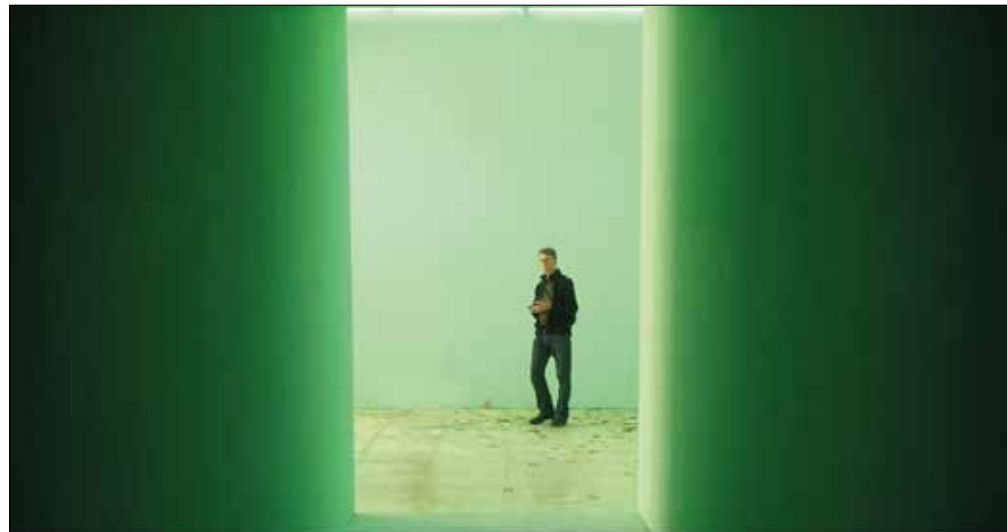
### Flowers

Flowers generally evoke a happy and energetic feeling, because of its bright colours and liveliness



### Round puffy shapes

The round puffy shapes of these lights give a joyful and happy experience, because of the playfulness and childlikeness



### High contrast

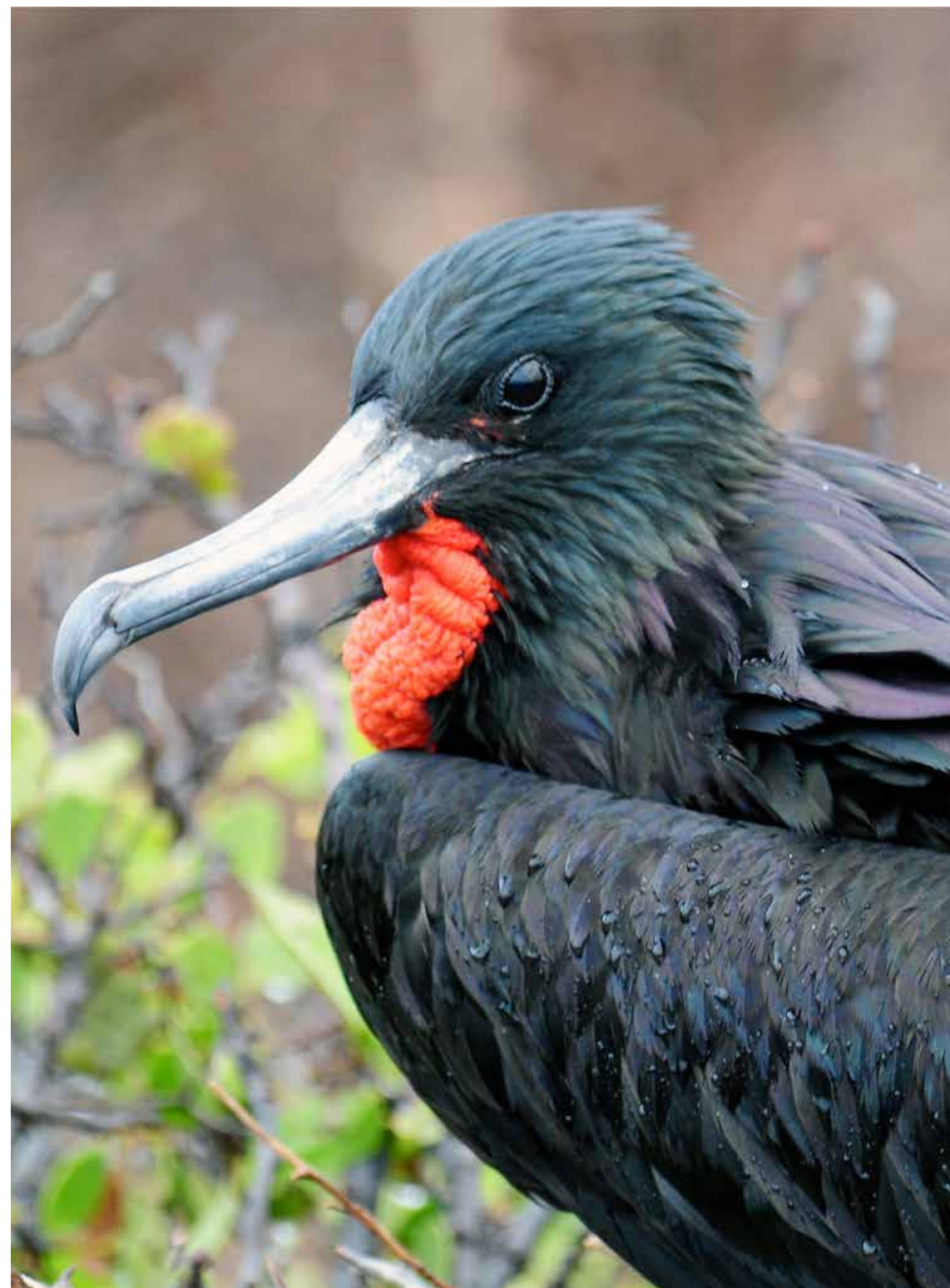
The large contrast between the black and neon green colour gives excitement, and therefore evokes happiness.

## 3.1 Design characteristics research

### Animal expressions

Day to day visual elements in the lives of people evoke certain emotions. Animals often present very interesting ways of expressing themselves, with a clear purpose. Some dynamic, some static, their appearance, characteristics and the reason of expression can be a great source of inspiration for what a dynamic garment can present visually.

The animals were collected and analysed, and the most promising were chosen to inspire the idea generation.. The main source of inspiration is the Great Frigatebird, and is presented on this page. The full collection of animals is presented in appendix 2.3. Visual elements of the dynamic expressions of the Great Frigatebird will be used as an inspiration for designing the physical form prototypes.





## **The Great Frigatebird**

The great frigatebird inflates their red throat sacks with air, in order to attract the attention of female birds. When the male bird succeed, the female bird will fly down and land alongside him.



### 3.1 Design characteristics research

## Techno fashion benchmarking

To continue with the search for product characteristics, an analysis was done about innovations in the world of Techno Fashion and integrated materials. This benchmarking gave an idea about what is technically possible and what has been done to present visually rich Techno-Fashion designs. The idea is to not specifically use these techniques or to copy certain designs, but to use the knowledge of what is possible to realize the chosen visual characteristics inspiration found during the characteristics research.. The most inspiring innovations are presented on this and the next page, and are used together with the product characteristics and the animal expressions to fuel the idea generation. The full benchmarking is presented in appendix 3.

Robotics with twisting and turning fibrous panels, animated in the presence of strangers



Fiber optic crochet



Tiny motors that move around parts of the fabric, that illuminates in the dark



Soft robotics with embedded LED's



Folded garments with hidden pneumatic pumps, triggered by movement and sound



Light patterns underneath cut structures



Moveable patterns with integrated shape memory alloys



15000 LED's embedded underneath fabric



Lights embedded in 3D layered dresses



LED ribbons hidden underneath soft and flexible TPU foils



Constructed non-technological transformable dresses



## 3.2 Form principle designs

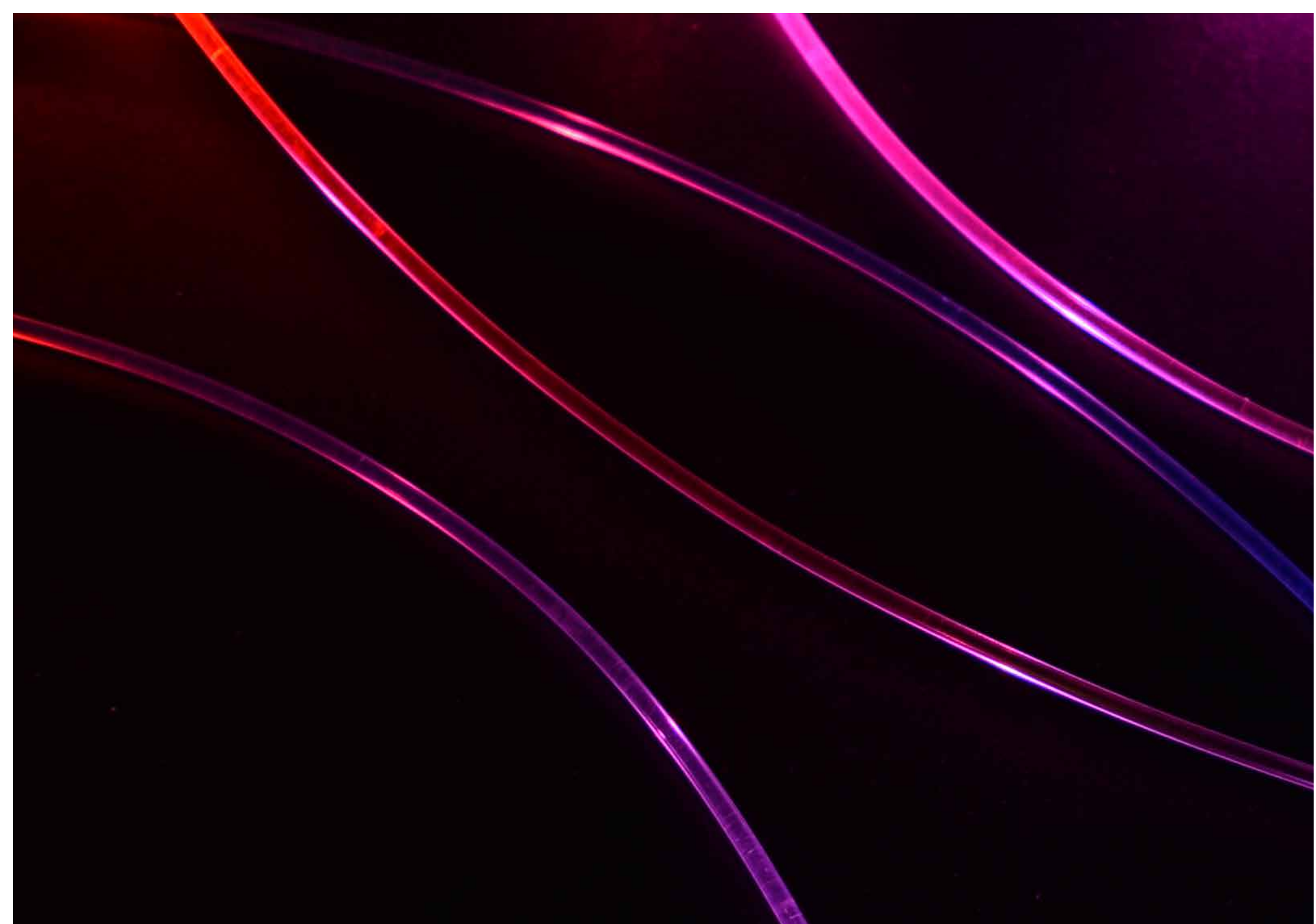
The selection of product characteristics, animal expressions and techno fashion benchmarking are used for inspiration of the design phase. The first step was to generate ideas of dynamically changing forms, that can be integrated in clothing. After collecting the promising characteristics and elements, an overview was created to look for overlapping and matching details and characteristics.

As been stated after presenting the visual elements, the expressions of these elements changed into different definitions than the two starting emotions: The two emotions (originally happy and calm) now represent two different opposed expressions: subtlety and expressiveness. This means the calm emotion group, that in itself contains the emotion groups relaxation and confidence, represent the subtle state. The happy emotion group, that contains Joy, represents the expressive state.

The characteristics "subtle" and "expressive" show two states of expressive behaviour. The dynamic integrated garment should be able to represent these two states with its shape and colors.

From this point we know what the final garment should be able to express. Now, physical form principle ideas are created to show in what ways the chosen and combined form characteristics could dynamically change to present and make a shift between the two expressive states. Together with the stakeholders, the most promising ideas were chosen to be realised as form principle concepts. These ideas should prove their ways of dynamically presenting the shift between the two states. On page 54, 56 and 58, the three concepts will present their principle and aesthetics. All the initial ideas are presented more detailedly in appendix 4.

Finally, together with the form principle concepts, implementations into dress designs will accompany the presentation of the principles. This gives an idea about how such a dress might make use of the form principles to be able to complete the initial project goal. These implementation ideas in the end will be used to make the final decision about which form principle is the most feasible to be put into final designs. All the dress designs are presented in appendix 5. Their inspiration is presented in appendix 7.



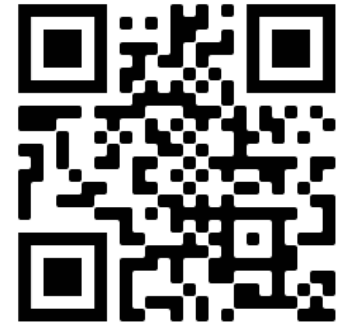
## 3.2 Form principle designs

### Concept X01 'Strings'

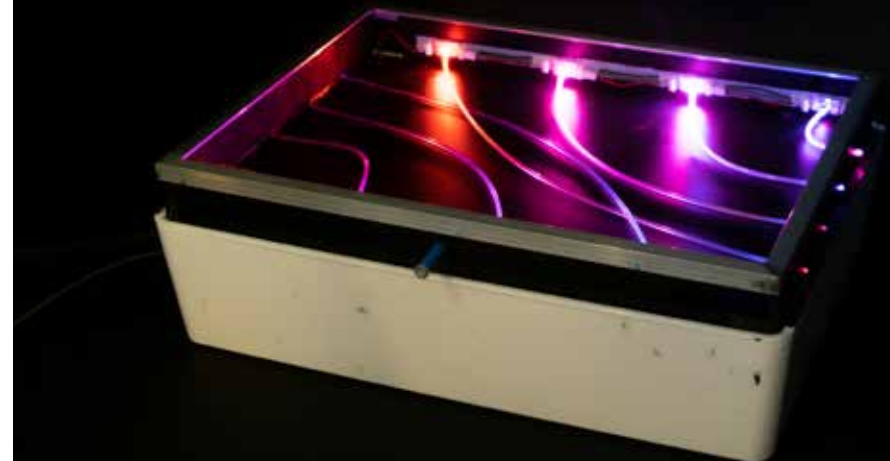
Concept X01 makes use of fiber optic wires, that are able to transmit light all the way through the wire when the source is connected to a LED. This creates an optical pleasant effect as the light travels through the wire evenly, but slowly dims. The parts where the LED's are mounted can be moved. In this way the pattern adjusts to show the two different states.

The subtle state presents a warm colour, all wires showing the same colour. The wires show a straight and evenly distributed pattern.

The right picture shows the expressive state. The single colour is changed into a rainbow like distribution of hues of red and blue. The mounts of the LED's are moved and creates a more organic and expressive pattern.



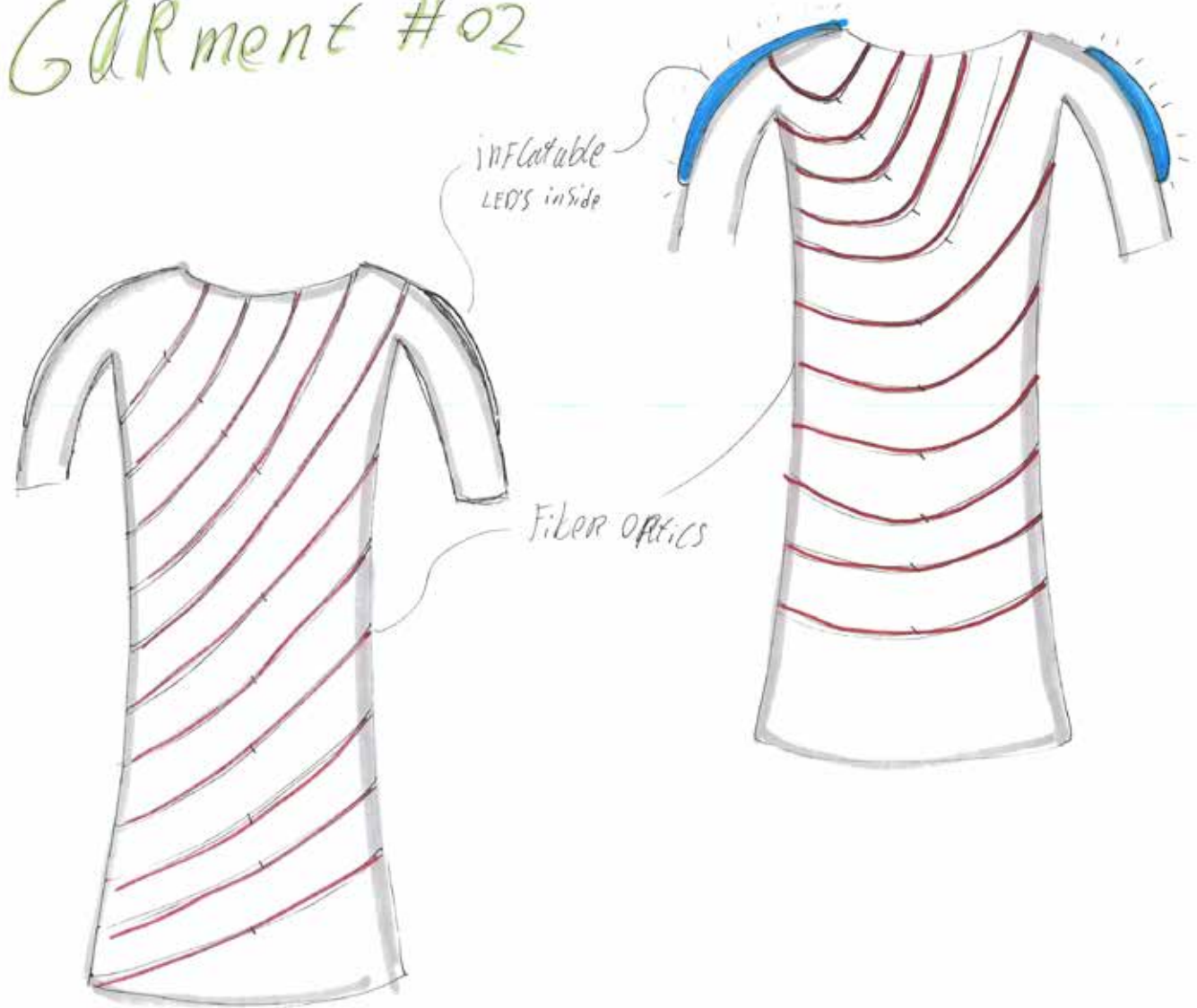
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The dress integration of concept X01 spreads out the fiber optics on the complete surface of the dress. From top to bottom, the wires are stretched out to give the dress the full aesthetic of the initial form principle concept. The wires can be moved up and down from the left side of the dress. They change pattern from a linear one to a curved one, representing the subtle and the expressive state respectively.

The design also incorporates inflatable detailing on the shoulders, which can be inflated to broaden up the shoulders to become more expressive. This is based on the form principle concept X02 presented on the next page.

## GARment #02



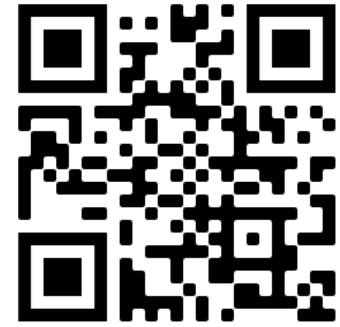
## 3.2 Form principle designs

### Concept X02 'Dome'

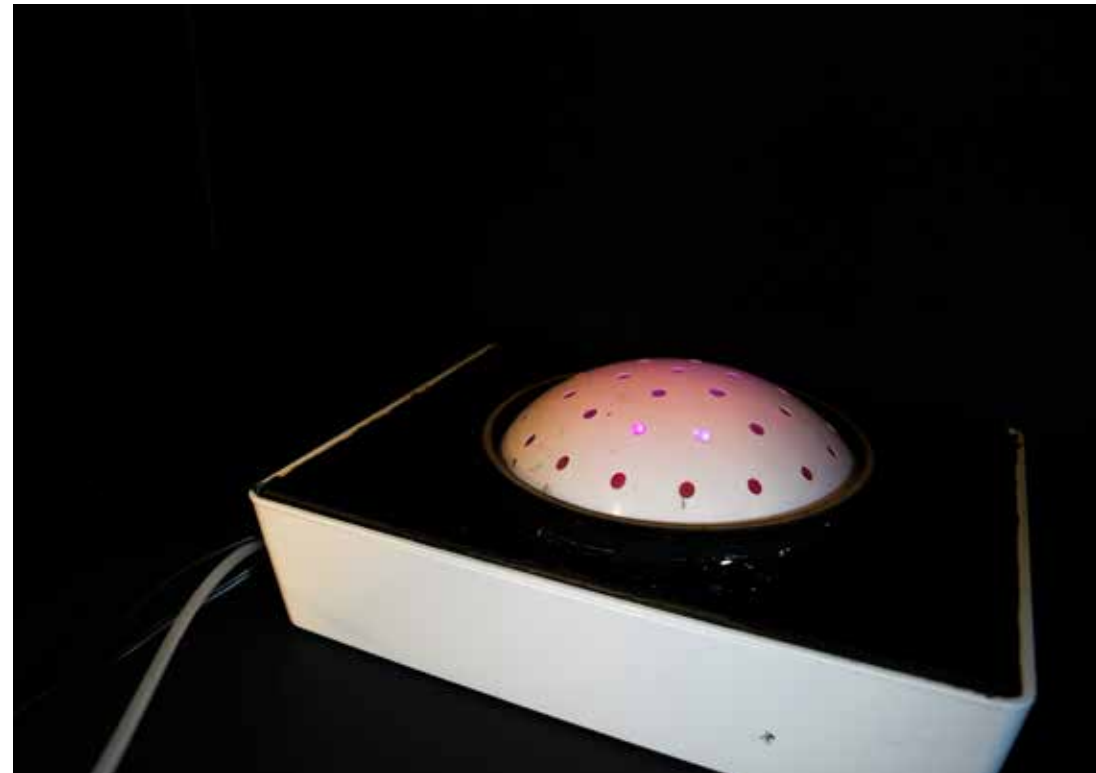
Concept X02 showcases the transition of a silicone surface to a inflated dome. A LED ring hidden underneath the surface helps highlighting the state the prototype is in.

The picture on the left shows the subtle state. The dome is almost completely deflated and the LED ring shows a pattern of a slowly rotating white line.

The right picture shows the concept it's expressive state. The silicone dome is almost completely inflated and the LED ring shows a constantly changing and moving pattern of rainbow colours.

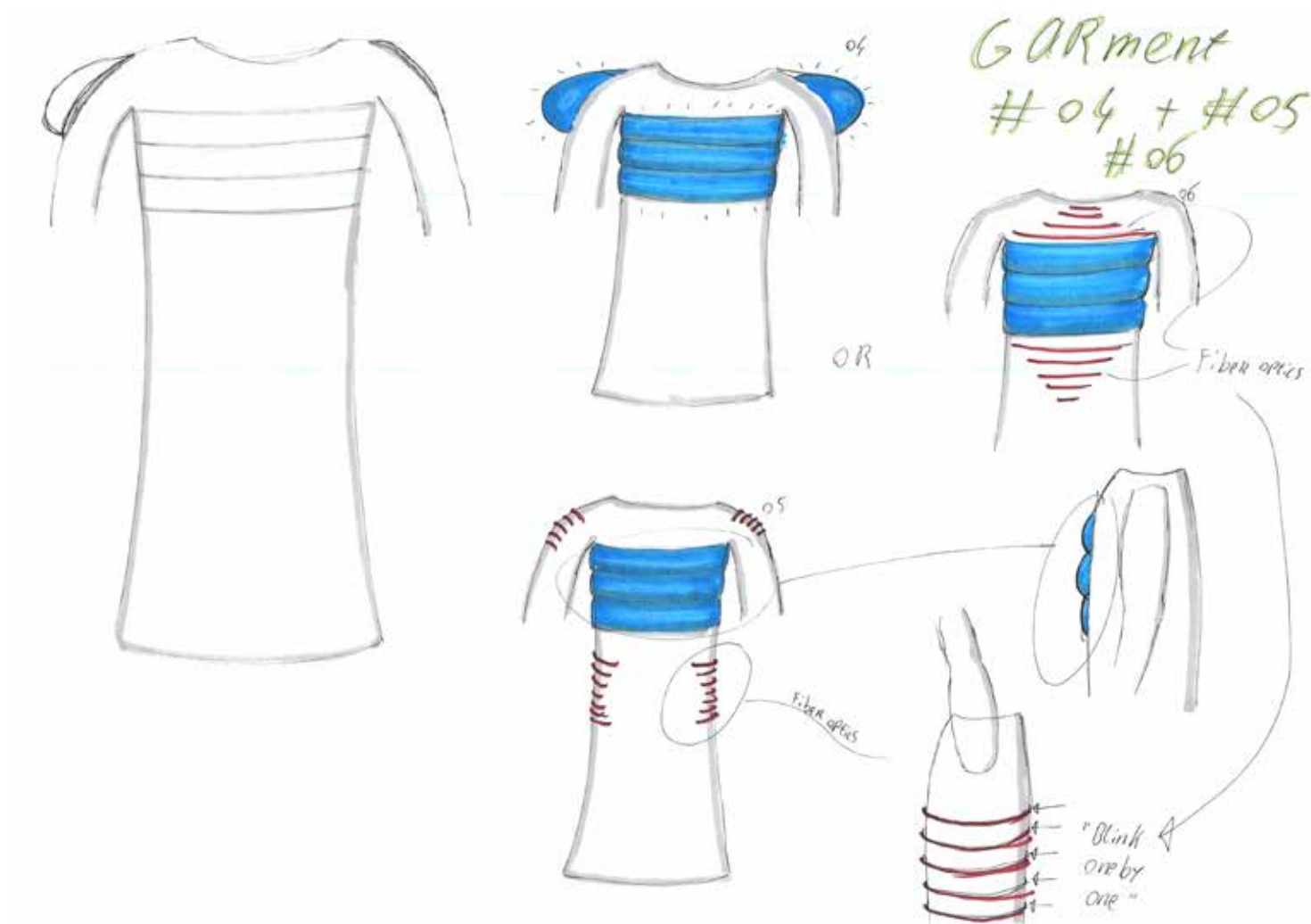


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This garment integrates inflateable shapes from the form principle concept X02 on the chest and shoulders, and are accompanied by fiber optics to highlight the shape of the body. The parts of the body on which the inflateable shapes are placed are known for showing non verbal communication through body language (Mehrabian, 1968/1969). When becoming bolder, the parts of the body show a different expressive state than when being timid.

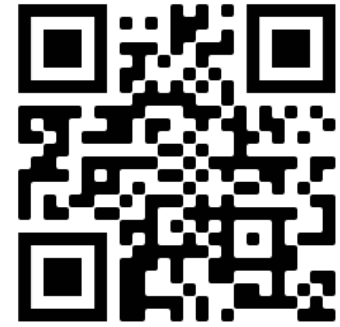


## 3.2 Form principle designs

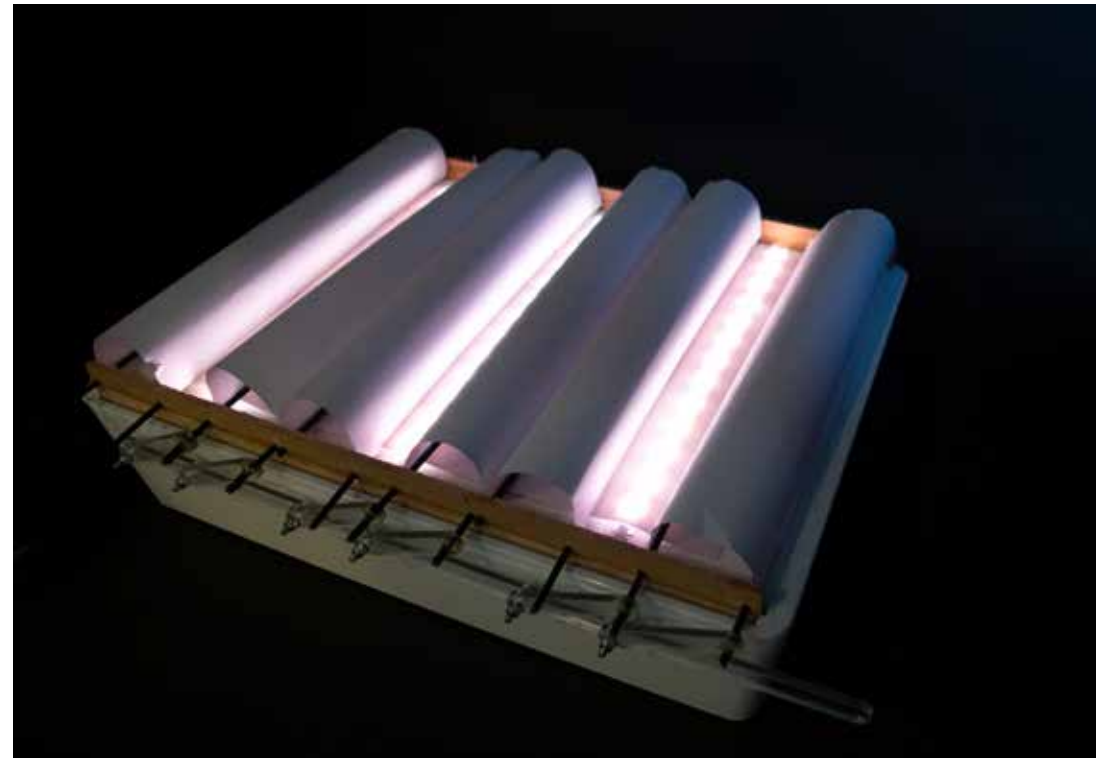
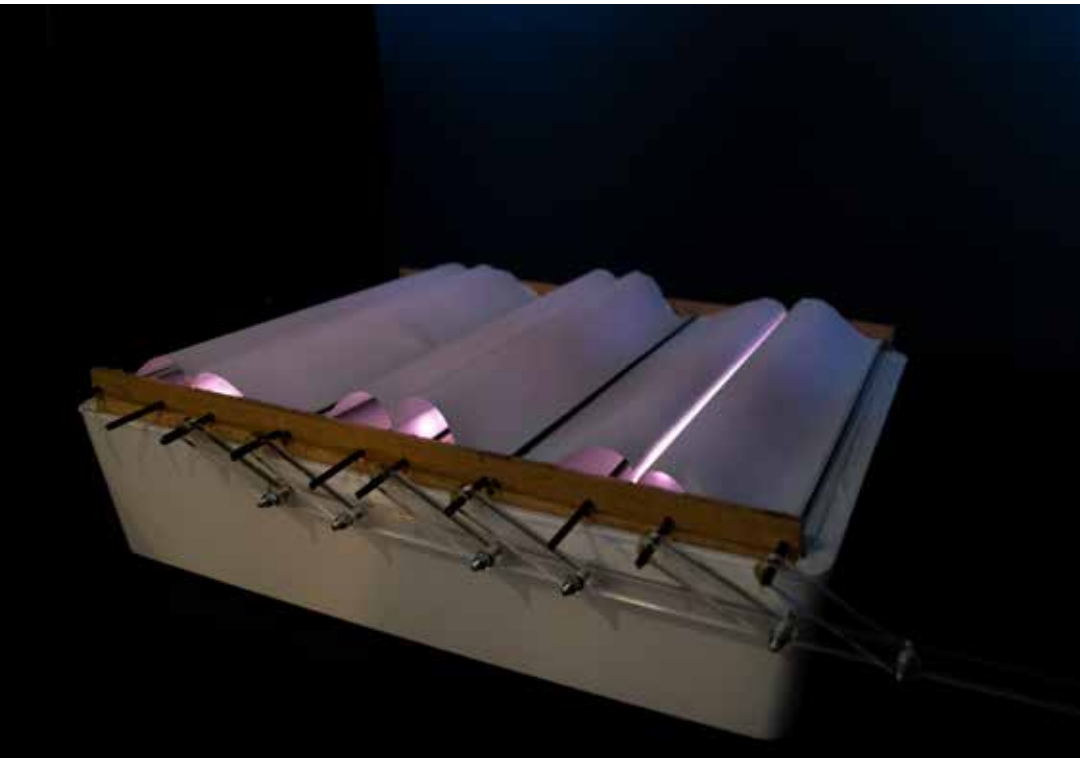
### Concept X03 'Waves'

The wave-like 3d pattern of concept X03 shows an organic form covering LED's. The pattern is made from simple printing paper, connected to PVC rods. The rods are alternately connected to a large lever, so they can be rotated simultaneously, both sides counter to each other. In this way the first, third and fifth "wave" can move the opposite direction of the second, fourth and sixth.

The picture on the left shows the subtle state. The pattern is organic and covers the LED's, only letting a little light escape. The expressive state of the concept, presented on the right, highlights the transition from an organic flow of the pattern to a little more aggressive and expressive. Because the pattern is more open, it fully shows the LED's hidden underneath. Both the expressive flow and the bare LED's complement the aimed expressive state.



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for video



This dress, like in the dress based on form principle concept 1, spreads out the patterns created in the form concept on the full surface of the dress. It follows the 360 perimeter of the human body. It makes use of the same technical operation as the principle concept.

Though, the design on the top has a slight different outlay of the 'waves' than the one on the bottom. The top dress has the exact same dual opposite wave outlay as the form principle concept, but the bottom dress has a single wave outlay. In both dresses, LED's are placed between the waves. This means the bottom dress has twice as many expressive LED's compared to the dress on top side.



# 3.3 Validation

What makes a design feasible? How do you decide on what principle is the best one? In the case of my form principle studies, how do I decide which one will work the best, proves it's principle and proves the best transition between the two expressive states?

Together with the graduation board and the team from Jasnarok, I held a meeting to show the different form principles and to discuss about the dress designs that integrated the form principles. The goal was to find out which form principle works best in the dress design and that is best made to complete the project goal.

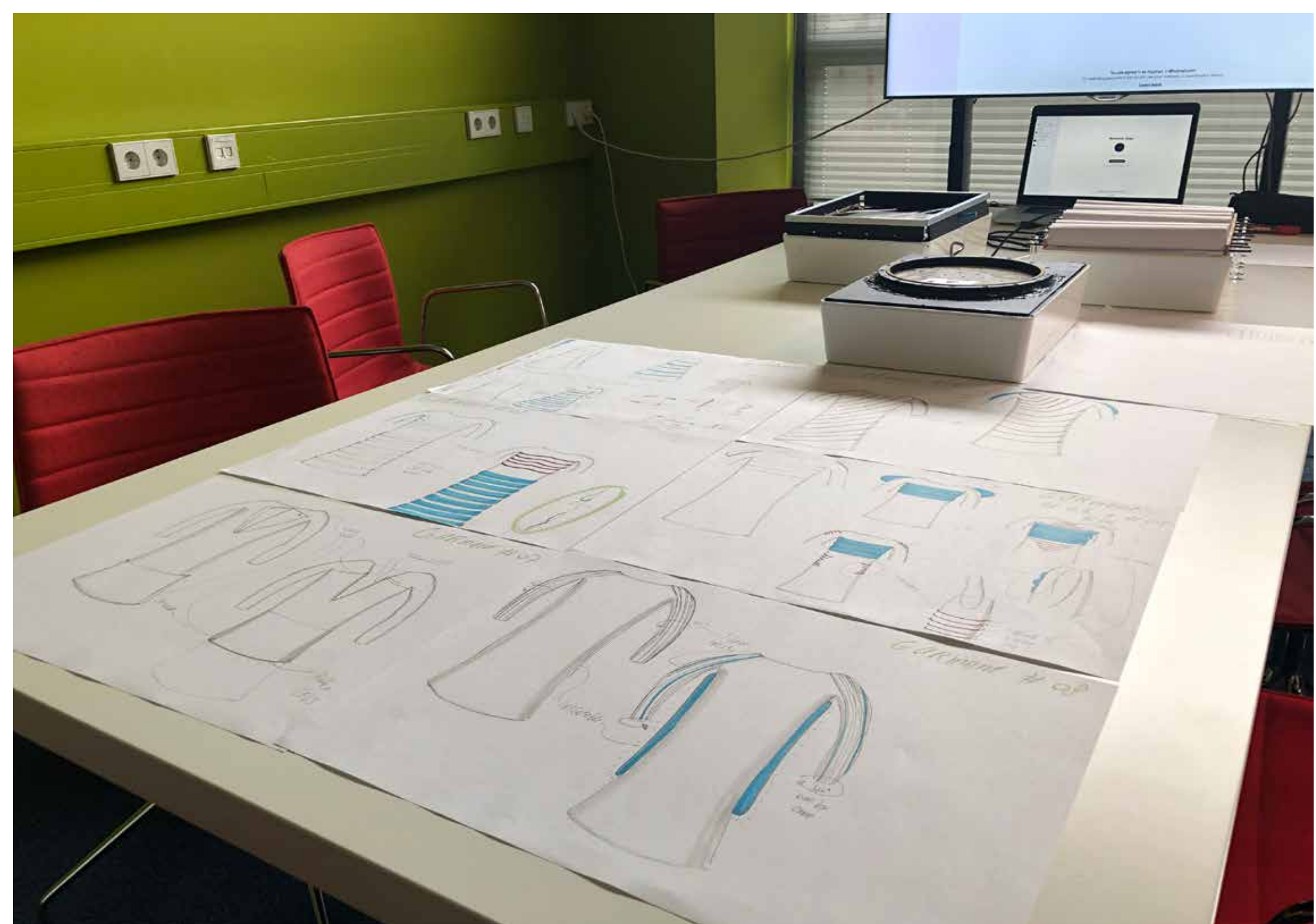
There was no specific topic of discussion, but we discussed about a few main topics:

- **Level of realization**
- **Amount of time it takes to be realized**
- **Level of innovation**
- **Aesthetic quality**

On the basis of these topics, me and the team decided on choosing concept X01 'strings' as the most promising principle to continue with in the design process. The design of the dress also promised great results as the team from Jasnarok found working with fiber optics the most innovative fashion tech principle.

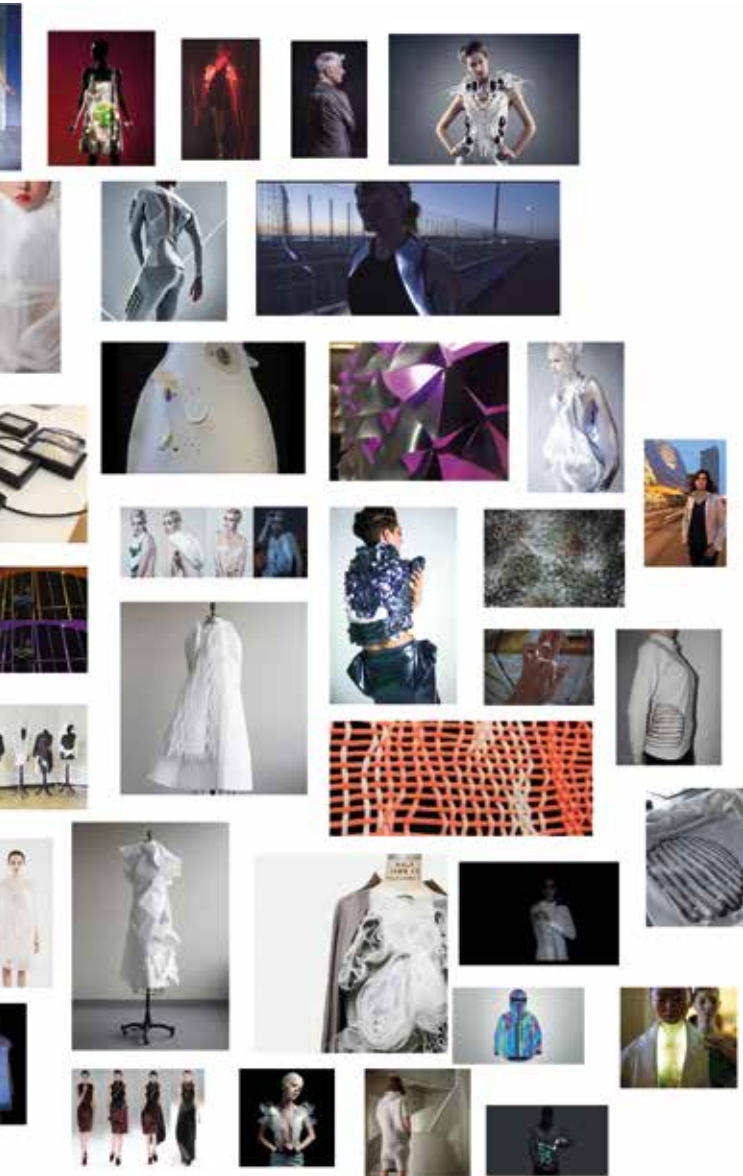
The approach of the dress design is iterative, which means the design will change during the prototyping phase.



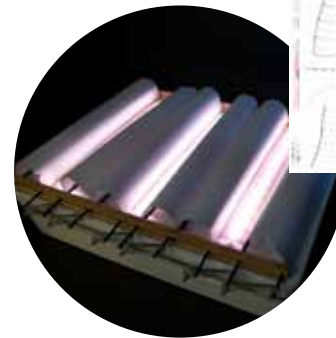
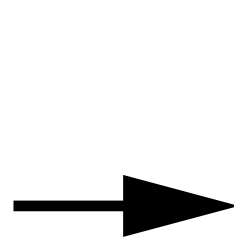




# Techno Fashion benchmarking

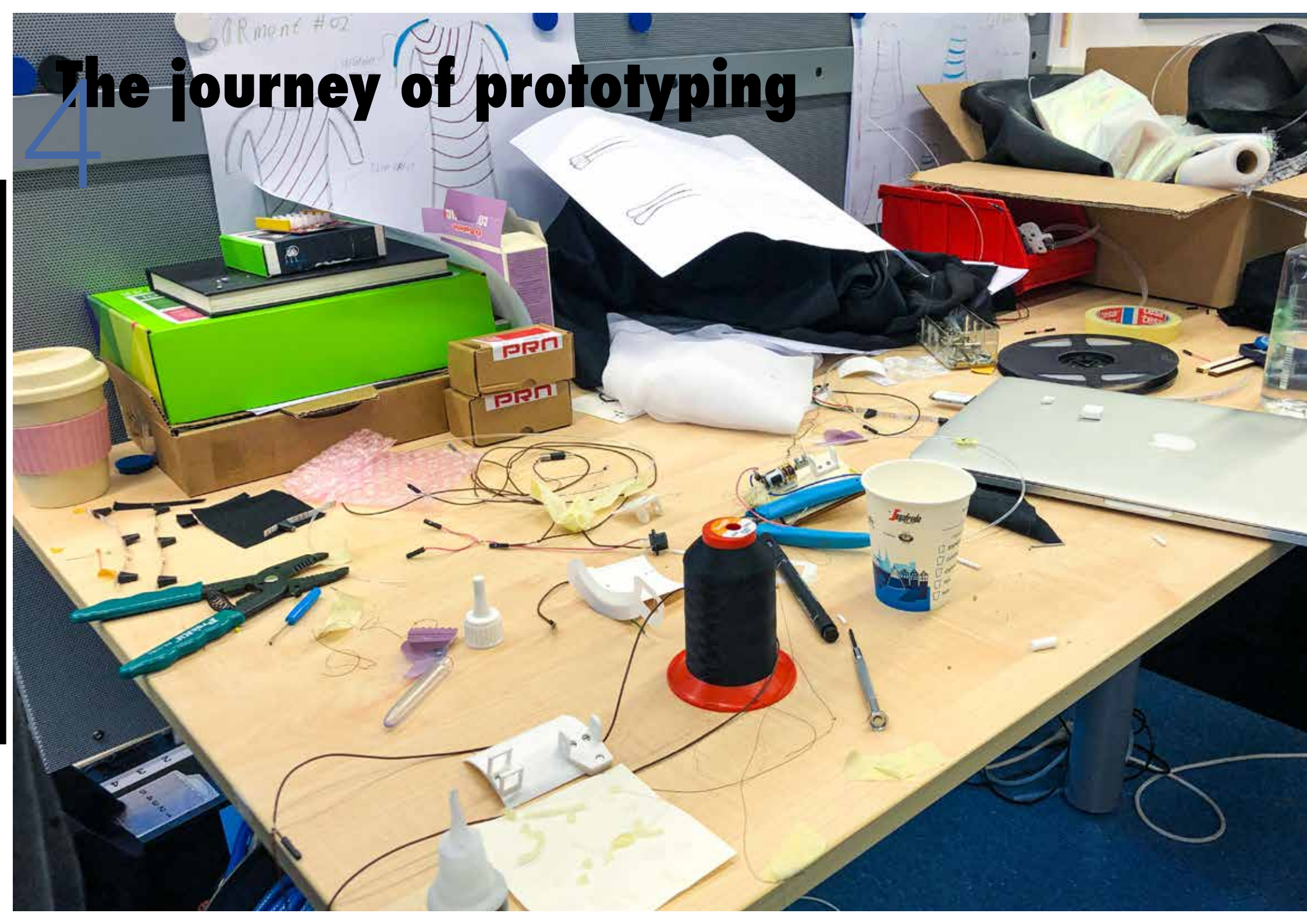


# Vorm principle and dress designs



- The visual design characteristics, that show the two opposed emotions calm and joy show expressions of subtlety and expressiveness respectively
- Techno-Fashion benchmarking show ways of designing physical elements that can dynamically change between the two expressive states.
- The subtle and contrasted expressive visual elements, and the ability to change from one state to the other, are presented in 3 form principle concepts, together with implementations in dress designs. The fiber optic concept 'strings' has been chosen to be worked out for the final design

# 4 The journey of prototyping





# 4

This chapter will show physical prototyping of the design elements of the dress and form principle concepts, presented at the end of the previous chapter. The design of the dress, presented together with the form principle concept "Strings", will be the start of the prototyping phase, as the goal is to start realizing that design.

To present the findings during the prototyping phase, the most significant moments will be presented in a visual journey. As this project is part of the "Design for Interaction" master discipline, and not "Integrated Product Design" oriented, the focus on this project was not put on researching technical detailing of a product, but rather on the interactive side between the product and its user. Though, a large part of this project was about prototyping, so it's important to show the journey and its most significant moments.



# 4.1 Prototyping roadmap

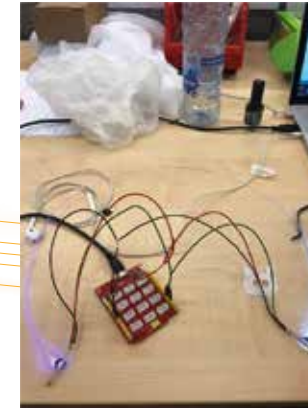
The first part of the prototyping roadmap presents the initial explorations and tests of integrating fiber optics into fabrics, and arrangements on a test dress. Furthermore, it was important to see how these fibers could best be lit, and to think about integrating the lighting source.

Also, an initial look was taken at how to create an element that can physically move, and that creates a cool expressive element. What are feasible arrangements, and how can this be made possible with electronics. At the end of this roadmap, an idea about what is possible and what arrangements are feasible should be clear.

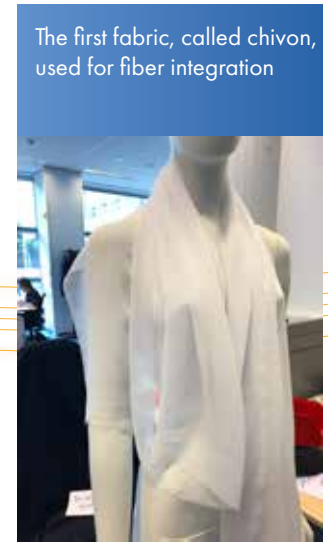
## Part 1. First prototype tests



Bought the first test dress



Testing the first fiber optic cables



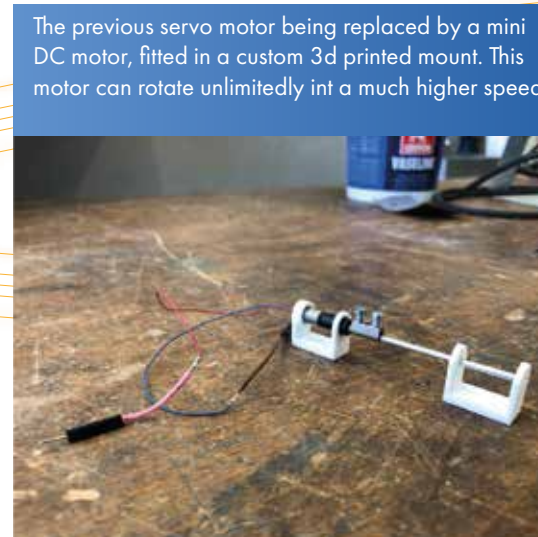
The first fabric, called chivon, used for fiber integration



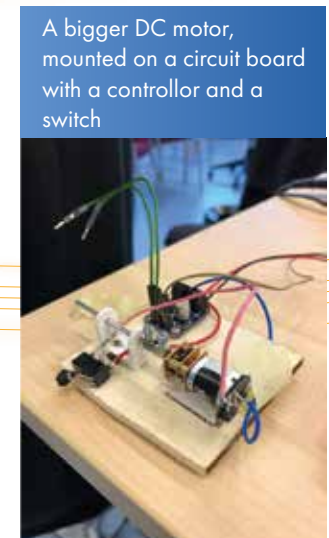
Newly designed and 3d-printed LED mounts for a stronger light emission



Fitting of the LED strips on the back spine of the dress, as a hidden set-up



The previous servo motor being replaced by a mini DC motor, fitted in a custom 3d printed mount. This motor can rotate unlimitedly into a much higher speed



A bigger DC motor, mounted on a circuit board with a controller and a switch



Integrating the optics in the chiffon fabric



First result of fiber optic cable integrated chivon



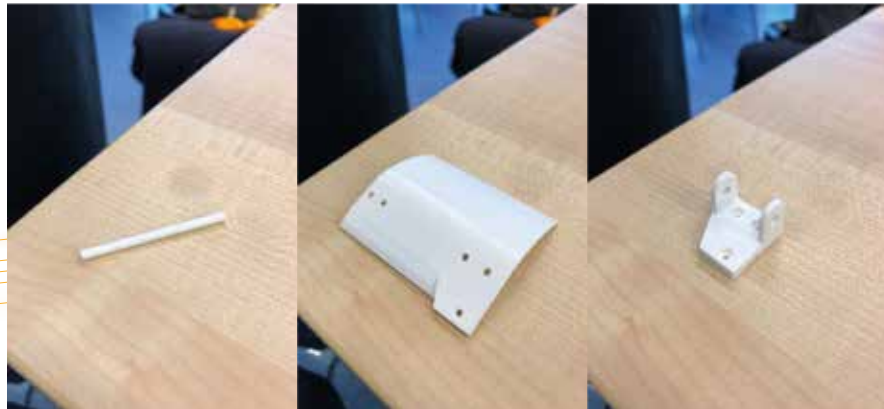
The first set-up. Placement of the fabric attached to a small motor



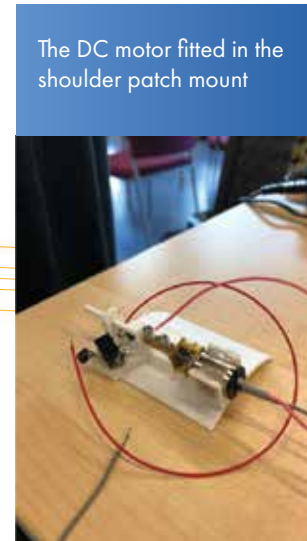
Trying the set-ups with attached LED's to the back ends of the cables



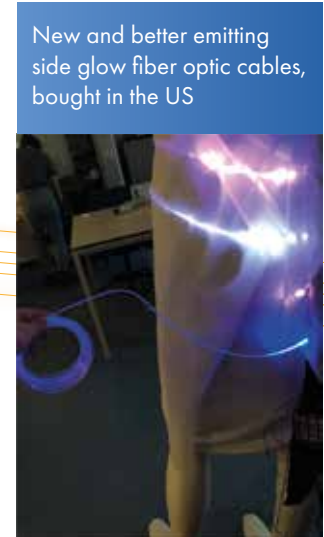
A new set-up, with twice as many lights to have a stronger light diffusion. Also, 2 motors are attached to the middle part for symetrical movements



The last DC motor was chosen, so a custom circuit board mount was designed and 3D printed, so it can be integrated into shoulder patches on the dress



The DC motor fitted in the shoulder patch mount



New and better emitting side glow fiber optic cables, bought in the US

## 4.1 Prototyping roadmap

The result of the first roadmap showed what was technically possible. Now it is time to think about the final design. A new dress was bought, with a new colour and silhouette. The new look and color was chosen to better match the subtle, less expressive state of the final design, as well as a better 'canvas' on which visual elements can be implemented.

In this roadmap, last visual elements were tested for it's desired effect, and final decisions on the dynamically moving element were made, based on it's feasibility to be finished on time.

As a results of this chapter, all the aesthetic and technical elements and arrangements for the dress should be clear.

## Part 2. Final prototype tests



A new dress, in a new colour, for the final design



Tailoring the dress in a more modern look

Trying out different top layers of chiffon, to see what kind creates a nice and subtle effect with the lights put underneath.



The fitting of the full LED strip in a self created lining in the dress, some fitted with an optic wire



Custom designed and 3D printed mounts for the front part of the dress, meant to align the fiber optic into arrowed patterns



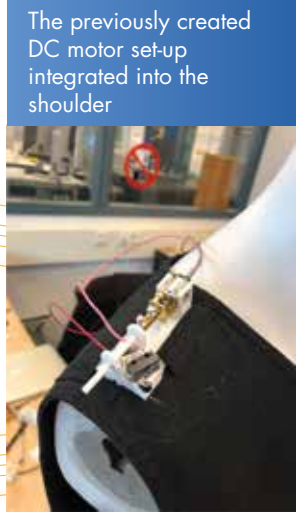
The guiding mounts fitted on the dress, with the first fiber optics aligned



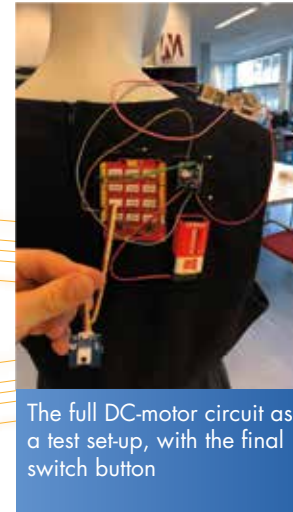
The first rough alignment of the fiber optic wires



The decision was made to not integrate the fiber optics in the fabric, but rather fixate the optics and the LED's in the dress itself, and cover the lights with fabric that can be moved



The previously created DC motor set-up integrated into the shoulder



The full DC-motor circuit as a test set-up, with the final switch button



The final designed LED mounts fitted on the final LED strip



The second rough alignment, powered by the LED's



Newly chosen fabric, draped as a top layer of the dress



Trying out different folding methods of the top layered fabric. As told before, the decision was made to make the top layered fabric as the dynamic element. The previous image represents the subtle state. These three present the expressive state.

## 4.1 Prototyping roadmap

All the aesthetic and technical elements are chosen. In the final part of the roadmap, the chosen elements are integrated and tested to complete the final design. Finally, to be able to make the final design even more technically feasible, together with the electronics staff of the faculty, the needed electronics hardware were gathered, the undesired elements stripped and a blueprint was made. This should complete the full design of the final product, presented in the next chapter.

## Part 3. Final prototype assembly



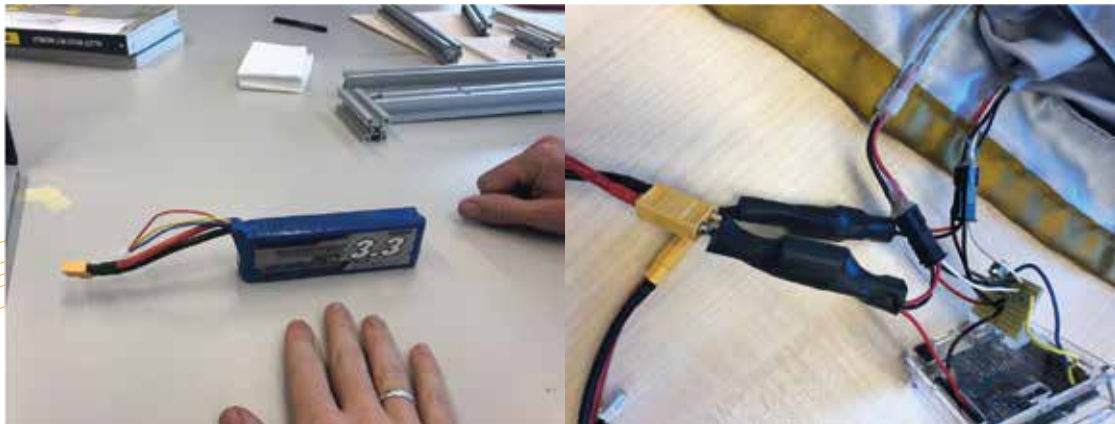
The final alignment and set-up has been completed. This shows the two states the dress can dynamically change into



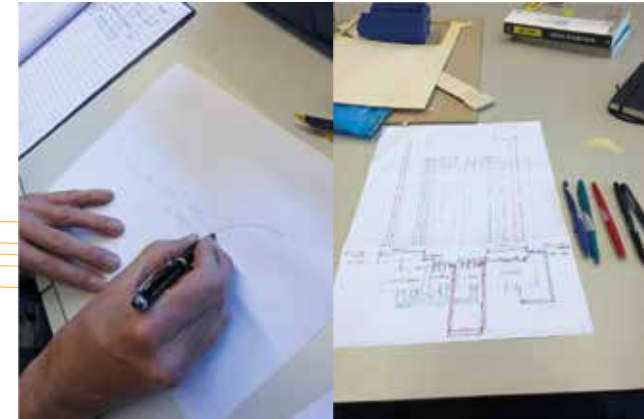
Same set-up, but shot with the lights in the room turned off.



The alignment, but slightly better directed on the front part of the dress. They have been stitched with small see through wires.



The final parts of the electrical circuit, chosen together with the electronics staff. The battery is shown on the left picture, and other conversion parts on the right. This should complete the full powering parts of the integrated dress.



Finally, the full electrical circuit, with all the parts, wires and ordering, drawn out on paper. This should be the guideline for making the final dress design

## The pattern design of the dress

As can be seen, the fiber optics integrated in the dress are shaped in a certain pattern. This arrangement was the consequence of a small design process, drawing different patterns inspired by the designs of fashion labels Issey Miyake and Comme des Garçons. The designs, and the inspiration, is presented in appendix 6 and 7.

- The first prototyping roadmap showed first designs and technical explorations
- The second prototyping roadmap showed explorations for design elements, meant for the final design
- The final roadmap showed the chosen design elements being integrated on the final dress design, together with a worked out electronic blueprint
- In the next chapter all the design en technical elements will be presented

# 5 The final design





# 5

What does the final design of the dress look like? After researching different design elements, techniques and combinations in the previous chapter, this chapter presents the final chosen formation of design and technique.

First a small research is done about what colors the LED patterns should show to represent the two different expressive states and their emotions. After that, all the design elements are shown and explained, continued by an explanation of the electrical and mechanical components. The full chapter gives a complete presentation of everything that have come together in the final design.



# 5.1 Color research

The integrated LED's, and particularly their emitting colours, are one of the most important design elements of the dress design. According to D'andrade et al., there are assumptions that colors have esthetic value, but foremost have some degree of emotional value. The last part is of course interesting as that applies to the two states of the dynamic dress appearance.

But what colours should the LED's emit to represent the emotions that are part of the two expressive states? Some research has been done to see how the hue, saturation and brightness of colors affect the emotions perceived by the user. This research is presented here, and analysed to see what colours match the emotions of the subtle state, like confidence, calm and serene, and the emotions of the expressive state, like joy, pleasure and cheerfull.

Terwogt & Hoeksma (1994) start with the preferred western adult colours, which are blue, red and green. White, yellow and black are less preferred. Odbert et. all. found that some colors best suit certain moods. It was found that red goes with "exciting", yellow with "playfull", green with "tender" and blue with "sad" and "solemn". Moreover, Wexner (1954) adds that red is associated with "exciting" and "stimulating" and blue with "secure/ comfortable" and "tender/soothing"

But eventually D'andrade & Egan (1971) show that "the emotional associations usually found with "color" do not seem to be due primarily to the actual hue, or light wavelength involved, but to the degree of saturation and brightness". This makes green restfull because it's unsaturated, and red vibrant because it is saturated. That statement is used to find the colors that should represent the two expressive states. The research of Valdez and Mehrabian (1994), called "Effects of Color on Emotions", presents a study that investigates the emotional impact of color saturation and brightness. Other studies in their research confirms the statement of d'andrade et. all., by providing "highly consistent evidence regarding strong and highly predictable relationships of color brightness and saturation to emotional reactions. In comparison, relationships of hue to emotions were surprisingly weak."

The evidence in their research show a few usefull relationships: more color brightness and saturation influences more pleasure. More color saturation increases dominance, but is decreased by more brightness. Also, their findings also present "consistent patterns of response to cool colors (low saturation, high brightness) versus warm colors (high saturation, low brightness)", where "warmer colors induce greater activity" (Hogg, 1969).

All these findings are concluded on the next page by bringing together the found relationships, and choose the final color characteristics that match the two expressive states of the dress. The colors are chosen with the help of the color wheel of Adobe Color.

## Expressive state colors

Red (exciting, stimulating, vibrant)

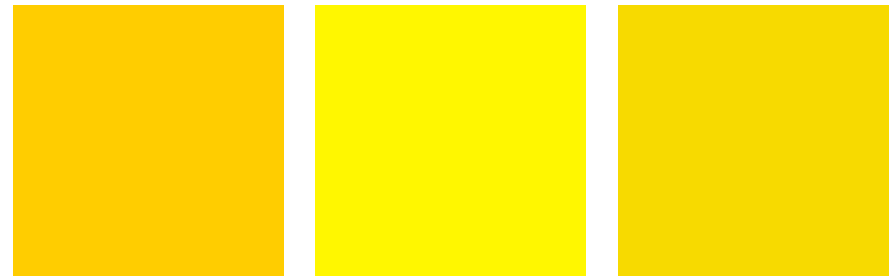
Yellow (playfull)

More brightness, more saturation (pleasure)

More saturation, low brightness (active)

### Emotions:

Exciting, playfull, stimulating and vibrant



## Subtle state colors:

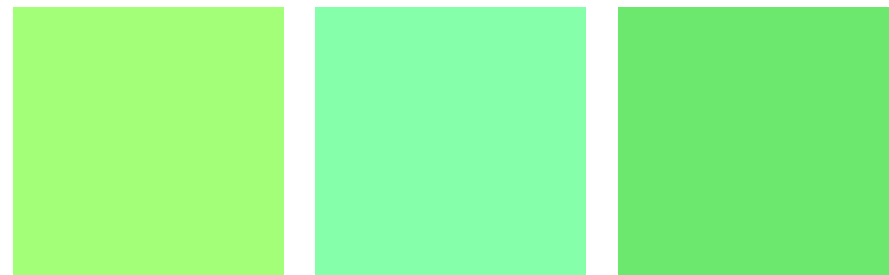
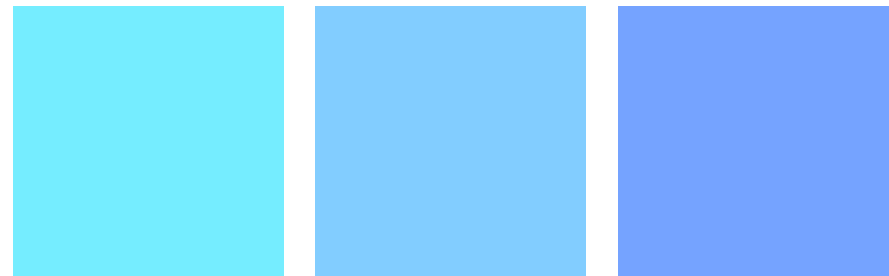
Blue (secure, comfortable, tender, soothing)

Green (tender, restfull)

Low saturation, high brightness (calm, cool)

### Emotions:

Secure, comfortable, tender, soothing and restfull



## 5.2 Design details

Finally, what does the final design look like? The visual presentation of the dress is extremely important because it represents what the wearer would like to express. Moreover, it should clearly show its influence taken from the design vision. Finally, it should show that it is based on previous findings and research, like the emotion research and the form characteristics concepts. What visual elements are presented in the final design and where do they come from?

This garment should present visual elements that reflect the desires of its wearer. These visual elements are based on research findings, but also on the designer's competence. The difficult task about designing visual characteristics is that they are subjective, especially in a design which main function is to visually express. When describing the design details in this chapter, I've tried to mainly focus on showing the backing of the visual characteristics.

The main proof of this design is not particularly the likeability of its aesthetics, although of course it's still an important element, but foremost whether the characteristics are matched with the two expressive states. In other words, the design should prove it can visually dynamically change from a subtle state in an expressive state. Again, when presenting the design elements, I will mainly try to focus on that.

This chapter is split into three parts, presenting the two states and the static design elements. Finally, the two "state" parts are presenting the two visually changing elements: The lights and colors (LED's) and the mechanically changing silhouette.



## 5.2 Design details

### The subtle state

The subtle state represents emotion such as assurance, secureness, relaxed and serene. The subtle state of the dress is meant for the user desires to be less expressive and more modest, without looking or feeling insecure and fragile. The whole look is based on the non abrupt and modest shapes and hues taken from the characteristics research.

#### The represented emotions:

##### Confidence

- Confident
- Assurance
- Secure
- Trust

##### Relaxation

- Relaxed
  - At peace
  - At ease
  - Comfortable
  - Peacefull
  - Light hearted
- Carefree
  - Placid
  - Serene
  - Tranquil
  - Easygoing
  - Calm

### LED's and lighting

The fiber optics that transfer the light and color around the dress are ordered in a simple and alligned pattern, creating a visually easy understandable effect. Initial patterns were designed, and are presented in appendix 6.

The color brightness is set to 100%, and present blue hues with a fair amount of saturation, based on the colors presented on page 75.

The colors dynamically change when being in the subtle state. The blue hue will very slowly flow in a more green hue, and back. That makes the dress still visually dynamic, and creates a little serene confidence without being too at ease.



## The silhouette

The silhouette of the dress in the subtle state presents a simple, minimalistic and enclosed shape. This creates a silhouette without many visual details in order to make it more modest and subtle.

Moreover, the front part of the dress is made from a little stiff and shiny fabric, and covers the lit fiber optics entirely. The fabric diffuses the lights a little bit, giving it a comfortable, calm but interesting look.



## 5.2 Design details

### The expressive state

The expressive state is meant, as the name might suggest, for when the wearer desires to be more expressive and to express their joy. The emotion represents playfulness, pleasure and enjoyment. In contrast to the subtle state, the user desires not to be modest but to express the happy feelings and moods. The complete visual appearance present abrupt changes and dynamics, and vibrant colors, taken from the characteristics research.

#### The represented emotions:

##### Joy

- Joy
- Bliss
- Overjoyed
- Pleasure
- Happy
- Good
- Delighted
- Wonderful
- Rejoice
- Smile
- Cheerful
- Enjoyment

### LED's and lighting

With the push of a button, the user can change the outfit to the expressive state. Twice as many fiber optics are lit, and the 8 simply aligned fiber optics from the subtle state are combined with 8 more arch-like shaped fiber optics lines. When lit altogether, the full patterns shows a more expressive behaviour, inspired by the designs of Issey Miyake (appendix 7). Just like the subtle state design, initial designs were drawn, and are presented in appendix 6.

The brightness is set to 100%, but compared to the subtle state, the colors are more saturated, showing pleasure. The colors uses red and yellow hues, and dynamically change brightness to make it visually more expressive.

Finally, dynamic patterns show transitions between yellow hues and red hues. The dynamics are more vibrant than in the subtle state to highlight the expressiveness.





# The silhouette

The fabric on the front, showing an enclosed and simple silhouette, part of the subtle state, has transitioned into a vibrant and flamboyant folded shape on the top part of the dress. The top part of the body is often used to become more expressive (Valdez & Mehrabian, 1968/1969) and therefore is used to make the dress more expressive.

Again inspired by designers such as Issey Miyake and Comme des garçons (appendix 7), when choosing to become expressive with the push of a button, the fabric is pulled up by small motors to be draped in a 4 fold shape. When the button is pushed again, the fabric retracts back to the subtle state enclosed silhouette.. Multiple fold shapes have been tried, and are presented in appendix 8.



## 5.2 Design details

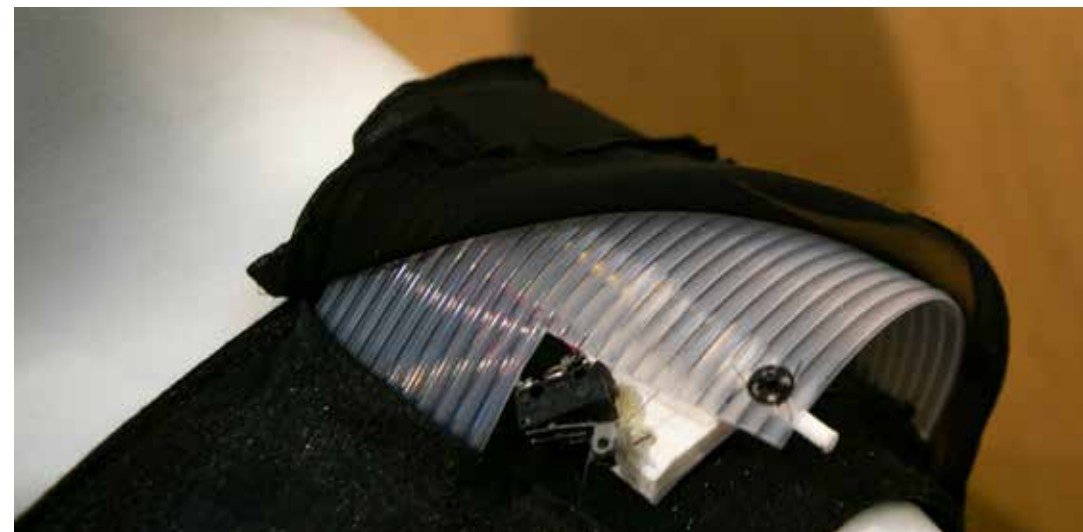
### The static design elements

Some of the design elements of the dress are non dynamic, and are added to make the dress aesthetically more appealing. For instance, parts of the dress are used for hiding or complementing the technical elements. On the next pages these elements are presented.

#### Shoulder patches

The shoulder patches are originally meant to cover up the motor mechanics that pulls up and down the fabric when transitioning between the two expressive states. It was desired to not show the mechanics too much, as the dress is very much meant to be worn in public and social environments. The dress aesthetics should not be too technological, like for example seen in robots, but more accessible.

The mechanical motors are covered with ribbed plastic sheets for protecting the motors against the fabric that is put on top of the sheets. The fabric is the same used around the main body of the dress, to function as camouflage. This gives the dress a more accessible look. Though, the shoulders are still notable, and gives the originally simple dress interesting details.



## The dress body

The fiber optics are integrated in the main body of the dress. To be specific, they are put in the spine of the dress, and are held in place with small stitches. To cover these functional details, Chiffon fabric is draped around the dress from the armpits down, to cover all the fiber optics.

The fabric is mostly see through, but very modestly diffuses the light. In this way the technical details are hidden, but the fabric creates an intricate effect, also adding finishing to the dress. Because the fabric is also black, it is camouflaged, but adds a modest detail.



## 5.3 Technical details

Besides the visual effect of the dress, it was also important to prove that those effects can dynamically change, and that creating the dynamics are technically feasible. Although mentioned earlier, the project is mostly about interactions, the technical, mechanical and electrical elements that provide for these interactions are very important to be mentioned. These elements are presented in this part of the report.

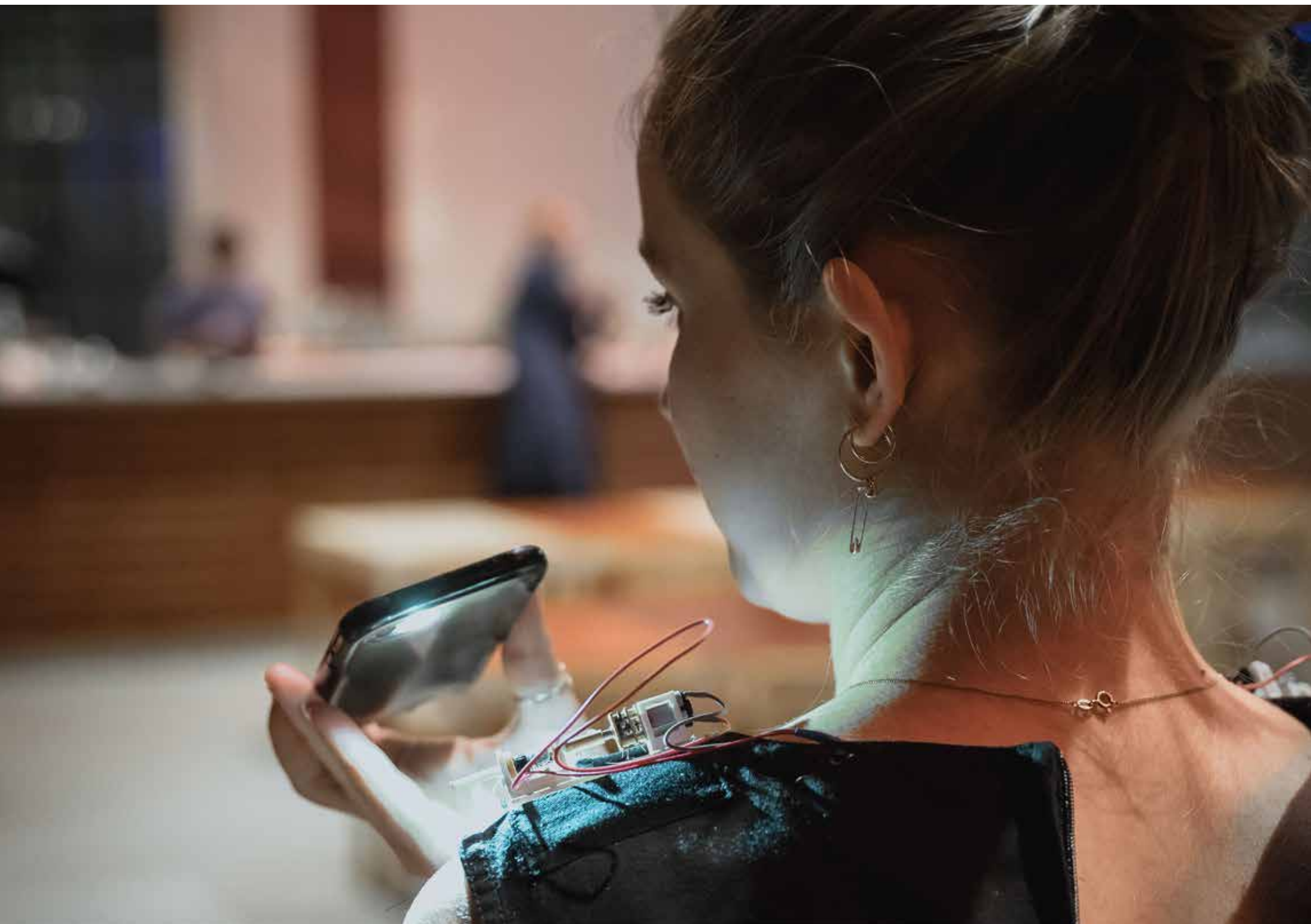
This project makes use of Techno-Fashion to create a desired effect for expressing emotions. The garment should be a statement about how Techno-Fashion and integrated technology can help achieving that effect. It should create a benchmark about what technologies can be used to create those effects, that contributes to current Techno-Fashion innovations.

The technical elements are a result of the Techno-Fashion benchmarking shown in chapter 3.1, page 50 and from the prototyping roadmap shown in Chapter 4. All the elements are thoroughly tested and iterated until it contributes to creating the desired visual effect. It was also important that it kept working after trying it out, but foremost it must be worn by an actual person! This was a big challenge, making sure the integrated technology was wearable.

Finally, most parts and fittings are designed to be easily replaced by new parts, or to be taken from the dress when in need for inspection, like the motor mounts and the controlling circuit.

This chapter is split up into two parts. The first part shows the lighting elements, and the second part shows the mechanical elements. The last part shows the controlling electrical circuit and the wiring map. All the parts present what elements are used and what they do.

A more detailed description of all the different materials used and the techniques used to integrate is presented in appendix 9.



## 5.3 Technical details

# The lighting elements

The lighting elements are the main part that contributes to the color of the dress. The lighting elements consists of the LED strips, 3d-printed mounts and the fiber optics. Together they are integrated in the dress to minimize visible technical elements and to maximize expressing light and color, in order to give the dress different programmable hues. The different elements are explained below and shown on the next page.

### LED strips

The "Adafruit Mini Skinny NeoPixel Digital RGB LED Strip" are digitally-addressable LED pixels. The pixels are fully individually programmable using an Arduino controller, and can give full RGB hues in adjustable brightness. They come in reels of 60 LED's per meter, and can be cut to desired lengths. In this case two LED strips of 16 LED's per strip were cut. Each strip lights one side of the fiber optics to create a coherent hue. Finally, at the start of the strips 3 electric wires were put to be able to send data, and for powering and grounding the electricity. For reinforcement, on each connection between the pixels a little tape was wrapped around so they don't break that easily when bend. The LED strips with their 3D-printed mounts are integrated in the lining in the spine of the dress.

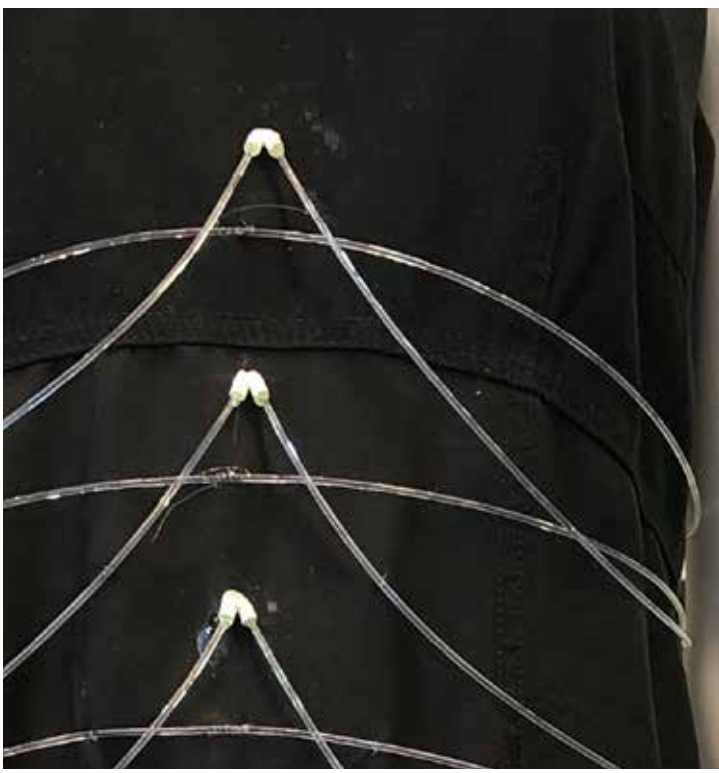
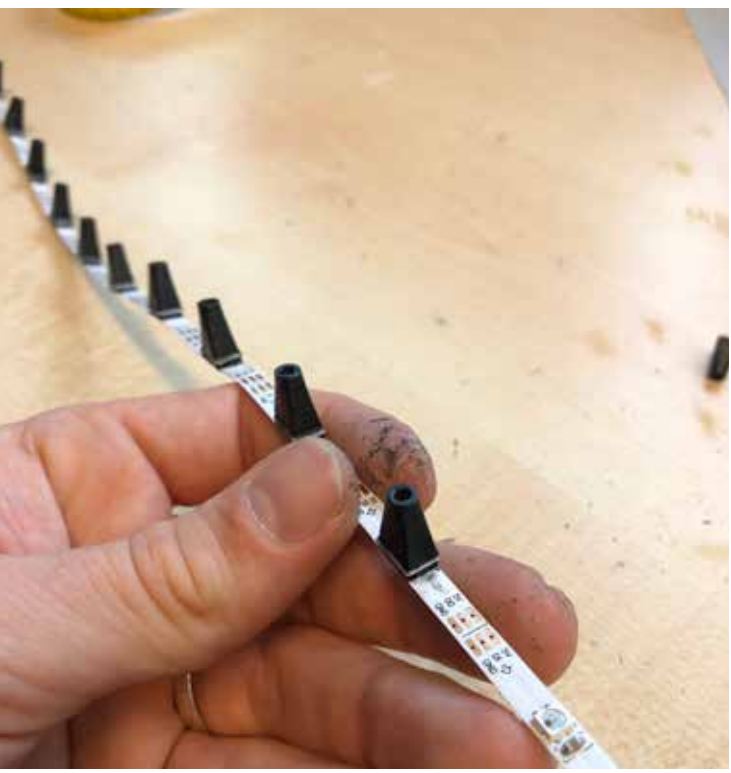
### 3D-printed mounts

To be able to mount the fiber optic cables on the LED strips, little mounts were needed. Another reason was to effectively guide the light through the optic cables, without losing light to it's environment. The mounts were customly designed using CAD software, and 3D-printed. After, black spraypaint was used to cover them so they don't lose light through the material. The mounts are mounted using fast-acting super glue.

### Fiber optic cables

Fiber optic cables originally are designed to transfer light containing data from one end to the other as efficient as possible, without losing light. These cables, called side glow fiber optic cables, lose a lot of light during it's travel through the cable, causing the cable to glow. That makes it possible to give the cable, with a LED source at the start of the cable, every desired color, fully programmable. This gives endless possibilities compared to for example electroluminiscent wires, that can only show one hue of color when powered.

The cables are integrated in the spine of the dress, cut through the fabric and mounted in the 3D-printed mounts using 2 components glue. To guide the cables in desired patterns, small stitches are used together with other mini mounts on the front of the dress.



## 5.3 Technical details

# The mechanical elements

Besides the dress being able to change its hue, technology also makes it possible to move certain parts of the dress. In this project it is used to make the silhouette dynamic, which should create a big surprise. It was pretty challenging to integrate mechanical parts while still making the dress wearable, making it possible to put on and take off without reassembling every time.

The mechanical parts make it possible to change the silhouette of the dress, being able to change the silhouette from enclosed to vibrant, inspired by Issey Miyake and Comme des Garçons. Below the different elements are explained, and shown on the next page.

### Micro metal gearmotors

The 6V micro metal gearmotors used in the dress are small motors with a rotating axle. On the motor, miniature gears are used to decrease its rotating speed with 1/50th of its original frequency. When fitted with an extending axle, the motor is able to wind up wires that move/pull up certain parts of the dress. In this case they wind strong fishing wires that are sewn through the front part fabric of the dress. When the wires are pulled up, the fabric folds itself. When the wires are rewinded, the fabric goes down, back to its original shape.

Together with a controlling unit (explained in "the electrical controlling circuit", on page 90), the motor can change its speed and rotating direction, making it fully controllable by an Arduino controller.

### Micro motor shoulder mounts

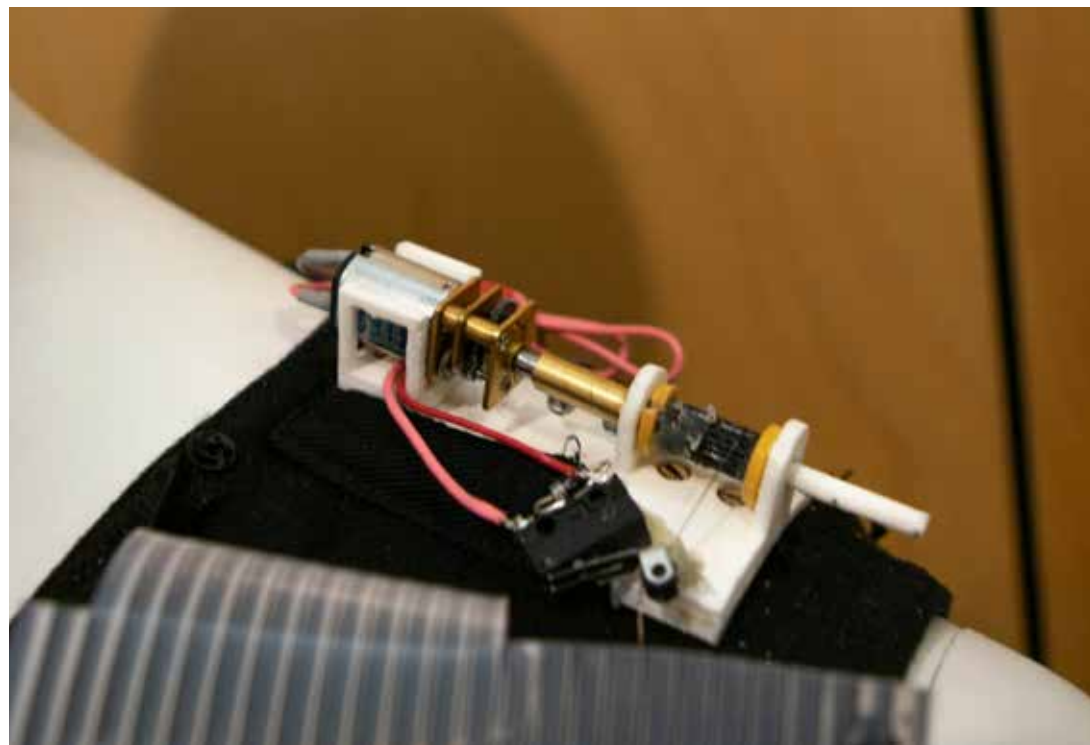
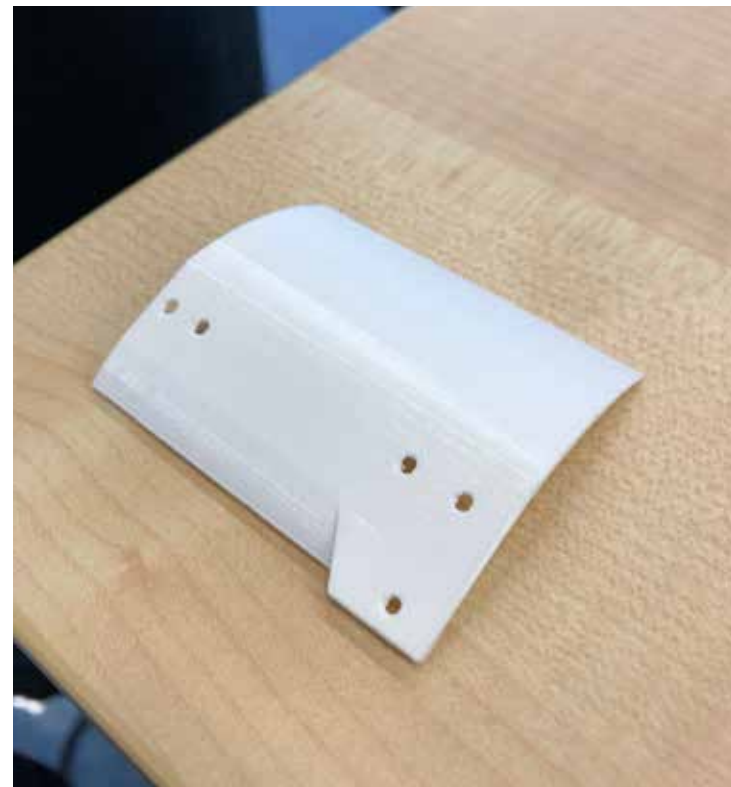
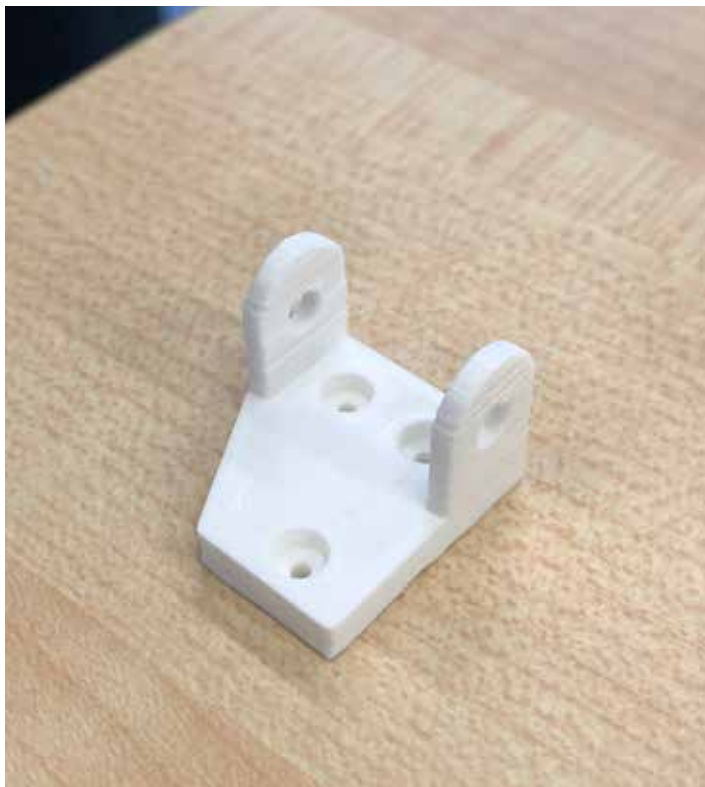
To be able to integrate the motors in the dress, 3d printed mounts were made to fit the motor on the shoulders of the dress. The reason the shoulders were chosen is because they stay rather stable when the body is moving. Also, they are on the highest part of the dress, making it possible to pull-up parts of the dress.

The mount consists of a base plate, a mount for the motor, an extending axle and a small base that hold the axle in place. That small base also controls the wire winding and gives a place for a switch. Small pockets in the shoulders hold the complete mounts in place, and are designed for the motors and mounts to be easily taken off from the dress.

### Fishing wires for winding

Finally, very strong fishing wires are used to be wind up by the motors, and are sewn through the front part fabric. When winded up, it contracts the fabric into folds, gathering on the top part of the dress.





## 5.3 Technical details

# The electrical controlling circuit

Last, but definitely not least, are the controlling elements that gives the user the ability to chose between the two different states. The principle is quite simple: With the press of a button the dress can change it's expression, controlled by the wearer. How does this work in terms of the electrical circuit and what is needed to regulate the light and mechanical elements? With the help of experts, and the requirements for the dynamic expression, translated into physical elements, the hardware for the controlling unit has been chosen. It was also very important that the unit can be worn, hidden somewhere in the dress. This is explained on the next page.

The different parts of the heart are explained below and shown on the next page.

## Arduino/Genuino Micro controller

The main control unit that manages the different states is called the Arduino/Genuino Micro. With the help of Arduino ... software it can be programmed. This enables the Arduino Micro to control the LED's and the micro motors. Also, external devices, like buttons, can be connected that can trigger these commands. The full code with commands is put in appendix 10

## Adafruit DC Motor Driver

This driver is the controlling unit and connection between the Arduino controller and the micro gearmotor. It is needed to send the motors the needed controls, commanded by the Arduino controller. It can mainly tell the motors to turn the other direction, without the need for switching its wires. 2 drivers are used to control both motors.

## The pushbutton

The button is connected to the microcontroller to change states.

## Battery

The battery is rechargeable, and delivers 7,4 volts to power the different parts: the LED strips, the Arduino controller and the motors. It's capacity is 5,2 Ah, which is sufficient to power the circuit for around 2 hours straight.

## Other electrical hardware

Other parts of the electrical circuit are for example a volt converter, needed to convert the 7,4 volts battery voltage to 5 volts for the LED strips. More parts are capacitors en ... zie adafruit website. The full electric lay-out is presented in appendix 11



### **The wearable control unit**

Again, the control unit needed to be separately integrated somewhere in the dress. Eventually the idea was to design the unit as a single piece, worn somewhere on the body, that can be easily separated from the dress. The electronics are fitted on a single sheet of PVC. After fitting, the full control unit got its nickname "The Heart". "The Heart" is put in a belt made out of soft fabric, to be worn around the waist, underneath the dress. With 4 single easily-to-connect connectors, the control unit could be connected to the LED strips and the garmotors.

## 5.4 Chapter summary

### Design details

Subtle state



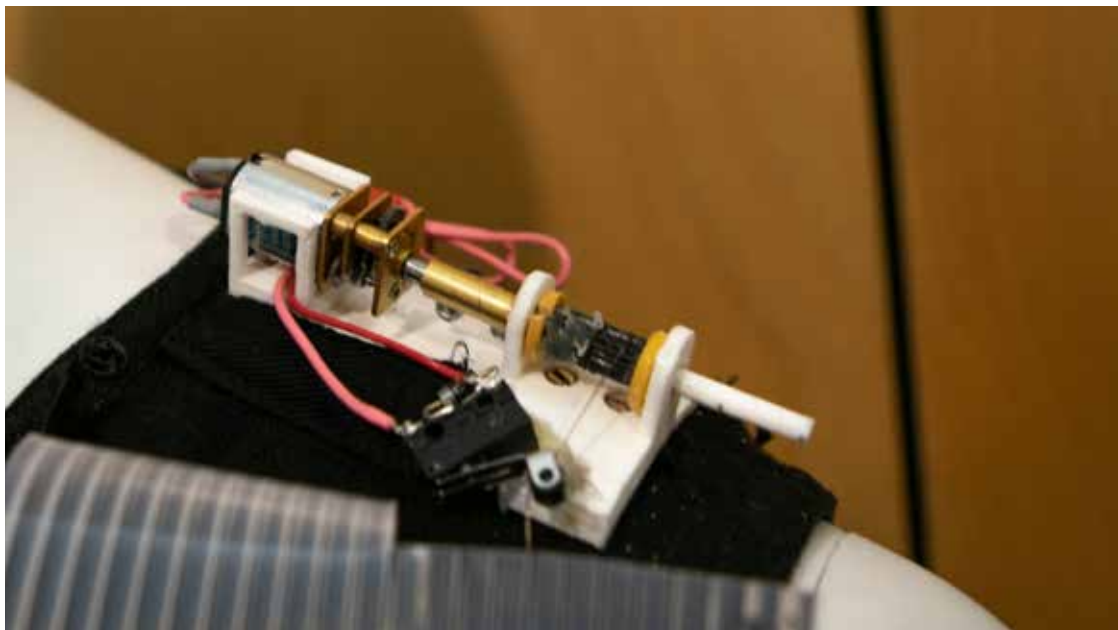
Expressive state



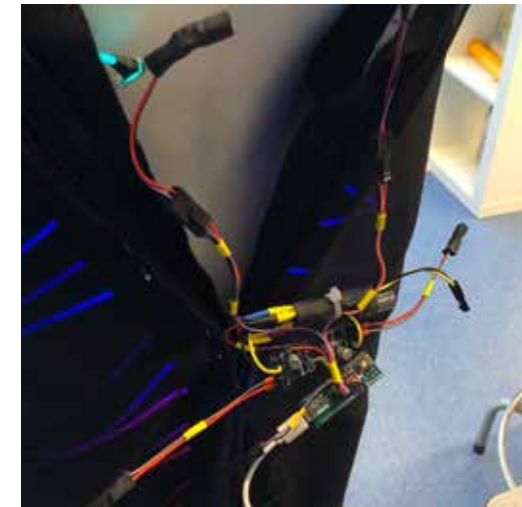
Static details



## Technical details



## Electrical details



## 5.5 User scenario

This subchapter presents an example scenario in which the dress finds its implementation. It presents the way the user can use the dress and what effect the dress has on the behavior of the user. A drawing on the right page shows the scenario visualized.

The user scenario is a combination of scenarios sketched during the user research interviews (Chapter 2.2, page 26). Together with the dress's functionalities, derived from the design characteristics research (Chapter 3.1), it tells a possible way of using the dress imagined by the designer.

### The scenario

From the user research interviews, an insight was gained about the desire for a mood adaptable outfit. Users found that certain situations force them to wear certain kinds of outfits, while they see themselves having other situations and moods during that day as well. "That situation does not take the full day, so the moods can bring nuances in dressing practically" (page 27). This gave the initial idea of a dynamically changing outfit that could change according to different emotion expressions, matching the different situations and moods.

The outfit is able to show two kinds of expressions: expressive, representing the emotion group 'joy', and subtle, matching the emotion groups 'calm' and 'confidence'. The expressiveness of the dress can be chosen by the wearer by pushing the button. The idea is when the user finds herself in a different situation with a different need for being expressive, she can let the outfit change itself to her need. This is not done in public, as the transition is not meant to be an eye-catching factor. That is because that may attract too much attention, that might be undesirable for the wearer.

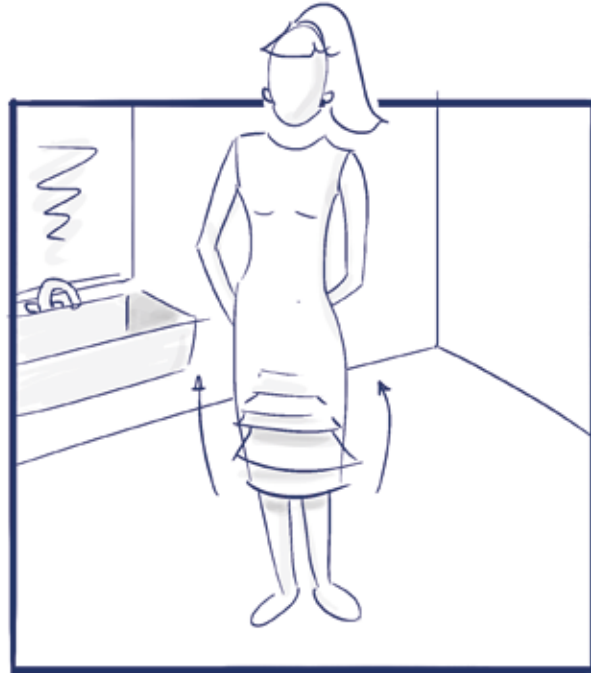
The dress is aimed for informal social situations, because a dress in itself is already a bit expressive. This means people are not used to wear a dress to, for example, business meetings or for a day of studying. Below two example situations are shown:

- The first situation involves a social setting, for example a bar or cafe. The setting is still a little modest but fun, and people are chatting and having a few drinks. It is around 8 pm. People are dressed nicely but not that expressive.
- The second situation involves a more vibrant situation, where people find themselves dancing in a club, later at night. This is a more expressive situation as it involves less talking but an even more informal vibe. It is around 11 PM - 0 AM. In these situations people can be more celebratory, drinking more, which makes them want to be more expressive.

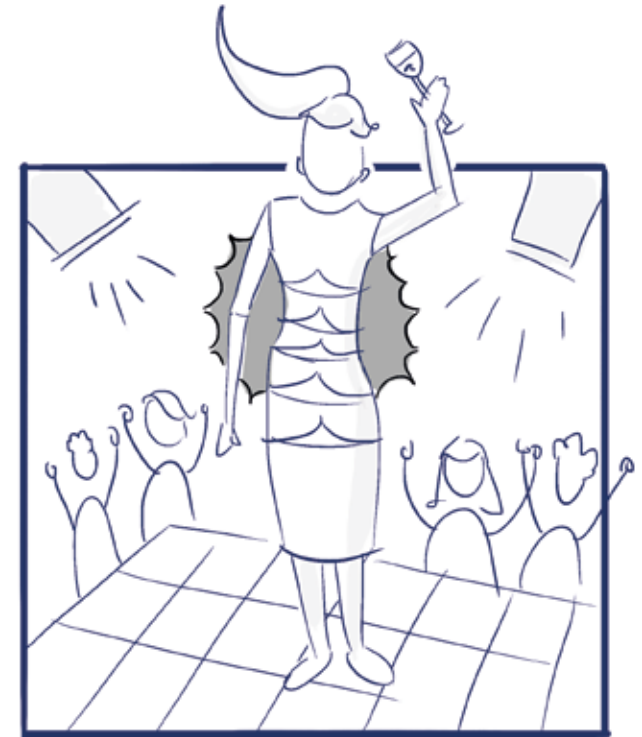
Again, this is an example situation in which this dress can be used. The principle behind the dress, being able to change its expressive behavior, can also be used in, for example, getting from a formal business meeting to an informal lunch with colleagues.



Subtle state  
Informal drinks  
Modest and social



Transitioning  
Private



Expressive state  
Party  
Outgoing and social

# Validation



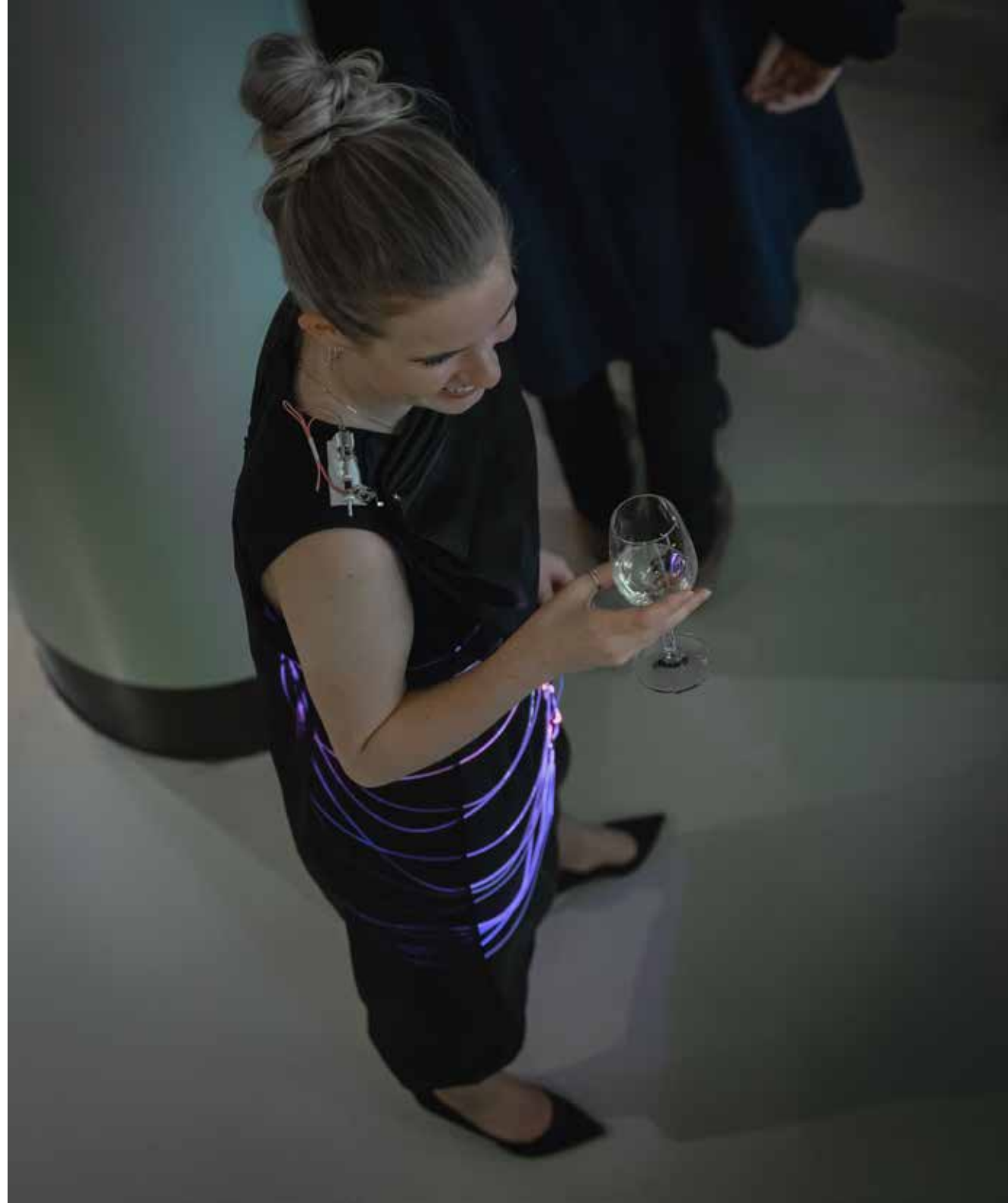


# 6

In the last chapter the final design was presented. These elements are the final physical outcome of the connection between the design vision (Chapter 2) and the design characteristics (Chapter 3).

But how can the design be validated according to the presented vision? How can it be proven that the dress will help the wearer with comfortable expressions and also have a positive effect on the social environment?

In this chapter, a validation test will be presented, in which the dress is worn during a social event of Het Nieuwe Instituut in Rotterdam. This event is used to validate the effects of the design on the wearer and it's environment.



# 6.1 The setting

Het Nieuwe Instituut, with the English translation being "The New Institute", is a museum and research institution, combining disciplines like architecture, design, digital culture and societal phenomenon. It tries to present activities that connect the different disciplines, to highlight our current culture of radical change. Their collections are meant as a conversation starter and to broaden the perceptions and expectations of its visitors.

Every Thursday night the institution, together with Het Nieuwe Cafe (the public cafe situated inside the institution), organizes a symposium, or public talks, that present professionals and their disciplines, and their view on certain topics. After these talks, the Cafe organizes drinks as a social closing of the night.

The setting was a perfect way of validating the designed dress during a social activity. Moreover, Het Nieuwe Instituut and its visitors should be interested in new phenomenon such as Techno-Fashion, which in advance would have been easier for the guests to understand the principle of the design.

I had the chance to present my dress design during this event. After the symposium and when the drinks started, the project was presented briefly in 5 minutes, talking about the dress, its desired effects and the backing of the project.

I invited 25 of my friends to come over and check-out the final design, being the stable amount of visitors that I needed for validation. Moreover, around 15 colleagues of the institution and the cafe were there to experience the design. Finally, around 20-30 visitors of the symposium were also present. Particularly the last group of people were interesting because they are completely unfamiliar with the project and might have different things to say.

My goal was to validate whether the different state expressions of the dress were experienced as being subtle and expressive, whether the design fitted the social setting and if the two states represented the emotions it should express. A model was invited to walk around in the dress, acting as a regular participant of the social setting. The goal was to change the expressive state of the dress a few times and ask the visitors about their experience through an online questionnaire sent a few days after the event. Moreover, more questions were asked to the wearer about her experiences and whether the dress' state expressions could have represented her emotions.

The results are presented on page 102 and 103. The event was photographed by a befriended photographer.



## 6.2 The questions

Again, at the start of the drinks a short talk presented the idea of the project and the design. Not foremost a request to receive feedback was sent out to all the different visitors. It was told to try to experience the dress as being a regular outfit and to think about the effect the different states had on them and the environment. The model walked around in the dress, acting social and to stimulate making conversations with the guests. They were asked to give their e-mail address when interested in giving feedback. A few days after the drinks, a very short online questionnaire was sent with 4-5 questions about their experience. The questions are presented below:

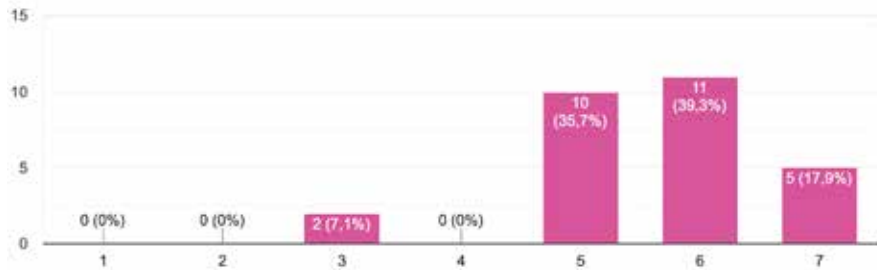
- Did you experience Lieke and the dress as being suitable, non-harming and comfortable for the social environment you were in?  
*(linear scale from 1-7)*
- What elements of the dress design do you think were appropriate or not for the social setting? (subtle = subtle state, expressive = expressive state)  
*(Multiple choice roster)*
- Do you think the subtle state matches the emotions of calm and confidence?  
General examples are soft hues and smooth form transitions  
*(Linear scale from 1-7)*
- Do you think the expressive state matches the emotions of joy and playfulness?  
General examples are vibrant colours, shapes and movements and strong lights  
*(Linear scale from 1-7)*
- Did you like the overall aesthetics of the dress? Subjective, not particularly focussing on the emotions  
*(Linear scale from 1-10)*
- Bonus: Any design suggestions?
- Bonus: Any naming suggestions?



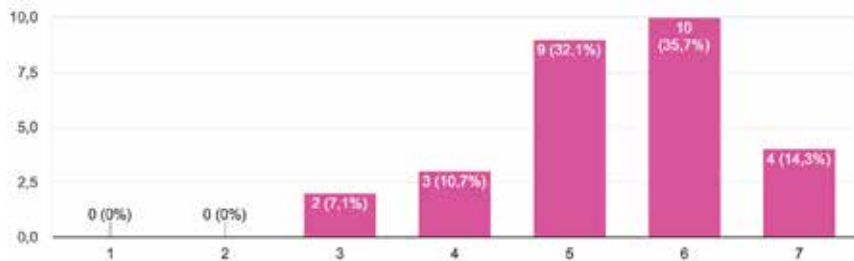
# 6.3 The results

These diagrams are the results of the 5 questions asked. The bonus question about design suggestions gave very credible suggestions. The suggestions are presented on the next page. The conclusion of these results is presented in chapter 6.4 on page 104.

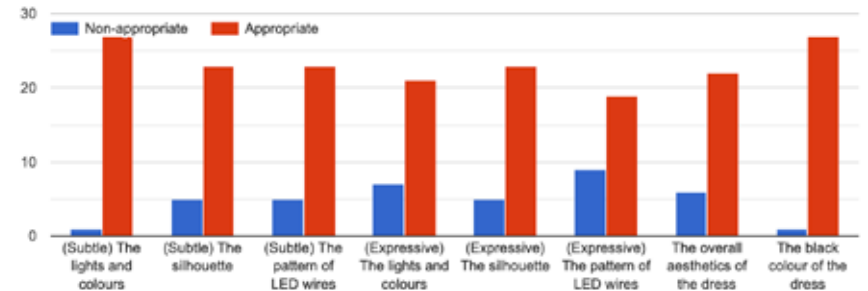
Did you experience Lieke and the dress as being suitable, non-harming and comfortable for the social environment you were in?



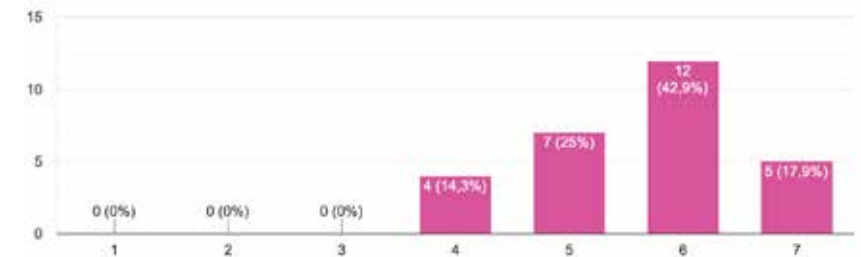
Do you think the subtle state matches the emotions of calm and confidence? General examples are soft hues and smooth form transitions



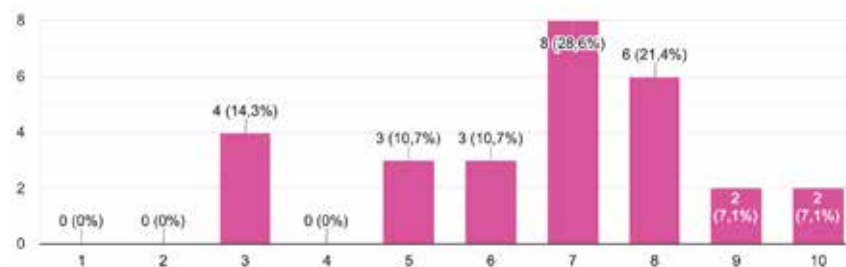
What elements of the dress design do you think were appropriate or not for the social setting?



Do you think the expressive state matches the emotions of joy and playfulness? General examples are vibrant colours, shapes and movements and strong lights



Did you like the overall aesthetics of the dress? Subjective, not particularly focussing on the emotions



## Design suggestions

These are a few suggestions made by participants. All the suggestions are presented in appendix 12.

"The subtle state would be for a professional environment whereas the expressive state would be for a more fun and social environment. I believe both states are very appropriate for their respective environment. I am just not sure if the casual Het Nieuwe Cafe was the appropriate setting for such a fancy looking dress."

"Maybe you could explore different dress colors and forms as well. I found the black dress to be a little bit too 'formal' for an informal situation like that evening. It could be a bit more playful perhaps?"

"The subtle state was very much appropriate for the more casual setting in the cafe. The expressive state was a little too flashy. My suggestion for the expressive state environment is a party, where people have the chance to be less casual."

"Most important in my opinion is the intuitive transition between the states. Changes should be small and unconsciously be experienced."

"The subtle blue LEDs for instance in combination with the subtle silhouette of the dress provide for calm aesthetics, whereas for confidence I would expect a very expressive dress (which the other state is) with, for instance, very in-your-face bright red LEDs."

"I suggest it is usefull to look at existing dresses, to see how they give woman to express the different emotions like confidence"

"For me the colours and the shapes of the dress matched the expressions really well. I would however, change the shape of the ledlights for the expressive state. I don't even know if the changement in the shape is necessary for the expressive state. I think by just showing them more clear and changing the colours it's already quite expressive."

## 6.4 Conclusion

Participating at an event like the one at Het Nieuwe Instituut was very fruitful. Approximately 60 people have seen the dress, and around 30 people gave their feedback about the impact the dress has had on them and the social setting. Below, the results have been summarized.

The first issue was whether the dress in general had a positive or a negative impact on the social environment. With the scale from 1-7, the overall feedback was on the positive side, with all but two reactions scoring a 5 or higher. At the event itself and when answering the feedback question about design suggestions, people talked about the subtle state being quite suitable for the environment without being too impactful. But, when in the expressive state, some stated the environment was too "casual" and modest, and suggested the expressive state to be more suitable for party environments where people are more expressively dressed.

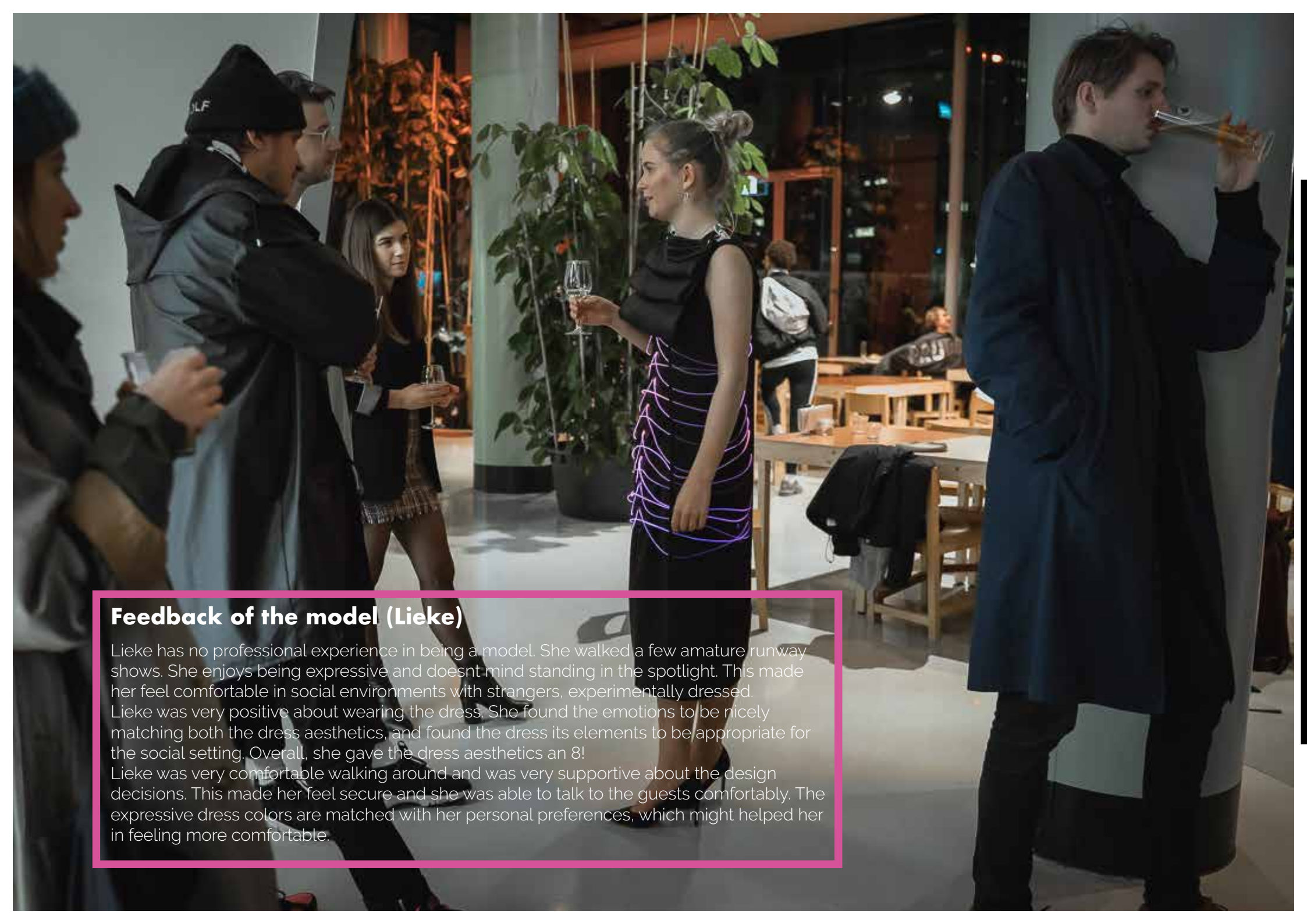
When asking about the expression of the intended emotions, for the subtle state 5 out of 28 people found the elements to be a mismatch with the intended emotions. When reading the design suggestions, this was mostly because people found the emotion 'confidence' to be a part of the expressive state. The overall silhouette was found to be matched with the emotions and the environment. For the expressive state, all but 4 people found the dress to be matching the emotions. For the expressive state people agreed on the design elements being more expressive, though they did not always like the aesthetics of the light patterns and the shaped silhouette on the chest.

Focussing more on the different expressive elements of the dress, like the lit fiber optics and the folded dynamic front panel, most people found the elements to be appropriate for the social environment. Though, looking at the expressive elements, like the folded fabric on the upper part and the fiber optic patterns, a few participants found them to be less appropriate than the subtle elements. That confirms the findings of the second paragraph.

Finally, without it being the main aspect of the validation, the question was asked whether or not the participants found the dress aesthetically pleasing. 25% found the dress to be not aesthetically pleasing, and stated in the design suggestions that either the light patterns or the folded expressive fabric were a mismatch. Moreover, some suggested to let the lights be more integrated in the dress instead of being put on top. In the end, 75% found the dress to be a 6 or higher, with 50% giving a 7 and a 8!

As a general conclusion, the dress is positively received, and the elements are found to be credible to what they are intending to do. Still, some useful feedback was given about the design elements of the expressive state. Some found it a little too flashy, or suggested a more playful approach to the light pattern design. About the subtle state, participants suggested the color to be a little less "cool". The most interesting part are all the design suggestions given, which suggest a great affection of the dress and its intention to the people.





### **Feedback of the model (Lieke)**

Lieke has no professional experience in being a model. She walked a few amateur runway shows. She enjoys being expressive and doesn't mind standing in the spotlight. This made her feel comfortable in social environments with strangers, experimentally dressed.

Lieke was very positive about wearing the dress. She found the emotions to be nicely matching both the dress aesthetics, and found the dress its elements to be appropriate for the social setting. Overall, she gave the dress aesthetics an 8!

Lieke was very comfortable walking around and was very supportive about the design decisions. This made her feel secure and she was able to talk to the guests comfortably. The expressive dress colors are matched with her personal preferences, which might have helped her in feeling more comfortable.

# Visual presentation



# 7

The design is finished, presented in the previous chapter, and is backed by all the preceding chapters. It is clear what the design should do and how it reaches its goal. Now it's time to present it to the outer world.

In this chapter, the visual presentation is presented. By making a short movie, together with a photoshoot, the goal and its credibility will be captured in an intimate and sensitive way. In this way, the more abstract features and functionalities will get highlighted, which are very important for the dress its unique character. At the end of this chapter the whole project visually comes together, marking the end of the project.



# 7.1 The objectives

When presenting the project and its final design, the presenter should very clearly present the why, what and how of the dress. The why can be told according to the future worldview context (page 24). The what is shown through chapter 6, that presents the design features. However, the how is still missing, and should very clearly show what the product does and how that affects the user, in its context.

Because the context is happening in the future, and is based on the ViP method, it does not yet exist. Moreover, the features of the product, e.g. the changing lights and silhouette that represent the emotions of the wearer, are rather abstract. It is a challenge to clearly communicate these abstract features together with their emotional representations. Below, the objectives of the video and the photoshoot are shown.

- A visual presentation of the dress and its aimed effects
- Showing and highlighting the dress state emotions in an intimate way
- A summarized story of the backing of the project, e.g. ViP and the design characteristics
- A short 1:30 pitch of the project and its goals

Together with the video, self-produced music will complement the effects created in the video. Also, some sort of choreography, executed by the wearer of the dress, will also highlight the different emotions and effects of the dress. This video will be a partnership between me, Huub Verburg as the producer and Danial Mohammad Sadeghi as the music producer. Finally, all the pictures are shot by Alex Santos Lima.

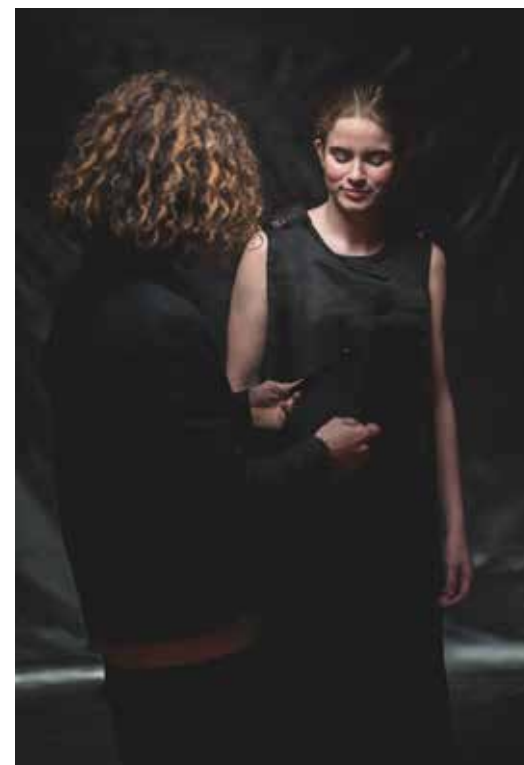
The full script of the video is shown in appendix 13.



## 7.2 The visuals



Scan QR  
code for the  
video



# Future goals





# 8

The thesis has come to an end. The dress design has been validated according to a real social context. The validation presented some very interesting remarks, that shows, besides the large affection and understanding about the dress, there is room for improvement.

In this chapter, a conclusion is presented, that takes these improvement steps into account. In the validation chapter it was proven that the dress was able to make the transition between subtle and expressive. Though, the original assignment asked for a desirable implementation of Techno-Fashion, and the research phase showed a future context for that implementation. Looking back even more, at the original motivation to start this project, I stated the desire to make a statement against the modern day fashion industry. What has been learned, and what can be expected for the future?



# 8.1 The design

Ofcourse, designing an aesthetically pleasing dress is hard. From the start of the design phase of this project, the prove of principle was to design a dynamically changing dress that can change from a subtle expression to an expressive expression. It's technological innovations were found to be important by the stakeholders, and for the project goal it was important to prove the ability of dynamic expression. The prove of principle was less about designing something that is subjectively very attractive to all users, because a person's commitment to dressing shows his or her personality (Rosenfeld & Plax, 1977). That commitment therefore is very subjective, and for every person unique.

Though, to affect the original design statement of "Non verbal expression of emotions through desirable Techno-Fashion", it is still important for the dress to become actually 'desirable'. Toussain (2018) states: "there is little academic research focusing on this specific fashion-focused subfield of wearable technology"

The last question of the validation questionnaire (page 100 & 102) was about asking the participants whether they found the dress to be aesthetically pleasing. The result and design suggestions are shown on page 102, but below these suggestions are taken into account to give suggestions about design changes, to make the dress more aesthetically pleasing.

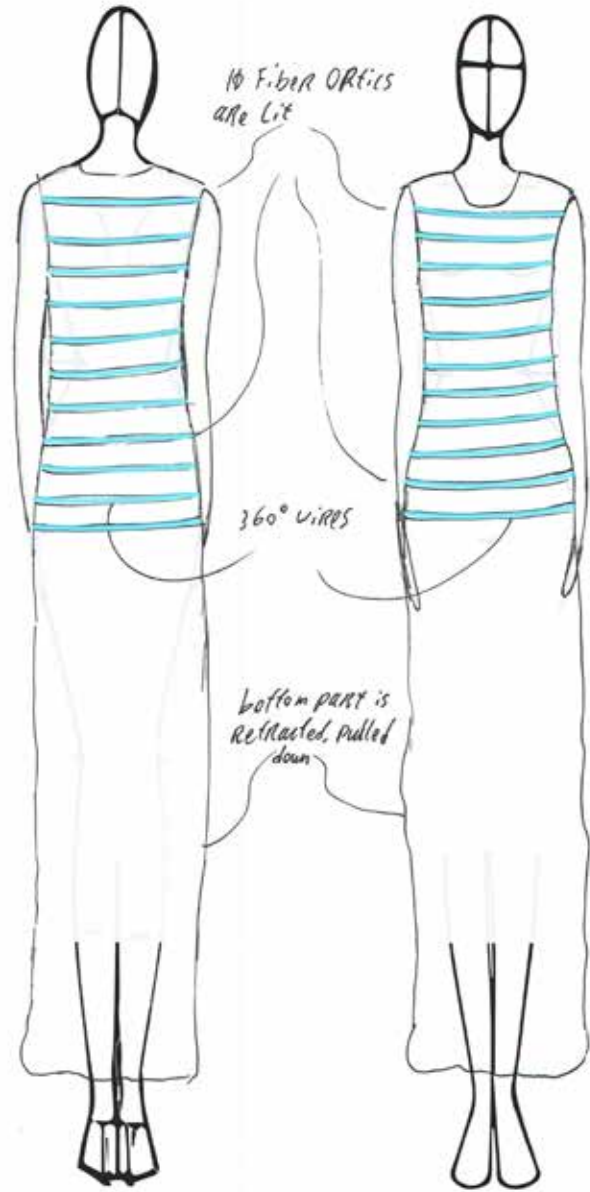
## Design

A few recommendations can be done about the final design. First of all, about the lights, the expressive pattern was being perceived as either associated with a christmas tree or being unnecessary. For simplification, some suggested that the straight lined pattern should stay the same in both states, but the light intension and hues should change. My personal suggestion is to get rid of the arch-like pattern, but to double the amount of straight lines. This suggestion makes it able to make the pattern itself becoming more expressive, instead of only the hues of the lights. The only straight lined pattern design should be more pleasing as people liked the subtle pattern. The redesign is presented on the next page.

About the changing silhouette, some people found the folded shape on the chest of the dress to be a little inappropriate. One other suggestion suggested to look at other dress designs. After taking a second look at photographs taken at the "Fashion Statements" exposition in 'Amsterdam Museum' (appendix 7), it was noticed that originally dresses tend to become bolder and bigger on the bottom half of the dress. This was taken as a suggestion for a redesign of the final dress design. This design is presented on the next page.

Finally, the expressive state design of the dress was found by some to be a little inappropriate for the more moderate setting of Het Nieuwe Cafe. This makes sense, as the proposed scenario (page 94 & 95) implies the dress to be used in a more outgoing social setting.

Subtle state



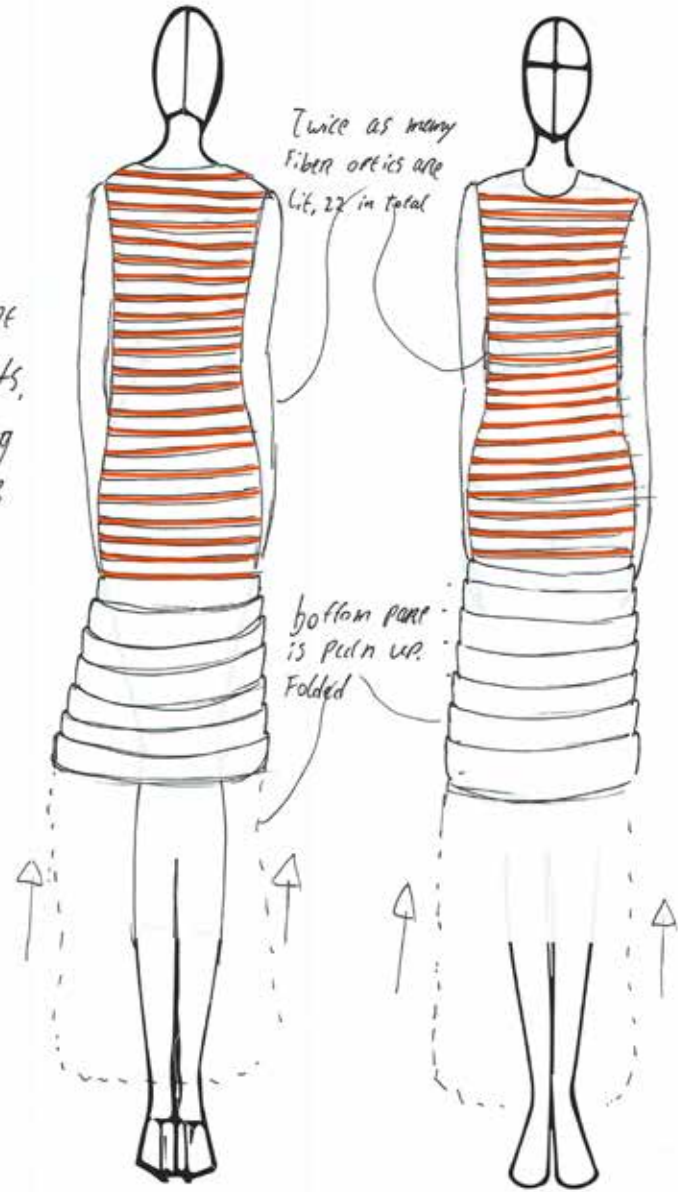
10 Fiber Optics are Lit

360° WRIPES

bottom part is retracted, pulled down

Sleek elements, moderate patterns

expressive state



Twice as many fiber optics are lit, 22 in total

bottom part is pulled up. Folded

Abrupt elements, outgoing patterns

## 8.2 Future expectations

What future lays ahead of the techno-fashion dress design? As stated in the original assignment, the following question was asked: "How do we express and experience body language, and how can we translate that into an application of Techno fashion that is desirable and understandable, for the wearer and his/her environment? How can this application provide an alternative for the current use of regular clothing?" With this design, backed with the research of a foretold future context (environment) (Chapter 2.1), and interviews with actual clothing wearers (wearer) (Chapter 2.2), a theory has been created about the way we express and experience body language and personal style (design vision). From this vision, a credible application of Techno-Fashion has been created. The interviews also show personal use of regular clothing, which insights are used to create an alternative use. The validation shows a first take on whether the design and its effects are understood and desired.

But, Techno-Fashion discipline itself is still mildly understood by the public, especially about a real implementation in the current context. During the validation test at 'Het Nieuwe Instituut', people asked a lot of questions about the implementation. The research of Toussaint, 2018, states in its introduction: "plenty of work still has to be done before the integration of fashion and technology will become truly seamless, wearable, acceptable and (commercially) successful". It is most unlikely Techno-Fashion will find an implementation real soon, especially because it is a newly occurring phenomenon (Dunne, 2010).

But, with the future worldview context (page 24), I've tried to show a credible future context based on current world phenomena. In this way I've shown there might be a credible world in which the dress helps users in social offline expression, in a world where technology has taken over our lives, but lets us stay in control. I hope this world can be seen as credible of becoming reality in a few years. But, according to the interesting discussions about the project and it's implementation, I think the awareness is there.

Finally, we live in a world where we use extreme amounts of clothing to satisfy ourselves, that most of the times apparently doesn't bring the desired satisfaction (The Nielsen Company, 2015). With this project and the dress design, I am trying to show a way of using technology to create a deeper meaning between the desire of expression of the user and the possibilities clothing give in expressing that expression. My dress is an example of an implementation, but I think Techno-Fashion in general can create a lot of possibilities in creating that deeper meaning. "Techno-Fashion invites a rethinking and reconceptualization of the matter of fashion by opening up a whole new array of materials and material properties" (Toussaint, 2018). My project, and the promising idea of Techno-Fashion in general, shows a more sustainable way of using clothing to express oneself.

"The dominant way to study techno-fashion has been through design practice. such practice-based, and design-driven research is important and relevant." (Toussaint, 2018)



# Personal reflection

The master thesis for some might be the most important project of your studies. It is one of the few projects that is completely executed by yourself, and is special because you have the option of coming up with a personal project brief. This makes it very interesting because of the endless possibilities.

As told in the premise of the original assignment (chapter 1.1, page 12), my goal as a designer is to combine my designer discipline with innovating the fashion industry. For me, it was important this is reflected in my master thesis. Moreover, I am interested in many different disciplines, like tailoring, visual presentation, marketing, prototyping and music production.

Finally, executing a project by yourself is a little scary, and was something I personally was scared off before starting this project. Things like relationships with your tutor team, if the topic stays interesting and inspiring, working together with an external partner and personal stress are all things that are part of the excitement.

## The execution of the project

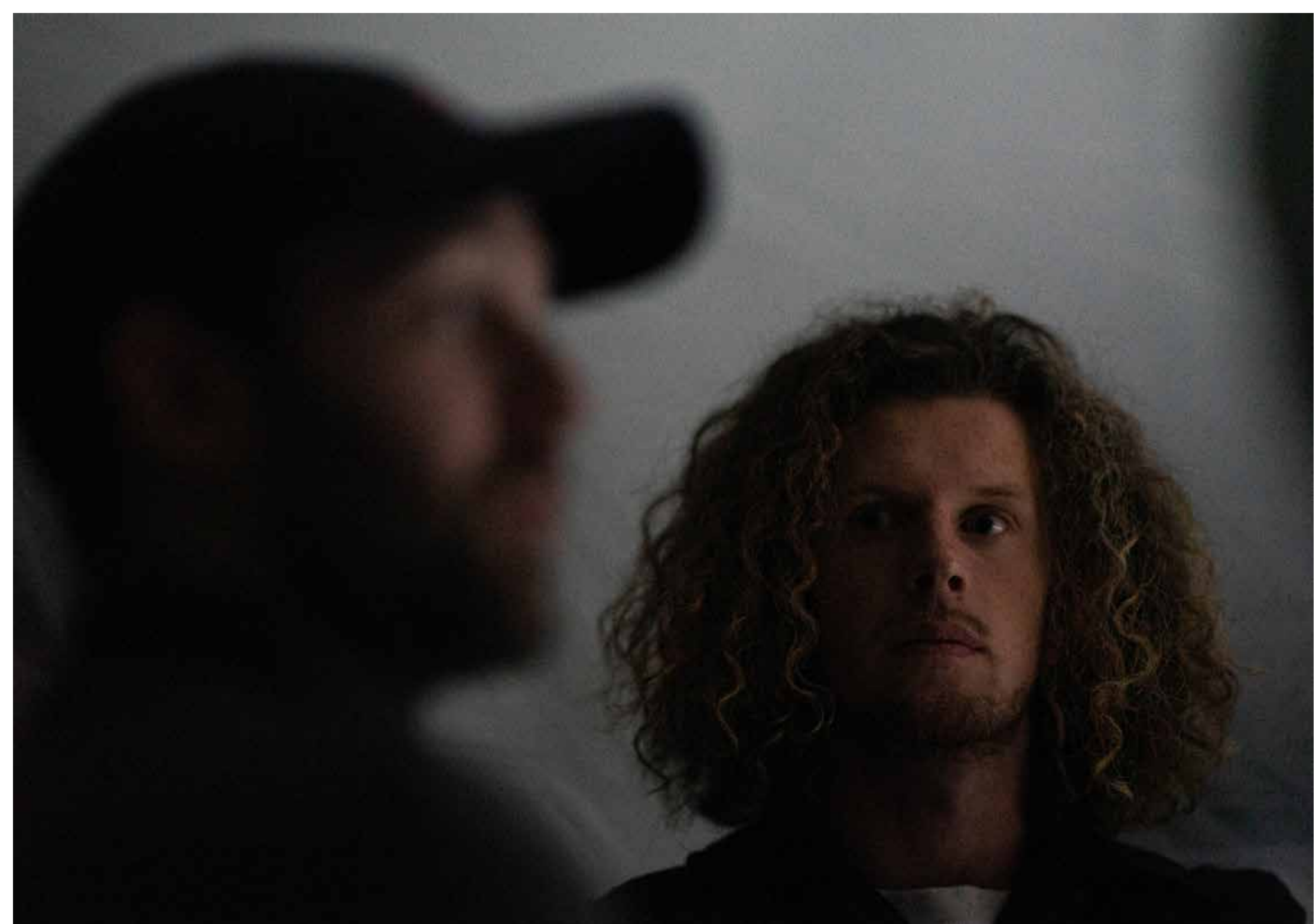
I am happy to say this was one of my most inspiring projects to date. The assignment was pretty personal, and got me interested and inspired throughout the complete project. The relationships with the board members were pretty good, and it was interesting to invite a board member that was pushing my limits in terms of my discipline: Kaspar Jansen encouraged me to develop a completely functional prototype, which wasn't something I would have come up with myself. Because the board knew my quite well, in a way that they knew I could have gotten too motivated, making the project too big, they showed close guidance during some parts of the project. This felt very organic. It made me feel secure and on track. That was very stress relieving.

## Personal ambitions

My personal ambitions of combining the design discipline with the fashion industry, and creating an innovative impact, are very much reflected throughout this project. Whether I've come up with a design that creates the desired impact is stated in chapter 8. Though it feels like my personal ambitions has led to a desirable and credible result, which feels very satisfying.

## The different disciplines

Throughout this thesis I encouraged myself to reflect my different interest in the execution of the project. Luckily my board gave me that space, and I was able to design my own garment, and organize visual presentations that combined photography, videography and music. That will be used to promote my project after it's finished. This was/is very cool and exciting.



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