# The making of ReThread Fashion



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ReThread Fashion®

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# Summary

This report outlines the design process and conceptualization conducted over the last four and a half months. It reflects on the iterations of the concept and the different design process which were developed. The project focused on theme of soft materials and material exploration while tackling issues within the fashion industry such as overconsumption, climate change and inhumane working conditions.

# Introduction

This project focused on the sustainability aspect of clothing. Different concepts and iterations were conducted before developing the service which creates the opportunity for people to repair their clothes in a fashionable and sustainable way.

The project initiation began with an improvisation session in the second week, during which the group created a modular sweater using various textiles. This activity revealed a shared interest in the sustainability aspect of garments. Subsequently, research was conducted to explore the sustainability of the fashion industry, which led to a focus on developing a sustainable garment. Different methods of connecting garment pieces together were investigated to facilitate easier disassembly and repair. Additionally, the potential of digital fashion was explored, sparking great interest. Consequently, three different concepts were formulated: a modular sneaker, an exceptionally durable garment, and a digital fashion store. The latter concept was selected because it was the most intriguing and offered the possibility of integrating AI. Furthermore, a repair service was incorporated to enhance the sustainability aspect of the store. Experimentation involved object recognition using machine vision and the utilization of MidJourney AI to assess its capabilities. AR filters were created and tested using Clo3D & Lens Studio to showcase a wide range of designs for clothing repair. During the midterm demo day, the progress made in the initial stages of the concept was showcased. Even though the concept itself was great, substantial improvements were required to accurately represent the intended idea. The interface underwent radical changes, the designs were refined to enhance creativity, the AR filter was adjusted to fit to the body, and several improvements were made to the machine vision system. To enhance the designs for damaged garments, a wide variety of repair options were explored. The machine vision recognition was improved by training the AI using a dataset comprising over 300 images. Finally, an interface was developed using OBS (a streaming platform), resulting in a more coherent user experience. To assess the viability of the concept, a validation stage was undertaken.

Semi-structured interviews were conducted with citizens and visitors in the city center of Eindhoven. The feedback received was largely positive, with many individuals expressing interest and enthusiasm for the proposed concept. While the majority of the feedback was favorable, it highlighted the need to improve the designs of the garment repairs. Consequently, focus was put on creating new designs. The final demo day arrived, providing an opportunity to proudly showcase the team's work from the past semester. The presentation included a machine vision system, AR filters displaying a variety of shirt designs to cover stains, and a cohesive interface integrated into a mirror with a distinctive brand identity.

## Project Goal

Our group aims to realize a project that prioritizes ethical and environmental concerns within the fashion industry. By designing with sustainability as our primary goal, we seek to address the issues related to inhumane working conditions and the environmental impact of the fashion sector.

# Design Process

This chapter is about the design process that was used during this project. Early on it was decided to use a reflective transformative design process. The unique characteristics of this process are its undetermined structure and its emphasis on reflecting on previous steps to decide a suitable next action. (Hummels & Frens, 2009). Also worth mentioning is the similarity to a material centered design process, which requires exploration on material properties by analyzing and experimenting, while also focusing on tangible user interfaces. (Doering, 2010). A visualization of the design process can be seen bellow, accompanied by the rest of this chapter which will outline the main steps that directly led to the final concept.

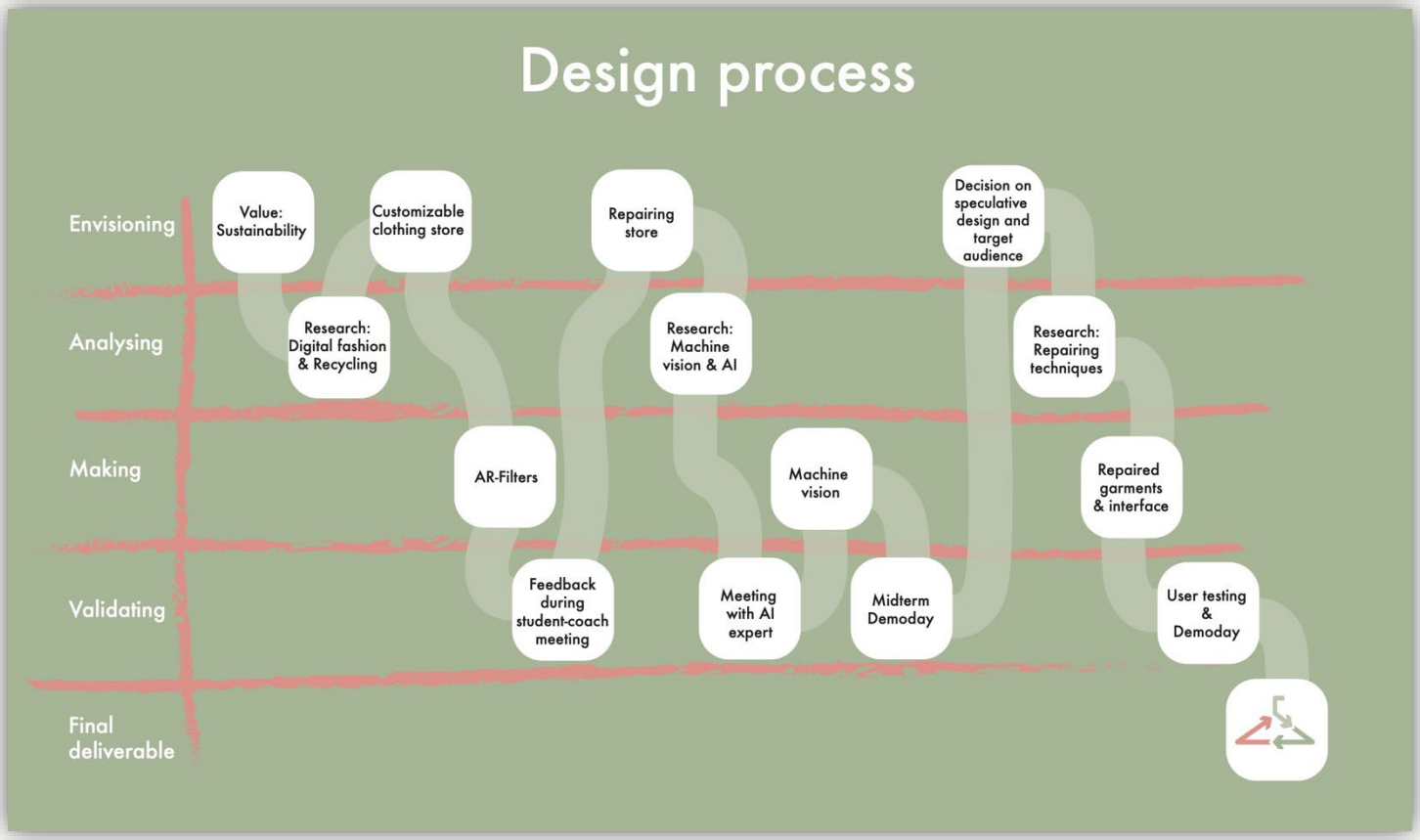


*Figure 1: Visual representation of design process*

## 1. Value: sustainability

As a first step, personal values were discussed, and a goal was set: creating a sustainable concept.

## 2. Research: digital fashion & recycling

During this step research was done on digital fashion and fabric recycling. This seemed promising for the sustainable qualities of reduction and reusability respectively.

## 3. Customizable clothing store

Building on the research done on digital fashion, a concept was created: a clothing store that made custom garments on demand, with customers being able to try them on using augmented reality.

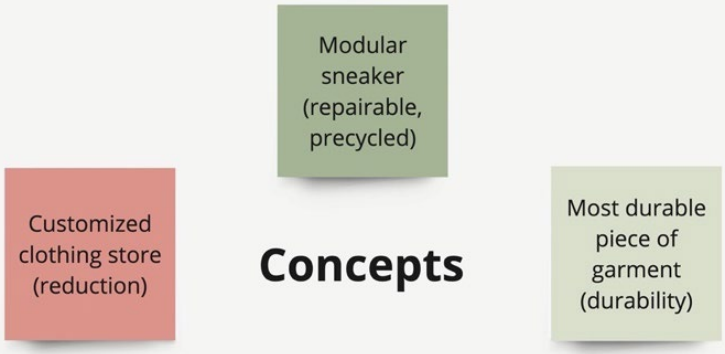


*Figure 2: Miro diagram made during conceptualisation*

## 4. AR filters

The first prototype of the AR try on system was made, importing a custom-made garment from Clo3D into augmented reality.

*Figure 3: Clo3D model of the repaired dress*

## 5. Feedback during student-coach meeting

The concept was presented in the form of a play and the AR-try on system was also demonstrated. A suggestion was provided on making the concept circular.

## 6. Repairing store

With the feedback from the student coach meeting in mind, a physical store people could go to for repairs and the recycling of their garments was envisioned. This made the concept circular. At this point the concept required a lot of interactions from store staff. This was replaced with an imaginary AI that create patterns for the repairs and automatically generate suggestions.

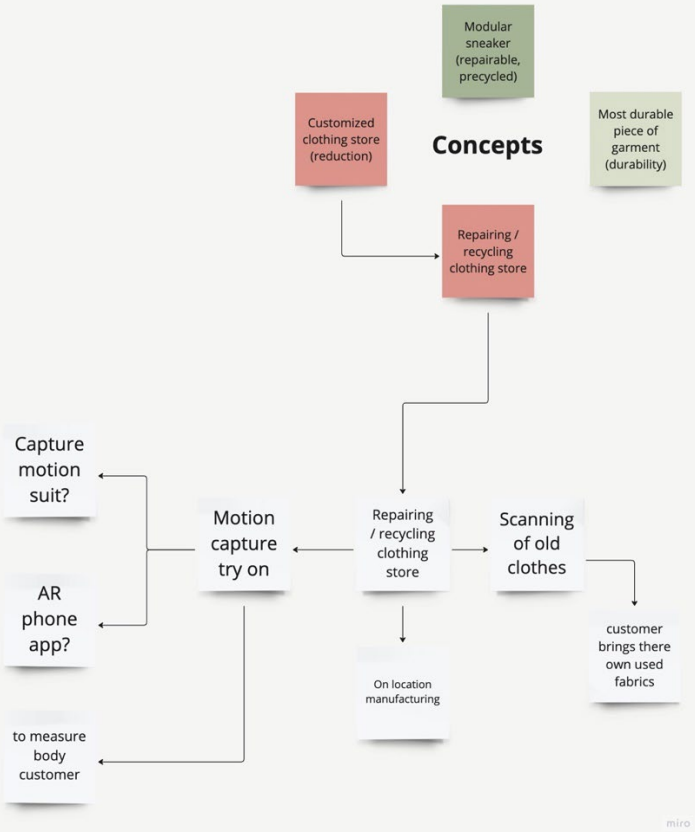


*Figure 4: Miro diagram made during conceptualisation*

## 7. Research: machine vision and AI

At this point experiments were done with existing AI generation tools.

## 8. Meeting with AI expert

To validate the feasibility of the concept an expert on creating with artificial intelligence, Douwe Teusink, was consulted. Teusink advised against trying to build the generative AI part as that was far beyond the group's skillset. However it was suggested that the scanning of the clothing part could be done using machine vision.

## 9. Machine vision

In this step the possibilities of machine vision were researched and a first prototype of a model that is able to detect garments and stains was created.

## 10. Midterm demo day

During demo day the different components of the concept were presented in a store setting. This was done because there was no interface yet, and there was no decision taken about whether the customer journey should include speculative elements. On top of that, the machine vision was a very early version that was barely working, and the AR-filters were still static, so the shirt did not move together with the body. The crudeness of the prototype led to not all the feedback being valuable. Still, every piece of feedback was written down and considered in the next step of our design process.

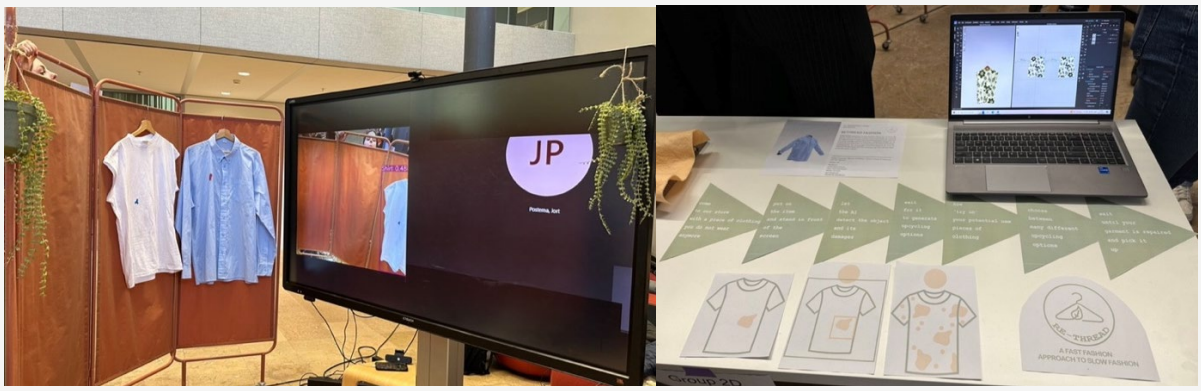


*Figure 5: Midterm demo day setup*

## 11. Reflection of midterm demo day

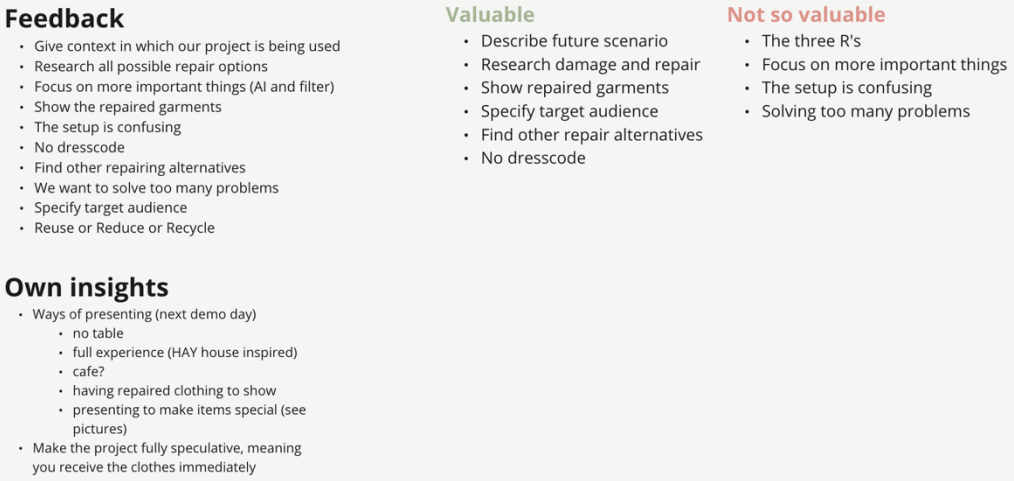


*Figure 6: Screenshot of our Miro notes on the midterm demo day feedback*

As mentioned previously, not all feedback was equally valuable. For that reason, the feedback was first thoroughly sorted. This process led to two important decisions; the design would be a speculative design and the target audience would be people shopping at fast fashion locations.

## 12. Research: repairing techniques.

Another conclusion that was drawn from the demo day feedback was that research needed to be done on damage and repair, to be able to show some examples of repaired garments during the next demo day. This was done during this step.

## 13. Repaired garments & interface

During this step the research was implemented into practice by repairing a piece of garment in five different ways. On top of that, an interface was designed to show of the customer journey better.

## 14. User testing & demo day

During this step the input of users was collected in the form of a semi structured interview. After this input some iterations were made on the designs of the repairs, to better resonate with the target audience. Another validating moment was during demo day, where the concept, the presentation and the execution of the prototype got positive feedback.

## 15. Final concept

After listening to each other, prototyping, researching, and validating the concept ReThread was born.

# Iterations

## Sustainability

At the start of the project, it already became clear that there was a shared interest in designing with sustainability as a goal. This came from the association of soft materials with fashion and the fact that the fashion industry has a huge issue with sustainability in its environmental impact and working conditions of employees. This was the first premise from which research and exploration emerged.

### Ethical Issues

First, research was done on the ethical issues of the fashion industry. This resulted in eye-opening facts, for example that the International Labor Organization has estimated that 11% of the global population of children are associated with working within the fashion and supply chain industries. In addition, it was found that the working conditions of employees in the production of clothing are often inhumane: exposure to fire and toxins, poor ventilation, unsafe buildings (lack of escape routes), overloading employees, low wages, no compensation in situations of illness or pregnancy, etc. (Fashinza, z.d.)

Below, a video can be seen about the current issues in the fashion industry. This video was also shown at demo day.

*Video 1: Fast Fashion – the dark reality (https://youtu.be/Sy7Ew7Qhx-U)*

Something that was also discovered through this research was a company that made an effort in making the fashion industry more transparent. They are called Tex.tracer. Their company allows brands to upload data of each supply chain partner on their website, after which they check and verify the information, creating a map of the whole production process of each brand. (tex.tracer, 2023)

At its core this is a very innovative idea with the right vision, but when investigating their website a bit, you soon find out that not much information is given about the supply chain partners. In addition, brands can leave parts of the production process blank, but still claim they are transparent because they use Tex.tracer. Even worse, some brands that were called out by Amnesty International for being directly or indirectly responsible for making use of forced labour of Uyghurs in Xinjiang in China, have a page on Tex.tracer (European Center for Constitutional and Human rights, 2022). This clearly shows that the fashion industry needs to work on its transparency in how its workers are treated.

These discoveries resulted in the realization that the production of (fast) fashion often has huge unethical consequences on production workers in this industry. This started the consideration of either designing to solve the problem of inhumane working conditions or reducing the need for producing clothing in this way. An example of the first consideration can be seen below. In the end the last principle was taken from this learning point; reducing the need for the production of fast fashion.

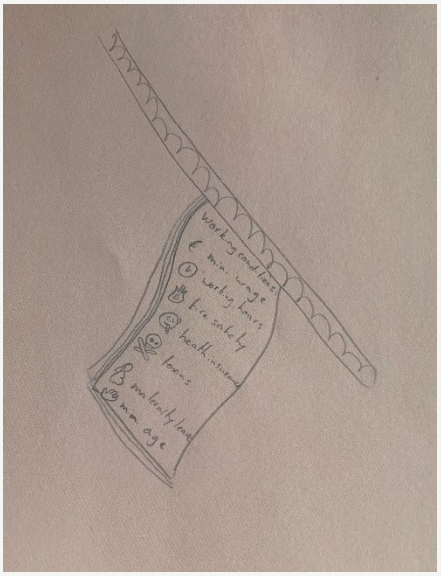

*Figure 7: 7Idea to solve the problem of inhumane working conditions.*

## Unsustainable mindset

Environmental impact of the fashion industry was also investigated. The image below shows four sustainability problems which the fashion industry is currently facing. The main learning point from this was that these researched issues were directly or indirectly caused by the mindset on which the fast fashion industry relies: clothes are seen as disposable rather than investments. Different ways to change this mindset were thought of, for example providing a more personal connection to pieces of clothing. This principle was incorporated in the design: the repaired clothing can be customized which provides personal attachment to the pieces. Later on, it was decided to present the final design as an experience to make people question this mindset and think about their relationship with clothing (see *Final Demo Day*).

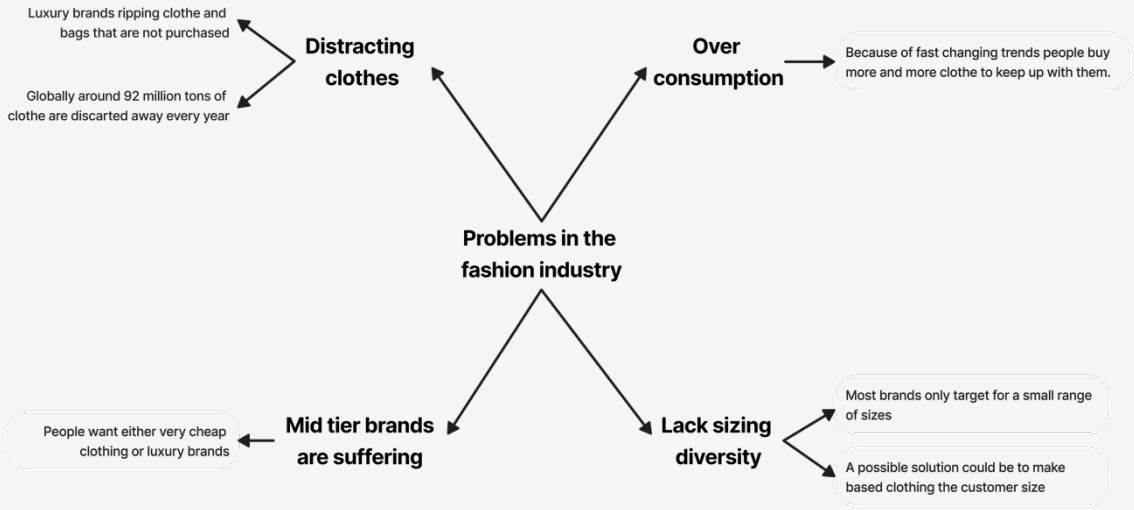


*Figure 8: Diagram with environmental problems*

After this, already existing innovations to solve these issues were researched. Below an overview with descriptions of each innovation related to the issues above can be seen.

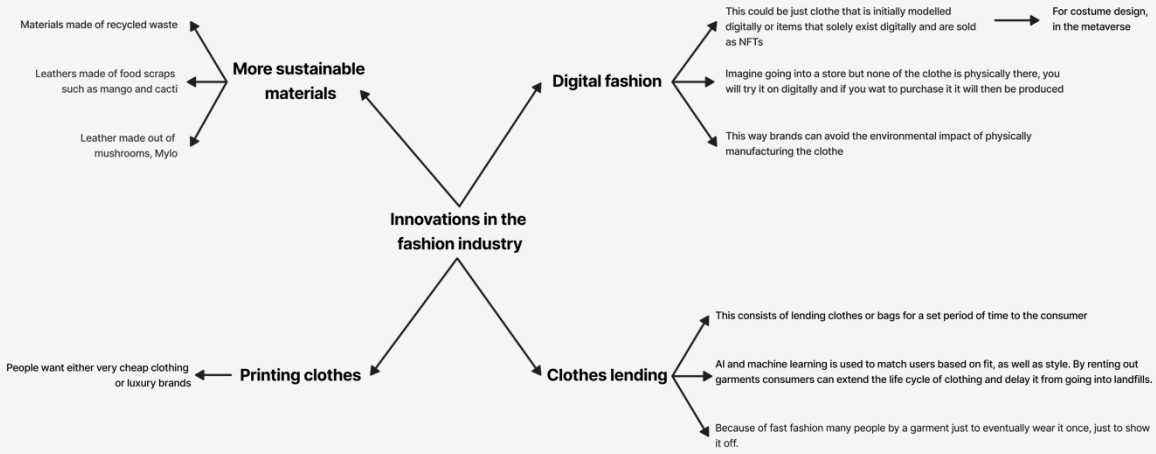


*Figure 9: Diagram with sustainable innovations*

This was inspiring and gave an idea of directions in which designs for tackling these issues could go. Some of the ideas from this diagram, for example digital fashion, were used as fundamentals for our concepts later on.

## Explorations on Integration of Sustainability

### *Recyclability*

Research was done on how to design with an eventual recycling process in mind, recyclability. From this it was discovered, for example, that shoes are hard to recycle because of the glue used in them and that garments can be recycled easier when they are made completely from one material. This last principle was also a premise for exploring alternative ways of attaching pieces of fabric together without using fasteners made from different materials (see *Modularity* below). The principle of recyclability was incorporated in the concept of a modular sneaker (see *Initial Concept Ideas).* This sneaker could be taken apart and would therefore make an eventual recycling process easier.

Later on, the gained knowledge in recyclability was used in investigating and documenting the repairing techniques (see *Repairing Options).*

Also, the current way in which garments are being recycled was researched. It turns out that it is a pretty hard process and it is not possible yet to fully recycle fabrics with the existing techniques (Insider Business, 2023). After discovering that when cotton is recycled, it is shredded first, an experiment was done with unweaving denim by hand to find out more about its recyclability. From this it was concluded that the recycling of fabrics is a really complex practice and because it is a big issue nowadays that a lot of companies are focusing on, it was not something to further explore.

*Figure 10: Denim being unwoven*

*Modularity*

At the beginning of the project, the task was given to make something ourselves within 10 minutes using limited tools. After this, these different creations were merged into one concept. The result was a modular sweater suitable for different seasons because it consisted of different layers that could be removed and added.

*Figure 11: Modular sweater*

Inspired by this exercise, the concept of sustainability through modularity was looked into. Techniques to connect pieces of fabric together were investigated. For instance, one that was based on the techniques used by Martijn van Strien (Tucker & Tucker, 2022).

*Figure 12: Martijn van Strien's connection technique, retrieved from dezeen.com*

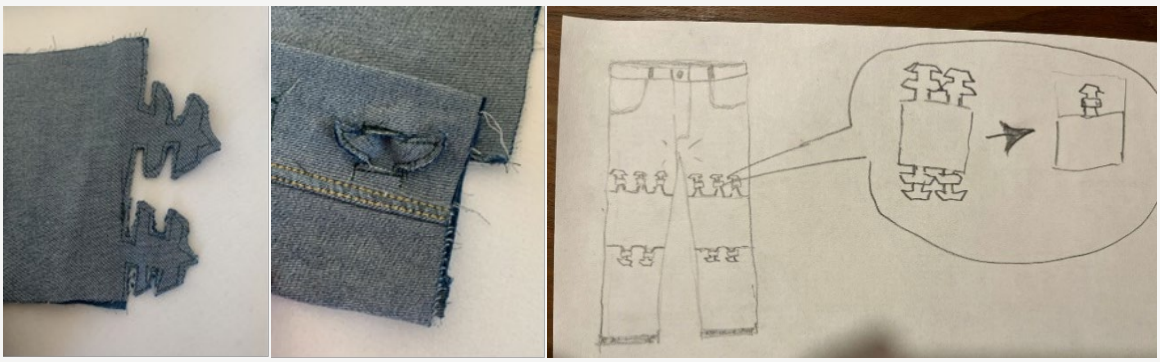

*Figure 13: Sketches and prototype of incorporating the Martijn van Strien system*

The goal of this experiment was to find a connection technique to modify the fit of clothing without the need to have sewing skills. This would help people reduce the need for buying new clothes when their size has changed. After doing research on this subject, a clothing brand called Mary Benson (mary glossary, 2022), was discovered. They make clothing with extra seam allowance so the pieces can be adjusted in size. However, for this, sewing skills are still required. Then, an idea where loops could be used to add pieces of fabric together was thought of.

*Figure 14: Loop system*

Each loop should go through the one next to it, until the last one is secured by a button. This way the loops could be on the inside of a garment, at different distances from the seam. Then people could easily attach the panels of the garment together at a distance that fits their size. After a quick sketch, the idea explored in a physical prototype, using different materials. One of the prototypes is crocheted, and the other is a sewn one from a mix of materials.

In order to improve the recyclability of clothes, besides the Martijn van Strien technique, also other ways of connecting fabrics without using fasteners were looked into. Garments which you could fasten with magnets were found. These would increase the general accessibility (Frost, A, 2023). Even though there were no modular clothes currently using magnets as fasteners, magnets can still be used with this purpose in mind.

*Figure 15: Magnet Me pyjamas, retrieved from reviewed.usatoday.com*

Another technique being used for modular clothes is a drawstring, which allows for adjusting the size of the clothing piece to accommodate for different situations. However, apart from the drawstring and magnets, there are no great alternatives to connect two modular pieces of fabric without using fasteners from a different material. The main learning point from this research was that even though these connection techniques are promising, there are still very few options to choose from regarding modularity.

The research and experimenting on modularity and recyclability resulted in the concept of a modular sneaker (see *Initial Concept Ideas).* Even though this concept was eventually left behind, the explorations were a great exercise in thinking outside of the box and broadening the idea of possibilities for integrating sustainability as a goal.

### *Biodegradability*

The picture below shows an experiment with felt. Felt seemed promising, as it is a biodegradable material. The goal of the experiment was to see if it was possible to pour wool drained in soapy water into a mold. This seemed to work; however, the end result was not nearly as strong as store bought felt. This has to do with the lack of friction added to the wool in this process.

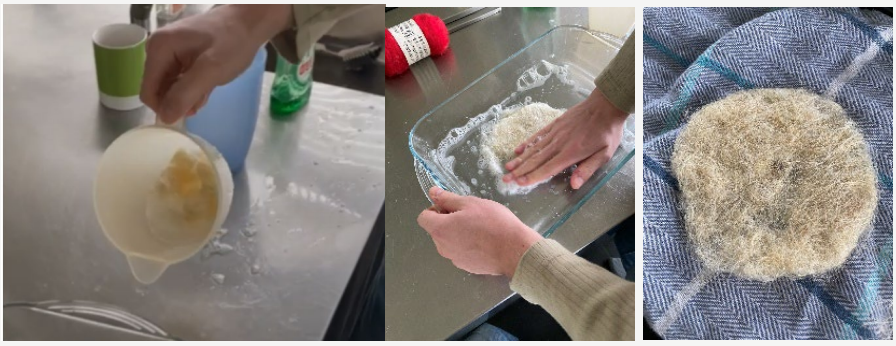

*Figure 16: Felt experiment*

In the end, the principle of biodegradability was mostly left behind, besides for researching and documenting the repairing techniques for the eventual design (see *Repairing Options).*

### *Durability*

The sustainability principle of durability was also explored. For this, durable stitches were looked into. The strength of certain stitches was also researched. An alternative way of stitching was also thought of, which was given the self-conceived term *parallel stitching.* The idea was to go back to the starting point of sewing with the thread after every stitch, inspired by parallel electrical circuits. This would prevent the fabric from coming apart as easily, making the garment more durable. However, the research done on stitching gave the realization that a durable stitch should be strong. Since the thread spans a larger distance for every stitch with the parallel stitching method, it can break. This means that this method of stitching is not more durable than normal stitching.

*Figure 17: Exploration of parallel stitching*

From these experiments, one of the concepts emerged: the most durable piece of clothing (see *Initial Concept Ideas).* However, it was eventually decided to not go with this concept as it is not as broad and versatile as the chosen concept.

*Sustainable Material*

In a student-coach meeting, it was noted that cork is not a sustainable material, because even though it is biodegradable, it requires cork trees to be harvested. However, it turns out cork can be harvested from trees without cutting them down. The harvesting of cork improves the plant's growth and increases the amount of $CO_2$ absorbed by the trees. This makes the production process have a reducing impact on $CO_2$ emissions. After the initial lifecycle of the cork, it can easily be recycled. Furthermore, it is durable, relatively light and a bit flexible. This means that cork is often an alternative to polymers that are way less sustainable (Knapic et al., 2016).

*Figure 18: Cork harvesting retrieved from uc-anr.com*

The use of cork was taken into consideration for the concept of the *most durable piece of clothing* as well as the *modular sneaker.* This is because the sustainable qualities of cork suited the principle of both durability and recyclability. The research of cork gave interesting new insights in the use of untraditional materials, even though it was decided not to go with either one of the concepts.

## Integration of Technology

From the beginning the integration of technology into the project was set as a goal. As an initial possibility digital fashion was explored. Cloth simulation software, such as Clo3D allowed the team to create a true-to-life piece of garment using 3D simulation, as well as AR filters which enabled a person to digitally try on these 3D garments were discovered throughout the initial exploration. The use of digital fashion could remove the need for new material production; therefore, a great interest was developed in the subject. These discoveries were what originally inspired the concept and why the project was focused on digital technologies.

### Generative AI

Inspired by the actuality of Dall-E and ChatGPT, artificial intelligence was explored with the hope that it could be the missing link in the concept: how the garments would be redesigned. The first experiment involved MidJourney, where it was asked to redesign the dress bellow into a shirt.

*Figure 19: Prada dress retrieved from cettire.com.*

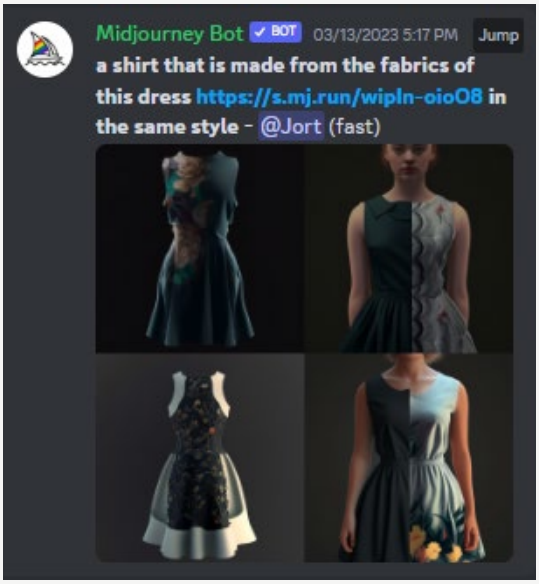


*Figure 20: Prada dress redesigned by MidJourney*

It is clear that the results shown above are very impressive, and that this model is great at visualizing, however, it did not do what it was asked and was unable to generate realistic designs.

Another way used as an attempt to get an AI generated clothing design was Point-E. This is a text-to-3D object model made for generating 3D designs through point clouds, provided by OpenAI. However as can be seen in figure 21, the results were not usable. This is because Point-E is in its earliest development stages, so it simply is not yet able to produce the most accurate 3D models. Furthermore, it has never been trained on clothing, where it would account for the physics of soft materials. These explorations were essential to understand how AI could be integrated in the project and its current capabilities.


*Figure 21: Point cloud of a shirt*

The problem with both MidJourney and Point-E was that it seemed like there was no way to gain control over it. Because of this it was decided to explore how difficult it would be to design and train an AI. When reaching out to a student who has experience with object recognition and AI generated art, insight was given to forget about training an AI that can design clothing. This is because it is unrealistic and outside our skillset. However, encouragement to explore simpler applications of machine learning was provided. It is important to mention that it would be possible to create the part of the experience where the user scans a of garment using machine vision.

### Machine Vision

The exploration began by using existing models with a software called YOLOv5 on Jupyter notebook, developed by Ultralytics. It worked well for conventional use cases of machine vision like comparing the number of cars against the number of trucks. Unfortunately, the pre-made model was not trained on clothing. As seen below, the model recognizes a pair of pants as a person and a pile of clothes as a bed.

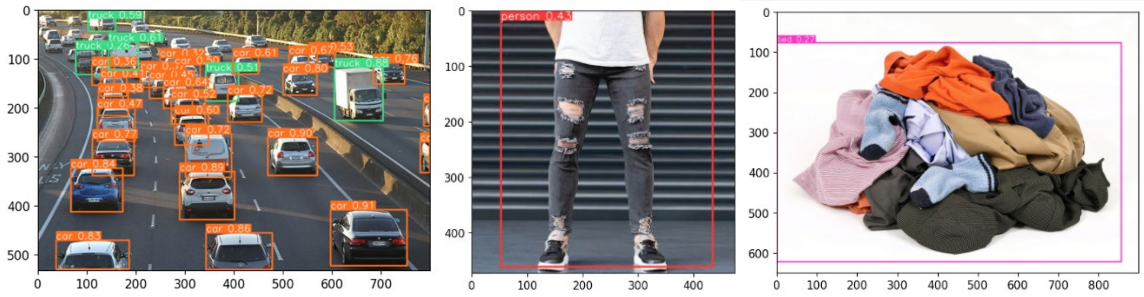

*Figure 22: Initial YOLOv5 detections, images retrieved from zalando.nl, iStock and Wikimedia*

In order to use machine vision for clothing, machine training was undertaken by individually labelling each subject within a complete dataset. This meant drawing boxes around shirts, pants, and stains. At first, LabelIMG was used which can be seen bellow.

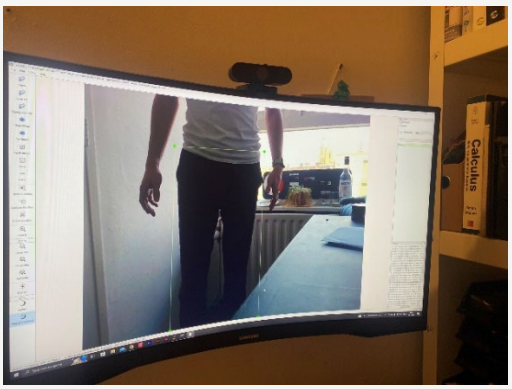


*Figure 23: Image being labeled using labelIMG*

This program worked well when labelling datasets with a size of around 50 images. However, more subjects were needed in our detections like stains and different types of garments. This resulted in datasets of more than 300 images. Fortunately, the app Roboflow, allowed for multi-user labelling, which made the process more efficient.


*Figure 24: Screenshot of recent jobs on Roboflow*

After labelling, the code could run in the Jupyter notebook that trained a model on our dataset. This model can be viewed by another program in Jupyter which overlays bounding boxes with labels onto a feed of the webcam.


*Figure 25: Machine vision detecting a shirt*

## AR Filters

An essential part of this concept was the possibility of trying on the clothes before its production. For this AR filters were needed. To make these filters CLO3D was used as the starting point to model the garments.

Initial 3D models were sent to Zero10 for them to turn them into filters, however there was no response back. Consequently, the realization dawned that it was necessary to create custom filters. There are two well-known systems to create filters Spark AR Studio, owned by Meta, and Lens Studio, owned by Snapchat. Lens Studio was chosen as they were already more established and had more information on creating try-on filters.

Models of the garments were created for the demo day using Clo3D; on top of these models patterns were added, showing the options to cover the stain.

*Figure 26: Clo3D models of the garments with repairs*

The idea was to add the models to the full body mesh in Lens Studio, however when doing so the garment appeared enormous and could not figure how to scale it down. As a last-minute fix PNG images of the 3D models were used to make a static image filter, to ensure there was something to show.

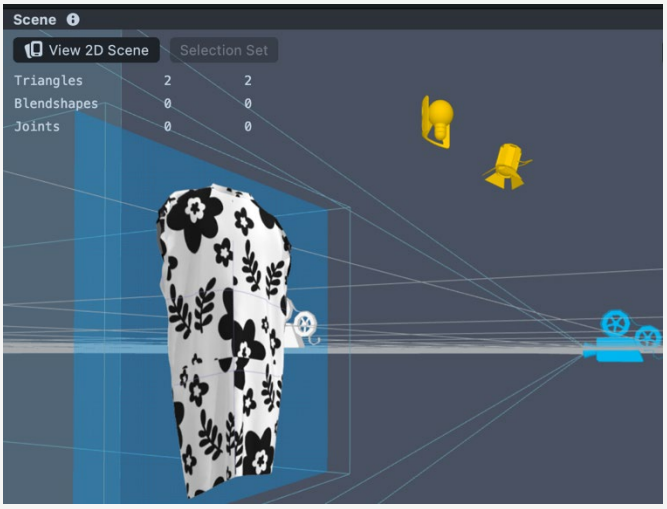


*Figure 27: Set-up in Lens Studio*

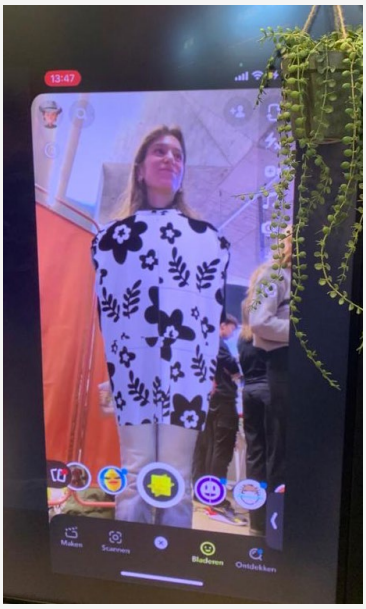


*Figure 28: Filters during mid-term demo day*

## Repairing Options

Research was conducted on various materials and their unique characteristics. During this exploration, the diverse techniques applicable with various fabrics was also looked into, as certain techniques cannot be used on some materials. Experiments were carried out with sublimation printing, embroidery, and vinyl printing on materials such as cotton, polyester, denim, ribbed fabric, lace, and more.

*Figure 29: Picture of experiments with embroidery*

In order to further iterate these experiments, the team needed to gain knowledge about the techniques that exist to add designs to fabrics, on which fabrics they work and the sustainability of the different techniques. The table below shows repairing techniques which were learned to use in the wearable sense lab and from a platform to help people repair and recycle their clothing called Fixing Fashion (*People Fixing Fashion*, z.d.). The solutions in pink were chosen for more explorations, as they allowed for more possibilities.

| Damage | Solutions | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Hole in garment | Put pocket over it | Embroidery | Put patch over it | Redesign item | Darning | Darning on sewing machine | Needle felting | Edge mending | Parachute stitch |
| Stain in garment | Put pocket over it | Embroidery | Put patch over it | Sublimation printing | Vinyl print | Needle felting | Screen-printing | Dyeing | Laser denim |
| Yellowing or discoloring of garment | Dyeing | Bleaching using UV light | | | | | | | |

*Table 1: Possible repair solutions*

In the sections below, the explorations conducted are explained and conclusions are drawn.

### Darning

Darning is a great way to cover up holes in fabric. It works by going over the fabric with thread multiple times in vertical and horizontal direction, manually or with a sewing machine. What is useful about this technique is that is stops hole from enlarging and creates a foundation to use other techniques like embroidery over it. If it is desired to take the eventual recycling of the garment into account, it is preferred to use a thread that is made from similar material as the garment it is used on, to prevent mixing materials.

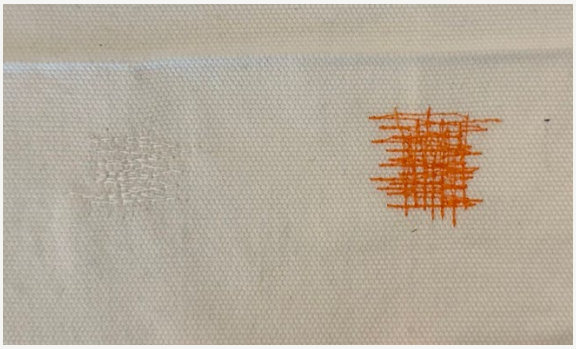

*Figure 30: Picture of darning*

### Putting a piece of fabric (pocket) over the damage

This would be a great solution for covering stains as it works on pretty much every fabric. For holes this could also work but only after making sure the hole will not expand, for example by using darning. To make it suit the project vision, scrap pieces of fabric could be used, as there is not much fabric needed for many designs in this category.

### Embroidery

Embroidery can be used to cover up stains and holes neatly. It covers stains well because it is not see-through, and it is possible to embroider over a hole after darning is used. Embroidery works on a lot of fabrics, but the best on non-stretchy fabrics. When using embroidery, it is preferred to use thread from the same material as the garment it is used on, to eventually make the recycling of the garment easier.

*Figure 31: Picture of embroidery*

### Parachute stitch

Cuts in fabric can be closed and stopped from expanding by using a parachute stitch as it is strong and long lasting. Through this technique ways to embrace the damage were explored, as this technique results in a very visible design. Using a thicker thread and contrasting colors are ideas to make it look more appealing. For this technique, it also applies that using a thread from a similar material as the garment improves recyclability.

*Figure 32: Picture of a parachute stitch*

*Figure 33: parachute stitch on damaged shorts*

### Sublimation printing

Sublimation printing is a great way to put complex images onto fabric. However, it is not an ideal technique; it only works on synthetic material (on organic materials the colors get faded) and the images it prints are not full-coverage, which sometimes leaves the stain visible and makes it hard to print on darker-colored fabric. However, this technique does not change the mixture of materials the garment is made from, which does not complicate a possible recycling process, unlike previously mentioned techniques can do.

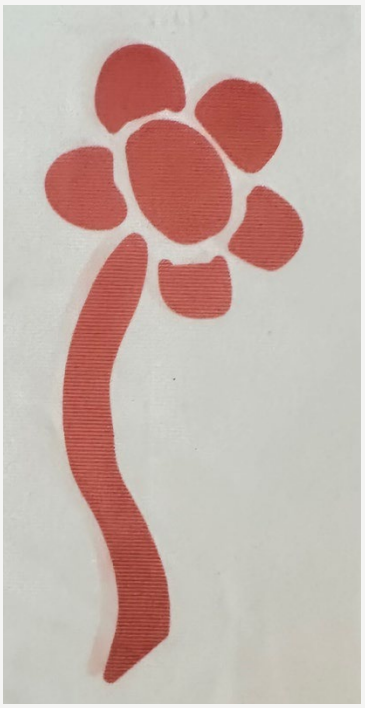

*Figure 34: Picture of a sublimation printing*

## Vinyl printing

Vinyl printing is a clean way of adding a design to fabric. It works on almost every composition when using different materials. The materials explored were film and flock, which can be used on cotton, polyester and blends of these materials.

Another thing to consider, when taking sustainability into account, is that the vinyl print is not biodegradable. So, when adding it onto garments of organic material, these also become non-biodegradable. This is why it is preferred to use this technique on (partly) synthetic materials.

*Figure 35: Picture of a vinyl print (flock)*

*Figure 36: Vinyl print on denim (film)*

## Needle felting

Needle felting is a technique that can cover up stains and holes in almost every fabric from every material. It creates a fun and playful look, rather than clean. In addition, it is not suitable for detailed or very small images. Because of this, it is dependent on the design, whether this technique can be applied. To come back to the idea of designing with an eventual recycling process in mind, needle felting can create a mixture of materials, which is not preferred, unless it is applied to garments made of wool. On the other hand, the material used is usually wool, which is organic and therefore biodegradable.

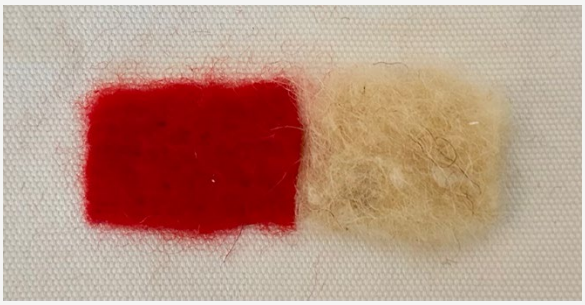

*Figure 37: Picture of a needle felted patch*

## Screen printing

Screen printing can be used to cover up stains with images. This technique was explored by creating a little makeshift screen printer from an embroidery hoop, mesh and glue. This technique also adds a nice streetwear look to the garment while covers up stains well, as it is not see-through. However, it is not suitable for really detailed images or when a clean look is desired. The technique can be applied on many fabrics depending on the dye used. Natural dyes were also considered, for the biodegradability and the toxic chemicals used normally, however it would need to be reapplied every five years.

*Figure 38: Initial logo screen printed*

*Figure 39: Process of screen printed logo*

## Bleaching with UV-light

For designs that required lighter colors than the fabric used, bleaching by using UV-light was explored. It would have been a great option, because it would not use any chemicals and wouldn't change the composition of the garment. However, through multiple experiments it was learned that it was not possible to bleach fabric in a short time frame. Below are two experiments done with bleaching with UV-light. In the first one lemon juice was put on a piece of fabric made from cotton and put it in direct sunlight for two days.

*Figure 40: 1st UV bleaching experiment*

In the second experiment lemon juice was also put on fabric but exposed it to UV-light from a sunbed.

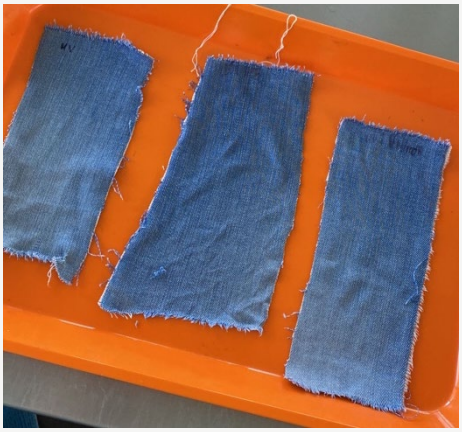

*Figure 41: 2nd UV bleaching experiment results*

## Customer Journey

In the early stages of the concept each group member had a different idea for what the concept should look like. To avoid confusion each member wrote their perceived customer journey so they could be compared.

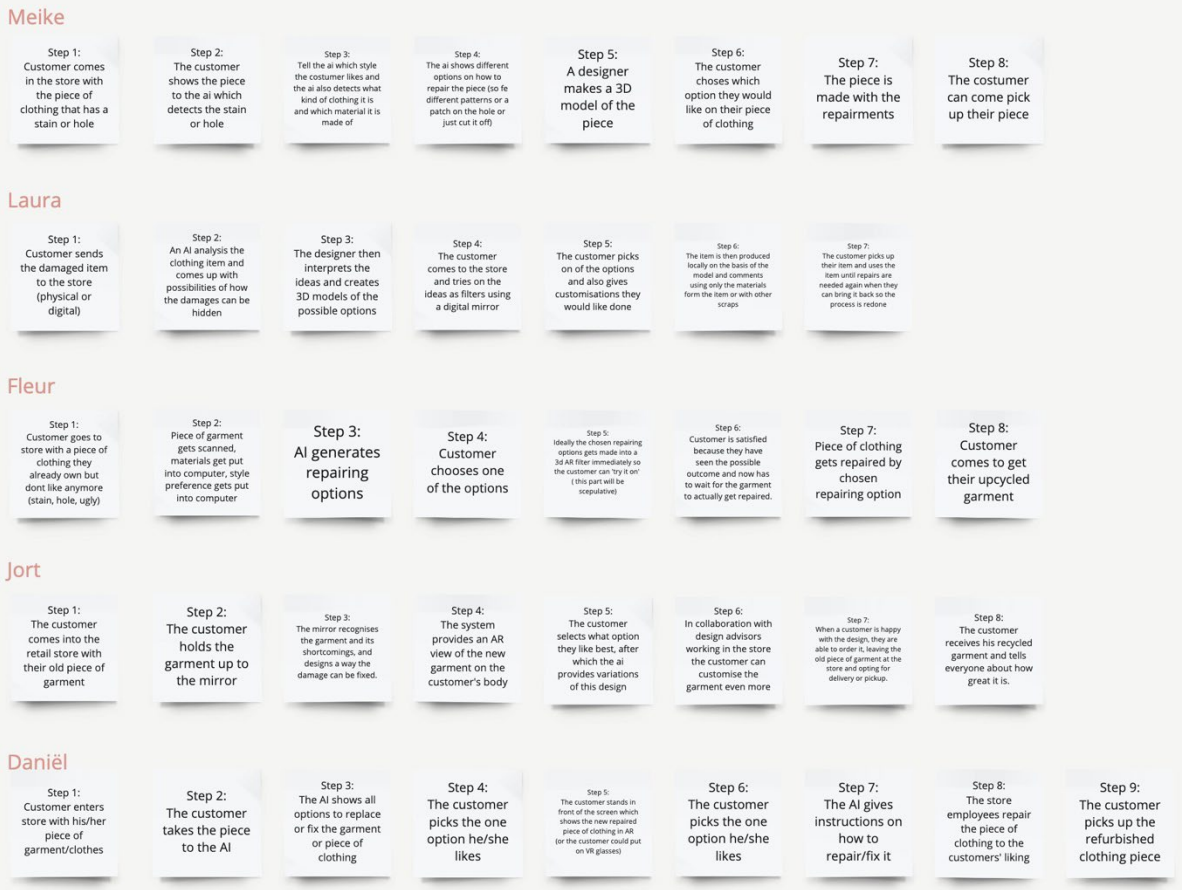


*Figure 42: Individual idea of customer journey*

By combining the results, three possible different versions for the executions of the concept were formed. The first two of these customer journeys would be feasible with the currently existing techniques on AI, while the third is based on the belief that AI would eventually be able to immediately generate 3D models of upcycled clothing, based on scanned garments. This belief is supported by already ongoing research in the generating of 3D-models by AI, which were previously explored.


*Figure 43: Three possible costumer journeys*

The more speculative concept was chosen for the mid-term demo day, as it offered the most interesting interpretation of the customer journey. After the demo the decision was made to continue developing the most speculative concept because it most closely met the vision established of a fast fashion approach to slow fashion. This was because with this version the garments could be repaired quickly, so the satisfaction of fast fashion shopping was still fulfilled by our concept. This choice also ensured that there were the most possibilities to continue with the project, as with enough validation you could go almost any way with speculative design.

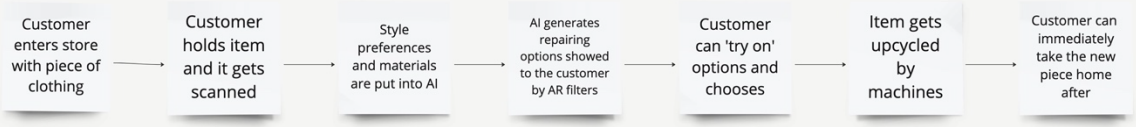


*Figure 44: Miro diagram of our customer journey*

In order to correctly create a speculative design, it is necessary to establish the context around it. It is important to understand an idea of the future of what the future could be and what the customer's need could be. To do this a cone of possibilities was used to look at what could be considered possible, plausible and probable in the future.

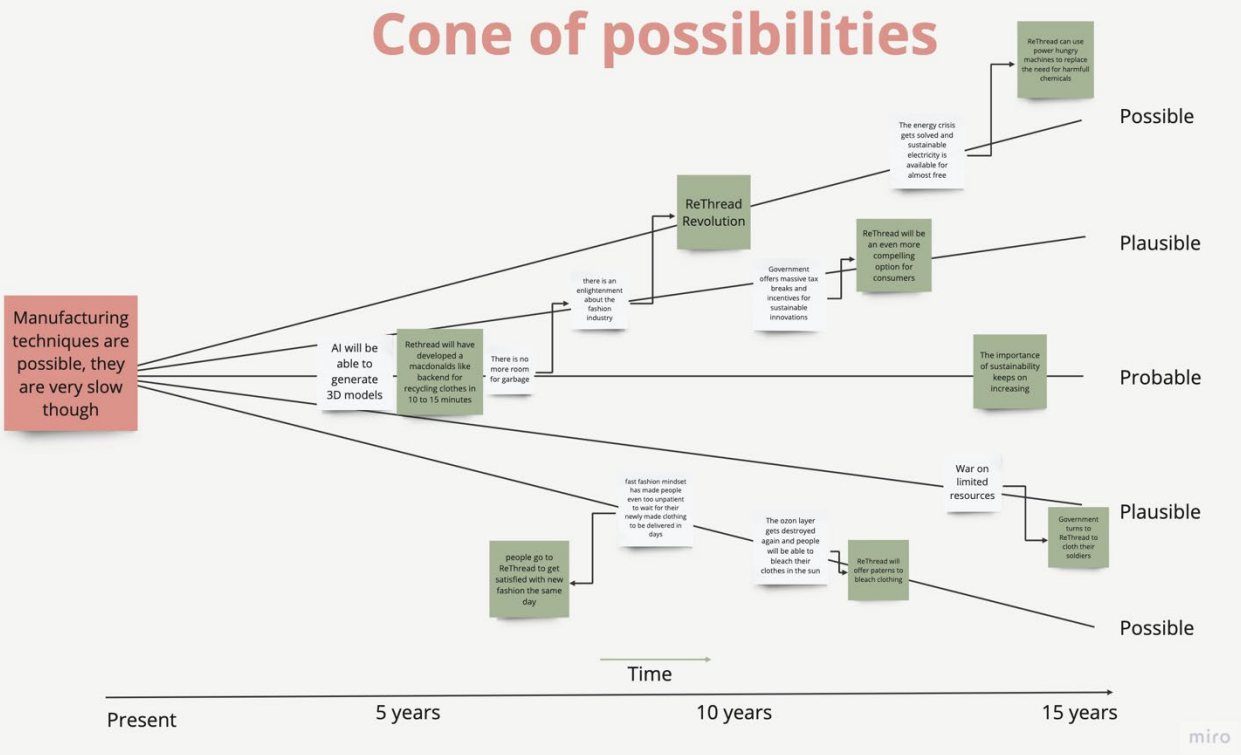


*Figure 45: Cone of possibilities*

All the steps that were taken to ensure a clear and specific customer journey were an essential part of the project as it allowed for many iterations. Discussing each members idea of what they believed the project could look like allowed for everyone to be heard and made sure an idea was not immediately jumped into without consideration.

## Target Audience and Validation

During the midterm demo day, participants were asked about their willingness to use the ReThread concept if it were realized. Taking the results into account, it was decided that the target audience would consist of individuals who have a passion for shopping and have the luxury to buy a lot of fast fashion clothes, with a budget similar to shopping at stores like Zara or H&M.

The validation stage played a significant role in the research process. After the Minimal Risk checklist was completed, data was gathered by conducting surveys in the city center of Eindhoven. The target population for these surveys was estimated to be individuals aged between 16 and 55. Participants were asked their opinions of the ReThread concept and how much they would be willing to spend on the repair service after a video was shown illustrating the store experience. The city center was selected as the survey location due to its higher concentration of potential target audience members, specifically fast fashion shoppers, in comparison to the campus area.

It is important to note that due to time constraints during the validation phase, it was difficult to maintain detailed and concise notes during the interviews, so it is possible that the results in the appendix might not be clear.

The findings from the validation stage led to the conclusion that, overall, participants thought that the ReThread concept was a great idea and expressed the will to use the service if it were to be realized. Furthermore, it was observed that a remarkable portion of participants already went to second-hand or vintage stores when looking for new clothing. This observation suggests that individuals are inclined to consider either their financial circumstances or sustainability factors when making purchasing decisions, thus providing additional affirmation for the initial assumptions.

What is more, surprisingly, when asking about the pricing of the repair service, one female participant, approximately 16 years old, said that she was prepared to pay half the original purchase price of a garment for the repair service, given that the redesigned garment will be at least as beautiful as before. Other interviewees indicated a price range of approximately 10 to 25 euros for the repair service. These findings emphasized the importance of improving the reparation designs to achieve a more realistic demo day experience.

## Visual identity

To bring the concept to life, the creation of a visual identity was necessary. Extensive exploration of various color palettes was done, leading to the combination of pink and green, as depicted in the figure. The incorporation of the color green was motivated by its symbolic representation of sustainability and growth. Similarly, the use of pink was to make the identity more playful, avoiding associations with fast fashion giants.

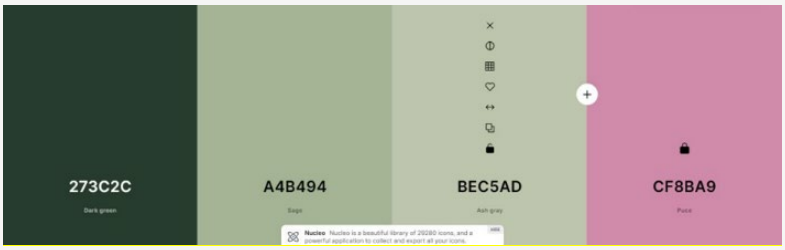


*Figure 46: Original color pallet*

In order to achieve a comprehensive identity, a name for the concept was needed. After brainstorming with the team, the name "ReThread." emerged. This name was very fitting as it encompasses the concept very well.

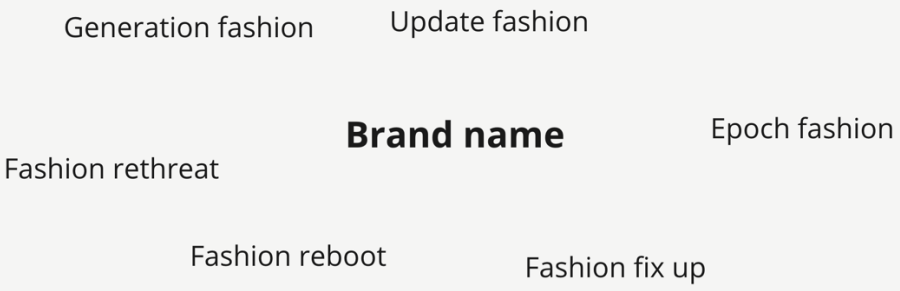


*Figure 47: Ideation for brand name*

After the initial identity was created, the first versions of the logo were made as can be seen below, trying to integrate the color of the vintage pink/orange screens.


*Figure 48: First versions of logo*

The logo remained unchanged until the midterm demo day. However, there was a realization that the identity presented during the initial demo day lacked vibrancy, and overall improvements were required to enhance the viability of the concept. To address this, the logo was redesigned, drawing inspiration from the clothing hanger as a source of creativity and reference. Various explorations were conducted to experiment with different uses of the colorway and to determine the optimal positioning of the accompanying text.


*Figure 49: Further iterations on logo*

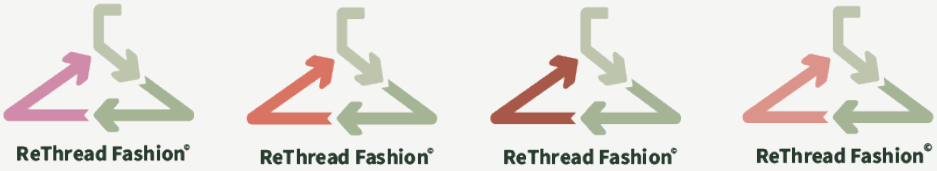


*Figure 50: Iterations integrating the color of the screens*

A lot of iterations were made, and it was eventually decided based on overall preference that the logo shown below was the one that was going to be used, for example for the interface in OBS.

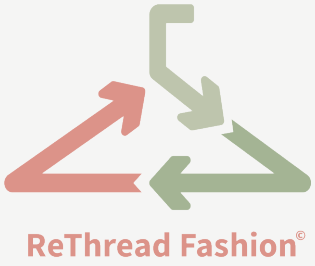


*Figure 51: Final logo*

## Ethical Evaluation

Some of the feedback received was that the ethical responsibility regarding intellectual property of the design should be questioned.

The first thing to consider is the fact that repairing designs are made by an AI and therefore might not be the intellectual property of ReThread. Research was done on this subject, and it seems to be more complex than thought beforehand. (De Grauwe and Sacha Gryspeerdt, 2022)

According to this source, the law on intellectual property in the EU says that copyright can only be given to things that are considered an 'original work'. For the repairing designs to be the work of ReThread, there must be a human intervention with the piece. The word 'original' in European law means: "if the author was able to express his creative abilities in the production of the work by making free and creative choices" (Hugenholtz & Quintais, 2021).

Therefore, the designs generated by the speculative AI model for ReThread would not be the company's intellectual property. Whether the choice in repairing technique for the execution of the design makes the design of the repaired garment suitable for copyright laws is hard to determine. It could be argued that it does not because the variety in techniques is limited and thereby no "free and creative choices" are made (Quach, 2023). According to this source, intellectual property can only be received when there is human input beyond the direct output of the AI. When relating this to the project, this would mean that the designs generated by the AI, whether it would be a 2D-picture or a 3D-filter, could not be the intellectual property of ReThread. However, after choosing a technique to execute the repairing, the repaired shirts could possibly be intellectual property of ReThread.

Another ethical issue regarding this, is whether the training data of a generative AI-model does not violate intellectual property rights of the designers whose garments are implemented in the dataset for redesigning the damaged garments.

This is an issue that has now raised in many art disciplines and has not been solved yet. The generative AI part of this design is now speculative, but when wanting to actually train a model that could design repair options, the intellectual property of the training data should be taken into account. A possible solution to this could be collaborating with a fashion store. This way the generative AI model could be trained with the design owned by that store.

Lastly, as ReThread redesigns garments, the intellectual property of the initial designers of the damaged garment should be taken into account. This is a complex issue, because the designers of the original garment might not wish for their pieces to be redesigned, especially when the design for repairing does not fit their aesthetic or vision. On the other hand, to keep rapidly changing their collections, fast fashion brands frequently copy designs from small businesses or designer brands, violating rights and ethical values regarding intellectual property. As the target group for this project is people who like fast fashion shopping, when launching ReThread, the damaged pieces that can be brought in should be limited to fast fashion garments, excluding small businesses and designer brands.

# Overall Results

## Machine Vision

To improve the machine vision, as it was not reliable enough, an additional 150 images were added to the dataset. The accuracy of the labels was also improved, as there was some miscommunication on how precise these had to fit around the images. Another improvement was a line in the code that flipped the webcam so the feed would look like a mirror.

```
In [23]: cap = cv2.VideoCapture(0)

while cap.isOpened():
    ret, frame = cap.read()
    if not ret:
        break

    cap_spiegel = cv2.flip(frame, 1)

    results = model(cap_spiegel)

    cv2.imshow('Pants or Shirt', np.squeeze(results.render()))

    if cv2.waitKey(10) & 0xFF == ord('q'):
        break

cap.release()
cv2.destroyAllWindows()
```

*Figure 52: Screenshot of the machine vision code*

## Shirt Designs

The user testing confirmed that great designs were needed to make the product more attractive, therefore a variety of different designs that could cover up or embrace the stains were created. Coming up with designs that would fit on a red shirt was difficult, however the results show that it is possible to create something nice, regardless of the original garment. The designs that were chosen for display for the final demo day show a variety of fashion styles while also sticking to the sustainable brand identity.

*Figure 53: The four designs that were integrated into the demo day set-up*

*Figure 54: Repaired shirts used in demo day*

## AR Filters

After the mid-term demo day, the focus shifted back to the basics of constructing the filter, meaning looking at tutorials and explanations to truly understand how they worked. The clothing modelled with the Clo3D avatar was too large. An avatar that was made specifically for use in Lens Studio was found, and a new model for the red shirts was created. But because of the small size of the avatar the cloth simulation did not work properly and made the garments look inflated.

*Figure 55: Picture of the first iteration of virtual garments*

In an attempt to solve this, further research on how other creators were making their filters was done. Eventually, the transform function in Lens Studios was discovered as a solution. This function could be used to scale down the garment. Therefore, utilizing the Clo3D avatar allowed for proper simulation. Adding the garment to the full body mesh required scaling it down by a factor of 10, resulting in a perfect fit.

*Figure 56: Improved version of virtual garment*

Even though the garments looked accurate, there were issues with the material used. To create a material for the filter a UV map is needed, and a detailed texture map including shadows. Making this would require a lot of time and skill not available at this point. So, more research was done for new ways to make the filter, when encountered the garment transfer feature, an upper garment substitution. To utilize this, a new mock-up needed to be created for the designs on Photoshop of someone wearing the garment. This worked very well and looked much more realistic than what was previously used.

*Figure 57: Filter with final shirt designs*

On top of the garment transfer an image carousel was used, which enabled to seamlessly go through different designs without having to open a different filter each time.

*Figure 58: Image carousel*

## Interface

For demo day the main goal was for people to be able to experience the concept, in order to make this happen, the Wizard of Oz method was used. A digital interface was made in Adobe Illustrator for the mirror. OBS, a software built for livestreaming, was used to complete the illusion of an interactive interface. Different scenes for every step in the customer journey were created on OBS, integrating the Illustrator artboards and screen capture of software. The monitor did not have a touchscreen to control the interface, therefore a keyboard was taped to the back which was configured to switch between the different scenes. To give the interface mirror a more rustic look and fit better with the set up a wooden frame was made around the monitor.


*Figure 59: Screenshot of the demo day interface*

## Final Demo Day

During midterm demo day, it became clear that when presenting the design as a store, people expect to have all the details of a business worked out. This influenced the reactions and feedback received. Some examples of the things to consider in this case are whether it will be a standalone “ReThread store” or a part of another clothing store, whether the people who control the machine for repairing are the same people who guide the customers in the store and how selling the garments would work considering prices. As the focus would rather lie on the incorporation of the technology into the designing and repairing process and on the experience for a possible customer, the design will be presented as an experience, rather than a store on demo day. To accomplish these explanatory posters in the ‘fitting room’ were present and by asking people whether they want to experience the customer journey themselves, rather than asking them whether they want to come into the store, as was done on the midterm demo day. This approach aimed to generate more insightful feedback regarding the experience and the utilization of the technologies employed.

During demo day, a lot of people were coming to the stand saying that they heard great things about the project from other colleagues and friends. This is in-line with most of the feedback that was given: the concept was a fun, involving experience and would indeed be a great way to stimulate slow fashion and continue the journey towards sustainability.

While preparing for the demo day, it became clear that each team member had developed his or her individual expertise, and there was a desire to express this through the dress code. The shirts helped to make a clear indication of who could answer questions about specific topics within the project.

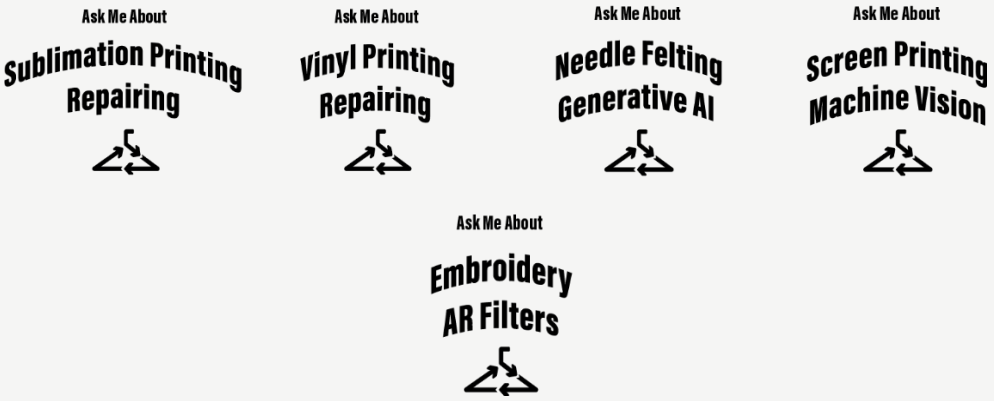


*Figure 60: Graphics on back of t-shirts*



*Figure 61: Final demo day setup*

*Video 2: Demo Day video*

# Conclusion

The goal of designing for sustainability could be considered achieved if the concept meets the principles of reducing and reusing. The design reuses damaged pieces of clothing so the garment can continue its circular journey. This reduces the need for replacing the old garment with a new one. These principles decrease pollution that is caused by the production of new materials and waste resulting from disposing garments. The goal of designing for sustainability was accomplished.

As it is almost impossible to take all principles of sustainability into account there are some things that were not focused on. For example, the energy that the machine vision and augmented reality installation would need and the $CO_2$ emissions that could result from that were not considered. However, this is negligible compared to the energy needed to produce a completely new garment or traditional recycling methods.

The ethical issues that are involved in the mass production of clothing; the bad working conditions of most employees were also considered. The concept fights against the issues of mass production, by repairing the garments locally and ethically responsible.

In the end technology was incorporated, even though it is in a different way than initially thought. Instead of using smart materials and electronics, inspiration was taken from digital fashion and made use of 3D filters.

Given the feedback and insights received after demo day, there are still two aspects that would really need to improve to make this a viable concept. The first one is the AI that generates designs for the repaired garments. Currently, there is no AI trained to create garments and the designs for the repairs. The AI would need to be trained with sample designs made by experts in the fashion industry, so that it can generate such designs on its own. A collaboration with fashion design companies could be useful to create this dataset. There is also no augmented reality platform that can generate filters within a matter of seconds from AI generated design.

Furthermore, the repair speed of the garments also needs to be improved, since the concept needs to be a fast fashion shopping experience. This could be achieved by acquiring several machines that repair garments combined with hiring the people needed to operate them.

## Integration of expertise areas

An important part of this project is to show how knowledge and skills from multiple expertise areas gained over the last year converge into a single design process. Reflecting on the process, six expertise areas were touched on during this project in one way or another. Visualized in the graph below is a radar chart of the expertise areas.

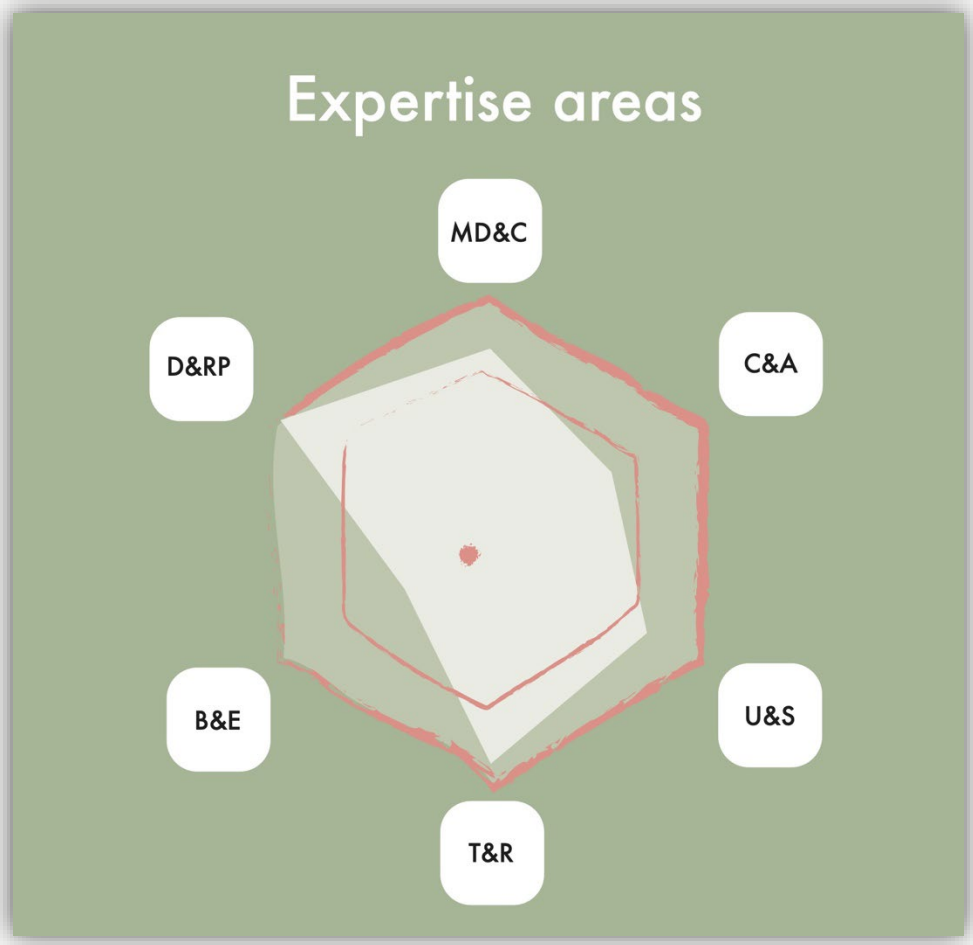


*Figure 62: Visualisation of expertise area integration*

### User & Society

As a part of the design process, the fast fashion industry was investigated. It was concluded that the issue boils down to overconsumption. A solution to this problem could be a sustainable shopping experience that is just as rewarding to the user as a fast fashion shopping experience. To validate this, user tests using a semi-structured interview were conducted.

### Creativity & Aesthetics

Especially after the validation stage of the concept, the importance of adding value for the user by improving the aesthetics of the repair options became clear. Another example of the C&A expertise area coming into play was during the hours of discussion the group had about different graphic design styles and logos.

### Math, Data & Computing

In this project the MD&C expertise area was touched on during the work on the machine vision system. For the last iteration of this system a dataset of 363 images was created, which was used by a neural network to create a machine vision model. The experience taught the implementation of existing repositories for unique use cases.

### Technology & Realization

In this project augmented reality filters were created, using innovative software such as Lens Studio and Clo3D in the AR space. The team also learned how to work with textile machines in the wearable senses' lab, which allowed to creation of convincing prototypes integrating soft materials.

### Business & Entrepreneurship

After demo day the commercial viability of the project was visualized. To do this the Business Model Canvas and the value proposition canvas were used. During the validation session users were also asked the amount they would be willing to spend on the service.

### Design & Research

During this project the intend was to follow the reflective transformative design process. In practice, there were a lot of similarities to a material centered design process.

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# Individual Reflections

## Daniël de Goederen 1847775

I chose to join this squad because the subject was completely new to me, not being familiar with soft materials or textiles in general. My goal was to learn as many new things as possible within this theme, trying to help me discover myself as a designer. I can confidently say that I accomplished this goal, although the learning outcomes were quite different from my initial expectations.

I thought Soft Materials was all about learning different textiles and its unique properties, which it was, but it did in fact not stop there. I still learned new properties about textiles and the possibilities with them, for example how all repair options could be used and on what material they can be applied to. I became an expert in needle felting, teaching me how to cover up holes in clothes using wool. Moreover, I familiarized myself with the stitching machines in the wearable senses lab and learned how to use the heat press.

What truly fascinated me was the introduction to new types of artificial intelligence and the opportunity to explore their applications. Examples are machine vision, Point-E and MidJourney. I knew about their existence, but not how one could utilize them for a project like this, which I think is very interesting. I now consider how these technologies can enhance functionality, interactivity, or even aesthetics in my projects. It has sparked my imagination to explore innovative ways of integrating AI into my work. Another important learning moment is when I got to know more about the sustainability aspect of fashion. I always used to see sustainability as something that was not really important to me. However, seeing what impact the fashion industry has on the environment around, was a real eye opener. It reshaped the way I think about sustainability. This new mindset about sustainability encourages me to think beyond the initial lifespan of a product and consider its longevity and potential for repair and upcycling.

Throughout the project, I also experienced personal growth as I confronted my struggles with receiving critique, sometimes taking things a little bit personal. Working alongside with the team I had presented great opportunities to address this challenge. I became more self-aware and learned to see critique as a valuable chance for improvement.

The project I worked on has greatly contributed to my growth as a designer, providing me with a deeper understanding of my interests, personal values, and access to valuable new tools for future projects. Although Soft Materials taught me fascinating things, I've come to realize that it may not be the field I want to pursue long-term. This project, however, sparked my curiosity about designing for behavior change, since our concept is essentially about influencing people's attitudes towards fast fashion. This has introduced me to the concept of designing for behavior change.

## Fleur Hoenderboom 1826735

As I look back at this project there are three subjects that I gained knowledge on that first come to mind for me. The first one is that when sustainability is the goal of the design, it is necessary to think about what sustainability means to you and which principle you want to focus on. This is because sustainability is such a broad concept and sometimes even has conflicting principles, for example durability and biodegradability. This has helped me a lot in this project and I think I will also use it in future work. This is because I have always been interested in designing with sustainability as a goal and it is something I want to keep doing in the future. However I was always quite unsure about the subject because it was so broad and felt elusive to me. Now I know how to approach sustainability step by step.

Another thing I learned is why I had always had a bit of a conflict with my moral values when designing products. Before I knew that something about it did not really match my vision but I did not know how to but it to words. Early in the process of this project I learned that my issue with product design was that it feels contradictory to put new products into a society full of over consumerism. I realized this after talking to my group members who sometimes also felt like this and doing research on the fast fashion industry, which might be the most obvious example of an industry led by over consumerism.

Second, I learned a lot about Artificial Intelligence. The first thing I learned about it was that AI actually means and what it is capable of. I also realized AI is still in development and has a lot of limitations too. Before I always thought AI was vague, that I would never have to work with it and that it was all about robots and had nothing to do with living beings. However, this project has made me realize that I am actually really interested in Artificial intelligence. I am specifically interested in the human features it can have/imitate and how this can have a huge effect on peoples attitude towards AI. I am passionate about the moral changes the further development of AI can trigger. This is something I might want to investigate further through design in the future.

Learning about these three subjects made me realize that using technology and innovations (such as AI and augmented reality) can help design for sustainability. Before I usually thought of product design using sustainable materials when designing for this goal, it never occurred to me that digital services can also contribute to this. I will keep this in mind in future projects.

More towards the end of the project I gained a lot of skills in working with fabric. I learned how to use an embroidery machine, a vinyl printer, sublimation printer and further developed my sewing skills. As I already had quite some experience in working with fabric, the software used by the machines were the biggest challenge for me. Mainly switching between different software programs and exporting files correctly is something I struggled with, especially when errors occurred. As the people in the wearable senses lab were really helpful and explained a lot to me, this is something I have gotten more competent in.

I have a broad interest, which has made me become a bit of an all-rounder in this project; I try to help where needed. This has made me gain various new skills, but has not really made me an expert in anything. For example, I have helped to start coding the machine vision model and in the end I have helped solving errors, but I wasn't able to help with a big remaining part of this coding, so I still wouldn't be able to immediately write such a code myself. I can say I have gained knowledge in coding, but it is still pretty shallow. Even though I really enjoy this role of all-rounder, in my next group-project I will try to also deep-dive into a certain topic to gain more expertise.

Something I also would like to improve in my next project is keeping an overview of the project. With this I mean keeping track of what has to be done in the process, as well as have a better overview of all the aspects of the project design. Our design for this project turned out to be pretty complex, which often made us loose track of what all had to be done, forget about tasks and sometimes caused for us to not be on the same page. This is something I want to prevent in my next project by being more organized and maybe writing and visualizing more.

## Jort Postema 1845926

At the start of this project, I really appreciated how we were fully engaged in the cocreation workshop as it would have been easy not to take this serious. In this workshop we expressed our strengths, learning points, expectations and pitfalls to each other.

Personally, I expressed how I want to take more time to listen and to appreciate other's ideas during this process.

Additionally, we took the Belbin test, which aimed to identify our strengths and preferred roles within a team. My test results revealed a combination between being a plant, contributing creative ideas, and a coordinator, assuming leadership responsibilities.

In light of my goal being to become more open to other voices, I expressed that someone else should take leadership responsibilities. I volunteered to be secretary, intending to note down everyones ideas and research. I am happy with this decision, however this role was not suited for me either, due to my lack of discipline and focus. The first two months I neatly wrote down everything in a word document. After this initial period however, I kept forgetting to update these notes which complicated writing this report on our design process.

Another thing that really helped during this collaboration was that we sat down early to discuss our shared values. From this conversation it became clear that we all had a passion for sustainability, which guided us throughout this design process. This was the driving force to make the clothing store concept circular for instance.

One thing that I would have liked to have seen different in our project is our iterations after the midterm demo day. In some projects it makes sense to think of a completely new concept half way through the process. In our case however, we were very fond of our concept and we unanimously wanted to iterate on what we presented during the midterm demo day.

Changes made after midterm were often either technical or aesthetic. Like improvements to the machine vision and the augmented reality or the addition of an overarching interface. We did, however completely work out all of the repairing options in our concept. The advantage of this approach was that it enabled us to present a polished experience during demo day which correctly conveyed our idea. It also enabled us to have the most complete design process I have been involved in yet. Touching on all stages of the reflective transformative design process.

Looking at our process you could say that half of it was getting to the idea, the other half was polishing the execution. To me this was a valuable learning experience. I feel like the decisions that led us to the final experience were all very conscious and well thought out.

If I had to choose one thing, I am most proud of in this project it is the machine vision. I spend many hours on trying to get the code to work and it was rewarding to finally see it in action. This experience has taught me that I can do way more than I initially thought, and I should give up less easy.

I am also proud of the fact that at the end of the project, I feel like I achieved my goal of being more open to other ideas and rediscovered the importance of listening.

To conclude this reflection I want to express my gratitude towards the team, who were great to work together with, to our coaches and to the members of other teams who provided valuable feedback to us nearly every week.

## Laura Nascimento 1838555

I chose to work in the Soft Materials squad for Project 1 as I believed it would allow me to create extensive prototypes and material exploration. The project did not follow these expectations exactly however, I learned a lot in terms of my personal development and professional growth.

Through the design process, I learned that I enjoyed discovering and learning new technologies, as well as applying these new emerging technologies to the concept I am working on. Such as Lens Studios which allowed me to produce AR filter and Clo3D, where I could make true to life cloth simulations. Now I feel more comfortable reaching out to these technologies and have more confidence that I can pick up these new skills. Therefore in the future, my curiosity and enthusiasm to learn needs to be pursued further to not only to software but also to other skills within industrial design.

Having people be curious and even impressed by the work I presented during the coach meetings gave me a lot of motivation to keep going with my explorations. Having to present weekly helped me be less intimidated by it and rather take the opportunity to receive feedback on what I wanted.

At the start of the semester, I believed that I did not have the traits of a leader in a group, as I thought that I was not extroverted or vocal enough. However, this project made me realize that I need to be more confident in myself and reach for that position. Usually, the groups I am in contain people with much more expressive personalities which tends to make me more afraid to take charge.

I am very grateful that my group was willing and prepared to put as much work in this project as I wanted to. However, understanding that this group had a different dynamic than I expected I needed to be prepared to take charge and be the driver. Something that now I feel prepared to do, having the confidence to be more expressive about my inputs.

Before this project I believed that if you wanted to create a sustainable product it had to compose all the principles of sustainability, to make the most sustainable product. I have learned that it is important to focus on specific principles to make sure your concept will have an impact in that area. Which makes me more confident on making sustainability a focus in future projects. This same theory can be applied to all projects even outside of sustainability as it is more effective to solve specific issues.

During the first weeks of the project, we decided to take minutes during the meetings so that we would documentation of our process. Despite this being a great idea, we were not consistent in implementing this and were left with many gaps. While working on the report I learned the importance of making this documentation, because each of us had a different idea of the order of the conceptualization. During the coach meetings we were told many times to document everything we did, which reminded me that sometimes the best way to learn is through making mistakes, so that I can apply these learning points more confidently in the next project.

While reflecting on this project I am very proud of the work my group and I have done during this semester. I am immensely satisfied with the final outcome as it shows how much time and dedication we put into each part of our design.

## Meike Omvlee 1809474

One of my goals from my personal development plan was that I wanted to get better at presenting. I think as a designer it is a valuable tool to communicate your ideas better and establishing myself as credible designer in the industry. The weekly presentations in this project played a key role in my progress. In high school, I had limited opportunities to speak English, which resulted in difficulty in articulating myself and increased anxiety. This year, however, I had the opportunity to communicate in English within my group, which helped me get more comfortable with this task. Through this experience, I have grown and now know better how to navigate presentations with more confidence and skill.

The process of this project required me to do a lot of online research, which was a new experience for me, and it improved my information-gathering skills. Moreover, I discovered the significance of documenting and capturing the process through photographs and text effectively. Especially at the end of the project, it would be extremely helpful if we documented well in between, because we now had multiple discussions on how and when things happened. By documenting often, it would showcase our process in the end well. I am going to really take that into account in my next projects since I learned from how we did it in this project.

As a designer, I find it really difficult to say what kind of designer I am and what kind of things I find important in my designs. Instead of easily identifying what I like, I often find it easier to conclude what I do not like. However, the squad Soft Materials inspired me to start sewing, crocheting and gain more knowledge about fabrics. I started to develop myself more in this because I simply really enjoyed doing it. Through this project, I discovered that fabrics and wearables are an aspect of design that appeals to me, and I really want to become an expert in this.
In addition, for this project I also studied Clo3d, through this application I learned more about how to make a virtual garment prototype. I found out that besides physically working with fabrics, I also find the digital part of fashion making very interesting.

This all has helped me with my identity as a designer to figure out that I am someone who would like to create designs perhaps within the domain of fashion or exploring various possibilities with fabrics in general.

In this project, we adopted a Value Based Conceptualization process, which centered our work around the principle of sustainability. Embracing this approach has revealed a valuable aspect of my design preferences, I thoroughly enjoy starting with a clear goal in mind, rather than diving into the creative process. I feel that we have gone through our process very effectively because you know that an idea must fit the clear aspects of the value. This is something I am taking into account in my projects in the future.

In the past, I believed that integrating sustainability into designs was a straightforward process. But I did not really know how to approach sustainability because I thought I had to consider every little detail. However, in this project, I learned that focusing on one aspect of sustainability is also affective and by paying attention to this can still make a positive impact. This new understanding has opened possibilities for me as a designer, allowing me to contribute to sustainability in my own way.

# Appendix

## Task division

In this chapter the division of work during this project will be outlined.

### Daniël

- Research
    - Connection techniques
    - Repair methods
    - Needle felting
    - Recyclability
    - Digital fashion
    - Generative artificial intelligence
- Experimentation
    - Needle felting
    - Generative artificial intelligence
- Visual identity
    - Final logo
    - Final interface
    - Fashion awareness video
    - Demo day aftermovie
    - T-shirt designs
- Prototyping
    - Training machine vision data set
- Validation
    - Preparing questions
    - Conducting interviews

## Fleur

- Research
    - Ethical issues fashion industry
    - Durable stitching methods
    - AI in fashion
    - AR in fashion
    - Durability of clothing
    - Connection techniques
    - Durable materials
    - Recyclability
    - Repair methods
    - Ethics on owners of design and AI
- Experimentation
    - Durable stitches/ parallel stitching
    - Recyclability
    - Training machine vision
    - Embroidery
    - Vinyl printing
    - Sublimation printing
    - Screen printing
    - Repairing with scrap pieces
    - Bleaching with UV-light
- Visual identity
    - T-shirt designs
- Prototyping
    - Training machine vision data set
    - Catalog repair techniques
    - Repair red T-shirts
- Validation
    - Preparing questions

### Jort

- Research
    - Cork
    - Felt
    - Recyclability
    - Machine vision
    - Generative Artificial Intelligence
- Experimentation
    - Felt
    - Recyclability
    - Machine vision
    - Generative Artificial Intelligence
    - Sublimation printing
- Visual identity
    - Initial interface design
- Prototyping
    - Creating machine vision dataset
    - Machine vision
    - Figuring out OBS interface
- Validation
    - Conducting interviews.

### Laura

- Research
    - Ethical issues in the fashion industry
    - Innovations in the fashion industry
    - Fast fashion industry
    - Digital fashion

    - AR filters
- Experimentation
    - Sublimation printing
    - Embroidery
    - AR filters
    - Clo3D
- Visual identity
    - First iteration of logo
    - Designs of shirts for demo day
    - AR filters poster
- Prototyping
    - Clo3D models
    - Mock-ups for filters
    - AR filters using Lens Studio

### Meike

- Research
    - Connection techniques
    - Fast fashion industry
    - Durability of clothing
    - Different fabrics
    - Repairing techniques
    - Vinyl printing
    - Sublimation printing
    - Embroidery
    - Dye
- Experimentation
    - Connection techniques
    - Different fabrics

    - Repairing techniques
    - Vinyl printing
    - Sublimation printing
    - Embroidery
- Visual identity
    - Making posters
- Prototyping
    - Repairing red T-shirt
    - Clo3D models
- Validation
    - Conducting interviews

## Appendix 1: Validation interview

1.

Couple around 35

I think so near my home

Men=New, women=thrift shop

Like but not my first option

Yea would replace it

2.

Belgian couple around 40

Both don't buy second hand clothing

Difficulty with supply

In Belgium there is little availability of thrift stores or second hand clothing

When favourite piece is permanently damaged > used as work clothes

Sometimes repair clothes themselves

Enthusiastic about our idea

Lower threshold, especially when the quality is good

They question whether it is worth it to repair fast fashion (which is very common nowadays)

Quality is expensive

Cheap is hard to repair

How much they would spend on our service depends on the price of the clothing and the service

3.

Girl around 16

Buys every now and then on Vinted

If a garment is damaged, she doesn't buy

When a garment is permanently damaged she sometimes wears it around house.

Our service is handy

She would definitely use it

Great idea

How much she would spend depends on the garment, but if it's her favourite piece AND the repair option is actually good looking, she would spend half of the original price of the clothing on our service.

4.

Store manager around 50

Worked in Spain called Preloved by Ester

Sold 60% kept 40% of the profit

Secondhand clothing must be in great condition

Seller needs to make sure secondhand garment is in a good condition

If garment is damaged, the price goes down.

She thought our idea was nice.

Actually, the same as printing on a t-shirt, 15 minutes

Price of our service depends on how it looks

Set up on store, Purdue gives a lot of coffee to clients so that they spend more time in the store

More expensive clothing = better service

If in the same business = they won't buy

5.

Women around 35

Buys second hand

Very cheap and unique and goes to tailor

Our idea sounds nice

Price depends on one kind of clothes

If it's a sweater for 80 euros

Then around 20/25 euros

## Appendix 2: Research

This appendix is about research we did for repairment techniques and fabrics.

### *Sublimation*

Sublimation printing on different materials and degrees.

| | |
|---|---|
| Polyester fabric | 200 to 205 °C |
| Ceramic sublimation mugs | 190 to 200 °C |
| Ceramic sublimation plate | 190 to 200 °C |
| Sublimation tumbler (made of metal) | 160 to 170 °C |
| Sublimation umbrella | 190 to 195 °C |

| | |
|---|---|
| Neoprene fabric (mouse pads, coasters, vapor foam kit) | 200 to 205 °C |
| Sublimation metals (Mobile phone covers, keyring, metal plates, trophy covers) | 190 to 200 °C |
| Sublimation substrate arm sleeves | 200 to 205 °C |
| Sublimation face mask | 240 to 245 °C |
| Sublimation overheats transfer vinyl | 175 to 180 °C |
| Canvas material | 185 to 190 °C |
| Polyester cushion covers | 200-205 °C |

(Craft, 2022)

The process alone is 100% eco-friendly. It can even replace traditional dyeing methods that consume too much water. And that means that instead of wasting hundreds of litres of water just by dyeing one t-shirt, you'll use 5ml of sublimation ink to achieve the same result.

100% polyester is by far the best material for sublimation t-shirts. Polyamide and nylon melt under temperatures of 170° C and higher. So not good for sublimation.

You cannot sublimate on 100% cotton because it is a natural fiber, contains no polyester so has nothing for the sublimation ink to bond to. And Dark fabrics

It will not work with Nylon fabrics or plastics (vinyl/PVC, ABS, etc.). Similarly, polyester will not work well with heat transfer materials since the adhesive type cannot bond properly to a plastic-based surface. Also, textured fabrics or loosely knit fabrics are not ideal for use with the heat transfer product.

(fush, n.d.) (Silhouette, n.d.)

*Embroidery*

Best: 100% cotton fabric, linen, fabric with a relatively tight and even weave

Worst: T-shirt Material, Synthetic Fabrics, Uneven or Looser Weave, Thinner Fabrics, stretchy fabric

(crewelghoul, 2022)

### *Dye*

Here are some options for creating different colors of dye in a natural way:

- Red and pink: Fresh beets or powdered beetroot, pomegranates, red and pink rose petals, avocado pits
- Orange: Carrots, turmeric, butternut seeds or husk
- Yellow: Marigolds, sunflower petals, paprika, celery leaves, onion skins
- Green: Spinach, mint leaves, lilacs, artichokes
- Indigo: Purple cabbage, blueberries, blackberries, woad, black beans

(Skillshare, 13)

### *Different interesting companies*

Colorifix minimises the environmental impact of industrial dyeing by replacing chemistry with biology at every step in the process, from the creation of the dyes to their fixation into fabrics.

(Colorifix, n.d.)

Living ink is creating carbon-negative sustainable fabric dyes from algae! Their process is pretty neat. First, algae are grown at large-scale using sunlight, water, and carbon dioxide.

The crude pigment is then purified and transformed into finished ink. Their black algae-based pigment has a negative carbon footprint, is bio-based, resistant to UV-light exposure, and is safe for humans and the environment!

(Livingink, n.d.)

Air-ink by Gravity Lab sequesters air pollution waste (PM 2.5 and PM 10 emissions) to create pigments and ink. Their mantra is to “take something as pervasive as air pollution and turn it into something as common as ink”.

(Air-ink, n.d.)

## Appendix 3: Visual identity


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RE-THREAD
A FAST FASHION
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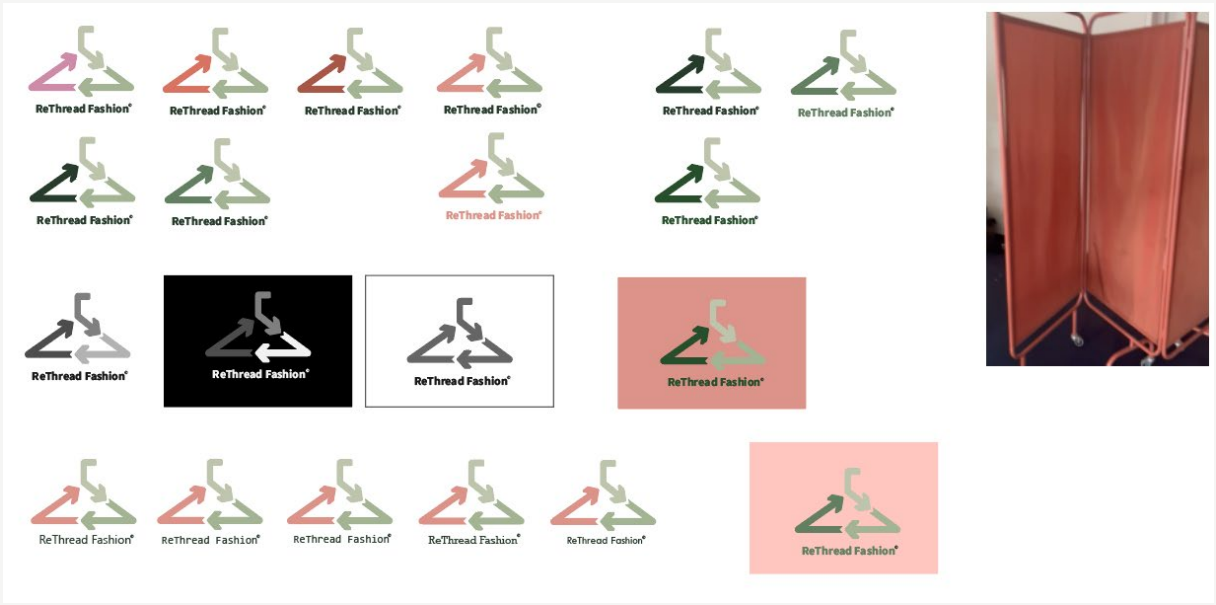
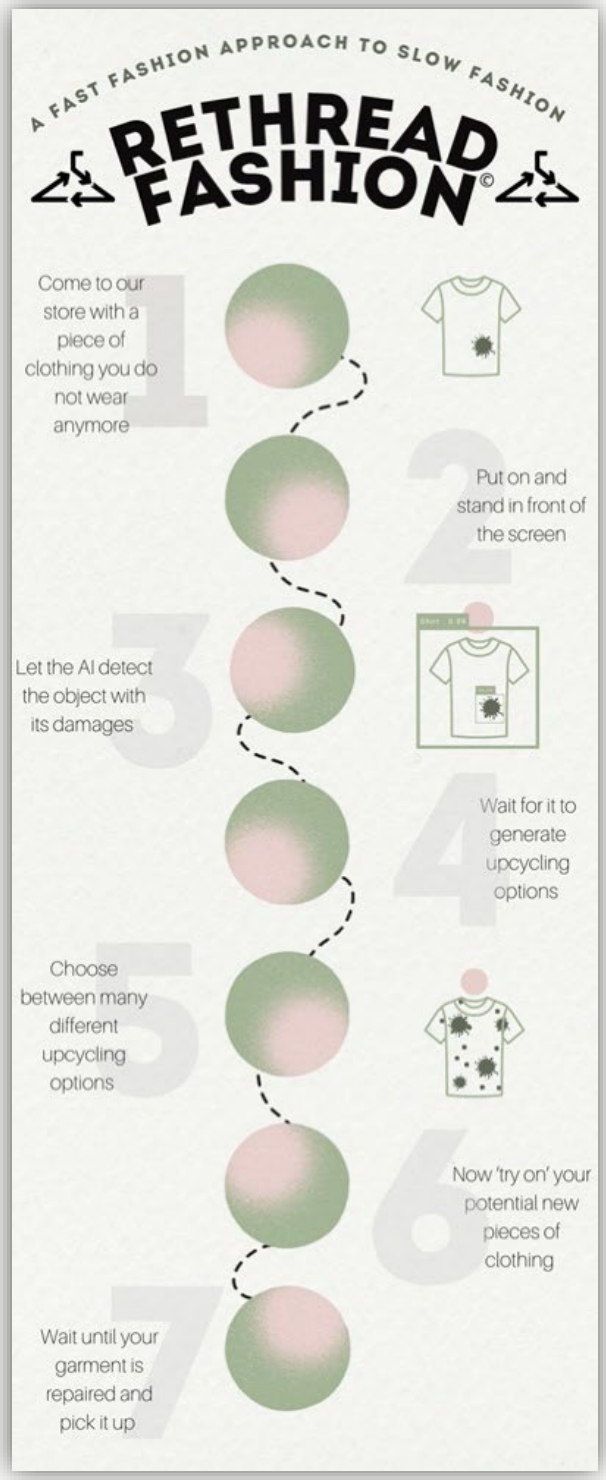

ReThread Fashion®

## Appendix 4: Shirt designs

## Appendix 4: Demo Day Posters



HOW WERE THEY MADE AND HOW DO THEY WORK

# AR FILTERS

## Option 1

3D cloth simulation models

We made 3D models of the garments on Clo3D, a virtual fashion design software. Then the model was imported into lens studios where it is placed onto a full-body mesh. Finally, material is then added onto the model.

## Option 2

Garment transfer and mock-ups

This option uses mock-ups made through Photoshop of the designs on someone wearing the garment. Then the jpeg is added to the garment transfer, a super garment substitution. The image carousel allows for a smooth transition between designs.

| | Pros | Cons |
|---|---|---|
| Option 1 | • full control of the shirt shape and design<br>• allows for 360 movement | • slow process and difficult to learn<br>• one design per filter<br>• can easily look unrealistic |
| Option 2 (chosen) | • all the garment designs are in one filter<br>• adjust to the person wearing it<br>• easy to add many designs | • shirt does not have a back<br>• does not have UV or movement simulation |

HOW WE TRAINED OUR OWN MODEL

# MACHINE VISION

## Step 1

We first took over 300 pictures of the object we wanted to detect

## step 2

We labeled the subjects in every single one of our images

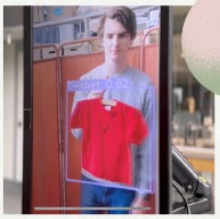
## step 3

We ran a program called YOLOv5 build by Ultralytics that generates the machine vision model

```
In [9]: !cd yolov5 && pyth
        train: weights=yolov
        =False, resume=False,
        ghts=False, device=,
        p, exist_ok=False, q
        -1, entity=None, upl
        github:  YOLOv5 is o
        fatal: cannot change
        YOLOv5  2023-3-29 Py
```

## step 4

We mirror the image from the webcam and analyse it using our model



WHAT DOES IT MEAN TO US AND OUR GOAL

# SUSTAINABILITY

From the beginning of our project, our clear goal has been to integrate sustainability. The importance of sustainability cannot be stressed enough, especially within the fashion industry, which is why we started our project from sustainability. We researched sustainability itself and what we can do to change it

## FIX THE FAST FASHION INDUSTRY

ReThread Fashion©

We came up with different concepts with different starting points, such as designing the most sustainable piece of clothing, designing for reduction, for reusing, for recycling, for repairing etc. Aware of the great pleasure people derive from fast fashion and the seductive appeal of trends, we came up with the idea of limiting excessive clothing purchases. With our final concept ReThread we seamlessly integrate and embodies all the principles.

## A FAST FASHION APPROACH TO SLOW FASHION