

# 3D WOVEN DENIM JACKET APPENDIX

Exploration and development of 3D weaving as a more sustainable way to produce a denim jacket

**Barbara Vroom**

Integrated Product Design  
Msc. Graduation Thesis

# Appendix A | Graduation brief

DESIGN  
FOR our  
future



## IDE Master Graduation

### Project team, Procedural checks and personal Project brief

This document contains the agreements made between student and supervisory team about the student's IDE Master Graduation Project. This document can also include the involvement of an external organisation, however, it does not cover any legal employment relationship that the student and the client (might) agree upon. Next to that, this document facilitates the required procedural checks. In this document:

- The student defines the team, what he/she is going to do/deliver and how that will come about.
- SSC E&SA (Shared Service Center, Education & Student Affairs) reports on the student's registration and study progress.
- IDE's Board of Examiners confirms if the student is allowed to start the Graduation Project.

#### ! USE ADOBE ACROBAT READER TO OPEN, EDIT AND SAVE THIS DOCUMENT

Download again and reopen in case you tried other software, such as Preview (Mac) or a webbrowser.

#### STUDENT DATA & MASTER PROGRAMME

Save this form according to the format "IDE Master Graduation Project Brief\_familyname\_firstname\_studentnumber\_dd-mm-yyyy". Complete all blue parts of the form and include the approved Project Brief in your Graduation Report as Appendix 1 !



family name Vroom  
initials A.B. given name Barbara  
student number 4445864  
street & no. \_\_\_\_\_  
zipcode & city \_\_\_\_\_  
country \_\_\_\_\_  
phone \_\_\_\_\_  
email \_\_\_\_\_

Your master programme (only select the options that apply to you):

IDE master(s): ☒ IPD ☐ Dfl ☐ SPD

2<sup>nd</sup> non-IDE master: \_\_\_\_\_

individual programme: \_\_\_\_\_ (give date of approval)

honours programme: ☐ Honours Programme Master

specialisation / annotation: ☐ Medisign

☐ Tech. in Sustainable Design

☐ Entrepreneurship

#### SUPERVISORY TEAM \*\*

Fill in the required data for the supervisory team members. Please check the instructions on the right !

\*\* chair Holly McQuillan dept. / section: SDE  
\*\* mentor Eleni Soerjo dept. / section: HCD-HICD  
2<sup>nd</sup> mentor Mohsin Sajid  
organisation: Endrime  
city: London country: UK  
comments (optional)  
:  
:  
:

Chair should request the IDE Board of Examiners for approval of a non-IDE mentor, including a motivation letter and c.v.



Second mentor only applies in case the assignment is hosted by an external organisation.



Ensure a heterogeneous team. In case you wish to include two team members from the same section, please explain why.



**APPROVAL PROJECT BRIEF**

To be filled in by the chair of the supervisory team.

chair Holly McQuillandate 30 - 05 - 2022

signature


**CHECK STUDY PROGRESS**

To be filled in by the SSC E&SA (Shared Service Center, Education & Student Affairs), after approval of the project brief by the Chair.  
The study progress will be checked for a 2nd time just before the green light meeting.

Master electives no. of EC accumulated in total: \_\_\_\_\_ EC

Of which, taking the conditional requirements into account, can be part of the exam programme \_\_\_\_\_ EC

List of electives obtained before the third semester without approval of the BoE

☒ YES all 1<sup>st</sup> year master courses passed

☐ NO missing 1<sup>st</sup> year master courses are:

name \_\_\_\_\_ date \_\_\_\_ - \_\_\_\_ - \_\_\_\_ signature \_\_\_\_\_

**FORMAL APPROVAL GRADUATION PROJECT**

To be filled in by the Board of Examiners of IDE TU Delft. Please check the supervisory team and study the parts of the brief marked \*\*. Next, please assess, (dis)approve and sign this Project Brief, by using the criteria below.

- Does the project fit within the (MSc)-programme of the student (taking into account, if described, the activities done next to the obligatory MSc specific courses)?
- Is the level of the project challenging enough for a MSc IDE graduating student?
- Is the project expected to be doable within 100 working days/20 weeks ?
- Does the composition of the supervisory team comply with the regulations and fit the assignment ?

Content: ☒ APPROVED ☐ NOT APPROVEDProcedure: ☒ APPROVED ☐ NOT APPROVED

comments

name \_\_\_\_\_ date \_\_\_\_ - \_\_\_\_ - \_\_\_\_ signature \_\_\_\_\_

## Development of a 3D woven denim jacket

project title

Please state the title of your graduation project (above) and the start date and end date (below). Keep the title compact and simple. Do not use abbreviations. The remainder of this document allows you to define and clarify your graduation project.

start date 27 - 05 - 2022

07 - 11 - 2022

end date

### INTRODUCTION \*\*

Please describe, the context of your project, and address the main stakeholders (interests) within this context in a concise yet complete manner. Who are involved, what do they value and how do they currently operate within the given context? What are the main opportunities and limitations you are currently aware of (cultural- and social norms, resources (time, money,...), technology, ...).

The clothing industry is one of the most polluting in the world, and the denim industry is a major contributor, with the production of four billion denim garments every year (Toepel, 2018). As an indication of the denim market in the Netherlands, in 2020, the Netherlands consumed around €124 million worth of denim apparel, corresponding to approximately 10 million units of clothing (CBI, 2021). The industry and production of denim garments is focused on speed, reproduction and saving money. The production of denim garments is polluting for multiple causes. For example, the production of denim garments uses loads of water, e.g. it takes around 2,000 gallons of water to make a typical pair of jeans (United Nations Environment Programme, 2018), partly for the production of cotton and partly for dyeing and washing the yarns and garments. Another cause is fabric waste from the cut-and-sew production process and garments that get thrown away, to showcase less than 1% of the material used to produce clothing is recycled into new clothing (Ellen MacArthur Foundation, 2017).

There have been innovations to reduce the pollution of denim garments. Developments are being made to reduce water use in the clothing industry, for example with more sustainable fabrics and sustainable dye and washing methods. To reduce pre-consumer waste, zero-waste thinking and pattern cutting, like the collaboration between Cone Denim and Endrime (<https://www.instagram.com/p/CV0ZNSPNo0i/>) (figure 1), is a positive development.

But since the first pair of jeans was developed in 1873, a pair of denim clothing has always been made using the cut and sew manufacturing process. The denim fabric is woven on a shaft loom, then the fabric is transported from the mill to the production factory. There the fabric is cut using patterns after which the pattern pieces are sewn and finished into a garment. Due to the same fabrication for years, the look and feel of denim garments nowadays are also still very similar to those of years ago.

Normally denim fabric is woven on a shaft loom, where you can only control the warp yarns in groups, moved by harnesses. When a harness goes up or down, all the warp yarns attached to it move with it (Guilford of Maine, 2015). With the use of a jacquard loom, where all warp yarns can be controlled individually. It is therefore possible to weave multiple separate layers (also possible on a shaft) with complex shapes in the same woven structure. Holly McQuillan used this technique to produce garments made fully on a jacquard loom in one piece. This comes with the advantages of less pre-consumer waste, fewer production steps and localization of the production of the garment. Together with my chair, Dr Holly McQuillan, we came to the idea to try to develop a denim jacket produced using 3D weaving.

Dr Holly McQuillan obtained her PhD title with her thesis called 'Zero Waste System Thinking: Multimorphic Textile-Forms'. Which explores the theoretical, aesthetic and technical development of systems and methods for zero waste textile forms. In her thesis, she undertook a series of experiments which aimed to expand the form-design methods available for whole garment weaving in the context of zero waste system design (McQuillan, 2020). My graduation project will follow up on her developed methods.

Mohsin Sajid is a denim design specialist and denim historian based in London. He is consulting and working together with multiple stakeholders in the denim industry on how to make the denim industry more sustainable. This is also why he is enthusiastic about working together with us on this project and sharing his knowledge, expertise and contacts.

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## Personal Project Brief - IDE Master Graduation

introduction (continued): space for images

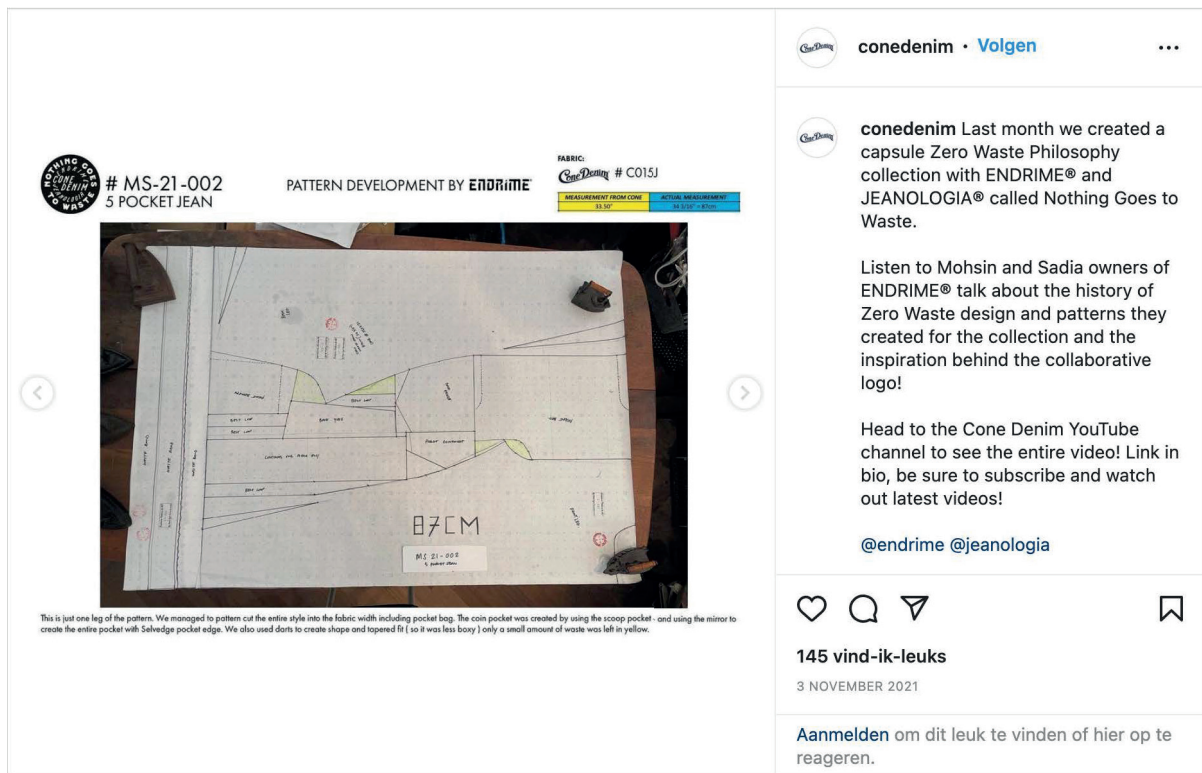


image / figure 1: [Zero waste pattern by Endrime for Cone Denim \(https://www.instagram.com/p/CV0ZNSPNo0i/\)](https://www.instagram.com/p/CV0ZNSPNo0i/)



image / figure 2: [Denim jacket type 1,2,3 \(http://blog.dc4.de/2013/10/denim-jackets-look-at-evolution-of-style.html\)](http://blog.dc4.de/2013/10/denim-jackets-look-at-evolution-of-style.html)

## PROBLEM DEFINITION \*\*

Limit and define the scope and solution space of your project to one that is manageable within one Master Graduation Project of 30 EC (= 20 full time weeks or 100 working days) and clearly indicate what issue(s) should be addressed in this project.

My research will focus on finding a way to produce a denim jacket using 3D weaving on a jacquard loom as the manufacturing method. I want to do this research and development in a sustainable context of limiting pre-consumer waste and reducing the number of parts to assemble the denim jacket. A change in the manufacturing process of a denim jacket will raise the question if the 3D woven denim jacket can and also has to look the same as the denim jacket produced with the regular cut and sew method. Another part of the research will be to research and explore the advantages and potentials that 3D weaving can bring to this denim jacket, its production and its users. In terms of advantages and potential for the denim jacket one can think of weaving in reinforcements of places that wear quickly or using different kinds of yarns to play with the shape and fit of the jacket. In terms of the user, one can think of improved user experience like better fit and sizing, personalization or longer durability. In terms of the production, one can think of already weaving in the after treatments or on-demand production.

At the start of my project, I will dive into what a denim jacket is all about; what kinds are there, what are the key characteristics, how is it made, what is the value to people, and why does it look the way it looks now. Based on this research, I will decide on the elements to include in the denim jacket I aim to develop using 3D weaving. In figure 2, I added a picture of the original Levi's denim jackets types 1, 2 and 3. Type 3 is the most seen model nowadays.

In addition, it is worth noting that 3D garment weaving is a new method that may bring problems, such as the fact that the machines are not built to do these kinds of things. Moreover, designers and weaving companies are not familiar with this technique, so how can we and they deal with this relatively new technique.

## ASSIGNMENT \*\*

State in 2 or 3 sentences what you are going to research, design, create and / or generate, that will solve (part of) the issue(s) pointed out in "problem definition". Then illustrate this assignment by indicating what kind of solution you expect and / or aim to deliver, for instance: a product, a product-service combination, a strategy illustrated through product or product-service combination ideas, ... . In case of a Specialisation and/or Annotation, make sure the assignment reflects this/these.

I will research and develop a new way to produce a denim jacket using 3D weaving as the production process. I will also look at the benefits and potential that this new production method can offer for the jacket, the user and the production. I will do this research in a sustainable context to reduce fabric waste and production steps.

During the design process, many prototypes will be made using paper, fabric, digital 3D models and weaving samples on the TC2 loom in the applied labs of the Faculty of Industrial Design Engineering. My design process will be an iterative process of constant development to find out the best way to produce a denim jacket on a jacquard loom.

With weaving, you are limited by the width of the loom, so it is important to know this size. This size can be leading to the development of the concept. Ideally, the concept should not depend on the width, but during the project, it will become clear how this will work out.

I hope to finish the project with a fully woven prototype that is at the proof of concept stage, if there is a chance that we can weave a prototype of the denim jacket at a professional weaving mill in, for example, Pakistan. Otherwise, there is the possibility to weave a sample on the TC2 loom in Applied Labs or at places like the Textiellab in Tilburg for example. If all these options do not work out before the end of my graduation I will present the concept in another way, for example, a combination of a 3D model in CLO3D and a sample made with fabric and sewing to simulate the idea.

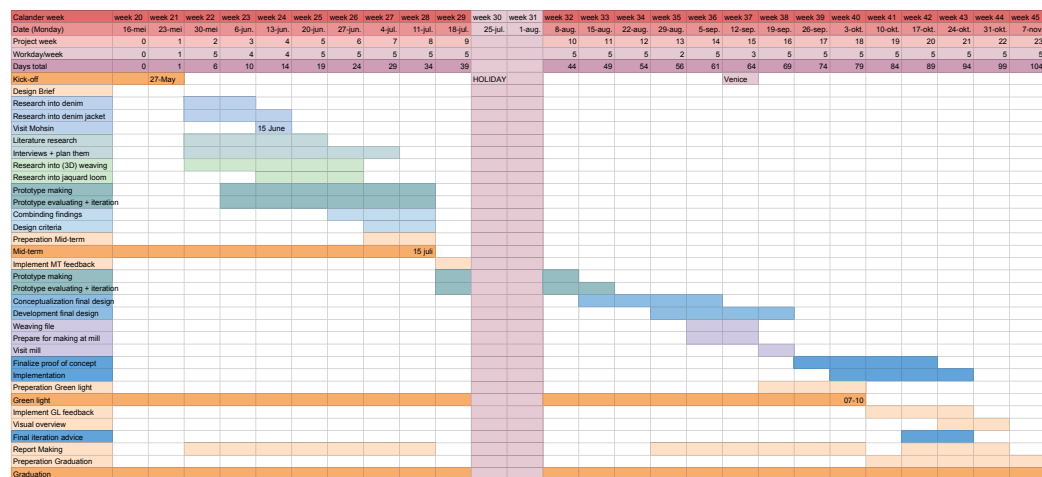
## Personal Project Brief - IDE Master Graduation

### PLANNING AND APPROACH \*\*

Include a Gantt Chart (replace the example below - more examples can be found in Manual 2) that shows the different phases of your project, deliverables you have in mind, meetings, and how you plan to spend your time. Please note that all activities should fit within the given net time of 30 EC = 20 full time weeks or 100 working days, and your planning should include a kick-off meeting, mid-term meeting, green light meeting and graduation ceremony. Illustrate your Gantt Chart by, for instance, explaining your approach, and please indicate periods of part-time activities and/or periods of not spending time on your graduation project, if any, for instance because of holidays or parallel activities.

start date 27 - 5 - 2022

7 - 11 - 2022 end date



The first weeks are the understanding phase; to gain knowledge about denim (jacket) and weaving. My project will use the Research through Design approach (Stappers, n.d.) (Reeker et al., 2016), where research and design will be constantly intertwined and will influence each other during the process. From the beginning, I like to put my ideas on paper and alternate research with some prototyping to try things out or make small mockups. The prototyping will consist of ideating, building, testing and evaluating the made prototypes in iterating cycles.

From 14 to 16 June, I am going to London to visit my project partner Mohsin at his studio in Crawley. The 14th I will visit some exhibitions in London, the 15th and 16th I will meet Mohsin to learn and discuss everything about denim, the denim jacket and possibly make a pattern as a basis for the 3D woven jacket.

In the planning, my midterm meeting is planned before my project reaches the 40 days on the 15th of July, because I want to plan this meeting before my chair Holly goes on holiday for four weeks. After my midterm, I plan to take a 2-week holiday myself, to rest and refresh my mind. I have also taken a few days in September to hopefully join my parents at the Design Biennale in Venice. These free days can also be used to cover the traveling to and from the mill we hopefully will visit around that time.

Sources: Reeker, Lars & van Langen, Pieter & Brazier, Frances. (2016). [UNPUBLISHED] Lessons Learned from Research through Design: An Empirical Research towards Practical Guidelines for Research through Design.

Stappers, P. J. (n.d.). Research through Design. [studiolab.ide.tudelft.nl](https://studiolab.ide.tudelft.nl/studiolab/stappers/about/rtd/)  
<https://studiolab.ide.tudelft.nl/studiolab/stappers/about/rtd/>

### MOTIVATION AND PERSONAL AMBITIONS

Explain why you set up this project, what competences you want to prove and learn. For example: acquired competences from your MSc programme, the elective semester, extra-curricular activities (etc.) and point out the competences you have yet developed. Optionally, describe which personal learning ambitions you explicitly want to address in this project, on top of the learning objectives of the Graduation Project, such as: in depth knowledge on a specific subject, broadening your competences or experimenting with a specific tool and/or methodology, ... . Stick to no more than five ambitions.

It has been a long-held wish of mine to do a fashion/apparel related project in my studies at the Faculty of Industrial Design Engineering. With my choice for the master of Integrated Product Design, I wanted to develop my technical design skills and use all the free space in the curriculum to fill with fashion-related projects. I decided to do an internship at G-star Raw in the denim design team where I learned a lot about the fashion design process and developed my interest in denim garments. After this great experience, I decided to do an exchange to Milan to study Fashion Design at the Politecnico. Here I got a glimpse of what a combination of industrial design and fashion design can be. I am so happy and excited about this graduation project in which I can further develop myself as an Industrial Fashion Designer.

My interest in fashion comes from its manufacturability. I started at home on the sewing machine and it was great to make things with my hands and the machine together. The repeated exposure to the fashion industry's huge impact on the environment and working conditions has had a great influence on how I think about the world of fashion. It excites me to work on this project in the context of developing garments more sustainably. To change the way people see and use products and in this case garments.

My goal for this graduation project is to make many iterative prototypes to guide the design process. I already have some experience with this from some design projects, but it is a skill that I want to develop further in this project. I will combine the design skills with my sewing and garment making skills from my own experience, some classes I have taken, my internship at G-Star Raw and my exchange in fashion design at the Politecnico. I like the fact that during this graduation project I will be delving into weaving, which is completely new to me.

Another learning goal would be to feel more in control of the design process, to feel confident in making design decisions and to prepare for my coach meetings well.

Sources Introduction:

- CBI. (2021, August 30). The European market potential for denim | CBI.  
<https://www.cbi.eu/market-information/apparel/denim-trousers/market-potential#:~:text=The%20Netherlands%20is%20the%20third,66%20million%20units%20of%20clothing.>
- Ellen MacArthur Foundation, A new textiles economy: Redesigning fashion's future, (2017, <http://www.ellenmacarthurfoundation.org/publications>).
- Guilford of Maine. (2015, December 17). Dobby vs. Jacquard: A Tale of Two Looms. <http://Blog.Guilfordofmaine.Com/>.  
<http://blog.guilfordofmaine.com/dobby-vs-jacquard-a-tale-of-two-loom/>
- McQuillan, H. (2020, December 10). Zero Waste Systems Thinking: Multimorphic Textile-forms. Holly McQuillan.  
<https://hollymcquillan.com/portfolio/hybrid-zero-waste-practice/>
- Toepel, A. (2018, March). Denim is Dirty, but Sustainability Leaders Make Strides to Clean It Up.  
<https://Sustainability.Ucsf.Edu/>. <https://sustainability.ucsf.edu/3.717>
- United Nations Environment Programme. (2018, November 12). Putting the brakes on fast fashion. UNEP.  
<https://www.unep.org/news-and-stories/story/putting-brakes-fast-fashion>

### FINAL COMMENTS

In case your project brief needs final comments, please add any information you think is relevant.



## Appendix B | Construction of a type 3 denim jacket



These were the pattern pieces that Mohsin prepared. The pattern pieces consist of the following:  
Front: 4 body pieces (1 front yoke, 3 body panels) + pocket lining and pocket flap (all to be cut 2 times and the pocket flap 4 times)  
Back: back yoke + centre back + side panel (to be cut 2 times)  
Collar: 1 collar piece  
Sleeve: 2 pieces + cuff (all to be cut 2 times)  
Waistband + side adjuster (to be cut 2 times)  
\*missing on this picture is the lining of the breast pockets (to be cut 2 times)  
Note: this jacket design has no welt or inside pockets in the front body.



The pattern pieces are placed on the denim fabric and traced before cutting them out of the fabric.



These are the 14 pieces to make the right and left front panels.



The first step is to sew together the front body pieces using felt seams.  
Seam [1],[2],[3],[4]





The front body pieces sewn together using felt pockets. The pocket opening lining is sewn on, turned and pressed and stitched down to create the front pocket opening. Now the pocket lining can be pinned behind the opening and stitched through.



The pocket flaps are sewn wrong sides together, turned and pressed and stitched down using a double needle. Then the front yoke and pocket flaps are attached to the bottom body pieces with a felt seam. This pictures shows them pinned together.

Seam [5],[6]



This picture shows the front body pieces fully sewn together. The front packet is pressed and sewn shut. On the left front body placket Mohsin made button holes.



For the back the first step is to seam down the bottom back pieces with a felt seam.

Seam [7],[8]





Then the back yoke can be attached to the other back panels using a felt seam.  
Seam [9]



The front and back panels are attached on the shoulder seams by a felt seam.  
Seam [10],[11]



For the collar Mohsin first sewn the sides shut and turned and pressed the collar then open. First is the underside of the collar is sewn to the body. Then the raw edge of the neck line is enclosed in the collar and the collar is stitched shut on the body.

This picture shows the results of the collar attached to the body.



The two panels of the sleeves are attached using a felt seam. The next step is to sew the slit at the bottom of the sleeve in that same seam. The underarm seam is left open.  
Seam [12],[13]

The sleeves are attached to the armhole of the body, then the jackets looks like this.  
Seam [14],[15]



The next step is to sewn the side seams of the body and the underarm seams shut in one go using a felt seam.  
Seam [16],[17]



The cuffs are first pressed and then one side is sewn to the sleeve opening. Then the cuffs are folded shut and pinned in place. The cuff is sewn shut all around.



The waist is attached in the same way as the cuffs. First the waistband is pressed so it will be easier to sewn shut afterwards. The waistband is sewn good sides on each other to the bottom of the jacket. Then the waistband is folded and sewn shut to the body.



Here you see Mohsin sewing down the waistband to the bottom of the jacket first with an erasable stitch. Hereafter he sewed the same line on a chain stitch machine. The last step for the waistband is to sew on the side adjusters, which are pressed to shape and then stitched down through.



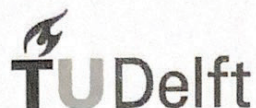


Photo back

The end results of the denim jacket after Mohsin executed the last steps. He added button holes on the waistband, side adjusters and cuffs. He also added buttons to the front placket, the waistband, the cuffs and the front pockets.

This is the end result for the back of the jacket.

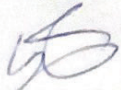
## Appendix C | Consent forms denim jacket user study



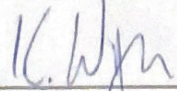
### Consent for interview

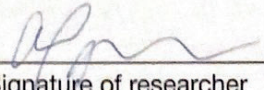
I volunteer to participate in a research project conducted by Barbara Vroom from Delft University of Technology. I understand that this interview is part of her graduation project about a new way of producing a denim jacket. I kindly ask you to read this form carefully and ask any questions that you may have.

- I understand that I can refuse to answer any questions and that I can withdraw from the interview at any time, without having to give a reason.
- Participation involves being interviewed by the researcher, which will last approximately 20 minutes.
- I understand that taking part in the study involves an audio-recorded interview. The interview will be recorded using a smartphone and also written down. The audio will be transcribed as text and the audio will be kept in the local hard disk of the researchers, for the length of maximum two years.
- I understand that taking part in the study involves getting photographed. The photos will be taken by smartphone or a camera. The photos will be used without a recognizable face, and will be kept for the length of maximum two years.
- I agree that my information can be quoted in research outputs.
- I give permission for the anonymised transcripts that I provide to be archived in the local data bank of TU Delft, so it can be used for future research and learning.
- I understand that the researcher will not identify me by name in any documentation using information obtained from this interview, and that my confidentiality as a participant in this study will remain secure.
- I have read and understand the explanation written in this consent form. I have had all my questions answered to my satisfaction, and I voluntarily agree to participate in this study.

  
Signature of participant

  
Date

  
Name of participant

  
Signature of researcher

For further information, please contact:  
Barbara Vroom  
barbaravroom@xs4all.nl





## Consent for interview

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I kindly ask you to read this form carefully and ask any questions that you may have.

- I understand that I can refuse to answer any questions and that I can withdraw from the interview at any time, without having to give a reason.
- Participation involves being interviewed by the researcher, which will last approximately 20 minutes.
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- I agree that my information can be quoted in research outputs.
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- I have read and understand the explanation written in this consent form. I have had all my questions answered to my satisfaction, and I voluntarily agree to participate in this study.

Signature of participant

27-06-2022

Date

Yolyn de Haan

Name of participant

Signature of researcher

For further information, please contact:  
Barbara Vroom  
barbaravroom@xs4all.nl





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- I understand that taking part in the study involves an audio-recorded interview. The interview will be recorded using a smartphone and also written down. The audio will be transcribed as text and the audio will be kept in the local hard disk of the researchers, for the length of maximum two years.
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Signature of participant

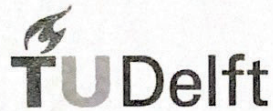
25-06-'22  
Date

Lieke Schweijenberg  
Name of participant

  
Signature of researcher

For further information, please contact:  
Barbara Vroom  
barbaravroom@xs4all.nl





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- I understand that the researcher will not identify me by name in any documentation using information obtained from this interview, and that my confidentiality as a participant in this study will remain secure.
- I have read and understand the explanation written in this consent form. I have had all my questions answered to my satisfaction, and I voluntarily agree to participate in this study.

Signature of participant

29-6-2022

Date

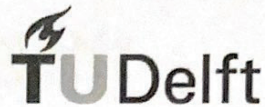
Cathelijne van der Zwan

Name of participant

Signature of researcher

For further information, please contact:  
Barbara Vroom  
barbaravroom@xs4all.nl

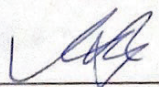




## Consent for interview

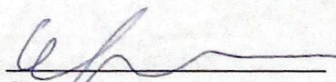
I volunteer to participate in a research project conducted by Barbara Vroom from Delft University of Technology. I understand that this interview is part of her graduation project about a new way of producing a denim jacket.  
I kindly ask you to read this form carefully and ask any questions that you may have.

- I understand that I can refuse to answer any questions and that I can withdraw from the interview at any time, without having to give a reason.
- Participation involves being interviewed by the researcher, which will last approximately 20 minutes.
- I understand that taking part in the study involves an audio-recorded interview. The interview will be recorded using a smartphone and also written down. The audio will be transcribed as text and the audio will be kept in the local hard disk of the researchers, for the length of maximum two years.
- I understand that taking part in the study involves getting photographed. The photos will be taken by smartphone or a camera. The photos will be used without a recognizable face, and will be kept for the length of maximum two years.
- I agree that my information can be quoted in research outputs.
- I give permission for the anonymised transcripts that I provide to be archived in the local data bank of TU Delft, so it can be used for future research and learning.
- I understand that the researcher will not identify me by name in any documentation using information obtained from this interview, and that my confidentiality as a participant in this study will remain secure.
- I have read and understand the explanation written in this consent form. I have had all my questions answered to my satisfaction, and I voluntarily agree to participate in this study.

  
\_\_\_\_\_  
Signature of participant

29-06-2022  
\_\_\_\_\_  
Date

Violet van Tilburg  
\_\_\_\_\_  
Name of participant

  
\_\_\_\_\_  
Signature of researcher

For further information, please contact:  
Barbara Vroom  
barbaravroom@xs4all.nl





## Consent for interview

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- I have read and understand the explanation written in this consent form. I have had all my questions answered to my satisfaction, and I voluntarily agree to participate in this study.

Signature of participant

29-06-2022

Date

Niels Balix

Name of participant

Signature of researcher

For further information, please contact:  
Barbara Vroom  
barbaravroom@xs4all.nl

# Appendix D | Digital pattern base

Basis of the experiments were patterns of a denim jacket found on the internet, see figure x. For the paper models these patterns were printed and for the digital prototypes the pattern was traced in Clo3D.

## SIZE

It was decided for this project to design the jacket to fit myself, this way I can try on all the samples and check the fit along the way. My measurements correspond to a US\_ASTM\_Missy\_Straight\_12 in Clo3D. For all the corresponding measurements see below.

Avatar Editor

Avatar SizeMeasureArrangement

Total Body

Height

Total Height

1663,7 mm

Millimeter

Width

Under Bust Circumference

825,5 mm

Details

Advanced (Dressform)Millimeter

Neck

Neck Base

Circumference

384,2

(0.2)

HPS

Height

1411,6

Shoulder

Across Shoulder (Curvilinear)

385,4

(0.3)

Shoulder Drop

41,3

(-0.0)

CF Neck to

CF Neck to Waist

400,0

(-0.1)

CB Neck to

CB Neck to Waist

412,8

(0.1)

Bust

Bust

Circumference

984,3

(5.4)

Height

1197,0

(6.1)

Height

1133,5

(4.8)

Apex

Apex to Apex

209,6

(0.9)

HPS to Apex

273,0

(-6.6)

Waist

Waist

Circumference

819,2

(-2.7)

Height

1028,7

(0.2)

Hip

High Hip

Circumference

952,5

(0.5)

Height

939,8

(-1.5)

Low Hip

Circumference

1041,4

(0.6)

Height

825,5

(-2.2)

Leg

Inseam

Height

774,7

(0.0)

Thigh

Circumference

600,1

(-0.1)

Height

744,7

(0.0)

Knee

Circumference

381,0

(-0.3)

Height

454,0

(0.0)

Calf

Circumference

368,3

(-0.0)

Ankle

Circumference

244,5

(-7.3)

Arm

Arm

584,2

(0.4)

CB Neck to Wrist

781,0

(0.4)

Bicep

Circumference

298,4

(-0.4)

Elbow

Circumference

257,2

(0.1)

Wrist

Circumference

158,7

(0.0)

Extra Measurements

Total Rise

666,8

(0.9)

Vertical Trunk

1574,6

(-19.6)



# Appendix E | Concept development experiment

## EXPERIMENT 1

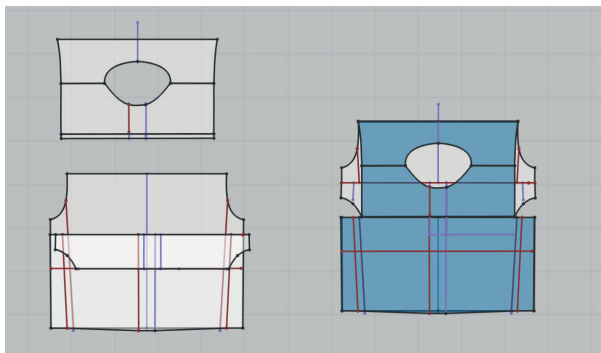
### Aim

To digitally prototype the body part of the folded jacket displayed in the figure beneath. It is not a denim jacket as you can see but the folding method looks potential and also applicable for a denim jacket.



### Method & observations

The jacket is folded so that the sleeves and the shoulder part align with each other. In this case the back of the body is folded onto itself. This section is then constructed of four layers; back 'yoke', middle part of the body, bottom of the back body and a layer of the front of the jacket.



This Clo3D file was the first digital pattern done for this project. So it was an exploration in Clo3D on how it worked to deconstruct and construct pattern pieces. The basis of this experiment was the traced pattern mentioned above. During this prototype it was concluded that a denim jacket and the digital pattern used are not so flat and boxy as the jacket. Therefore it was a pattern cutting adventure to get the front and back yokes to be connected and form a rectangle. This will make an aesthetically different outcome. Another point where the denim jacket pattern differs from the jacket in figure x was the arm hole construction. The denim jacket has a more shaped and curved arm hole to sleeve connection. Therefore in figure x you can see that the arm seam, when folded like this, has a particular shape. Whereas the arm seam in the jacket would most likely be much straighter.

## Result/reflection

The arm seam had such a particular shape which made it difficult to connect a sleeve pattern to it. Also this folding formation creates four layers in the main body, which is not desirable. The body and the sleeves+front and back yokes can however be divided into two parts so that both parts would consist of a maximum of two layers.

## EXPERIMENT 2: FLATTENING A CONSTRUCTED DENIM JACKET

### Aim

The aim of experiment 2 was to explore how a constructed denim jacket could be flattened, while keeping it (partly) fully constructed. Flattening means to take the 3D shape and flatten it into a 2D formation. This experiment was done in order to be inspired to create prototype ideas on how a 3D woven denim jacket could be constructed. This experiment also helped to understand the shaping and the pattern construction of an exciting type 3 model denim jacket.

### Method & observations

By playing around with a constructed denim jacket, multiple ways of flattening the jacket were found. The jacket was flattened by laying it on a flat surface and trying out different ways to make a flat packet out of the whole jacket. Some experiments considered the jacket as a whole and other experiments took on half a jacket, of which the centre back seams would need sewing. Considering the jacket as two halves gave more freedom in playing around with different formations. By flattening only half a jacket, fewer layers were also created as a result overall. During this process the maximum amount of stacked layers that the formation created was taken into account. Therefore formations with a maximum of 4 layers were explored. These first explorations of flattening the jacket were done with the idea in mind that the jacket should consist of 1 piece, so at least everything is attached to each other in some place.



A rather simple formation but doing this on multiple denim jackets made it visible that the fabric **in the armpit could not be laid flat when the rest of the jacket laid flat**. If considering this formation, with a flattened and simplified armpit construction, the maximum number of layers for the main construction would be two. But this would compromise on the fit of the jacket. **A straightened armpit construction translated into a less inward-curved arm seam.** Another observation is that the sleeve is at a sharper angle than the shoulder line.

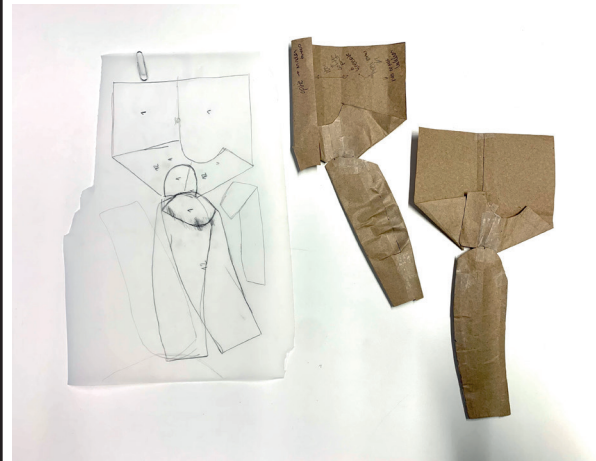


Flattening the constructed jacket and trying to keep the exact shape intact results in creating random folds along the pattern, as you can see in this image. This formation was considered in a left and a right part, because of the maximum amount of layers. If looking at this formation a half jacket the section where the sleeve lays on top of the body creates a stack of three layers; top of the sleeve (1), bottom of the sleeve (2) and the body panel (3).





Trying to get the armpit flat in another way by folding it on to the back of the jacket, this creates many (5) layers though; top sleeve, bottom of sleeve, body piece, body piece, body piece.



Folding the jacket like the image on the left, looked interesting but the arm seam should be opened up in order to lay the sleeve flat. To see how this flattened shape would work out, a paper model was made. On the left of the paper model a drawing is shown in which the translation is made to a flat drawing. The number in the drawing stands for how many layers that section is. With many shapes also the layout in the loom was taken into account. By tilting the sleeve to the right the formation would be more efficient to make a minimal waste layout.

### Result/reflection

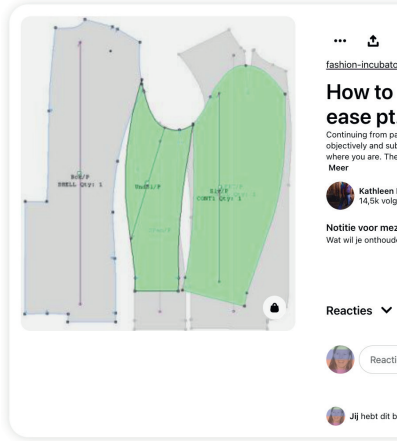

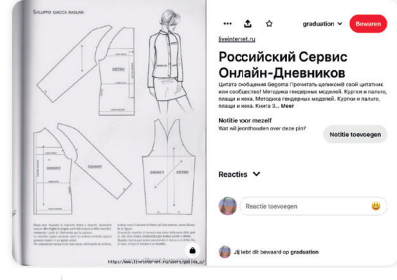
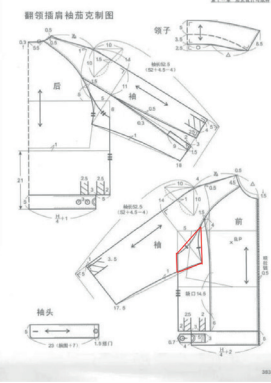
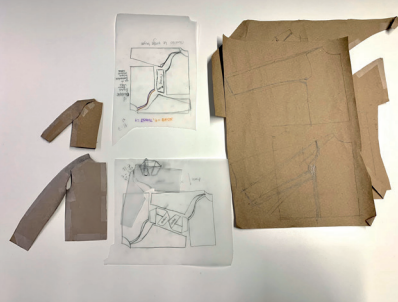
From the observation when trying out different formations of flattening a denim jacket it can be concluded that the area around the armpit brings the most complexity. The area of the armpit is at the bottom of the armhole, where the tube of the sleeve is attached to the body tube.

## EXPERIMENT 3: PAPER PATTERN FLAT FORMATION INSPIRED BY PINTEREST

### Aim

After trying out different flattening methods by free experimentation, Pinterest was used to gather inspiration for clever pattern cutting methods. These methods could bring inspiration on how to flatten the constructed denim jacket and/or on how from a pattern cutting perspective the jacket could be constructed.

### Method & observations

		<p>This paper prototype is made from a pattern perspective. The image on the left gave inspiration to open up the sleeve at the back seam and try to lay it flat on the body as a second layer. This formation would require quite some sewing when cut off from the loom; closing the sleeve, shoulder seam, attaching the rest of the sleeve to the armhole and the centre back.</p>
 		<p>Raglan sleeve inspired. Coming across multiple images visualising the pattern cutting principle of a raglan sleeve, gave inspiration to try the same with a denim jacket. In a raglan sleeve the sleeve extends into the collar, characterised by a diagonal seam from the underarm to the collar. This idea was tried in miniature by laying the sleeve pattern against the armhole line of the body and overlapping the armpit area. The sleeve is then extended into the shoulder of the body pattern. By tilting the sleeve, keeping the collar point together, the overlap in the armpit is resolved.</p>

The raglan inspired formations were puzzled into layouts to see how waste efficient they could be. The shapes puzzle together quite nicely because of their block shape. The material inside the raglan seam would be used as seam allowance to sew the seam together.

### Result/reflection

The downside of the raglan sleeve is that the construction is sweater like and this will influence the fit and

aesthetics of the denim jacket. Another observation is that the shoulder to sleeve seam in this prototype was completely straight, which would give a not too fitting aesthetics to the denim jacket. Experiment 5 continues on this shape but with a slanted shoulder and sleeve line.

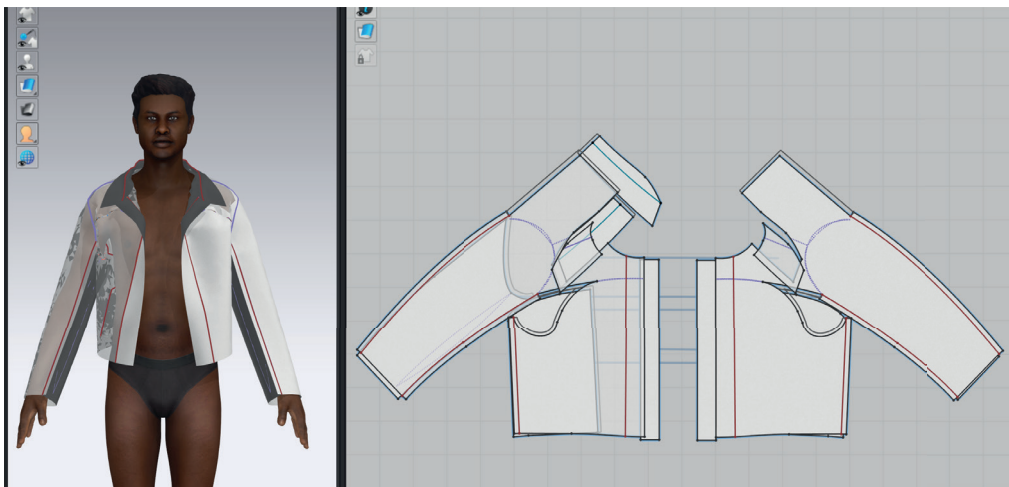
## EXPERIMENT 4: UNDERSTANDING DR. HOLLY MCQUILLAN'S STUDY AT A 3D WOVEN DENIM JACKET

### Aim

Quite early on in the process Holly, supervisor on this project, showed her try on a flattened denim jacket. The aim of experiment 3 was to understand how she got to this shape by manipulating the existing patterns of a denim jacket into a new formation.

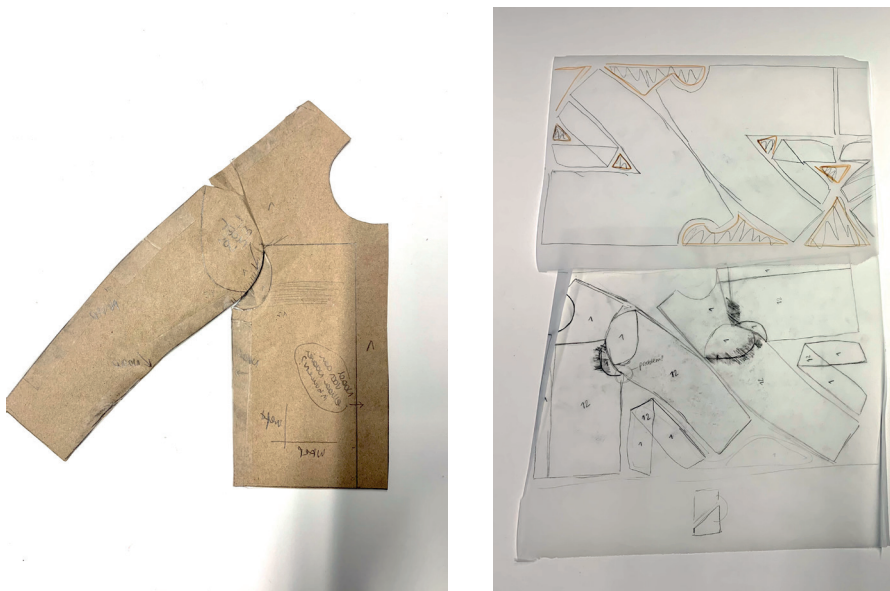
### Method & observations

The basis of Holly's design is the same traced pattern as mentioned in the the report. In the design the back yoke of the jacket and the underarm seam are cut open. The back yoke is then folded open and with that the sleeve comes loose from the body and makes a straight panel with the back yoke. By also opening up the front yoke of the jacket a bit, the arm can be tilted more into the collar line. This opens up space to free up the armpit area. By placing the side seam more towards the back, the back body panel is moved to the side and closing off the gap between the sleeve and the arm hole seam. The left panel is made slightly transparent to show the layer of the underarm and the back panel under the complete top panel consisting of the front body, back yoke and top part of the sleeve. The underarm and the back body panel are then woven to the main top part, indicated by the red lines in the figure. The back panel and the bottom part of the sleeve would need some cutting in order to open up the construction. The lines that would need sewing would be from the front yoke to the back yoke passing the under arm seam in one go. To understand Holly's way of working to come to this kind of result the same approach was made by





cutting and reattaching pattern pieces in Clo3D. Later on also small paper models were made to get a better hang of this way of pattern cutting. In some ways it is needed to manipulate the pattern a bit, which will influence the final look of the jacket. For example, to connect the sleeve top to the shoulder seam in a flat way requires both seams to be redrawn a bit and add some extra pattern space between both panels. The principle was understood but the same result was not achieved. It was difficult to understand how the area around the armpit was established.



### Result/reflection

This experiment tested my pattern cutting knowledge. One of the tricky things with manipulating pattern pieces is how to make sure that when changing all the length and shapes of lines, they will fit to each other well. For example the length of the arm hole and the underarm sleeve seam should match in order to be sewn back together correctly.

This shape, although it requires little sewing lines after weaving, does not puzzle that efficiently to a little waste layout.

I did not immediately continue with this prototype because the construction of the arm pit was confusing and the shape did not look promising in creating a layout with as little cut-off waste as possible.

From this prototype my understanding of the layering of 3D weaving grew. The front placket, where the button for the front closure shall be attached at the end of the manufacturing process, should be sturdy enough to hold the buttons. Because of the limiting density of the loom my estimation was that the front placket should be a one layer weave structure. This way the front placket will have full density and hopefully be sturdy enough to carry the metal buttons. This observation was taken along into the other experiments.



## EXPERIMENT 5: DEEPENING EXPERIMENT 3

### Aim

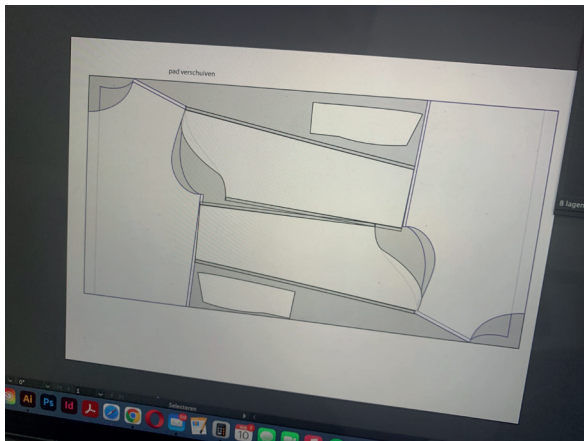
To deepen the raglan pattern shapes more of experiment 3 in order to further check the potential of this formation when putting the shoulder and arm sleeves under an angle and go more into the details by adding seams. Also the idea of the front placket being only woven in one layer was incorporated.

### Method & observations

This experiment was done in actual size on paper and digitally, in Clo3D and Adobe Illustrator.

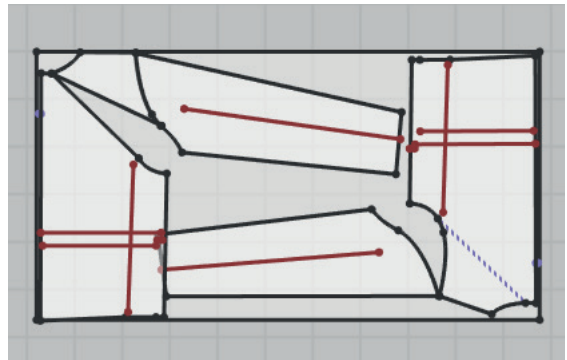
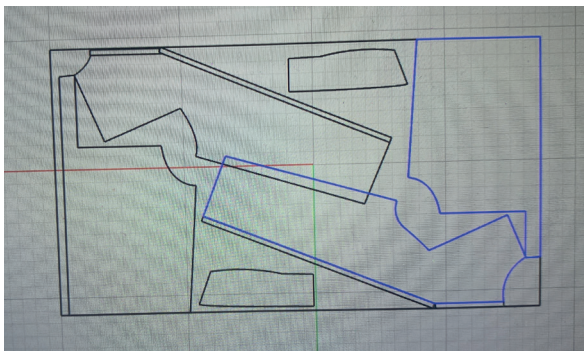


This experiment began by drafting a denim jacket pattern on paper, traced from a constructed denim jacket. This was also interesting to further explore how the panels of a denim jacket are constructed. By tracing the body pattern and playing around with different ways of attaching the sleeve I looked for new formations.



From the ideas I got by trying out pattern formation I made computer models in Illustrator and Clo3D. These configurations are placed also in a layout to explore how they could fit into the repeat of 59.5 cm at Diamond Denim.

In this formation the front and back body panels are attached to each other by a woven seam on the shoulder and the side of the body. The sleeves are woven together by a seam on the top and the bottom of the sleeve. The two halves make one jacket when the centre back is sewn together.



### Result/reflection

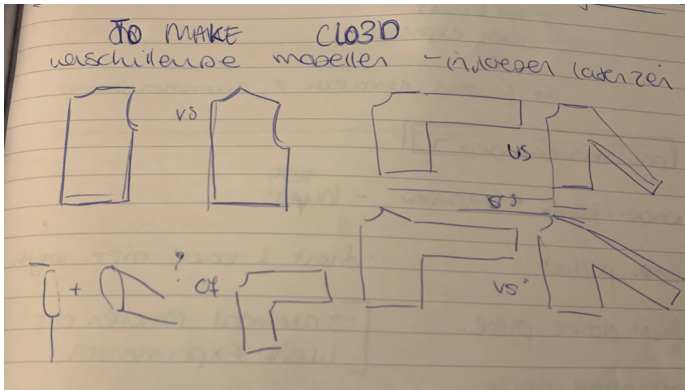
It was concluded from these experiments that the shape does not lend itself to an efficient layout. By putting an angle on the shoulder and arm sleeve seams, the layout puzzle for these shapes creates a lot of off cut waste. It was decided to not continue further with these shapes.

This experiment sparked the idea that with the shoulder seam and the sleeve seam under an angle,

to stay true to the fit like a denim jacket now, the shape would fit the repeat size more efficiently if the sleeve would be tilted down. This way the sleeves could fit mirrored alongside each other. This formation will be explored in experiment 5.

## EXP?

Idea to add in an experiment where I show the different fits a straight and a slanted shoulder seam give. And straight sleeve to body connection or an angled sleeve to body connection.



## EXPERIMENT 6: REPEAT FITTING SHAPE

### Aim

To explore the shape and layout of a pattern where the body is the width of the loom and the sleeves arm is angled down.

### Method & observations

	<p>This experiment was conducted in Clo3D. The idea behind this concept was that the two halves of the denim jacket would fit very nicely into the repeat of the loom. The two halves both consist of a front and a back panel woven together by woven seams that follow the red lines in figure As seen on the model in the figure this would fit rather fine, but the requirement of having a fitting arm hole construction was a bit forgotten. The woven seam created in the armpit was considered not strong enough to encounter the amount of movement.</p>
	<p>This pointed corner in the armhole could be curved out in order to make it less weak. This aesthetic however, deviated too much from the desired effect for a denim jacket.</p>
	<p>Next to implementing the front placket extending over the rest of the shape to be one layer, the front of the body panel was made longer than the back of the body. By doing this the underside of the front of the jacket will be of a thicker density than the rest of the body, but the same thickness as the front placket.</p>

## Result/reflection

So whereas the layout idea of this concept remains potential, the armhole construction in this one does not contribute to great shaping. In further experiments ways to solve this underarm shaping are explored. The triangle between the body and the sleeves would be used for fitting in half a collar. The space could also be used to make a piece to fit into the armhole to create more space in the armpit and therefore give for moveable freedom.

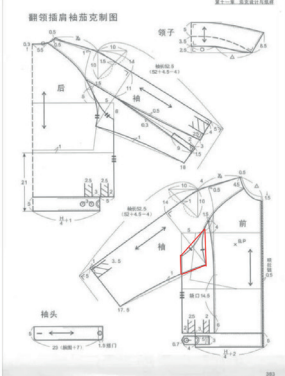
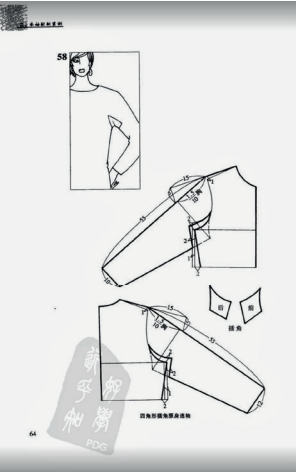


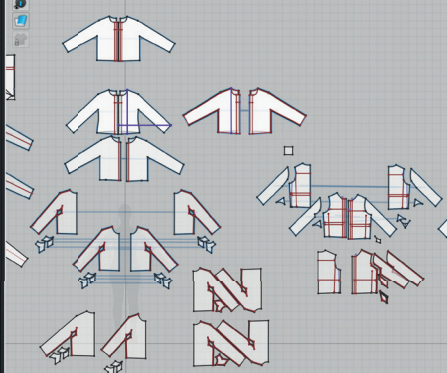
The idea of elongating the front of the body is taken along to other experiments.

## EXPERIMENT 7: ARM HOLE GUSSET

### Aim

To find a way to use the shape and layout of the shape from experiment 5 but to explore methods to add in a gusset.

### Method & observations

	<p>In these figures the sleeve is laid against and over the body piece, causing the underarm parts to overlap. In this experiment it was explored how to make a gusset out of this quadrangle (red line in previous figure) that is formed by the overlap.</p>
	
	

The picture displays the process and appearance of one gusset experiment. This was done by taking the quadrangle out of the whole body and sleeve panel. This quadrangle was dubbed to represent both the corner of the sleeve as the body. And the two pieces were attached to each other as how they would be sewn together if the sleeve and the body would be separate pieces. This joined piece then was a bit remodelled to make one shape. This shape should be woven in a double layer and connected at one edge.

### **Result/reflection**

This experiment resulted in a jacket with a shaped armhole construction. This way of construction does create some seams in the armhole area and that will influence the aesthetics in some way. This experiment was not tested in fabric in order to assess this aesthetic by eye. Another mentionable thing is that the hole in the main piece now creates a bit of waste in that area and the gusset that was created is an odd shape that fits inconveniently in the triangle between the body and the sleeve. In experiment 7 another way of solving the armpit area was explored with these results in mind.

## **EXPERIMENT 8: OPTIMISED GUSSET**

### **Aim**

To explore another way of solving the armpit area with these results of experiment 6 in mind.

### **Method & observations**

For this experiment the overlap between the body and the sleeve, as mentioned in experiment 6, was taken on in a different way. This experiment was done first by pattern cutting on paper before translating the idea to Clo3D and seeing how this concept would look on the mannequin.

The idea of this experiment was to not take the whole quadrangle out of that armpit area but to leave it on one of them and make a gusset for the other part. This was tried in both ways. First the quadrangle was taken out of the sleeve and the body panel was kept intact. The panel would, when taken from the loom, be cut in along the side of the body and along the arm hole seam. This would separate the sleeve from the body at the place where the gusset will be inserted. The gusset will be a two layer piece, front and back. To figure out the pattern of the gusset was a process of adding seams to the pain quadrangle. In order to sew in the gusset to the cut made earlier it is needed to have seam allowance in that area. So the lost centimetre on some edges of those seams were added to the gusset. And also the gusset needed seam allowance so another centimetre was added to some sides of the gusset. The side of the gusset where the gusset will function as an extension of the sleeve will be woven together on the loom. The paper pattern looks like this and resulted in a pinned sample.

For the second try the same process was applied only the gusset was taken out of the body piece and the sleeve was left intact. The panel would, when taken from the loom, be cut in along the underside of the sleeve and along the arm hole seam. This would separate the sleeve from the body at the place where the gusset will be inserted. The paper pattern looks like this and resulted in a small pinned sample.



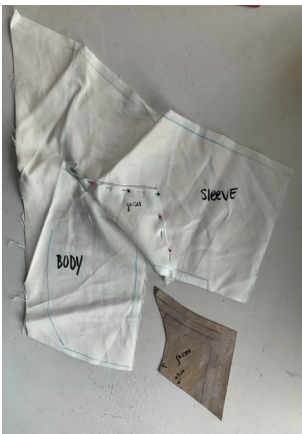
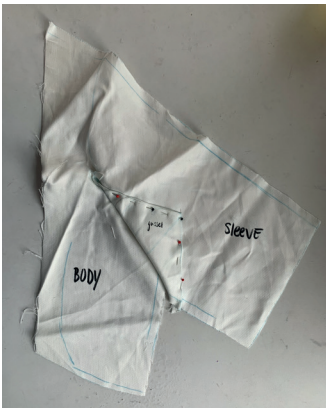
Fotos papieren protos

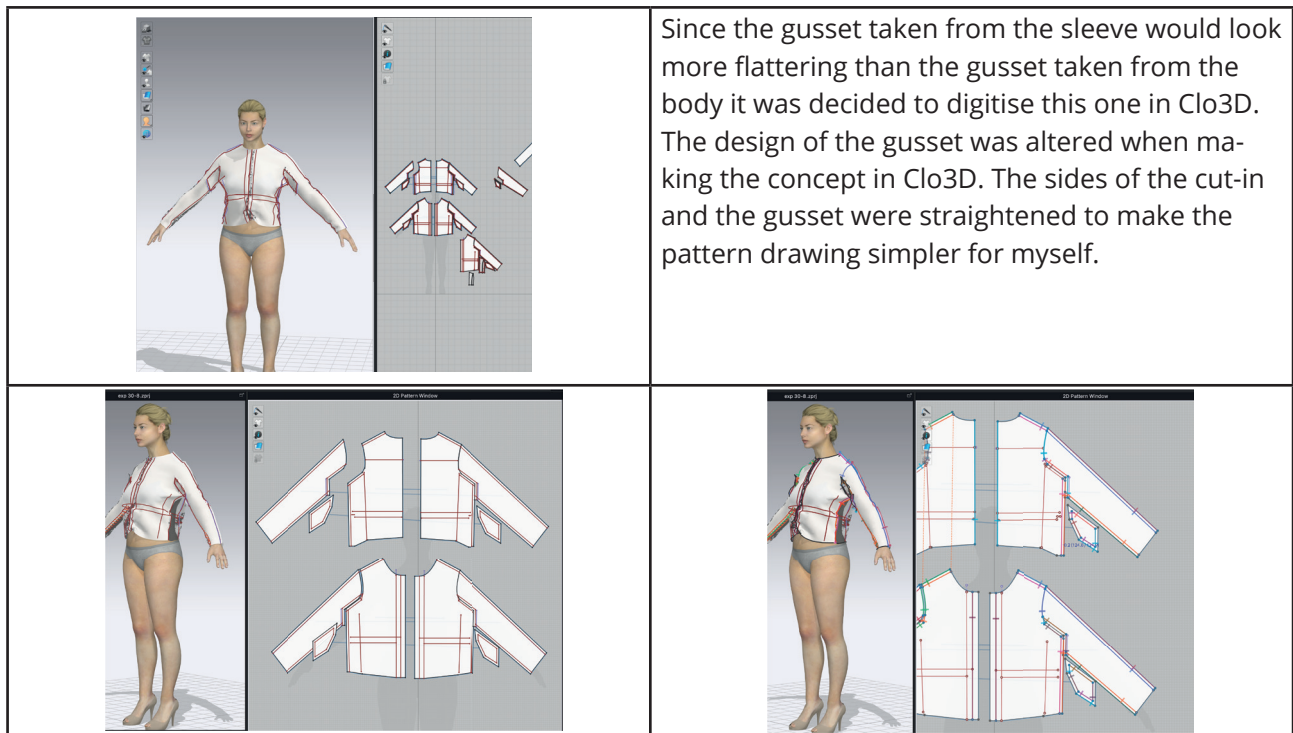


Morgen maken



Fotos 2 gepinde stoffen samples





### Result/reflection

The pinned samples showed some of the complexity of this gusset construction. The pointed top corner is cut in, but therefore there was not much seam allowance for the gusset to be attached to. A guess is that this could be solved by drawing seam allowance in that part rather than drawing the seam allowance into the cutting point. The gusset therefore would also need some redrawing.

The sewn version of this concept can be seen in the report as Concept 1.

### INSIGHT ABOUT THE LOOM REPEAT

In a conversation with Maurizio Baldi, Farhan Afzal and Omar Daraz of Diamond Denim about the first weaving samples they would make for us, it emerged that the denim fabric would shrink quite a bit. The repeat of the loom is 59.5 cm and that part, after finishing the fabric, will shrink to between 48 and 54 centimetres or a percentage of about 12 %. (The total width of the fabric will shrink from 144.27 to about 137 centimetres).

This affected the experiment because the last experiments were set up so that the body's height could fit into the repeated width. This was not expected to differ too much from the 59.5 cm repeat width on the machine. A height from shoulder to bottom of the jacket of 54 or even less centimetres would be too small for the intended size.

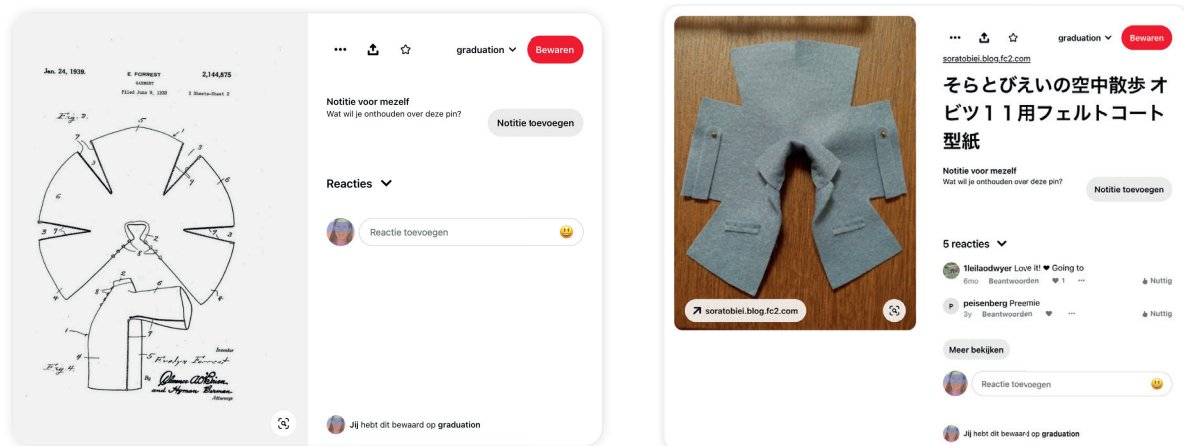
Design for this loom's repeat or design for no repeat. Now that a one-piece jacket would not fit on the loom, those designs would have to be divided into two (or more) parts to weave the designs. Therefore, it made more sense to choose to abandon the repetition measure and design a concept and its layout as if there was no repetition. That way, the design would fit on all jacquard looms without a repeat and on some jacquard looms with wider repetition, including the loom at Diamond Denim.



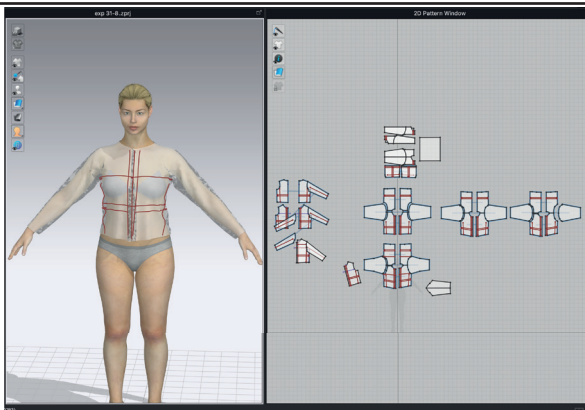
## EXPERIMENT 9: BEGINSEL CONCEPT 2, SOORT VAN VERVOLG EXP

## Aim

To digitally explore and prototype another folding formation for a 3d woven denim jacket with less complex armhole sewing construction of experiment 8. Inspired by experiment 1 and 4.



## Method & observations

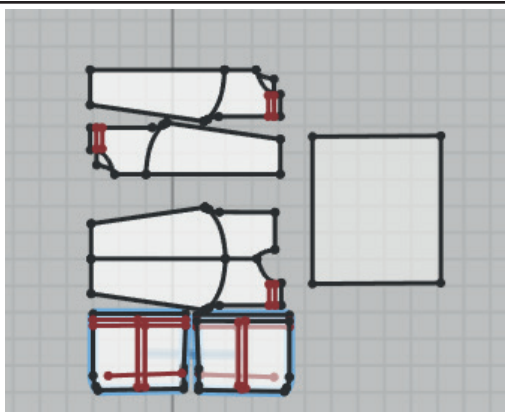


The digital pattern of the denim jacket in Clo3D was flattened as the inspiration pictures in figure x and x. This required the shoulder seams to be straightened. This also required the top of the sleeve to match the curve of the armhole line in the front and back body panels, see figure x. When the denim jacket was laid out so flat the idea arose to, like in experiment 1, make one piece of the sleeve and the top of the body parts that are directly connected to the arm hole seam. The bottom of the body will be a separate part then.



From this idea came the idea to fold that sleeve and top body panel in half again so the sleeve would be woven as a tube.

To better understand the concept of this way of separating the top and the bottom of a jacket, a constructed denim jacket was cut in a straight line from the bottom of the armhole to the centre back and front. Note that a straight line was cut, but in the top part connected to the sleeves these lines curved down after cutting, probably due to the construction of the arm seam. This sparked an idea for an updated digital prototype.



## Result/reflection

This idea sparked the development of concept 2, see chapter x. The concepts showed an interesting different way of trying to translate the existing shaped arm construction of a denim jacket into another flat and consisting of less panels construction. Only by making the concept out of fabric will it really show how good this jacket construction works fit-wise. The sewing construction is estimated to be relatively simple. The straight edge of the body panels can be attached to the edge of the top body.

Another benefit of this concept is that the separation of the jacket in this way can simulate the front and back yoke lines as on a traditional denim jacket.

## EXPERIMENT 10: HOW TO COME TO CONCEPT 3

### Aim

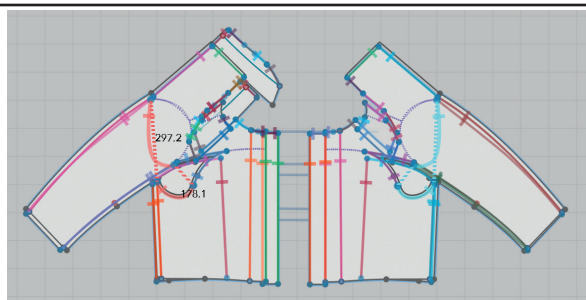
To take the potential of experiment 4 under further investigation.

### Method & observations

The concept idea of experiment 4 was further investigated because of the interesting construction of sewing 1 simple line, like in experiment 9 (concept 2), which at the same time would visually look as the front and back yoke line from a cut and sew denim jacket.



The figure above displays almost the same formation as Holly's design was constructed, laid out with a cut open constructed denim jacket. After analysing experiment 4 again I noticed the length of the armhole seam in the body was too small for the length of the armhole seam in the sleeve. The folded jacket in the figure displays what part is sort of missing in that construction.



This could be solved by extending the length of the armhole seam in the body, but as can be seen in figure x this would be tricky because the armhole seam would go really deep into the front body which will transform the fit of the jacket. Another way could be to shorten the length of the armhole seam in the sleeve, although this would mean a smaller armhole which is not desirable.



As constructed in figure x the armhole seam in the body is big enough. By having the armhole seam in the body like this, the sleeve can not be pointed down towards the bottom of the jacket. Having the sleeve pointed down could create a triangular composition which could, as mentioned in experiments 4, 6, 7 and 8, benefit to the layout of the design in the loom. With the sleeve sticking up the formation of the top part and the body attach would make a shape that would be difficult to fit efficiently in a loom without creating off-cut waste. It was therefore decided to continue with this concept by separating the sleeve and the body parts.



## Result/reflection

By separating the sleeve and body parts an interesting new concept arose. A sewn version of this concept is discussed in the report as Concept 3. It will be interesting to see how much of a difference the construction at the shoulder, where the top of the sleeve and the arm seam from the front and back yoke are connected into one piece, makes to the fit of a cut and sew denim jacket. The separate pieces could bring a lot of freedom in figuring out the least wasteful layout for a loom.

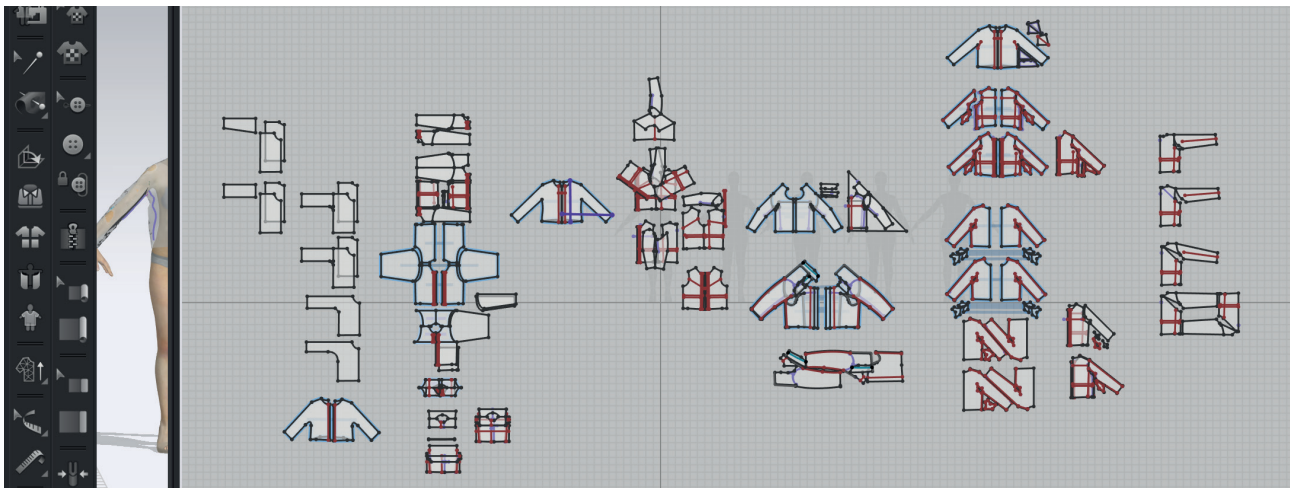
## EXPERIMENT 11: OVERVIEW: BOXY TO MORE ARM FITTED RANKING

### Aim

To create a digital overview in Clo3D of all made prototypes from the aforementioned experiments on a scale from a straight sleeve to body pattern construction to a fitted sleeve to body pattern construction.

### Method & observations

All experiments and sketches were put together in one Clo3D file. The jacket constructions were ranked on how much the pattern construction matches the construction of a cut and sew denim jacket, mostly looking at the sleeve to body connection. In the figure, the experiments are ranked from left to right in order of resembling a cut and sew denim jacket construction.






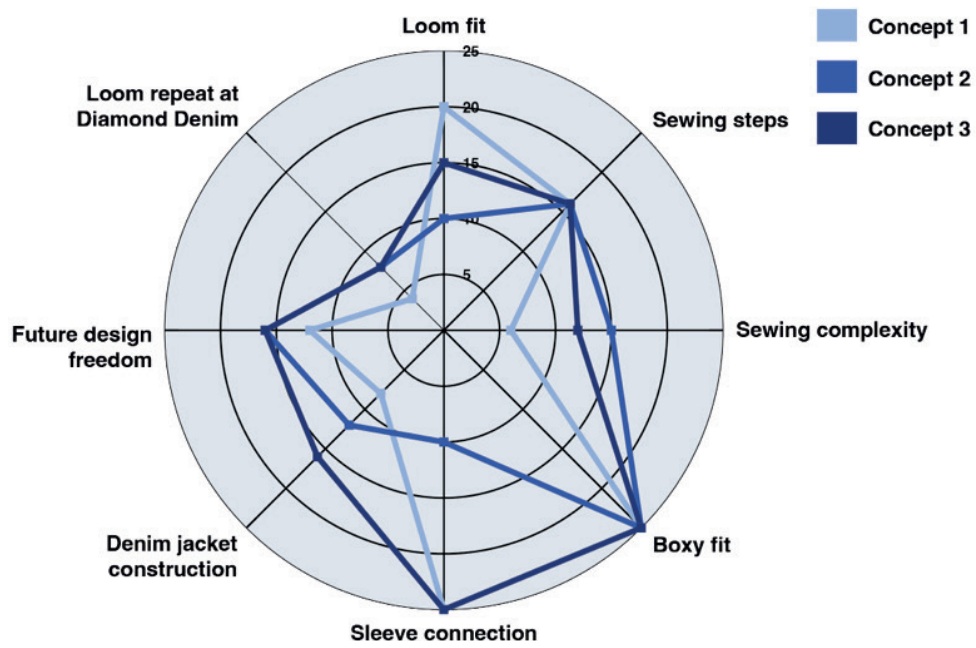
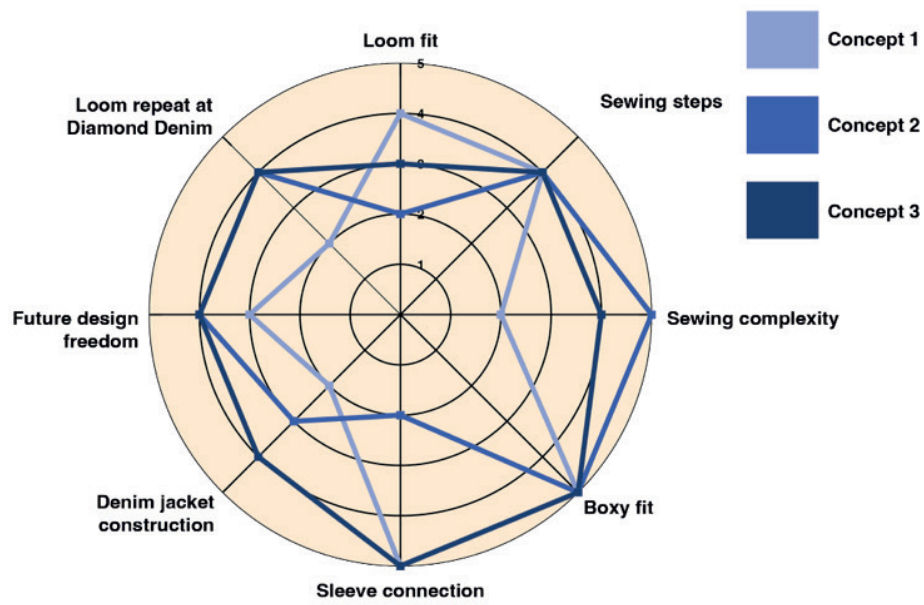
## Result/reflection

The overview is based on my personal understanding and estimation of how the armhole construction relates to each other and to an existing denim jacket. Where the second from the left, from experiment 7 and 8, would create a fitting arm hole shape, the aesthetic of this gusset does not correspond so well with a standard denim jacket. The third row of concepts from the left will have a bit of a different fit in comparison to a cut and sew denim jacket because of the construction. But in comparison to the second from the left the aesthetics of the construction with the sewing lines creating some sort of front and back yoke lines will correspond better to the aesthetics of a cut and sew denim jacket. The same can be said about the second from the right concept. Although the armhole fit will be even more off from a cut and sew denim jacket, the construction lends itself for creating an aesthetic look that corresponds with a cut and sew denim jacket. These three concepts are translated into sewn samples to explore which of the concepts has the most potential for this project.

## Appendix F | Concept choice - weighted decision matrix

### WEIGHTED DECISION MATRIX

	Criteria rating	Concept 1 	Weighted rating concept 1	Concept 2 	Weighted rating concept 2	Concept 3 	Weighted rating concept 3
<b>Yield waste</b>	<b>5</b>	4	20	2	10	3	15
<b>Sewing steps</b>	<b>4</b>	4	16	4	6	4	16
<b>Sewing complexity</b>	<b>3</b>	2	6	5	15	4	12
<b>Boxy fit</b>	<b>5</b>	5	25	5	25	5	25
<b>Sleeve connection</b>	<b>5</b>	5	25	2	10	5	25
<b>Denim jacky construction</b>	<b>4</b>	2	8	3	12	4	16
<b>Future design freedom</b>	<b>4</b>	3	12	4	16	4	16
<b>Loom repeat at DD</b>	<b>2</b>	2	4	4	8	4	8
Total weighted rating			116		112		133





# Appendix G | Weave experiment 1 & 2

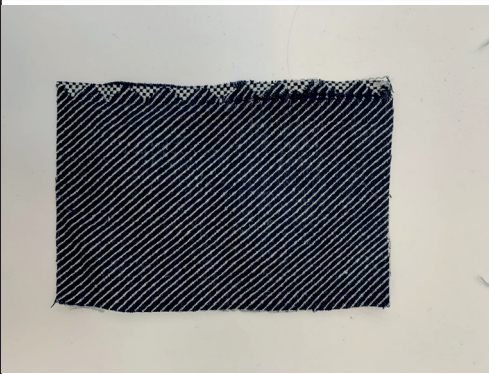

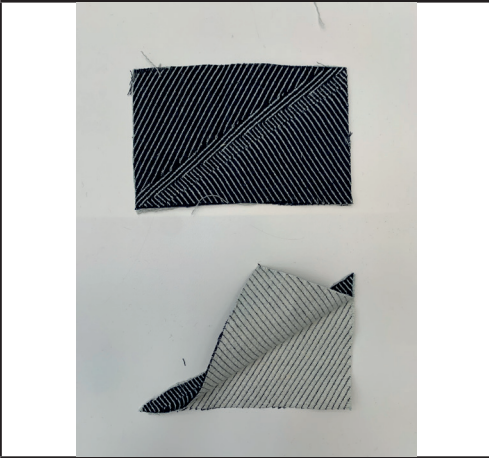
## WEAVE EXPERIMENT 1

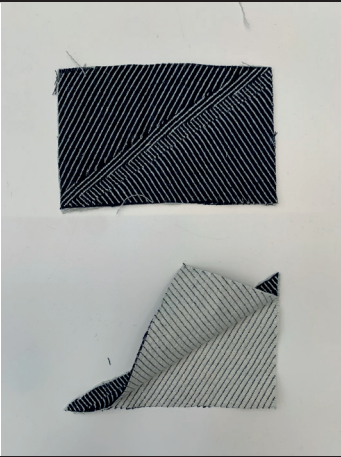
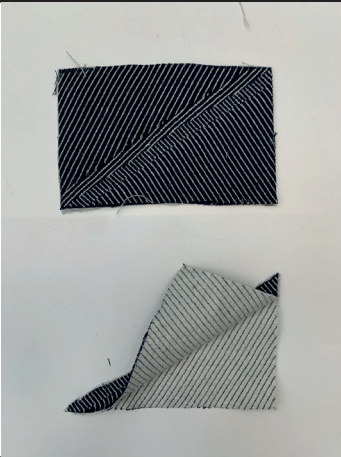
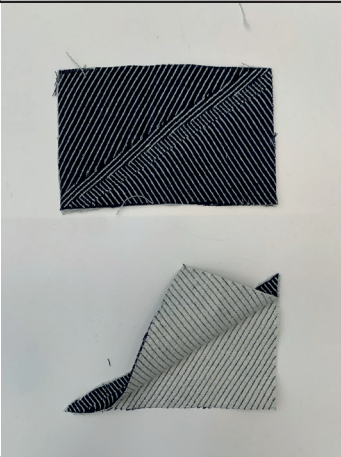
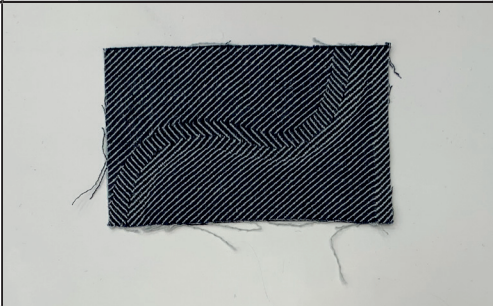
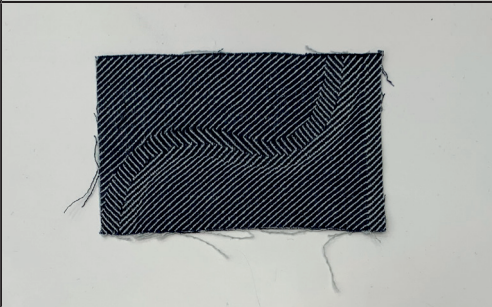
**Aim:**

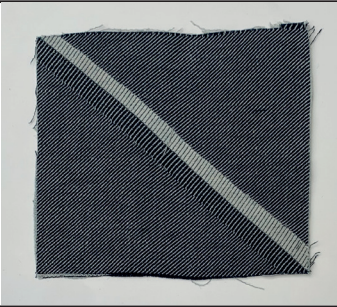
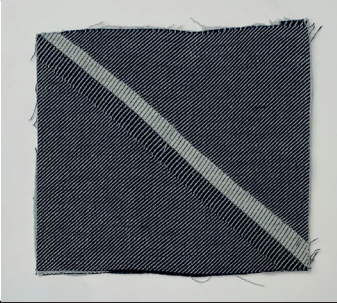
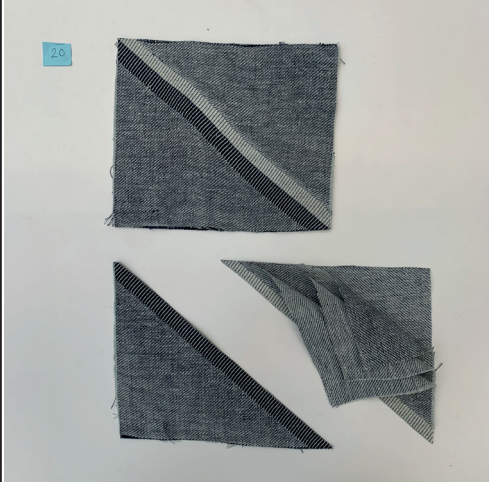
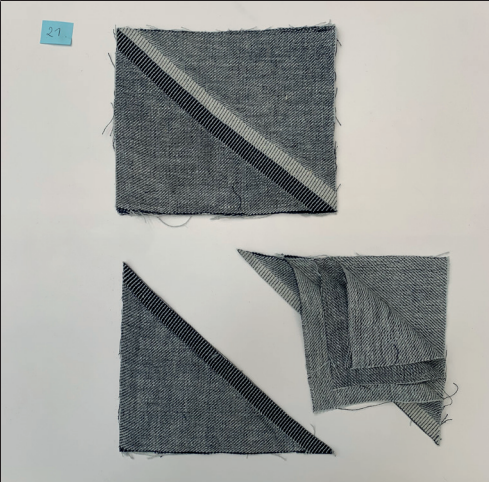
To explore the weaving machine at diamond denim. To weave samples to explore how to recreate a denim look by weaving different weave structure compositions. To weave samples of multiple layer construction to examine the fractional density. And to weave samples with seam in order to test the strength of the woven seam constructions.

**Method, results & observations**

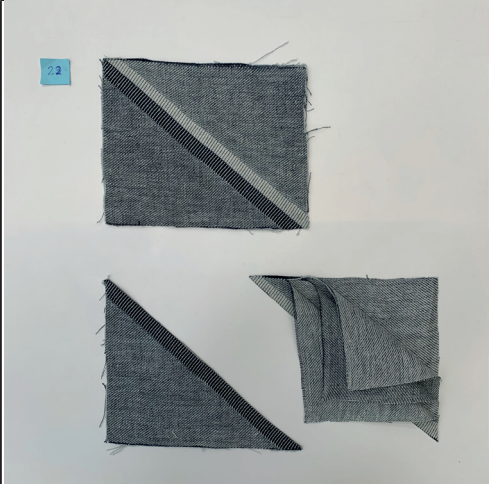
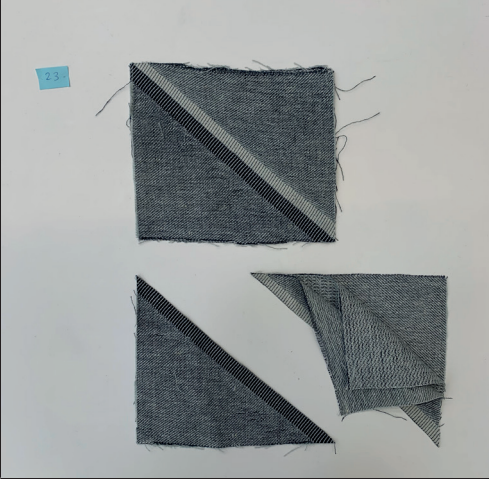
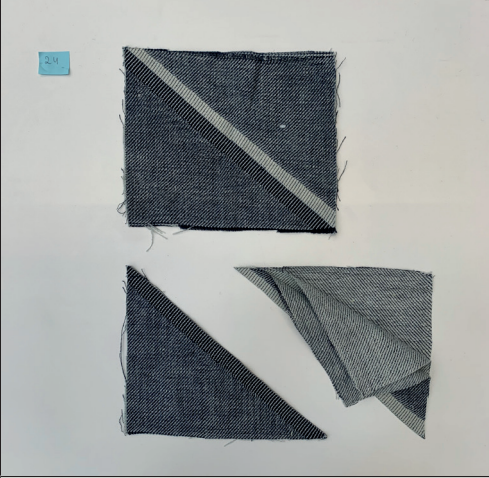
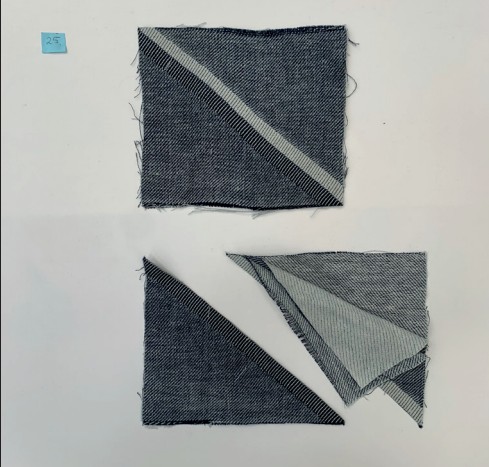
Figure x shows the corresponding map of bindings for the sample. The samples will be discussed based on the main weave structure used in the sample.

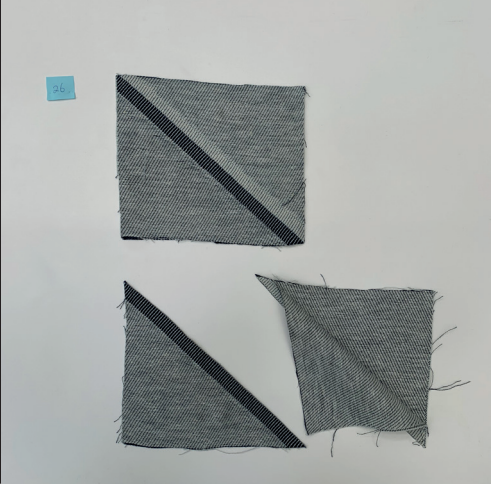
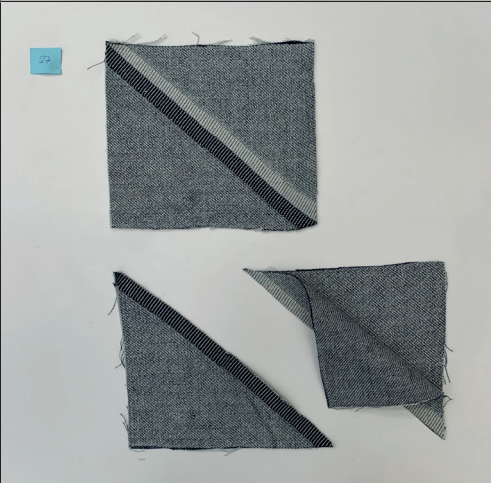
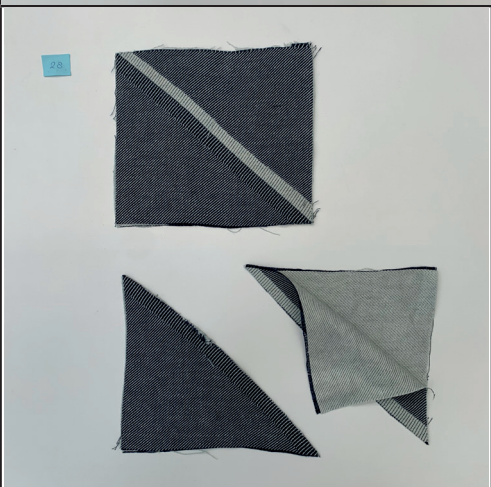
Weave structure	Idea and illustration	Photo samples	Observations
1			
3			
4	13AB/24CD 2 layer weave structure		

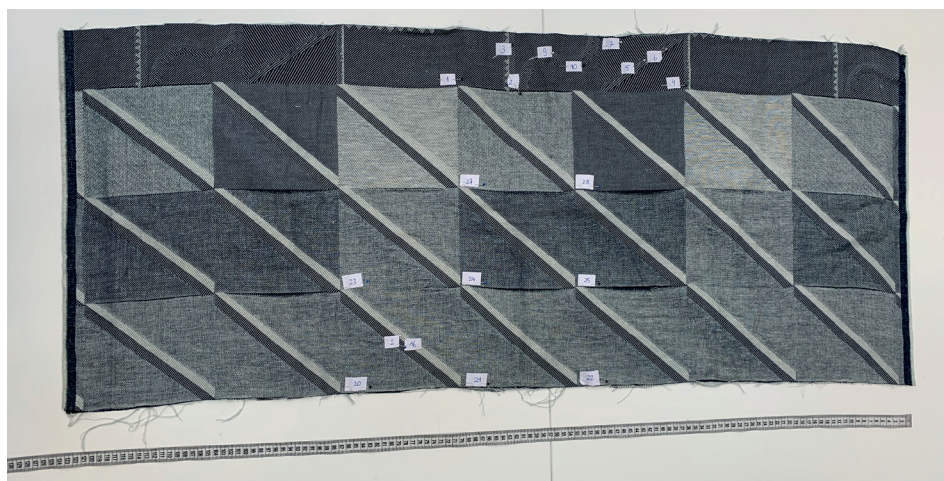
5	1A3B2C4D 1 layer weave structure			
6	1A3B2C4D 1 layer weave structure Same as 5 but the twill goes in a different direction			
7	13AB/24CD 2 layer weave structure Same as 4 but the twill goes in a different direction			
9	Same as 6			
10	Same as 5			

2	Seam Compound binding 1 layer, as blue as possible			
16	Seam Compound binding 1 layer, as white as possible			
20	4 layer weave structure  2/1 twill 1A/2B/3C/4D			
21	4 layer weave structure			



22	4 layer weave structure		
23	3 layer weave structure 1A/23BC/4D		
24	3 layer weave structure 1A/2BC/3D		
25	3 layer weave structure 1A/2BC/3D		

26	2 layer weave structure		
27	2 layer weave structure		
28	2 layer weave structure 1AC/2BD		



## WEAVE EXPERIMENT 2

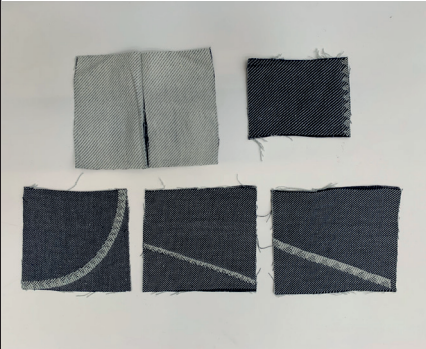
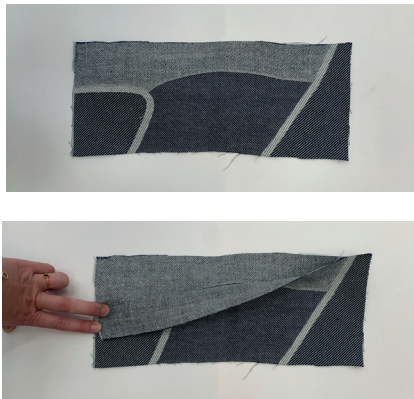
### Aim

To try out different weave and form construction related to the aesthetics of the 3D woven denim jacket.

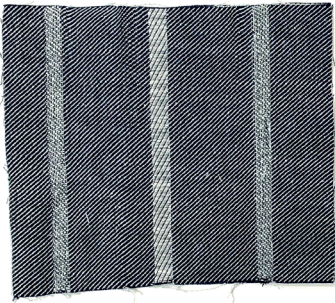

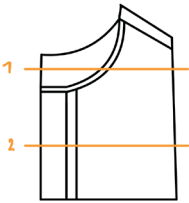
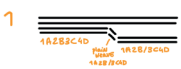
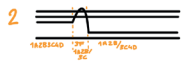

### Method, results and observations

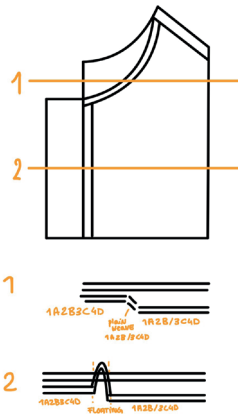
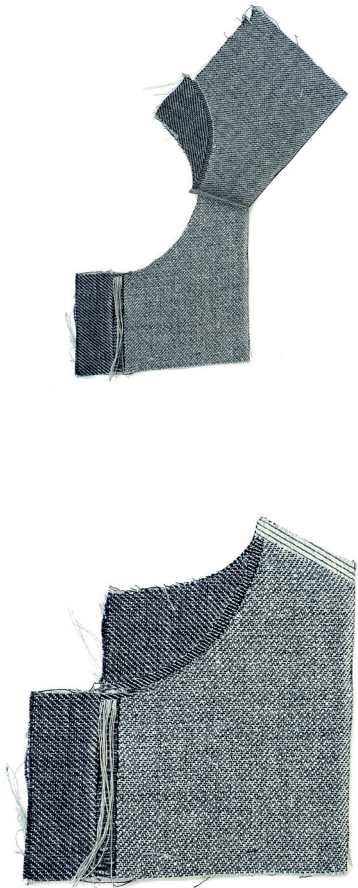
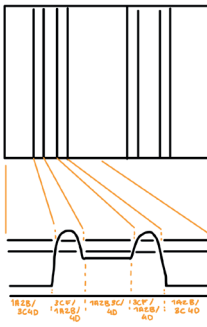
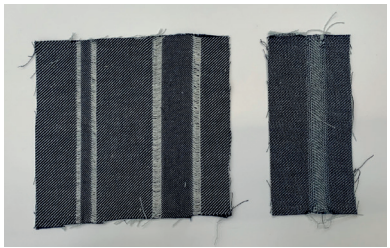
The sample illustrations were designed in Illustrator and translated into weaving files by Milou Voorwinden. At the moment of sending out these samples the prototypes were at the stage of experimentation with creating a denim jacket shape that would fit sideways in the width of the repeat, neckline to waistline. Therefore the samples that represent a part of a denim jacket are woven in that direction, so turned 90 degrees on their side.

Sample 4 and 5 test two different ways to design for a denser front placket. Samples 7 and 8 use the front placket alterations from sample 4 and 5 and combine that with a test to make the front waistline longer than the back waistline.

Sample	Idea and illustration	Photo sample	Observations
1	To test seam constructions that have a zigzag pattern in them. The idea behind this was to recreate the working of a serrated scissor that prevents fabric edges from ruffling too much.		The seams did not work as intended and were weaker than the other woven seams in these samples. Small triangles of fabric are cut from the seam with serrated scissors that prevent large pieces of yarn from fraying. In these woven seams, the yarns remain uncut, only alternating in different weave structures, so the seams still fray.
2	To test the visual idea of creating the idea of an arm seam without there being an actual sewing line, by changing the direction of the weave structure in the sleeve. In this sample the purple part is a part of the body and the grey part the top of the sleeve.		The purple weave structure did not turn out as blue as preferred so in this sample the difference between the body and the sleeve is too obvious. Therefore the sample does not represent the intended idea.

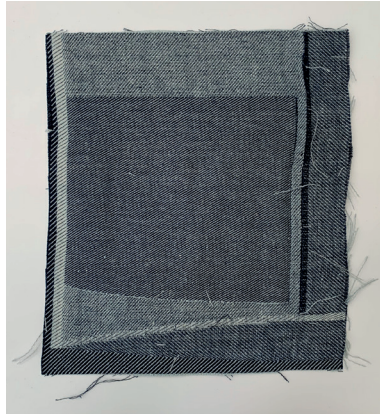
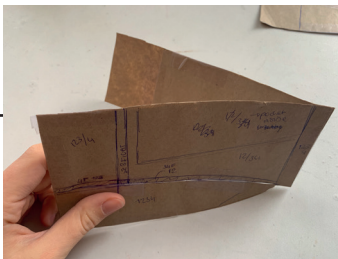
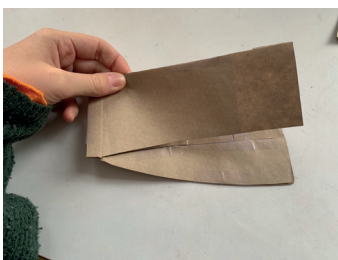
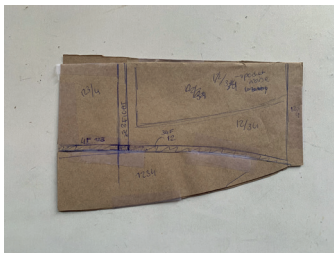
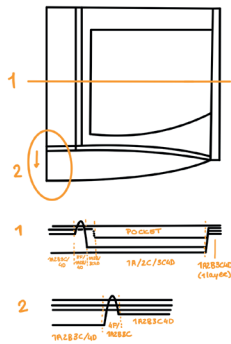


3	<p>To try to create visual lines by applying an alternative weave structure. This effect could mimic the V-shaped lines on a Type 3 denim jacket. The idea was that one line would have a more angled twill weave, one line an s-twill (instead of the z-twill) and one line a weft twill weave that would appear white.</p>	<p>Front side</p>  <p>Backside</p> 	<p>Due to some miscommunication the idea did not work as planned, so two lines were woven the same. But the idea of creating visual difference by switching the weave structure there works well.</p>
4	<p>To try to make the front placket, the yellow-green part, denser than the bodice part (purple), which is a 2-layer weave structure. To make this work, one of the warp threads of the back piece will pass to the front layer to make it a three-layer structure and the centre back a one-layer weave structure. This example shows the neckline of a half jacket. The front neckline must be cut loose from the back to open up the bodice, held together by the blue seam of one layer. The yellow line is a twill weave, a heavier weave compared to a twill weave, to prevent the neckline from fraying after cutting.</p>   		<p>The change in fractional density for the front placket worked out. The float weave structure that should help to separate the front and back from each other did not work out, due to a wrong binding in that area.</p>

5	<p>To try to make the front placket denser than the 2-layer fractional density of the bodice part (purple) by moving it separate from the back pattern. To help cut the front and back loose a float (black) was added. This example shows the neckline of a half jacket. The front neckline must be cut loose from the back to open up the bodice, held together by the blue seam of one layer. The yellow line is a twill weave, a heavier weave compared to a twill weave, to prevent the neckline from fraying after cutting.</p> 		<p>The float did not work and was also not so needed for the sample because the cutting area was accessible. Although the weave structure from the front placket is wrong (3 layers instead of 1) the idea has potential.</p>
6	<p>To test the idea of going from 2 layers with even distribution to two layers with uneven distribution. This would require cutting the two layers loose from each other. For that reason the idea was to add floats of the switching yarns to make it easier to separate the two layers, see figure x and x.</p> 		<p>The floats unfortunately did not work. Instead of warp yarn 3 floating, 1A is floating. The change in layer distribution does work though and can potentially be used for example as a subtle to add decorative visual differences in the textile and to give a section more density in order to strengthen that part.</p>

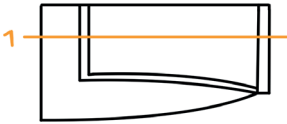
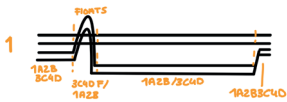
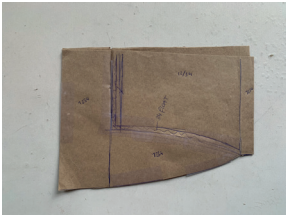
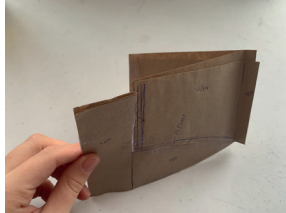

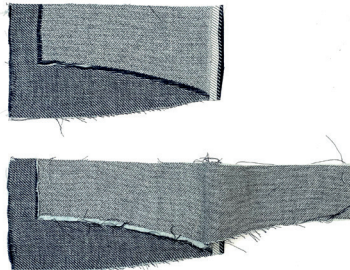
7

Test the idea of example 4 in combination with the idea of making the front waistline longer than the back waistline, see figure x. So the bottom of the front waistline will be denser than the rest of the front layer. In this sample a pocket is integrated in the front body panel, this pocket separates the front panel into two layers. Floats are added to make the separation of the front and back easier.



In this sample, different warp and weft distributions were used for the different weave structures, making it unable to separate the layers. The inside pocket construction worked out well but the weave structure of 1 layer is very thin and fragile for a pocket.



8	<p>Test the idea of example 5 in combination with the idea of making the front waistline longer than the back waistline. So the bottom of the front waistline will be denser than the rest of the front layer. Floats are added to make the separation of the front and back easier.</p>     		<p>Although the floats only worked in the line between the front placket and the body the sample demonstrated well the idea of cutting the back panel loose from the front body. The front placket is denser and the bottom of the front longer than the back.</p>
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## Appendix H | Seam tensile strength tests

### Machine used:

Zwick tensile tester

Setting: Tensile 500N load cell 1kN grips crosshead

The clamps measures 30 mm in high and

Set parameters

Maximum extension: 3 mm

Test speed: 305 mm/min (ASTM D1683)

Pre-load 0,1 N

Test samples

### Seam samples:

The samples that are used for the seam tests measure 150 mm by 43 mm, in the same ratio as the given measurement in ASTM D1683. For the seam test the clamps are placed 75 mm apart, according to ASTM D1683. The samples are placed with the seam in the middle of the 75 mm gap between the clamps. A line was drawn in the middle perpendicular to the to be tested seam in order to align the sample in the centre of the clamps.

### Fabric samples:

The samples that are used for the fabric tests measure 75 mm by 43 mm. For the seam test the clamps are placed 15 mm apart, sample size minus two times the height of the clamps. A line was drawn in the middle perpendicular to the to be tested seam in order to align the sample in the centre of the clamps.

Sample code	Measurements sample	Weave structure code	Seam structure	Material	Weave	Yam count (Ne) warp	Yam count weft	Fabric setting (threads / cm) warp	Fabric setting (threads / cm) weft	Maspe-runitarea (g/m <sup>2</sup> )	Fabric thickness
Seam samples											
WS1- Seam	150 x 43	28 with seam in 2	seam in weave structure 2 blue	CO/HE	Twill	8	20	24	25		0.335, 0.365, 0.385, 0.330 = <b>0.354</b>
WS1- Seam 2	150 x 43	28 with seam in 2	seam in weave structure 2 blue	CO/HE	Twill	8	20	24	25		0.345, 0.405, 0.385, 0.350 = <b>0.371</b>
WS1- Fabric 1 ("good" side)	75 x 43			CO/HE	Twill	8	20	24	25		0.340, 0.405, 0.380, 0.380 = <b>0.376</b>
WS1- Fabric 2 ("wrong side")	75 x 43			CO/HE	Twill	8	20	24	25		0.365, 0.335, 0.340, 0.330 = <b>0.343</b>
WS2	150 x 43	28 with seam in 2	seam in weave structure 2 white	CO/HE	Twill	8	20	24	25		0.365, 0.350, 0.345, 0.335 = <b>0.349</b>

WS2-seam 2	150 x 43	28 with seam in 2	seam in weave structure 2 white	CO/HE	Twill	8	20	24	25		0.350, 0.380, 0.385, 0.370 = <b>0.371</b>
WS2-fabric1 streepjes kant	75 x 43	28		CO/HE	Twill	8	20	24	25		0.350, 0.425, 0.390, 0.370 = <b>0.384</b>
WS2-fabric2 vlekken kant	75 x 43	28		CO/HE	Twill	8	20	24	25		0.380, 0.350, 0.355, 0.375 = <b>0.365</b>
WS3-seam	150 x 43	27 with seam in 2	seam in weave structure 2 blue	CO/HE	Twill	8	20	24	27		0.405, 0.440, 0.395, 0.480 = <b>0.430</b>
WS3-fabric	75 x 43	27		CO/HE	Twill	8	20	24	27		0.360, 0.355, 0.460, 0.474 = <b>0.412</b>
WS4-seam	150 x 43	27 with seam in 2	seam in weave structure 2 white	CO/HE	Twill	8	20	24	27		0.445, 0.385, 0.425, 0.355 = <b>0.403</b>
WS4-fabric	75 x 43										0.380, 0.410, 0.445, 0.450 = <b>0.421</b>
WS5-seam	150 x 43	26 with seam in 2	seam in weave structure 2 blue	CO/HE	Twill	8	20	24	26		0.440, 0.370, 0.470, 0.405 = <b>0.421</b>
WS5-fabric	75 x 43 ,3 clamps placed 15 mm apart, seam in middle	26		CO/HE	Twill	8	20	24	26		0.440, 0.370, 0.470, 0.405 = <b>0.421</b>
WS6	150 x 43	26 with seam in 2	seam in weave structure 2 white	CO/HE	Twill	8	20	24	26		0.345, 0.375, 0.460, 0.395 = <b>0.394</b>
WS7-seam	150 x 43	27 with seam in 2	Vertical warp	CO/HE	Twill	8	20				0.375, 0.355, 0.465, 0.400 = <b>0.399</b>
WS7-fabric1	75 x 43	27	Vertical warp	CO/HE	Twill	8	20				0.405, 0.385, 0.430, 0.420 = <b>0.410</b>



WS7-fabric2	7.5x4.3	27	Vertical warp	CO/HE	Twill	8	20				0.430, 0.445, 0.415, 0.405 = <b>0.424</b>
Fabric samples											
WS8	75 x 43	28, warp horizontal	No seam	CO/HE	Twill	8	20				0.370, 0.360, 0.370, 0.390 = <b>0.373</b>
WS9	75 x 43	28, warp vertical	No seam	CO/HE	Twill	8	20				0.390, 0.325, 0.380, 0.375 = <b>0.368</b>
Idea											
WS9		28	Sewn SSa-1		Twill	8	20				
Ws10		28	Sewn LSc-2		Twill	8					
ES1	105x43	Warp vertical	Sewn LSc-2	Cotton	Twill	un-known	un-known	24	21		0.520, 0.495, 0.505, 0.520 = <b>0.510</b>
ES2	150x43	Warp horizontal	Sewn LSc-2	Cotton	Twill	un-known	un-known	24	21		0.545, 0.545, 0.585, 0.545 = <b>0.555</b>
ES3	100x66	Warp vertical		Cotton	Twill	un-known	un-known	24	21		0.520, 0.550, 0.565, 0.535 = <b>0.543</b>
ES4	100x66	Warp horizontal		Cotton	Twill	un-known	un-known	24	21		0.490, 0.545, 0.475, 0.475 = <b>0.496</b>

# Appendix I | Experiments at Diamond Denim

## INTRODUCTION

### DD\_3\_1

Mixing in 2 blue weft yarns.  
Changed the number 2  
binding from the seam test  
to a more blue less white  
binding.

W: Weave structures with more blue looks good.  
Some seams raffle to much: Side seam body is a problem (in the horizontal direction) (thought EXP WITH Milou, waarbij achteraf bleek dat de binding getest in DD\_4\_1 al een heel stuk heeft geholpen), cuffs binding is to loose, side seam sleeves bit to much raffle maybe.

Collar option with the fold: wrong weave programming so it does not open as it should. Not going further with this idea. Trying a new collar idea in DD\_3\_2.

In the breast pocket and side pocket the colours are the wrong way around, now white outside and blue inside. I want them the other way around.

F: Fit is a bit off -> fix that (see notebook).

Drop the front collar with 2 cm.

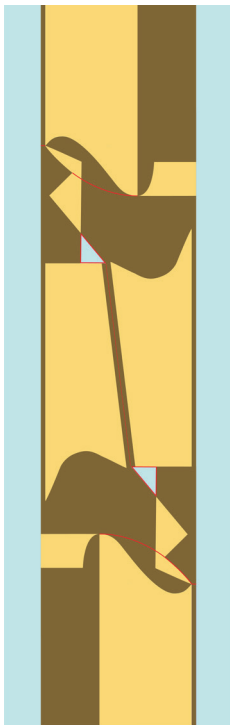
Extent back neck point with 1 cm.

Photos: weave structure, side seam, cuff



## DD\_4\_1

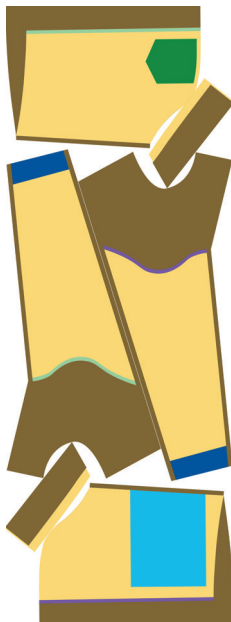
DD_4_1	<p>W: Changing the 1 layer (number 2) binding to make it a more neat and denim looking weave structure (HOE?) in comparison to the one used for DD_3_1 because that was a bit smoochy.</p>	<p>W: Weave structure 2 looks nether, so we will continue with this structure for the following samples. Some parts on the outside are now white instead of blue. And some directions of binding points go the opposite way as the parts next to it. Will change this in 4_2.</p> <p>F: Very small for me -&gt; made 10% bigger. Front top is a bit bulky. On the back the front and back seam and the back sleeve seam are almost aline, which would look really nice and I want to try.</p> <p>Photos: weave structure, side seam</p>
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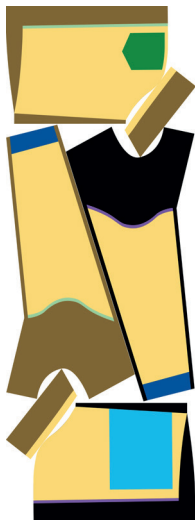
## DD\_3\_2

DD_3_2	<p>Implemented:</p> <p>W: New weave structure number 2, tested in DD_4_1. Cuff weave structure adjusted to a tighter weave, 1 step tighter than the 2 layer weave structure 28 used in arms and body.</p> <p>Added a plain weave structure in the seam part underarm. Changed the colour order of the pockets.</p> <p>F: Fit updated as discussed in DD_3_1.</p>	<p>W: In the breast pocket and side pocket the colours are the wrong way around, now white outside and blue inside. I want them the other way around.</p> <p>One side of the breast pocket is very open and displaced.</p> <p>Side seam with the new weave structure still raffles. The seam is under a slight angle which is not serialable for this weave structure in the weft direction. Therefore I decided to straighten the side of the side seam to make it parallel to the weft yarns.</p> <p>In the transition from front panel to front placket the weave structures are to open, maybe because of this line being parallel to the weft, so one yarns carries the whole transition. -&gt; We checked the weave structures again + put this line under an angle. + we hope that with the finishing of the fabric the weave structure becomes tighter and this problem occurs less.</p> <p>F: good, no more changes Colour ideas are good.</p>
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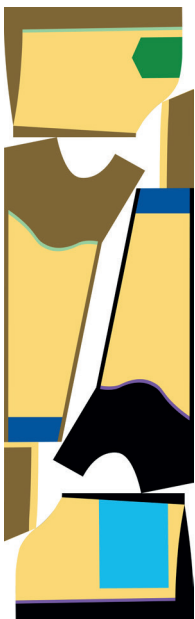
### DD\_3\_3

DD_3_3		<p>Implemented:</p> <p>W: Adjust pocket colour.</p> <p>Pocket weave structure changed to a plain weave to make it as tight as possible in this density. (+ dissolve this of DD_3_2: One side of the breast pocket is very open and displaced.)</p> <p>Side seams are made straight.</p> <p>Front placet to centre back line put under an angle.</p>	<p>W: Directions of weave structure bonds do not go in the right directions everywhere, -&gt; change in DD_3_4</p> <p>Front placet to centre back line put under an angle, still a bit open, see how it goes after fabric finishing.</p> <p>Pocket colours in this sample are right with blue on the outside. Structure is a bit more stiff as expected.</p> <p>Pockets all look fine now.</p>
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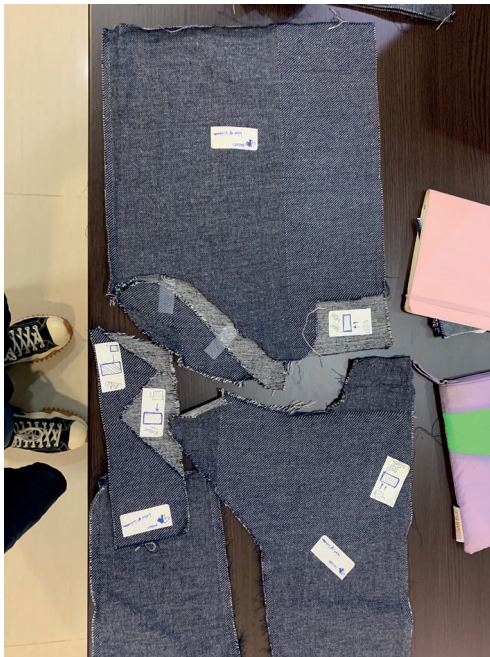
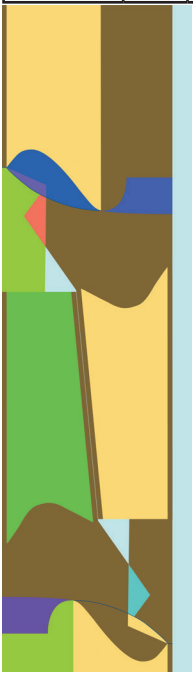
### DD\_3\_4

DD_3_4		<p>W: Direction of the bonds of some part changed to go in the same direction as its aligned structures.</p>	<p>W: Direction now good.</p> <p>F: To add an extra 2 cm on the cuffs in order to sewn them</p>
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## DD\_4\_2

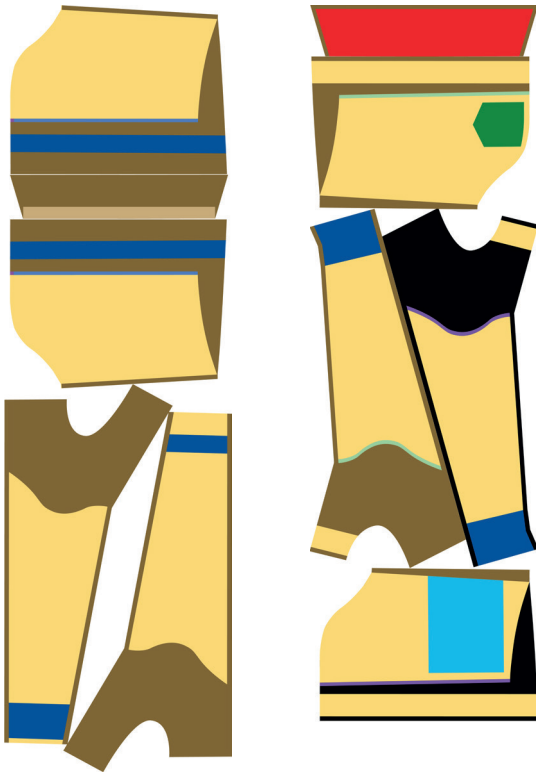
DD_4_2	<p>W: Difficult structures of number 2 for the machine to weave, warp kept breaking and you saw the weft line curving on the loom, so we changed the weave structure to a same version of that weave structure, where Milou divided the bonding point in a different layout. Invert and redirect the weave structure at some places of the image in order to have the binding point go the same way where I want them to and in order to make all outside visible parts blue colored instead of white.</p> <p>F: To align the body side seam and the back sleeve seam, I moved the side seam 1,5 cm (3cm in total) to move to the back. This made the whole structure a bit wider so therefore I had to widen the sleeves a bit and the leftover triangles became a bit bigger. I also lowered the back seam of the sleeve panel 3 cm in order to hopefully align the two seams. Make the overall shape 10% bigger.</p>	<p>W: In all parts the colour is right. All but 2 parts of the direction are off. Changed weave structure for number 2 was good to weave.</p> <p>F: The point of the side seam and back sleeve seam do not align with the made changes. Still a difference of 4 cm. There is too much space in the neck line, standing up. On the front the yoke seam is not a nice, flattering line. Could use more rounding. At the back yoke there is a bit too much room near the armpit. 10% bigger looks a bit big now but it will shrink still a lot.</p>
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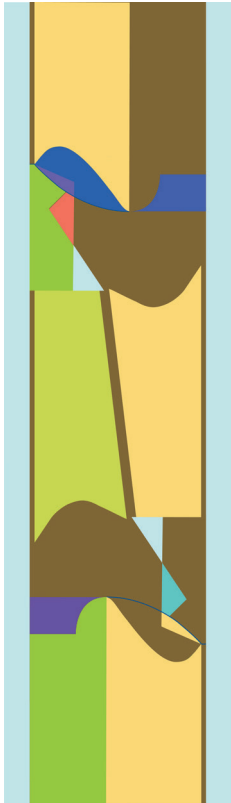
## DD\_5\_2

DD_5_1	Not woven, only tiff file made al- ready in NL		
DD_5_2		<p>W: Changed the design to use less fabric by making the front placket a double layer weave structure. Took the weave structure of number 2 optimised in DD_4_2.</p> <p>F: Also added the fit adjustments that were changed after fitting design DD_3_1</p> <p>Changed the design of the cuffs.</p>	<p>W: Front placket idea works nice. But the colours need to flip in order to get the blue on the outside.</p> <p>F: Fit is good, Maybe a bit too much room at the armpit but I have to see after finishing.</p>



## DD\_4\_3\_1

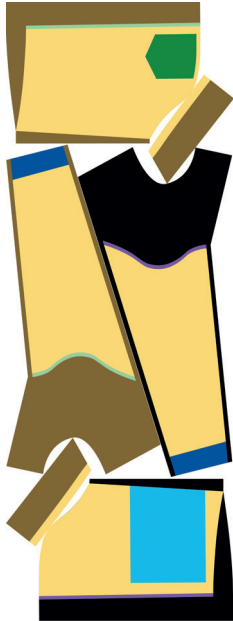
DD_4_3		<p>W: Changed the direction in 2 parts.</p> <p>F: Took out some room in the neck line. Curved the front yoke line. Lowered the back yoke line a bit to take out space. Did not change the fit any more to achieve the seams to align.</p>	<p>W: All but 1 direction are good now.</p> <p>F: Seam does not align but not the end of the seams do align, so that is a nice start. I will leave it with that. Fit is way better and the front curve is flattering.</p>
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# Finals weave prototypes

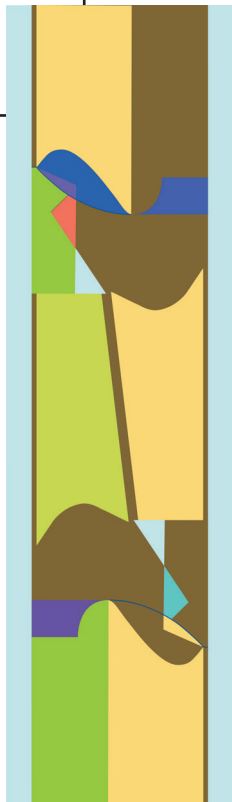
## DD\_3\_5

DD_3_5		<p>W: Changed the number 2 weave structure to the one optimised in DD_4_2</p> <p>F: Made the whole design bigger by 10%. Changed the collar design so it actually works.</p>	<p>F: To straighten the end of the cuffs in order to better sew down the end seam, just like in the cuff of DD_5_2</p>
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## DD\_4\_3\_2

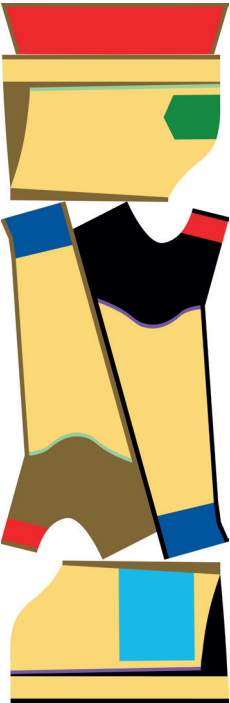
DD_4_3	<p>same with very little change</p>	<p>W: Flipped direction in one part Added my initials on the left over triangles to make a label out of those.</p> <p>Weave not in the middle of the repeat but at a side so two samples can be cut out of 1 weave because the file is 41 cm wide and the side repeats 42 cm.</p>	
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DD\_5\_3

DD_5_3		W: flipped colour in front placket idea.	Future option W: For 1 cm in that front placket the colour should be changed back with the colours.
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## Appendix J | User study consent forms



### Consent for interview

I volunteer to participate in a research project conducted by Barbara Vroom from Delft University of Technology. I understand that this interview is part of her graduation project.

I kindly ask you to read this form carefully and ask any questions that you may have.

- I understand that I can refuse to answer any questions and that I can withdraw from the interview at any time, without having to give a reason.
- Participation involves being interviewed by the researcher, which will last approximately 10 minutes.
- I understand that taking part in the study involves an audio-recorded interview. The interview will be recorded using a smartphone and also written down. The audio will be transcribed as text and the audio will be kept in the local hard disk of the researchers, for the length of maximum two years.
- I understand that taking part in the study involves getting photographed. The photos will be taken by smartphone or a camera. The photos will be used without a recognizable face, and will be kept for the length of maximum two years.
- I agree that my information can be quoted in research outputs.
- I give permission for the anonymised transcripts that I provide to be archived in the local data bank of TU Delft, so it can be used for future research and learning.
- I understand that the researcher will not identify me by name in any documentation using information obtained from this interview, and that my confidentiality as a participant in this study will remain secure.
- I have read and understand the explanation written in this consent form. I have had all my questions answered to my satisfaction, and I voluntarily agree to participate in this study.



Signature of participant

6-12-22

Date



Name of participant



Signature of researcher

For further information, please contact:

Barbara Vroom

barbaravroom@xs4all.nl

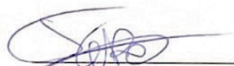


## Consent for interview

I volunteer to participate in a research project conducted by Barbara Vroom from Delft University of Technology. I understand that this interview is part of her graduation project.

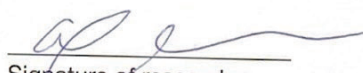
I kindly ask you to read this form carefully and ask any questions that you may have.

- I understand that I can refuse to answer any questions and that I can withdraw from the interview at any time, without having to give a reason.
- Participation involves being interviewed by the researcher, which will last approximately 10 minutes.
- I understand that taking part in the study involves an audio-recorded interview. The interview will be recorded using a smartphone and also written down. The audio will be transcribed as text and the audio will be kept in the local hard disk of the researchers, for the length of maximum two years.
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- I understand that the researcher will not identify me by name in any documentation using information obtained from this interview, and that my confidentiality as a participant in this study will remain secure.
- I have read and understand the explanation written in this consent form. I have had all my questions answered to my satisfaction, and I voluntarily agree to participate in this study.

  
Signature of participant

30-11-2022  
Date

Tara Mulder  
Name of participant

  
Signature of researcher

For further information, please contact:  
Barbara Vroom  
barbaravroom@xs4all.nl





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- I understand that I can refuse to answer any questions and that I can withdraw from the interview at any time, without having to give a reason.
- Participation involves being interviewed by the researcher, which will last approximately 10 minutes.
- I understand that taking part in the study involves an audio-recorded interview. The interview will be recorded using a smartphone and also written down. The audio will be transcribed as text and the audio will be kept in the local hard disk of the researchers, for the length of maximum two years.
- I understand that taking part in the study involves getting photographed. The photos will be taken by smartphone or a camera. The photos will be used without a recognizable face, and will be kept for the length of maximum two years.
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- I understand that the researcher will not identify me by name in any documentation using information obtained from this interview, and that my confidentiality as a participant in this study will remain secure.
- I have read and understand the explanation written in this consent form. I have had all my questions answered to my satisfaction, and I voluntarily agree to participate in this study.

  
\_\_\_\_\_  
Signature of participant

  
\_\_\_\_\_  
Name of participant

6-12-2022  
\_\_\_\_\_  
Date

  
\_\_\_\_\_  
Signature of researcher

For further information, please contact:  
Barbara Vroom  
barbaravroom@xs4all.nl