COMMUNICATIONS IN
DEVELOPMENT AND ASSEMBLING OF TEXTILE PRODUCTS

Digital Deconstruction Project – exploring the possibilities of re-designing digital designs for more sustainability

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ABSTRACT

The fashion industry is in a critical state of overproduction and overconsumption, often disregarding any social or environmental concerns. Pre-consumer waste, including unworn and unsold garments such as leftover stock, represents up to one third of total production and is regularly landfilled or incinerated. This study presents early-stage research whether AI-automated design suggestions can be developed using pre-consumer waste from unworn garments. The Digital Deconstruction Project is a preliminary study conducted at the Hochschule Hannover, University of Applied Sciences and Arts with a team of seven students. It explores the possibility of creating new, appealing designs from existing pattern- such as a classic women's shirt, which in this study represents overproduced clothing - while minimizing waste using the computer-aided design system Clo3D. The focus is on determining how many of the existing pattern pieces can be re-used, creating as little waste as possible. The starting point of this project was a pattern block from the modular library of Clo3D, which is generally accessible within the software. The finding indicates that it is indeed possible to redesign a CAD file of an existing garment, the developed design results range from wearable-commercial to very fashionable. However, future iterations of this study should aim to reduce material waste even further. It is suggested to start with a simpler pattern block or a zero-waste pattern system to validate the concept of digital deconstruction. Next steps will involve investigating effective methods for connecting multiple designs to a single pattern and solving the first steps in the automating processes.

Keywords
Clo3D,
CAD,
overproduction,
re-design garments,
fashion design,
recycling,
reduce waste

Introduction

Rapid technological progress after the Industrial Revolution (1780-1900) contributed to the development and globalization of the fashion industry. Scaling up the amount of produced goods and reducing manufacturing time and cost was the beginning of mass production. [1] Due to persistent overproduction and overconsumption, the fashion industry has entered a critical phase in which social and environmental concerns are often overlooked. [2] Research results show that the global clothing production nearly doubled from 2002 until 2017. A growing middle-class population across the globe with a demand for fast-changing collections and cheap clothes is one reason for this rapid development. Clothing is worn less frequently and is often made from non-renewable resources with a linear production lifecycle. [3] Pre-consumer waste, including unsold and unworn garments, accounts for up to one third of total production and is often landfilled or incinerated. [4] Textile waste management has become a significant environmental concern, particularly with the rise of fast fashion and consumer disposal practices. Three key strategies for managing textile waste are reusing, recycling, and redesigning. Major retailers implement various take-back programs to address the issue. The redesign phase of textile waste management focuses on creating unique pieces from disassembled parts, though producing multiple sizes proves challenging due to colour variability. While designers attempt to create size ranges using consistent colour themes, the process need to combine both, draping and flat pattern cutting techniques to maximize fabric utilization. [5]

Despite waste prevention programs implemented in 2013, waste generation increased by 5.2% between 2014 and 2018, with 10 out of 32 countries lacking prevention programs by mid-2021. [6] Today, the fashion industry faces significant environmental challenges, including global warming and the increasing exceedance of planetary boundaries. The industry's linear business model creates two major interconnected problems: overproduction and overconsumption. Overproduction occurs when companies manufacture more than needed, while overconsumption involves excessive consumption beyond basic needs. [6] In 2023 the European Environment Agency (EEA) conducted a comprehensive survey of textile waste management across the EU countries. The report from 2020 reveals the response from 24 EU members, the estimated total amount generated for all EU27 countries is 6.95 million tonnes of textile waste. Post-consumer waste accounts for 82% of total textile waste, followed by post-industrial waste (17%) and pre-consumer waste (1%). [7] Pre-Consumer Waste is with only 1% the smallest figure, nevertheless this are 69.500 tonnes of clean and unworn garments which could be reused and re-designed with the help of the research idea “Digital Deconstruction” to keep these resources in circulation.

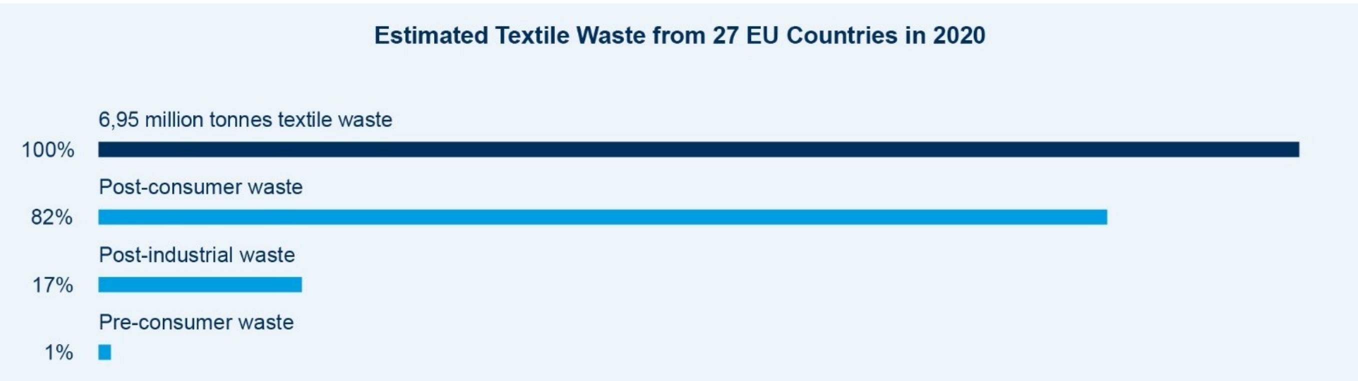

Figure 1 Adapted from " Textile waste management in Europe's circular economy," by Deckers J., Duhoux T. 2024 Technical Report, European Environment Agency, Copyright European Topic Centre on Circular economy and resource use, page 3-4

Research indicates that clothes which are insufficiently worn and not recycled in any way results in a loss of over $500 billion annually. If the fashion industry continues this linear business, until 2030 they will see a clear profit reduction for the manufacturers and fashion companies. It is estimated that each second, a truckload of textiles ends up in landfills or is incinerated. Meanwhile, the fashion industry releasing 1.2 billion tonnes of CO_2 every year and produces more greenhouse gas emissions than all airplanes and ships in the world combined. Less than 1% of clothing production materials are recovered and reused to make new clothing. If the current trend continues, textile production could consume over 25% of the 2°C carbon budget by 2050. Shifting to a sustainable fashion system is essential to meet climate goals. [3]

Figure 2 Adapted from " A NEW TEXTILES ECONOMY: REDESIGNING FASHION'S FUTURE," by Ellen MacArthur Foundation 2017, page 20, (http://www.ellenmacarthurfoundation.org/publications)

Due to this alarming numbers, the fashion industry is undergoing a significant transformation toward sustainability, with consumers increasingly embracing up-cycling, circular design, and slow fashion principles. While manufacturing waste has received attention, the design and cutting stages still face significant challenges, with the traditional cut-and-sew method resulting in 15% fabric wastage despite its 85% efficiency. [8] Which results in 12.36 million tonnes of annual cutting room waste, 92 million tonnes of total industry waste annually, 35% of global fibre production is wasted and another 20% waste occurs during spinning and weaving. [9] At the same time, consumer demand for environmentally friendly products is increasing and as well a need for business and policy collaboration. [10] To ensure a sustainable future for Europe, the European Union introduced an action plan for a Circular Economy in 2015. [11] A circular economy is a society that reuses resources and therefore does not produce waste along the production chain. Contrary to popular belief, recycling is not the first and best solution for a sustainable fashion industry, but rather the reuse of existing clothing and resources. [12,13] However, a circular economy aims to extend textile product-life through reuse and repair, and to keep materials in circulation by recycling at end-of-life. [14] To redesign and recycle worn garments can demonstrably reduce the carbon footprint, i.e. the global warming potential. Which shows the investigation on discarded military training uniforms at Taiyuan University of Technology. [15] Another study in Bangladesh's apparel industry demonstrates that direct reuse of cutting waste can be more efficient than recycling or landfilling, with potential for significant economic benefits for Bangladesh's apparel industry. Companies like C&A, H&M, and Patagonia are already promoting similar circular fashion initiatives, suggesting a viable market for these sustainable practices. [16] Product redesign should be adopted by industries in the quest for zero waste generation. [17] The role of the designer should focus more on developing circular products and introducing sustainable working practices, as they play a key role in the creation process of the products. [18] Designers, particularly those working at the initial stage of the product lifecycle must be familiar with how to work using leftover material and enable through their design large-scale production of upcycled garments. [19]

Yet, the implementation of sustainable procedures in the textile industry meets considerable barriers including high recovery costs, technical challenges with fibre blends, and logistical issues, requiring coordinated efforts from consumers, industry stakeholders, and legislative authorities to achieve sustainable practices. [20,21] The H&M group and Vargas Holding understood the need for a closed-loop fabric-to-fabric recycling systems and launched Syre in 2024, a new venture focused on textile-to-textile recycling of polyester efficiently. [22] High-quality fibres are currently produced through chemical and biological recycling. Trends in material development indicate that mechanical recycling also offers the potential for producing valuable fibres with fewer contaminations. [23] Textile waste is processed in different ways and is usually classified into mechanical-, chemical-, biochemical-, and thermal recycling. [24] Mixed fibre blends complicate the recycling process as well as chemicals and other contamination. Other challenges are the consumer awareness gap and the economic barriers to recycling and limited processing infrastructure. The industry requires urgent action, for example through comprehensive waste management frameworks, Extended Producer Responsibility (EPR) schemes and legislative and taxation changes. While mechanical recycling is cost-effective, chemical recycling shows promise for maintaining fibre quality. Nevertheless, reusing garments should be prioritized, followed by recycling, with downcycling and energy recovery as last resorts. [25,26] A study on denim trousers comparing the carbon footprint associated with the consumption of jeans as a fast fashion item indicates that second-hand trading can reduce the environmental impact by up to 90%. This surpasses the reduction achieved through recycling, which lowers the carbon footprint by approximately 85%. [27]

Based on these considerations, greater investment should be directed toward clothing redesign and recycling, with particular focus on unused new garments. Redesigning such garments utilizes existing materials, thereby significantly reducing the carbon footprint associated with new garment production. To address this, the proposed process named “Digital Deconstruction”, which employs computer-aided design (CAD) and AI-driven automation to digitally upcycle deadstock, unsold overstock or pre-consumer waste. This method enables the transformation of otherwise discarded materials into second- or even multi-generation products, offering a scalable and sustainable solution for circular fashion.

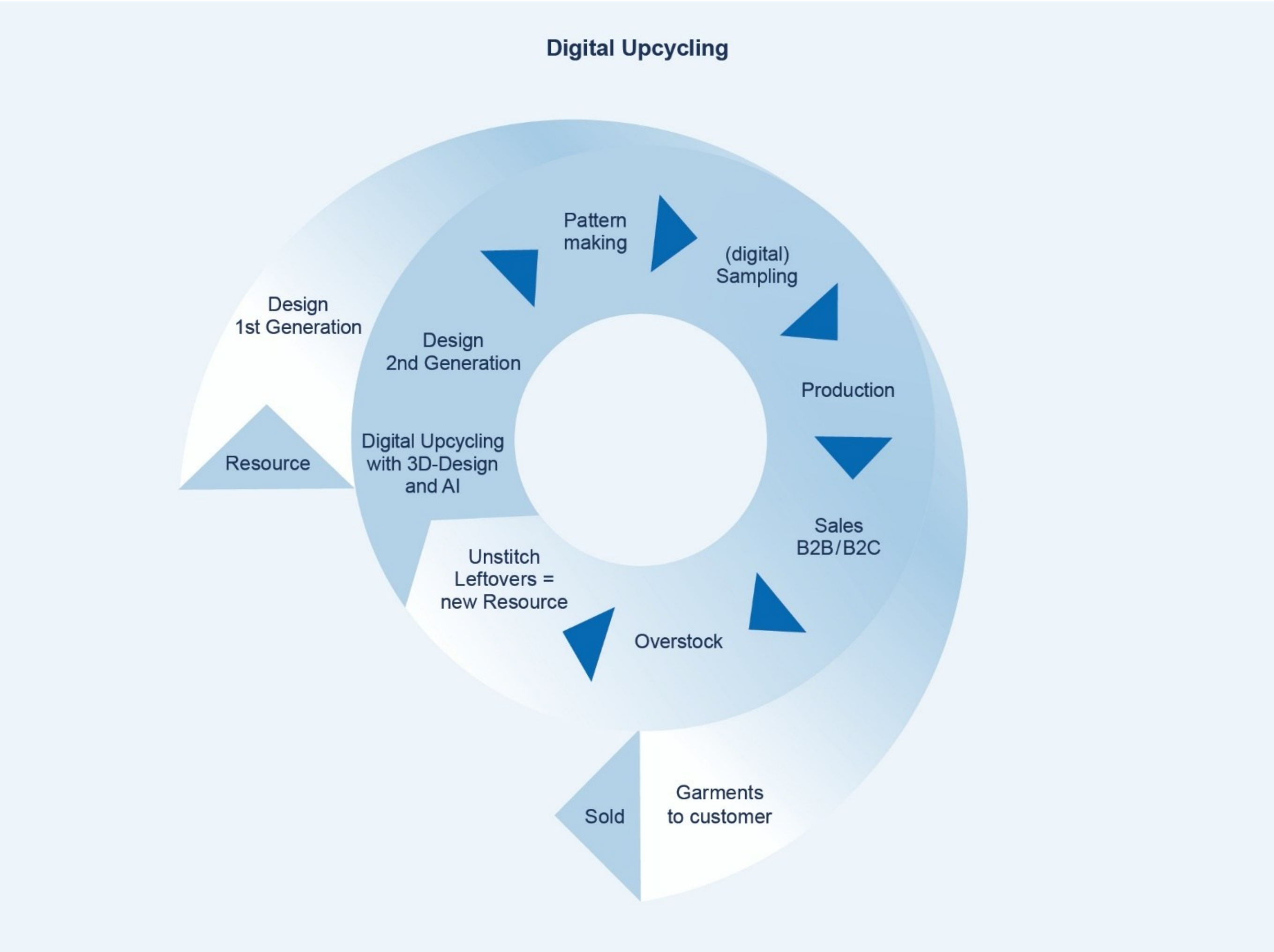

Figure 3 Digital Upcycling, a visualization about the circulation and digital design process called “Digital Deconstruction”, through redesign from unsold garments/overstock. A resource of virgin material is only used at the first step of design and development and with the use of CAD the unsold garments are possible to be digitally upcycled.

1 State of the art – Digital Fashion and wasteless pattern design

Already in 1998 Allison Gill highlighted in her essay on deconstruction in fashion, the emerging environmental crisis that may bring dramatic reduction in resources and the need to reduce, reuse, recycle and recover existing garments. [28] Across all segments of the fashion industry, new digital technologies are driving significant progress. In particular, 3D design with its visualization capabilities and integration of product lifecycle management system, supports the collaboration across the entire supply chain and has the potential to transform the fashion sector. [5] Virtual prototyping offers new research opportunities concerning virtual clothing and textile material simulation. [29] Market analysis, grounded on big data will be the new trend book for fashion designers to work with. The goal is to minimize overproduction and create more customer-oriented clothing. [30] Research on Digital Twins in Fashion Design in correlation with sustainability becoming increasingly important in industrial operations. [31] And to stay competitive and guarantee sustainable transparent, the consequent orientation towards digital and innovative business processes has become an essential factor for success. [32] 3D digital products improve the product development process with less physical samples and faster prototypes. Because of the high accuracy of the 3D renderings, it is possible to make much earlier design decisions, based on the digital technology. [33] Digital Twins could be used as an information basis on environmental, social and economic aspects along the whole lifecycle and help by optimizing the product's environmental and social impact. In general, it needs to be investigated if and how the Digital Twin concept can function as an enabler for more sustainable products in a digitized world. [31,32,34]

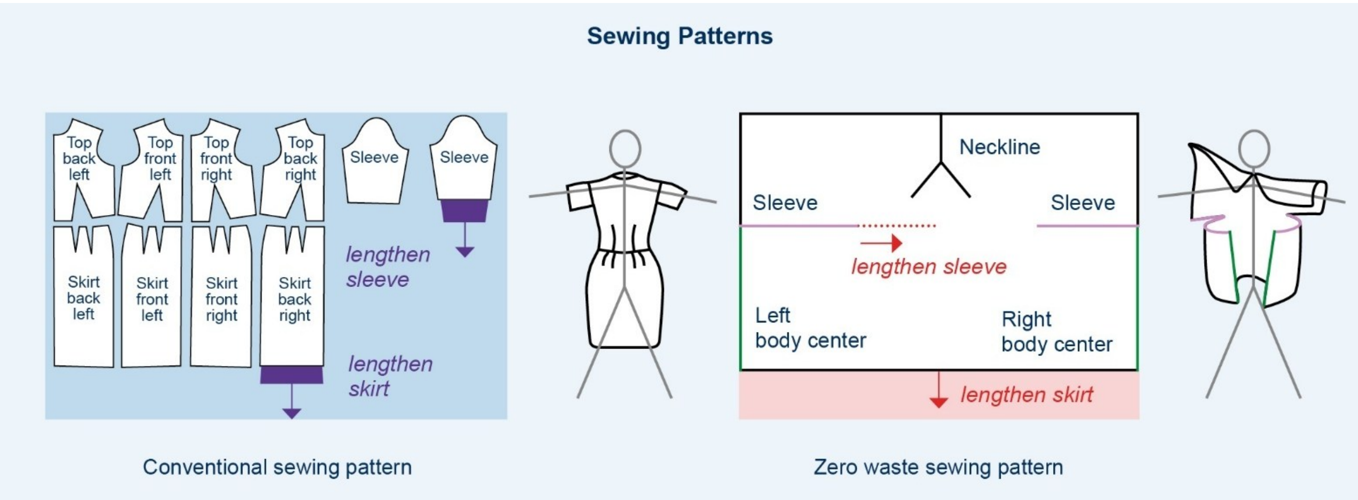

Figure 4 Adapted from: "WasteBanned: Supporting Zero Waste Fashion Design Through Linked Edits" by Zhang R., Mueller S., Bernstein G., Schulz A., Leake M. Proceedings of the 37th Annual ACM Symposium on User Interface Software and Technology 2024

"A Zero-waste garment refers to a garment that has been designed and pattern cut in such a way that when the garment is cut, all of the fabric is in the garment, and none is left behind as off-cut waste. Zero-waste fashion design refers to the activities and design processes that lead to such garments." [35] 10% material is lost during garment production, for example as offcuts and can be reduced through zero waste. The immediate implementation of waste prevention is recognized in the EU legislation and in the 2020 circular economy action plan. [36] Zero-Waste Fashion Design means avoiding fabric waste based on a sophisticated design that uses all material in the cutting process. [9] To redesign an existing garment but with Zero-waste means, that the overall desired form is known, but the result is something similar without making waste. [37] With the traditional cut-and-sew method, 15% fabric is wasted in the cutting room prior to assembly and distribution phase and creates pre-consumer waste. [8] That is why Zero-waste pattern making has emerged as a crucial sustainable fashion development over the past decade. Multiple methodologies of Zero-waste pattern making have been analysed since. Using a transformable and multifunctional modular system with 3D digital clothing technology is one example of how to reduce manufacturing time and cost without fabric waste. [38] Another development named "Waste Banned"

(Figure 4) supports the design process and works in combination with computer-aided manufacturing (CAM) and Computer-aided design (CAD) to develop efficient fabric layouts. [39] To validate theoretical ideas, practical guidelines and recommendations for the industry are needed to embrace sustainable fashion, which is based on Zero-waste pattern making with an integration of digital technologies and 3D modelling. The awareness and preference for resource-conscious fashion demonstrates increasing tendencies, accompanied by the willingness of the customer to pay more for sustainable garments. [40] Design and production of garments is being re-evaluated and research into reducing pre-production waste leads to an increasing choice of Zero-waste pattern making. [41] Zero-waste has played a minimal role in fashion, and it remains uncertain how effectively it can establish itself within the industry. [35] The latest developments in 3D software enable a rapid demonstration of design, ideation and construction. Using Zero-Waste patterns to prevent the creation of waste in combination with software like Clo3D saves also toile fabric. The traditional way to create zero waste patterns was difficult, time consuming and inaccurate. A highly effective workflow is generated through the latest digital tools and helps to create accurate alterations. Working on Zero Waste pattern is a hybrid activity between 2D and 3D design tools. 3D tools help to understand 2D pattern modifications directly and the latest 3D design software has already had a significant impact on the industry. [37] The combination of Zero-waste pattern drafting and virtual prototyping creates garments that are both sustainable and durable, while maintaining aesthetic appeal and quality finishing. This integrated method has proven effective in reducing fabric waste while producing unique, marketable clothing. [42] Traditional pattern making requires extensive time and specialized skills, but 3D technology offers a transformative solution. Modern virtual fashion design software provides comprehensive capabilities including draping, 3D/2D conversion, fabric analysis, and virtual try-on, without requiring extensive traditional pattern-making knowledge. This shift toward 3D technology is revolutionizing the fashion industry by making pattern making more accessible, efficient, and environmentally conscious, while maintaining professional standards and design quality. [43]

This research explores how existing garments can be re-designed in a sustainable and circular way using computer-aided design (CAD) tools, with a focus on integrating 3D prototyping. The study uses a classic women's shirt as a representative example of typical overproduction. This case study helps to evaluate the potential of digital design methods in reducing pre-consumer textile waste. Based on the findings, the study further investigates whether the CAD data, generated in Clo3D provides a viable foundation for future automation or AI-assisted re-design. The core problem lies in the fashion industry's linear model, which generates significant pre-consumer waste through overproduction, unsold inventory, and returns. While pre-consumer waste is more uniform and easier to process than post-consumer waste, current recycle practices often neglect its reuse potential. This research gap is to be addressed with this work. Existing recycling solutions are insufficient on their own, and more emphasis is needed on design-led reuse strategies supported by digital tools. Although technologies like 3D virtual sampling show promise in minimizing waste during early development phases, they remain underutilized in circular design processes. Furthermore, there is a notable gap in design-specific data that links digital visualizations to garment patterns—data that would be essential for future AI-driven automation. This research aims to help close that gap and lays the foundation for exploring how Generative Adversarial Networks (GANs) could support automated, sustainable fashion design.

2 Methodology

The explorative study, referred to as the "Digital Deconstruction Project," analyses whether it is possible to generate new design variations from existing garments, by re-utilizing pattern pieces that have already been cut and sewn. The data for this study was collected through a practice-based experiment conducted by a group of eight students from Hochschule Hannover – University of Applied Sciences and Arts. The participants, all in their 7th semester or higher, carried out the project during the winter term of 2023–2024. The "Digital Deconstruction" experiment was implemented as a supplementary task alongside the students' main assignment, which involved developing a fashion collection, producing one physical outfit, and creating a digital twin using Clo3D. To investigate the research question without generating additional material waste, a computer-aided design (CAD) system was used; specifically, Clo3D was chosen for

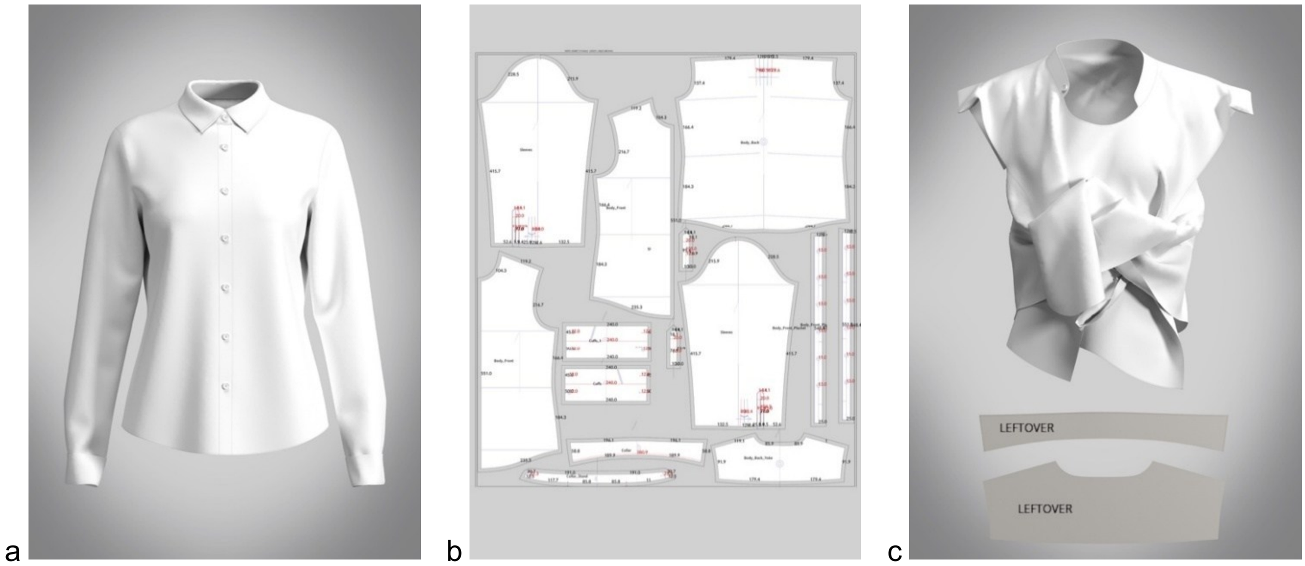

Figure 5 (a) CAD image of basic design; (b) pattern in CAD-system Clo3D; (c) new design with leftover

digital prototyping and visualization. Previous studies indicate that using Clo3D can lead to a 23% increase in design diversity among design students, underscoring its value as a tool for creative exploration. [44] In this study the investigation starts with a classical women's shirt pattern which is available in Clo3D's

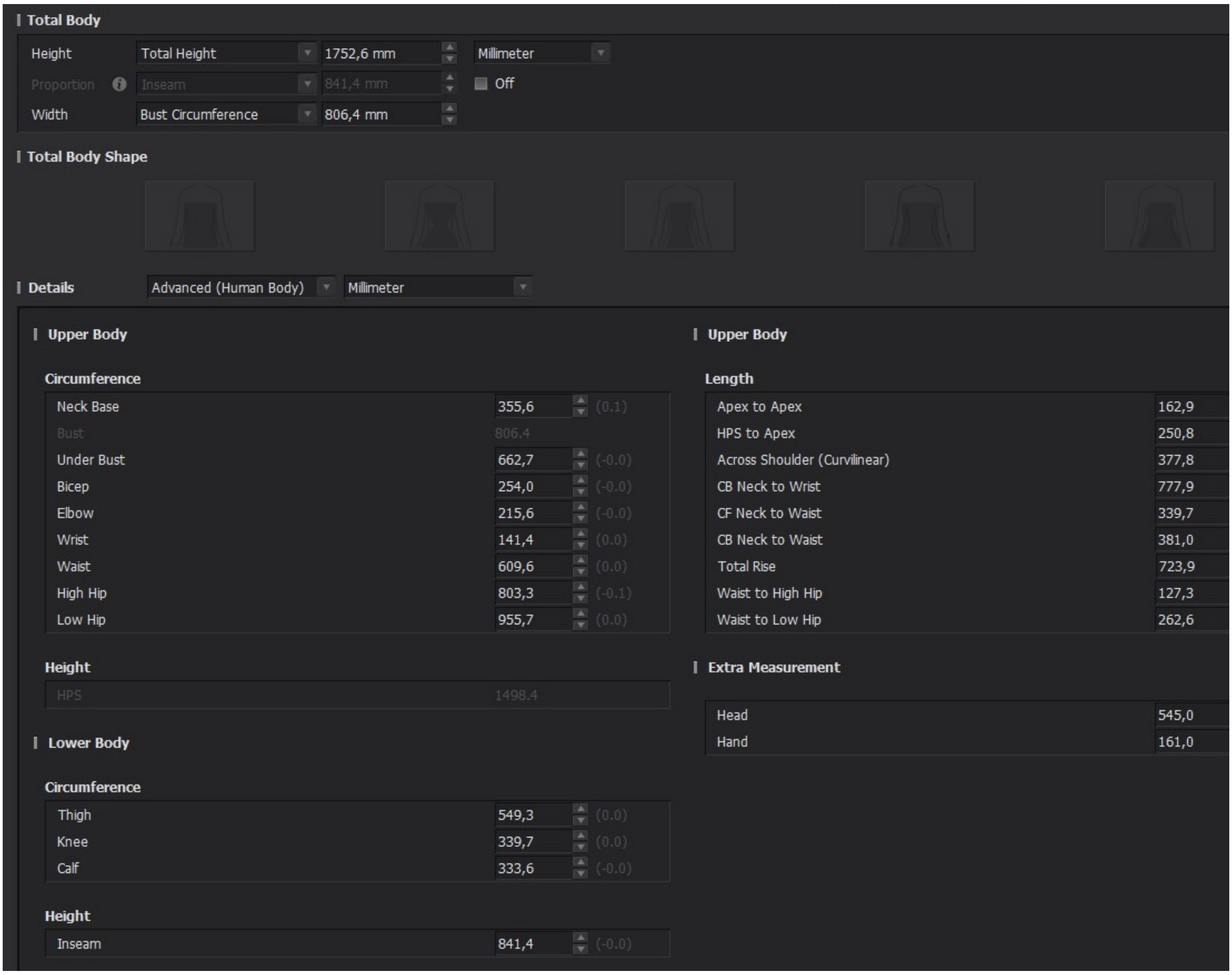

Figure 6 body sizes from the Avatar used for the shirt form the Modular Library in Clo3D

Modular Library (before 2025 update), as a ready-to-use pattern block. This pattern block serves as the "basic design" and forms the foundation for subsequent design variations. All further analysis and discussion in this research will refer to this initial pattern as the basic design. Additionally, Figure 5 illustrates an example of the basic shirt (a) with the pattern (b) and a possible digital deconstructed version of the shirt with two pieces leftover (c). Figure 6 provides the avatar measurements associated with this pattern block, which are crucial for ensuring design consistency and alignment with user specifications. By using Clo3D in this context, the study aims to demonstrate that digital deconstruction and re-design methodologies can significantly expand design possibilities while supporting sustainable fashion practices. In addition, this method generates data that would be necessary and helpful for possible automation later.

2.1 Data collection and Analysis

In the context of the Digital Deconstruction project, students were asked to create new design variations using an existing shirt pattern from Clo3D's Modular Library. They were permitted to use the pattern pieces from one or two shirts per variation and were required to submit three distinct designs. Each variation was documented through high-quality Clo3D renderings and the corresponding. zprj project files, both were submitted at the end of term. Additional data included a post-project questionnaire, which is evaluated in the following sections. One physical sample was created to prove the feasibility from the 3D Design.

All data was submitted at the end of the term and compiled for analysis. The evaluation focused on identifying recurring strategies for sustainable redesign, assessing the feasibility and conceptual implementation of the Digital Deconstruction method, and examining the diversity, commercial potential and fabric waste of the resulting outcomes. Qualitative feedback was also collected to better understand user experience and highlight technical or creative challenges encountered during the process.

This setup also aimed to investigate whether, and to what extent, the digital twin concept can serve as an enabler for more sustainable product development in a digitized fashion industry. [31]

Table 1 Self-assessment skills/ knowledge in Clo3D

Participants digital skills	number of people
professional	0
advanced	4
initial knowledge	3
beginner	0

Table 2 Access to software per week

Participants access Clo3D	number of people
every day	1
more frequently per week	1
once a week	5
less than once a week	0

Table 3 Knowledge practical sewing from the cohort

Participants practical sewing skills	number of people
have sewn a shirt before	5
have never sewn a shirt	2

The task "Digital Deconstruction"

The term *deconstruction* was first introduced into fashion discourse in 1998 to describe garments that appeared "unfinished," "coming apart," "transparent," "grunge," or "recycled." This anti-fashion aesthetic emerged as a form of rebellion against the polished styles of the 1980s. One of its leading figures, Martin Margiela, an alumnus of the Antwerp Royal Academy of Arts, was known for presenting recycled garments on the runway, often contrasting them with high-end designer pieces. [28] The Digital Deconstruction Project drew inspiration from this conceptual framework. The task challenged students to reimagine existing classical women's shirts using only the original pattern pieces from a standardized Clo3D garment.

Each student received two digital files of the same shirt: one presented as a fully stitched garment on a female avatar, and the other with pattern pieces laid flat in 3D space. The digital files were described as easy to work with (Table 4). To provide design direction, students were shown two deconstructed shirt examples from the instructor. The assignment required each student to create three distinct designs, documented in separate files. Students could use one or two sets of the base shirt pattern to generate a single design and were encouraged to incorporate additional elements (e.g., zippers, elastics, buttons) as needed. Unused pattern pieces were to be clearly labelled as “leftovers” and retained in the working files. Each final submission included rendered visualizations as well as the corresponding. zprj project file. Before beginning the quasi-experimental design task, preparatory instruction was necessary. Not all participants had prior experience with Clo3D, so training sessions were conducted to ensure a shared baseline of CAD skills (Table 1). Additionally, the conceptual principles of deconstruction were introduced and discussed with the group (Table 5).

Data preparation In Clo3D	**number of people**
easy to work with digital data	7
rather easy to work with digital data	0
rather not easy to work with	0
not easy to work with	0

Table 4 Data preparation in Clo3D from instructor

Knowledge of fashion deconstruction system	**number of people**
doesn’t know deconstruction	3
have worked before with deconstruction concept	3

Table 5 Knowledge about fashion deconstruction

Table 6 Assessment of difficulty level by students: 1=easy 10=difficult

Level of difficulty	1	2	3	4	5	6	7	8	9	10
number of people	0	2	0	1	0	1	2	0	1	0

The level of difficulty of the task was perceived very differently. (Table 6) The questionnaires revealed that this answer was related to the students' prior knowledge of the CAD software.

2.2 Timeframe

The timeframe for this project was approximately four months, depending on the individual student. The task was assigned at the beginning of the semester, with the deadline set for the final class session, during which the completed work was also presented. The project began with a group of ten students: one student only attended two sessions, another did not submit any work, and a third did not return the questionnaire. Half of the group was able to begin working on the task immediately, as they already had sufficient knowledge of Clo3D (Table 1), while the other half first needed to learn the software. Throughout the four-month period, students had the opportunity to meet weekly with the instructor to receive guidance on the software and feedback on their design progress.

The process

This research analyses the potential for reusing an existing pattern to create new designs. One objective was to determine how many pattern pieces could be repurposed and whether this approach could effectively reduce waste. Out of eight distributed questionnaires, seven were returned.

As shown in Table 7(a), 66.6% of the 24 submitted designs were created using only one shirt, while 5 designs, 20.83% were based on two shirts and 3 designs were not specified. Table 7(b) illustrates the number of reused pattern pieces. The basic shirt design consists of 18 pattern pieces; in the deconstructed designs, between 8 and 18 pieces were reused. Notably, 25% of the new designs reused 100% of the original pattern pieces from one shirt (18 pieces).

In contrast, designs that used two shirts tended to generate more waste. As seen in Table 7(c), only 1 new creation (20%) of these designs incorporated all pattern pieces, highlighting a decrease in reuse efficiency when working with multiple garments.

Table 7 (a) new designs made of one or two shirts; (b) how many pieces from one shirt were re-used for the new design; (c) how many pieces from two shirts were re-used for the new design

a

new design made of 1 shirt	**new design made of 2 shirts**	**not specified**
16 designs 66,66%	5 designs 20,83%	3 designs 12,50%

b

pattern pieces reused (pc) from 18	**percent pattern pieces reused (%)**	**number of new designs (pc) from 16**	**number of designs (%)** from 16
8	44,44%	1	6,25%
9		0	
10	55,55%	1	6,25%
11		0	
12	66,66%	2	12,5%
13		0	
(13,5)	75%	3	18,75%
14	77,77%	3	18,75%
15		0	
16	88,88%	1	6,25%
17	94,44%	1	6,25%
18	100,00%	4	25%

c

pattern pieces reused (pc) from 36	**percent pattern pieces reused (%)**	**number of new designs (pc) from 5**	**number of designs (%)** from 5
11	30,55%	1	20%
12	33,33%	2	40%
…			
32	88,88%	1	20%
36	100%	1	20%

2.3 Additional material and miscellaneous

The students were allowed to add new materials to their designs and were asked to list them at the end of the project. Out of 28 new designs, 16 were based on the pattern of one shirt, 5 were based on two shirts, and 3 were not specified. In 16.6% of the designs, participants added new elements, most commonly elastic. Other details included:

- 1 buttonhole on the backside pattern
- another fabric, transparent
- 2 x new fabric for a hoodie
- 4 x elastic
- cutouts as waste, not complete pattern pieces
- multiple, often cut pieces, no addition

Figure 7 CAD images of digital designs made by the students

2.4 Physical Twin

This recent study focused primarily on digital CAD work. Additionally, the group explored the concept of a digital twin and brought one of their deconstructed designs to life after completing the corresponding Clo3D file. For this implementation, the group used similar-looking second-hand shirts for men and women. They also received donations of white second-hand shirts in various shapes, sizes, and designs from the Logistik Zentrum Niedersachsen (LZN). Studies show that the Digital Twin concept can help to implement more sustainability directly. [32]

Figure 8 Image of physical designs made by the students

2.5 Feedback from participants

Finally, the students were asked a qualitative question about their opinion and work experience on the task. The results of the questionnaire showed that a boxy, unisex or oversized shirt pattern might have been easier to deconstruct, as the given pattern pieces of a classical women's shirt, which were often too small in some places and needed to be stretched. It was shown that a zero-waste or historical shirt pattern would be more optimal for this project, since the base pattern pieces would be squares. The study also found that a larger shirt size for more fabric could be helpful, but still many items would likely remain unused if the pattern pieces are too small. Without prior knowledge of Zero-Waste, the task proved difficult and an introduction to Zero-Waste would be helpful. For some participants was it challenging to start directly in Clo3D with the deconstruction work, it might be easier to take the shirt apart physically and study the pattern, before working digitally. It seems recommended to first learn other techniques, such as zero-waste or historical cutting, in order to achieve better results.

3 Results

A cohort of eight people participated in the Digital Deconstruction Project for one winter term. Each student handed-in three requested digital re-designs, resulting in 24 total designs. One questionnaire was missing. 1 out of 7 (14,3%) questionnaires was not finished, according to the remaining seven surveys, 25% of the new designs used 100% of the existing pattern pieces from one shirt (18 pieces). As shown in Table 7(c), using two shirts resulted in more waste on average. The results (Figure 7) demonstrate that re-designing a CAD-file of existing garments is feasible, when leftovers and material waste are acceptable. The design outcome varies greatly from commercial, wearable to very unusual and creative art. Nevertheless, there is some room for improvement in the conduct of the study. The cohort had different knowledge about Clo3D, which impacted design quality and speed. The most important obstacle was the elaborate cut of the "basic design" which made it difficult to create designs without leftovers and will make it challenging to generate an automation with.

4 Conclusion

The aim of this research was to explore whether it is possible to generate new design variations from existing garments by re-utilizing pre-cut and sewn pattern pieces, and to examine how many of these pattern pieces can be reused with as little material waste as possible. This study, which is called "Digital Deconstruction" serves as preliminary work to assess the feasibility of using AI-based systems to generate design proposals out of fabric remnants.

The findings indicate that the research question can be answered positively; it is indeed possible to digitally re-design garments. However, the garment for the simulation needs to be reconsidered. Although it was possible for the cohort to generate new design proposals from the existing women's shirts in Clo3D, the resulting waste and leftovers were still significant. A future study group should start with pattern making in 2D and consider Zero Waste pattern to reduce the amount of waste for a valuable study. If the cohort is creating a physical twin in fabric, the initial physical garment needs to be the same. A major limitation was the chosen classical women shirt with too many pattern pieces, complicated by the short project timeframe. Future research should focus on a simple base pattern with fewer pattern pieces to reduce waste and enable more commercial designs. This approach would also support the work on the automation attempt. The data generated is not sufficient and a new garment must be determined. In this context, integrating Zero-waste pattern cutting should also be considered, but this would limit the study, and it would not apply to pre-consumer waste in general, but only to collections that use zero-waste cuts.

This research contributes to a better understanding of the potential for digitally upcycling pre-consumer waste. One clear advantage of this approach is the contribution to more sustainable fashion practices by extending the lifecycle of existing materials. Several startups are already exploring similar concepts, using AI to automate collection design but for virgin materials, which highlights the current relevance of this research topic. By tackling overstock and overproduction, this research supports a transition from the take–make–waste mentality to more circular, sustainable practices.

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Figure 8: Image of physical designs made by the students from Hochschule Hanover: From left to right: Liza Weiß, Marie Schulze, Jannes Trauernicht, Zarah Theobald, Xenia Ambrosi, Sara Zrelli, Julia Huang

Figure 7: CAD work made by the students from Hochschule Hanover: a.- c: Jannes Trauernicht, d. – e.: Liza Weiß, f.+h.+l.: Marie Schulze, g.: Sara Zrelli, i. + k.: Regina Ahmadi, j.: Julia Huang

Conflicts of Interest: The authors declare no conflict of interest.

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