A RECONFIGURED DESIGN PROCESS FOR WOVEN GARMENTS: PRODUCTION CONSTRAINTS AS DESIGN INSPIRATION

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Figure 1.

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SALT FASHION FILM: https://youtu.be/YclXe8EiSDw?si=iU4E3cXpUdaPCBVv

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I want to extend special thanks to my fellow master's students, Jahnavee, Jarubhorn, Kristin, Elham and Yen Hua, whose companionship over the past two years in Finland has been invaluable.

In Africa, there is a concept known as ubuntu – the profound understanding that we are only human through the humanity of others. Nelson Mandela once said that if we are to accomplish anything in this world, it is due to the work and achievements of others. My community has shaped me for this purpose, and even though we are 15,000 kilometres apart, they remain close in spirit, cheering me on as we work together and negotiate the evident environmental impacts towards a better future.

Importantly, I am grateful for my family's unwavering belief in me. I would also like to mention my sister, Helaina, who thoughtfully designed and produced a corresponding conceptual jewellery range made from salt to accompany the final prototypes.

I want to give all the glory and honour to our Heavenly Father, who laid out my path long before my birth. My journey is a living testimony to His grace and provision.

ABSTRACT

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Abstract

This master's thesis addresses the disconnect between the textile and garment sectors that hinders sustainable development. Recognising the interdependence of the two sectors, this research examines a textile-led design process focused on material creation for garment construction. The primary objective is to demonstrate the impact of textile thinking by developing a fashion collection from a single fabric made on a shaft loom in collaboration with a textile mill. By using only one fibre and one yarn, the study simplifies production and promotes zero-waste practices, demonstrating how constraints can enhance integrated design within the industry.

The thesis has two main components: a theoretical section and creative design work, using a literature review and practice-based research following a constructive design methodology. This approach begins with the designer's vision and employs controlled prototyping to test ideas structured by the anatomy of prototypes framework. This framework uses specific design "filters" aligned with the research goals and focuses on the process to ensure it is goal-oriented. The iterative cycle of making, reflecting and remaking challenges the disconnect in the linear fashion model.

Through this process, practitioners develop embodied knowledge known as “textile thinking”, where intuition informs technical skills. Hands-on experimentation with materials allows exploration of the possibilities and challenges of textile-led design, connecting theory with practice.

Textile thinking is fundamental to progressive textile-led fashion design, illustrating how a structured, iterative process can yield significant outcomes. The thesis outlines the development of a new design framework that began during an internship at Marzotto Wool Manufacturers in Italy in 2023, culminating in a zero-waste fashion collection. The research explores alternative design strategies that offer innovative opportunities for sustainability.

Focusing on resource-limited environments such as South Africa, the textile-led design process has broader applications within the industry. While centred on woven textiles and garments, the findings have implications for the entire textile and fashion sector. By embracing a textile-led approach, designers can promote sustainability goals at the beginning of the supply chain and minimise the industry's environmental impact.

This study demonstrates how a textile-led design process can bridge textiles and garments, providing a scalable and sustainable method for industrial production while addressing the environmental challenges facing the fashion industry.

Keywords: textile thinking, textile-led design, woven garments, design within contraints

Figure 10

CHAPTER 1

INTRODUCTION

The fashion industry has a far-reaching and consequential impact on the environment (Dottle & Gu, 2022). A major issue contributing to this challenge is the disconnect between the textile and garment sectors, which hinders sustainable development (Niinimäki, 2011). However, textiles and garments are inextricably linked, as garments cannot exist without textiles (Niinimäki, 2018). Research suggests that an integrated textile and garment design process could help bridge the gap and promote sustainable design practices across the industry (Forst, 2022; Niinimäki et al., 2020; Salolainen et al., 2018).

This study explores a textile-led design process that prioritises material creation to inform garment construction (Briggs-Goode & Townsend, 2011). The study also combines practical research with a literature review of fashion production models and introduces the concept of textile thinking. In Interwoven (2022), Maarit Salolainen defines textile thinking as a synthesis of tactile knowledge, aesthetic creativity and technical skills. Textile thinking involves the continuous reevaluation of the relationships between materials and structures, considering the properties of fibre and material components as well as the properties of their internal construction (Salolainen, 2022). This approach to textile thinking encourages innovative adaptations of textile practices and manufacturing processes.

This study demonstrates an understanding of textile thinking by producing a fashion collection from a single piece of fabric. The fabric is produced on a shaft loom in collaboration with Marzotto Wool Manufacturers in Italy (2023). By limiting this study to only one fibre, one yarn and the production of a single piece of fabric, the production process is simplified and promotes zero-waste practices. This approach shows that the use of textile thinking enables designers to develop fabrics and materials that are specifically aligned with their design objectives. It also aims to demonstrate that embracing constraints can significantly improve the accessibility and practicality of integrated design practices within the industry.

Driven by a commitment to sustainability, this study draws on my first-hand experience of growing up in the Karoo, a semi-arid region in South Africa, where the environmental impact of the fashion industry is evident. By working within certain constraints and focusing on accessibility, the textile-led design process remains practical for resource-limited environments in countries such as South Africa. Therefore, the findings can be applied more broadly within the industry. Although the study focuses primarily on woven textiles and garments, its findings are applicable to the entire textile and fashion sector. By using textile thinking and a textile-led design approach, designers can influence sustainability goals early in the supply chain, helping to reduce the industry's environmental footprint.

This thesis is organised into several chapters. Chapter 1 outlines and motivates the research, along with the objectives, research questions, methodology and an introduction to the sponsoring partner. Chapter 2 presents a literature review that examines the relationship between textiles and garments, their production cycles, the concept of textile thinking, the textile-led design process and outlines the role of the textile-led designer. Chapter 3 describes the constructive framework that structures the textile-led design process. Chapter 4 explores this process in detail, tracing the journey from textile design to garment realisation. Finally, Chapter 5 present the findings and Chapter 6 includes the discussion and conclusion.

This research study aims to demonstrate how the textile-led design process can bridge the gap and disconnect between textiles and garments, providing a scalable and sustainable design approach for industrial production while addressing the broader environmental challenges facing the fashion industry.

1.2 MOTIVATION

Simplicity is not about deprivation. It is about a greater appreciation for things that really matter.

– Anonymous (Forbes, 2013)

I grew up on a Merino sheep farm in central South Africa, where my childhood was shaped by experiences in the shearing shed, playing hide and seek among wool bales and claiming the soft 19-micron bin as my sanctuary. Although I have a deep connection to wool, my limited exposure to textile production has created a disconnect between the production of the fibre and the fabric I use as a designer. The disconnect may be due to South Africa's export-dependent economy, which has led to a shrinking textile industry and the exclusion of textile subjects from school curricula. The separation of these interdependent stages of production creates a gap between the production phases of fibre selection, yarn processing, fabric production and garment construction.

It was during my studies at Aalto University, Finland, with its interdisciplinary approach to design, that I began to uncover a significant connection between the textile production phases. Through hands-on studio practices, I developed textile thinking (Salolainen et al., 2018). By practising textile thinking, I began to recognise the interdependence of fibre, fabric and garment and realised how the industry often treats the production phases as separate processes, despite their inherent connections.

An internship at Marzotto Wool Manufacturers (2023), a weaving mill in Italy, deepened my understanding of the connection between fibre and fabric, albeit on an industrial scale. The time I spent in each department of the supply chain, from purchasing the raw materials to shipping the finished fabric, gave me the opportunity to see how fibre transforms into fabric. As Marzotto Wool Manufacturers sources merino wool from South Africa, this experience was meaningful because it allowed me to connect the production process to my heritage. Seeing the extensive resources and labour involved in textile production at Marzotto Wool Manufacturers increased my appreciation for wool as a fibre. This newfound appreciation cultivated a deep respect for the material and motivated me to minimise material waste in my designs. I consider this not only as a moral responsibility but also as a response to the challenges of sustainability in the fashion industry. My upbringing in a resource-limited environment in South Africa instilled a gratitude for simplicity and honed my creative problem-solving skills.

During my internship at Marzotto Wool Manufacturers, I found that the skills I had developed earlier were particularly useful. I decided to harness the creative potential that comes from working within constraints. The complex variations created on shaft looms changed my view of dobby designs from restrictive to a source of innovation. Instead, I began to see how these initiatives could spark creativity. This experience motivated me to investigate how constraints can help turn conceptual designs into practical applications in industrial production.

To ensure that this research is applicable, accessible and feasible across the industry, particularly in resource-limited contexts such as South Africa, the choice of a constrained framework seemed appropriate. I focused on using a single fibre, a single yarn and a specific structure to develop a piece of fabric. By deliberately limiting my process, I aim to demonstrate that even designers with minimal textile knowledge can unlock numerous possibilities by applying textile thinking, especially in a textile-led design process. Therefore, this research aims to demonstrate how textile thinking and creativity can provide solutions while designing within constraints. The result of this approach is a zero-waste fashion collection.

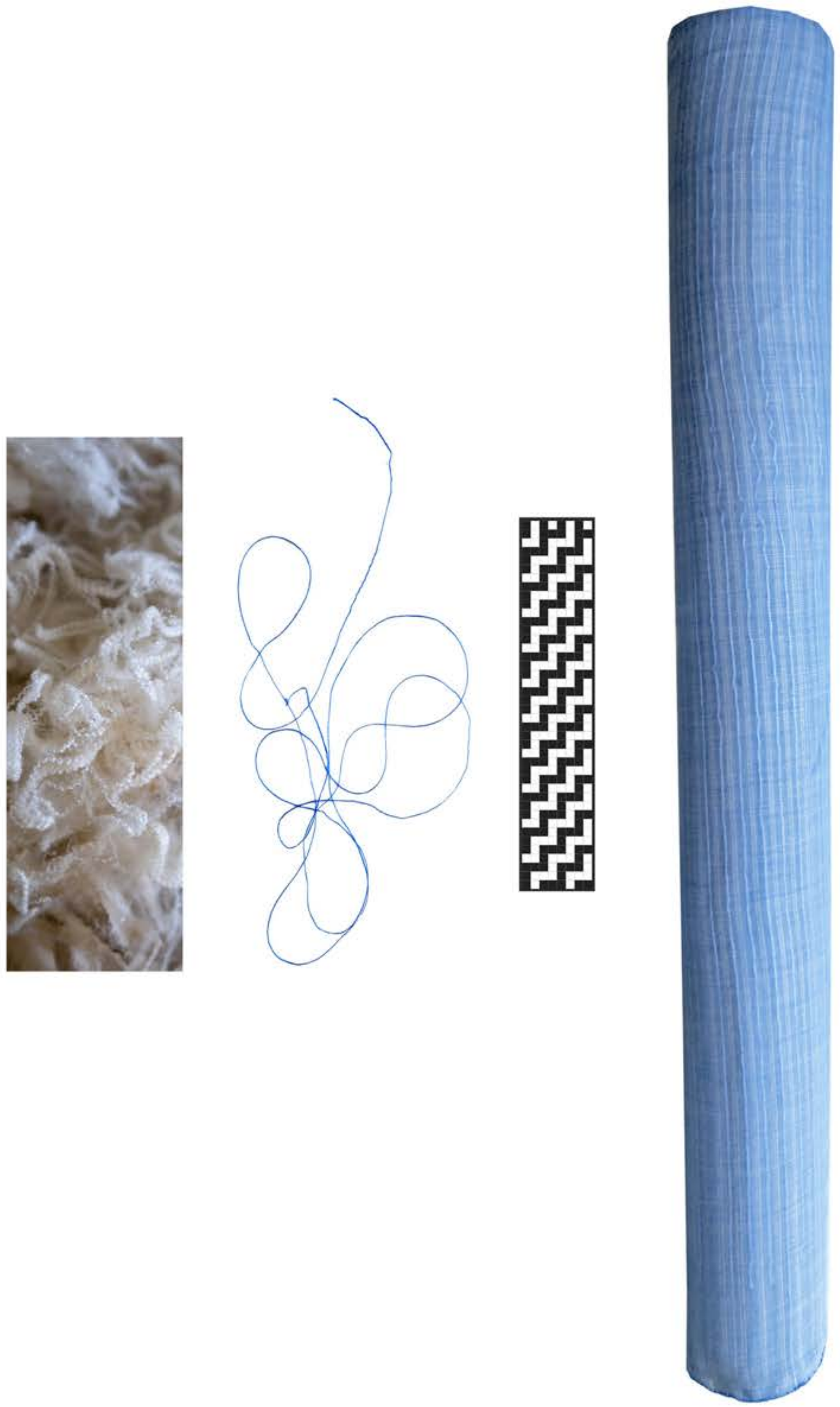


Figure 11. *One fibre one yarn, one structrure, one piece of fabric. 2024*

1.3 OBJECTIVES AND RESEARCH QUESTIONS

Objectives:

This study aims to investigate the role of textile-led design processes, guided by textile thinking, in fostering a deeper understanding of the relationship between textiles and garments. It also explores how different constraints act as production filters within the textile-led design process and how these constraints influence the relevance of the findings for the wider industry.

In order to achieve these objectives, this research is structured around the following research questions:

1. How does textile thinking inform and impact a textile-led design process from fibre to garment?

2. How can constraints in a textile-led approach be used as a design tool to promote innovative solutions?

This master's thesis seeks to address the disconnect between the textile and garment sectors that hinders sustainable development. In acknowledging the interrelationship between these two sectors, this research explores a textile-driven design approach that emphasises the creation of materials for garment production.

The main goal is to demonstrate the influence of textile thinking by creating a fashion collection from a single fabric produced on a shaft loom in collaboration with a textile mill. By using only one fibre, one yarn and one structure to produce one piece of fabric, the study aims to simplify production and promote zero-waste practices to demonstrate how constraints can promote integrated design within the industry.

1.4 METHODOLOGY

The research questions establish the foundation for a methodology that integrates both theoretical and practical components. Chapter 2 presents the theory in the form of a literature review, which creates the foundation for the practice. As Nimkulrat (2012) explains, because knowledge of any craft or design practice is gained through the practice itself, findings from practice are just as important as those from theory. However, a structured approach is essential to derive meaningful insights (Lim et al., 2008). Building on this understanding, Chapter 3 presents a restrictive framework to structure the textile-led exploration. Chapter 4 implements the textile-led design process from textile design to garment realisation. Chapters 5 present the findings and Chapter 6 includes the discussion and conclusion.

This practice-based research adopts a constructive design methodology (Koskinen et al., 2012). This methodology begins with the designer envisioning the product and progresses through the implementation and testing of ideas through controlled prototyping. In order to structure the prototyping process, this study utilises the anatomy of prototypes framework (Lim et al., 2008), which focuses on selecting specific design elements, or "filters", that align with the research objectives. These filters help to refine the focus of the prototyping process by eliminating irrelevant elements, ensuring that it remains goal-oriented and aligned with the project's objectives. As a result, the prototyping process becomes highly focused and follows an iterative cycle of making, reflecting and remaking.

Through this iterative process, the practitioner develops embodied knowledge that is referred to as textile thinking (Salolainen, 2022). Textile thinking occurs when intuition guides the application of technical expertise during the act of making (Salolainen, 2022). It equips the practitioner with the necessary material understanding and technical skills to effectively implement a textile-led design process. By actively engaging with materials through hands-on experimentation, textile thinking enables practitioners to fully explore the possibilities, requirements and challenges of this design approach (Groth, 2017; Salolainen, 2022). This iterative and reflective practice not only generates insights but also bridges the gap between theory and practice.

As such, textile thinking serves as a foundation for advancing textile-led fashion design, demonstrating how a structured, iterative approach can yield meaningful and impactful outcomes as seen in Figure 12. Consequently, textile thinking forms the central methodology of this study, shaping both its theoretical and practical components.

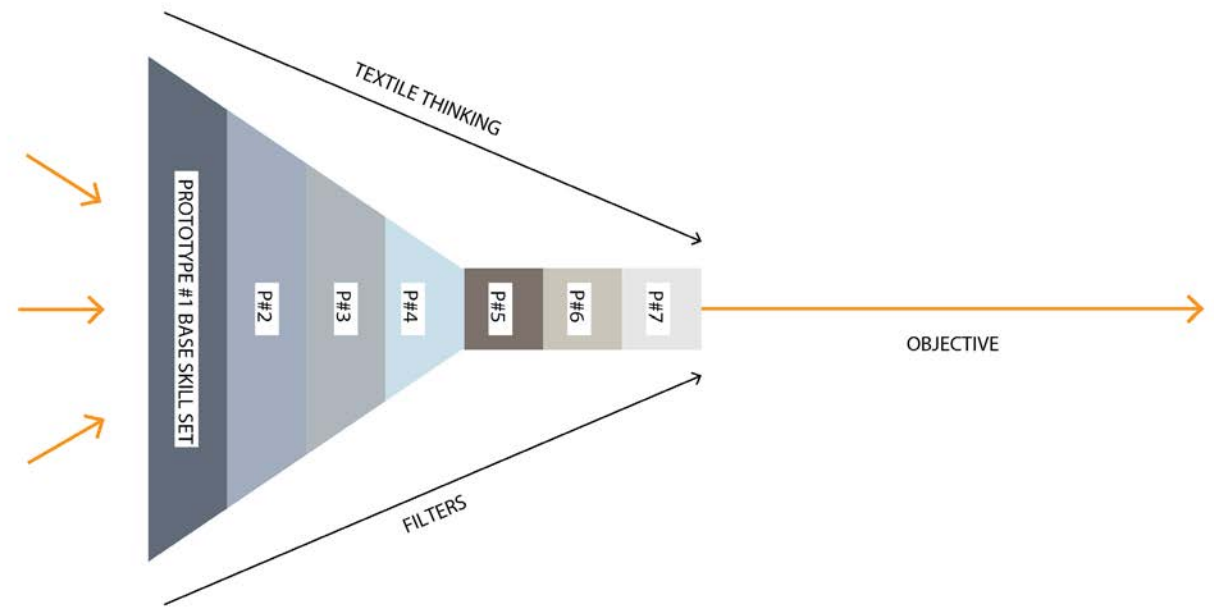


Figure 12. *Methodology*

1.5 SPONSORING PARTNER

In 2023, Cape Wools, the authorised representative body of the South African wool sector, offered an introduction to Marzotto Wool Manufacturers in Italy and recommended an internship to further develop this research project. The time at Marzotto proved profoundly transformative and had a significant impact on both my personal and professional growth.

The internship at Marzotto Wool Manufacturers enriched my perspective on the textile industry. With Marzotto Wool Manufacturers sourcing Merino wool from South Africa, this opportunity provided a personal journey to explore the various industrial processes involved in such a well-known fibre. The mill encouraged engagement with each stage of the supply chain, leading to a comprehensive understanding of how fibre is transformed into fabric. Training was provided in essential skills such as yarn development, weaving and finishing. This exposure to the artisanry and resources involved in textile production broadened my understanding of the different phases of textile and fabric production.

An important lesson learned from my time at Marzotto Wool Manufacturers is the creative potential that comes from working within constraints. Although shaft looms are often perceived as limiting, they can drive innovation by pushing the design process towards resourceful and imaginative solutions. This insight highlights the importance of constraints in designing for industrial production and emphasises how limitations can enhance accessibility and feasibility in design.

A key factor in the project's success was the importance of keeping ideas simple. The language barrier between the Italian-speaking technical staff and myself, an English speaker, highlighted the need for clear communication and practical solutions. This clarity proved to be vital to the project's success.

Marzotto Wool Manufacturers' support as the sponsoring partner for this research project enabled me to explore textile thinking and assess the feasibility of a textile-led design process on an industrial scale. This collaboration allowed a connection to wool to be combined with professional aspirations for sustainable material innovation, bridging the gap between roots and goals in thoughtful textile and garment design.

Figure 13.

CHAPTER 2

BETWEEN TEXTILES AND GARMENTS

I start with the material. I work with it; I listen to it.
If you do not listen to the material, it will not respond to you.
You cannot go against the grain of the fabric.

– Issey Miyake (Miyake & Sato,1999, p. 18)

This chapter investigates the relationship between textile design and garment construction. The first section examines production models that either recognise or ignore this relationship and discusses their environmental implications. The text highlights the need for the fashion industry to move from linear to circular production models. It advocates a systems thinking approach, urging all stakeholders to understand the connections between the different stages of production and the consequences of their decisions. The chapter investigates the connections between circular production models, systems thinking, and textile thinking, introducing textile-led design as an integrated design process. Finally, the chapter outlines the role of the textile-led designer and identifies the skills required for this position.

Figure 14 presents the conceptual framework for this chapter, illustrating how production models, design processes, and the designer's role interconnect to address the disconnect between textiles and garments.

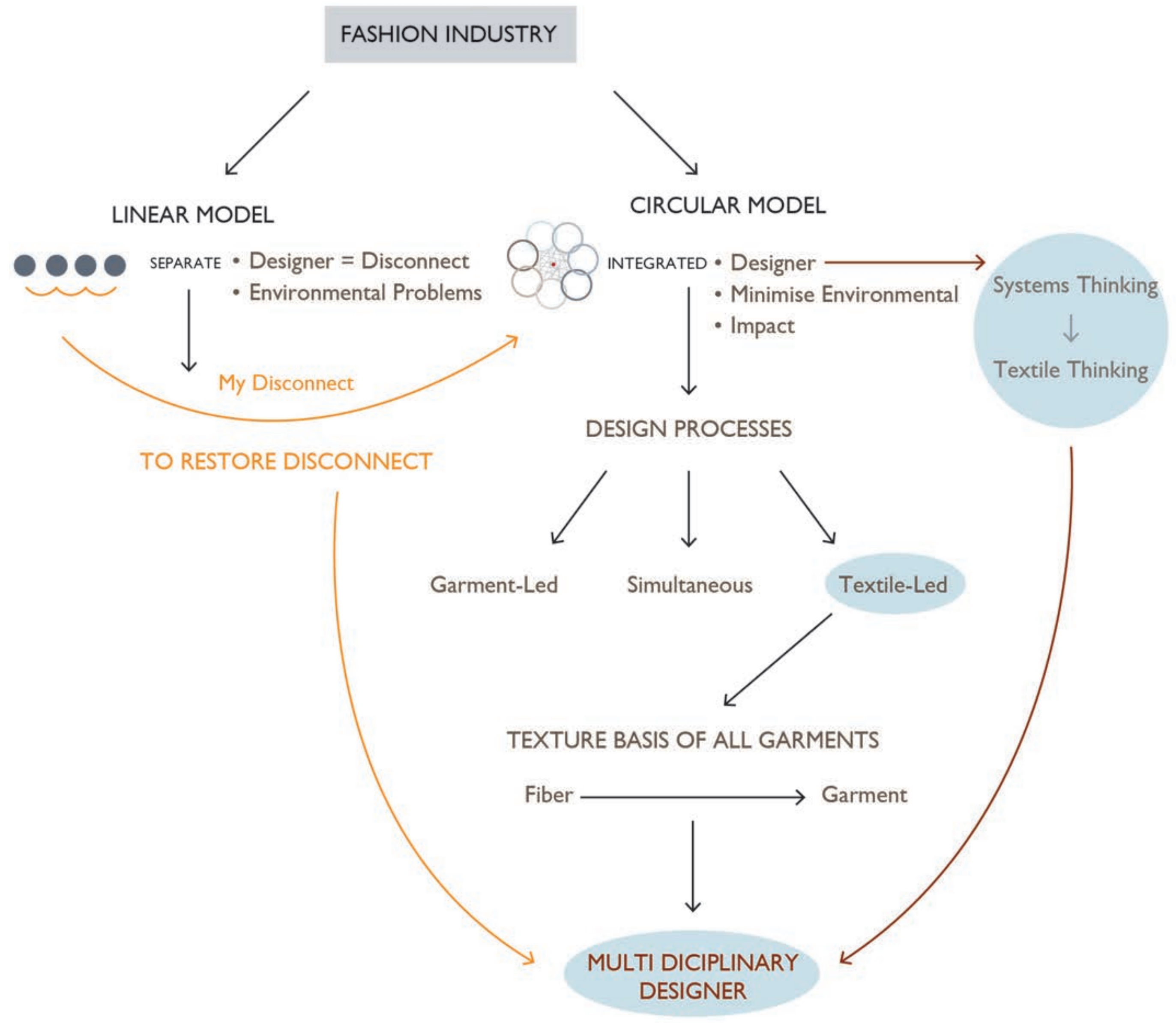


Figure 14. *Production models, design processes, and the designer's role*

2.1 TEXTILE AND GARMENT PRODUCTION MODELS

There are two primary production models: linear and circular. The linear production model (Figure 15) prioritises efficiency (Niinimäki et al., 2020) by separating each phase of the production: textile manufacturing, garment design, garment construction, use, and disposal (Csanák, 2014; Gale & Kaur, 2004). In the linear model the separation often overlooks the connections between stages, limiting collaboration and hindering the adoption of sustainable practices (Piippo et al., 2022).

Figure 15. *Linear production model*

An alternative to the linear model is the circular production model (Figure 16), which emphasises collaboration, systems thinking and resource efficiency by linking the phases of production (Figure 15). Karell and Niinimäki (2020) explain that unlike the linear model, which isolates each stage, the circular model promotes sustainable strategies by creating connections between textiles and garments. In a circular model, the designer employs systems thinking, considering not only the current, previous or next phase of production, but all other phases. Therefore creating the opportunity for materials and products to be continuously cycled back into the system, also known as the cradle-to-cradle concept (Stahel, 1982).

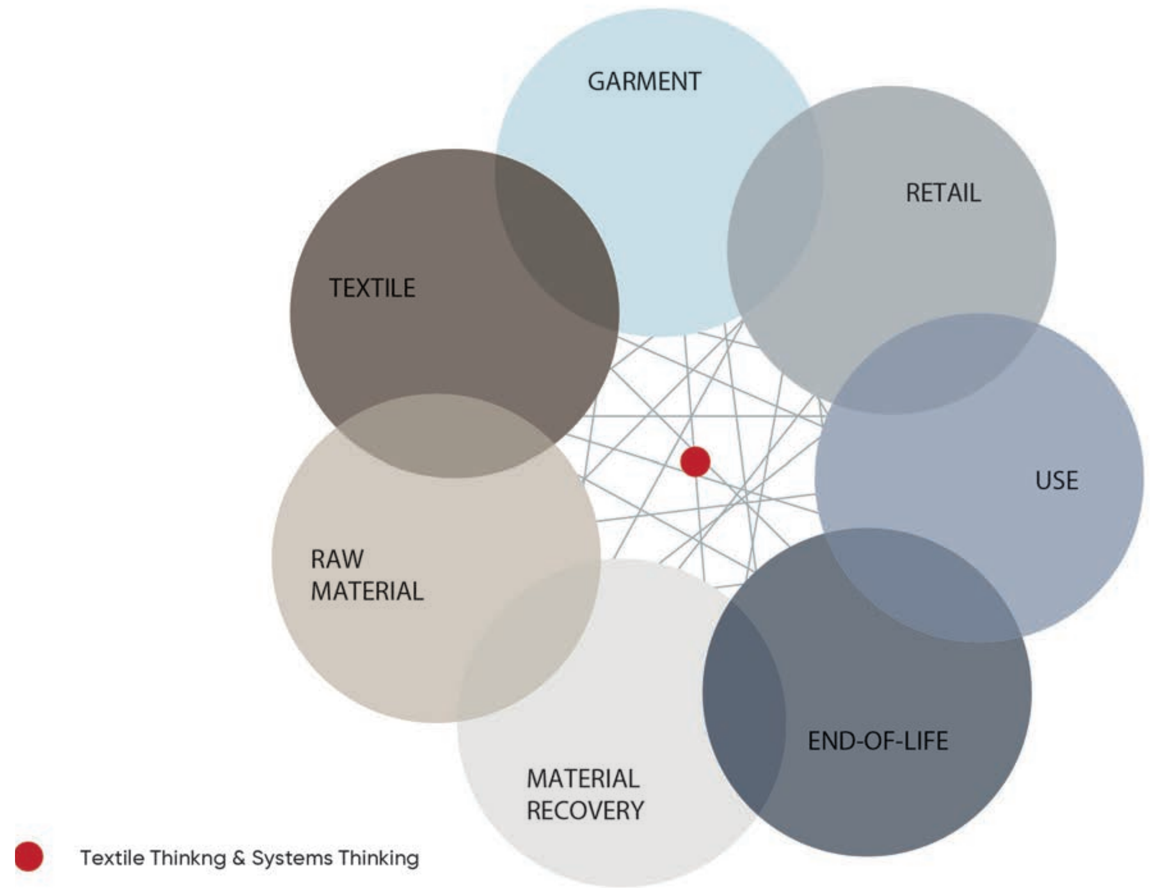


Figure 16. *Circular production model*

The current fashion and textile industries rely on a linear model but face critical environmental challenges and a disconnect between production phases. According to Leppisaari (2022), addressing these challenges requires designers to adopt an integrated design approach that acknowledges the connection between textiles and gar-ments (Leppisaari, 2022). Briggs-Goode and Townsend (2011) identify three approaches to integration: garment-led, textile-led and an approach that combines both methods, known as the simultaneous approach. In garment-led design, the requirements of the garment dictate the selection and properties of the textile (Figure 17). In textile-led design, the textiles guide and shape the garment form (Figure 18). In simultaneous design, the textile and garment are developed as a cohesive unit (Figure 19). When designers implement an integrated design process, it is possible to apply systems thinking (Leppisaari, 2022). Salolainen et al. (2018) explain that textile thinking is closely intertwined with systems thinking, which enables designers to consider the broader consequences of their choices within the production model.

Figure 17. *Yamamoto's (2021) collection focuses on silhouette and deconstructed tailoring*

Figure 18. *In Iris van Herpen's (2019) ensemble, the textile is the textile is the focal point*

Figure 19. *In Issey Miyake's (2001) A-POK, garments are woven in a single piece of cloth*

2.2 TEXTILE THINKING

Salolainen (2022) defines textile thinking as an embodied form of knowledge that arises when intuition guides the application of technical skills during the creative process of making. This concept can be linked to Albers (1972), whose experiences at the Bauhaus influenced her experimental approach to textiles. Albers (1972) engaged in tactile and intuitive interaction with materials, which allowed her to develop a deep understanding of their properties. In *On Weaving* (1972), Albers describes how this hands-on engagement combines physical exploration with intellectual insight to form the basis for textile thinking. Through her work, Albers (1972) illustrates how textiles can transcend their functional purpose and evolve into works of art.

Groth (2017) describes the design process, during which designers switch back and forth between the act of making – interacting with materials – and imagining potential outcomes. She explains that this iterative movement between making and imagining allows designers to gain embodied knowledge that not only informs their creative process but also enhances their understanding of the realm of imagination. Igoe (2010, 2013, 2021) also points to the importance of understanding materiality and the making process. She argues that the embodied knowledge developed through design practices contributes significantly to knowledge creation. This understanding helps to clarify the unique characteristics of the thinking process involved in textile design, which she refers to as *textile thinking.* Krogh and Koskinen (2020) also emphasise that this cycle of making and imagining contributes to the expansion of knowledge and skills, enabling designers to better interpret and perceive imagined possibilities.

In her thesis, *Blending the roles of the designer and technician,* Kähkönen (2023) explains how textile thinking contributes to sustainable innovation in the development of industrial knitwear. She stresses the importance of the "cyclic experimental process" (Kähkönen, 2023, p. 66), demonstrating how textile thinking evolves as designers accumulate skills and knowledge through their experiences.

In response to the research presented by Albers (1972), Groth (2017), Kähkönen (2023), Krogh and Koskinen (2020), and Salolainen (2022) Figure 20 illustrates the iterative process of knowledge accumulation that characterises the concept of textile thinking. As designers engage in the process of making, their embodied knowledge and skills expand, allowing them to imagine and refine outcomes. These imagined possibilities, in turn, intuitively influence the next step in the making process.

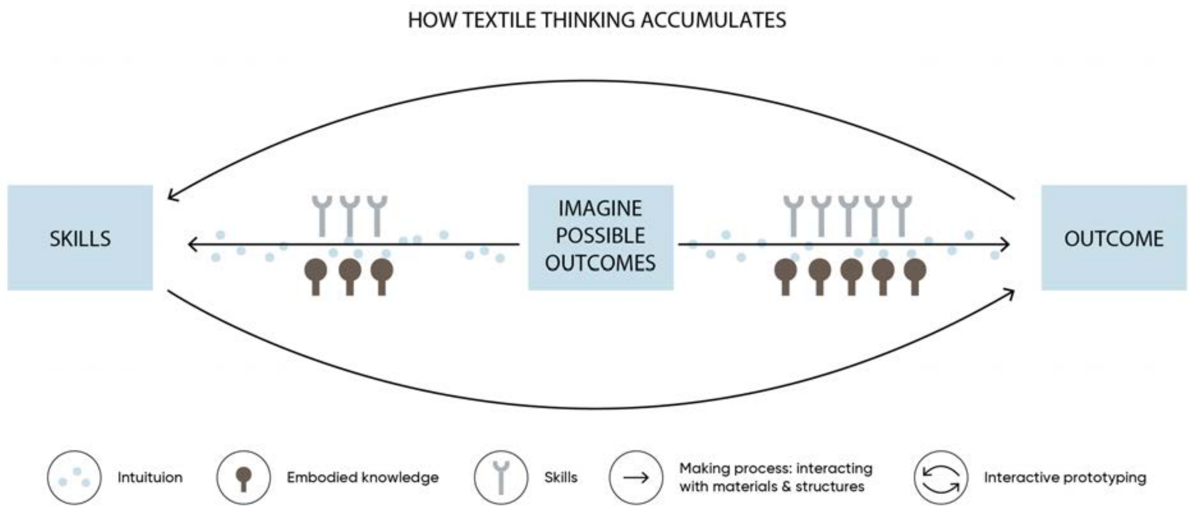


Figure 20. *Textile thinking*

Textile thinking is not limited to the creation of textiles; it also extends to other fields, such as architecture and product design, where the use of materials, techniques (manual or automated) and knowledge are carefully considered when creating new products. Architects, for example, also rely on an understanding of materials and technical skills to construct buildings. With each project, their knowledge base expands, allowing them to design certain aspects of a new structure to achieve the desired outcome. Similarly, textile designers can engineer fibres and textile fabrics to meet the specific requirements of products such as clothing or furniture.

Textile thinking can be applied at both microscopic and macroscopic levels (Forst, 2022). On a microscopic level, designers apply textile thinking in fabric selection within a garment-led approach. Examples include Yamamoto (2021) and Ilmonen (2022). On a macroscopic level, textile thinking allows designers to consider the systemic impact of their choices throughout the production process (Forst, 2022) seen in Figure 21. Examples include Miyake's (Penn, 1999) textile-led *Pleats Please* collection from 1993 and the research on simultaneous design processes by, Buso et al. (2023), Ferrell (2024), Konings (2023), McQuillan (2020), and Elonsalo (2023) which demonstrate how textiles can be developed for specific purposes. While all three design processes are significant, this study primarily focuses on textile-led design, which will be discussed later in this chapter.

Through the lens of textile thinking, designers can evaluate the broader implications of their choices and create more sustainable and impactful designs. Therefore, this study's theoretical and practical research is founded on textile thinking, which serves as the overarching conceptual framework.

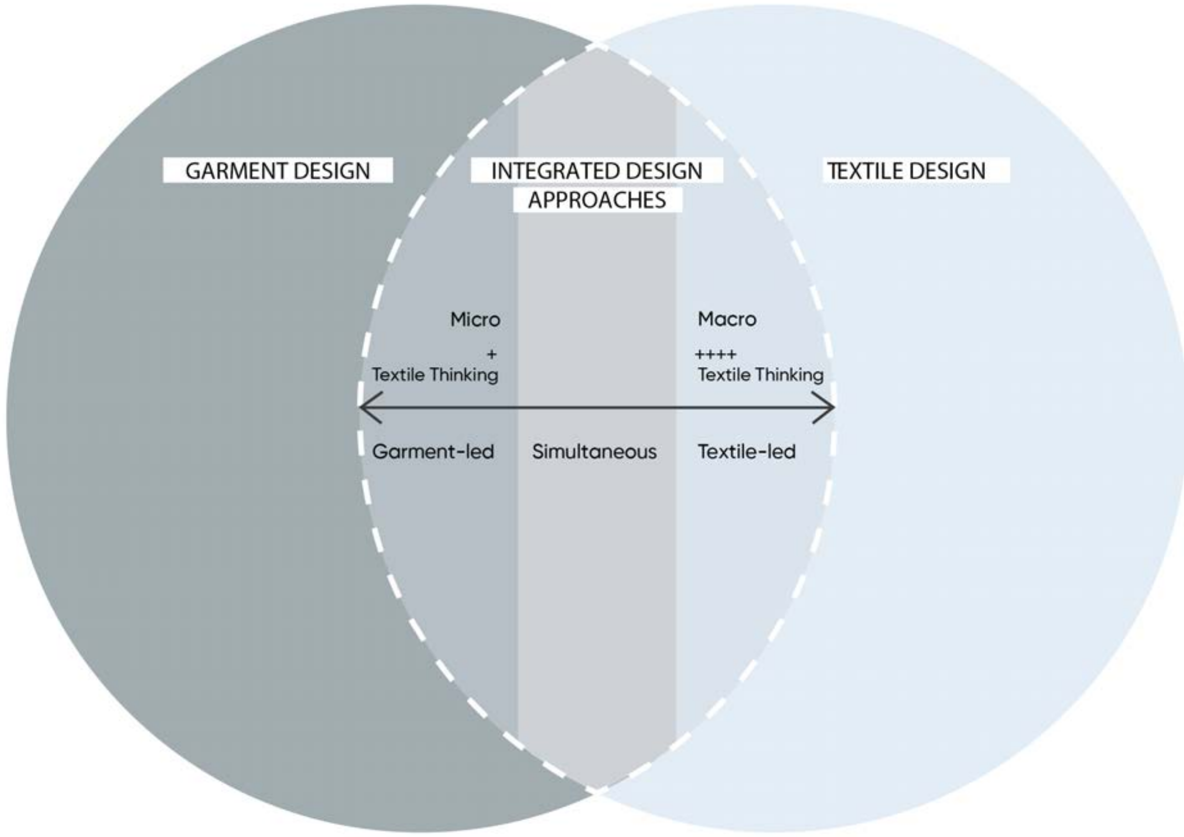


Figure 21. *Integrated design approaches and textile thinking*

2.2.1 Textile Design

Textile design is a specialised field that differs from other design disciplines in that it prioritises the creation of materials over the mere shaping of existing ones, as is the case with woodworking, ceramics or garment construction. The process of textile design requires a thorough understanding of the qualities and properties of different fibres and begins with the transformation of raw fibres into functional fabrics (Pouta, 2023).

Textile designers also have the unique ability to imbue their materials with stories and meanings. Salolainen (2022) points out that in the weaving process, designs evoke deeper connections through their complex woven structures, different material properties and visual attributes. This dual function of material creation and narrative integration distinguishes textile design from other craft and design forms and enables it to convey significant messages through woven textiles (Pouta, 2023).

2.2.2. Textile-Led Design

This research study follows a textile-led design process that places textile thinking at the heart of the design approach. By prioritising the properties of the textile, this method influences and shapes the garment’s form. Consequently, the thesis argues that textile-led design depends on the application of textile thinking, a concept that emphasises the embodied knowledge that designers acquire through their interactions with materials.

This research study follows a textile-led design process that places textile thinking at the heart of the design approach. By prioritising the properties of the textile, this method influences and shapes the garment’s form. Consequently, the thesis argues that textile-led design depends on the application of textile thinking, a concept that emphasises the embodied knowledge that designers acquire through their interactions with materials.

Moreover, the paper argues that when textile-led design incorporates textile thinking on a macroscopic level, designers can apply systems thinking and engineer textiles for a specific intention (Leppisaari, 2022; Salolainen et al., 2018). For example, they can embed fabric characteristics that support sustainable design strategies such as durability, recyclability, adaptability, or facilitate zero-waste techniques (Fletcher & Grose, 2012; Karell & Niinimäki, 2020). As a result, textile-led designers transcend traditional specialisation and evolve into multidisciplinary professionals with in-depth knowledge of textiles and garments. The role of a textile-led designer involves integrating material characteristics into a garment’s design, ensuring that the textile contributes significantly to its intended function (Salolainen et al., 2022).

2.2.3. Textile-Led Designer

The transition to circularity naturally starts at the design phase, especially for fashion and textile designers, as this stage offers significant opportunities to influence environmental impacts (European Commission, 2012; Graedel et al., 1995). This research focuses on textile-led fashion processes, where the designer uses textile thinking to combine technical knowledge with the aesthetic and functional aspects of fashion design (Forst, 2022; Salolainen., 2022). Salolainen confirms at the centre of this approach is textile thinking, which encompasses “textile aesthetics, material knowledge and techniques” (Salolainen et al., 2018, p. 2). This knowledge enables multidisciplinary designers to understand how the properties of materials and their structural interactions influence the final garment (Leppisaari, 2022).

Subsequently, textile-led designers proactively develop fabrics tailored to specific outcomes instead of modifying existing materials. Designers who adopt a systems thinking approach to textile design should consider several stages, including design, fibre cultivation, combing, spinning, dyeing, yarn production, warping, weaving, finishing and cut-make-trim. For instance, when creating adjustable garments aimed at increasing longevity, textile thinking allows the designer to choose appropriate structures and yarns from the start. This method incorporates the qualities of materials into the design of the garment, making certain that the fabric plays a significant role in fulfilling the garment’s desired purpose (Salolainen et al., 2022).

There are two approaches to implementing integrated design in woven textiles: one in which the designer acts as a technician and another in which the designer collaborates with a technician.

Designer as technician

Designers need direct access to industrial production facilities to act as technicians (Kähkönen, 2023). Open-access production facilities allow for iterative experimentation when integrating textiles and garments (McQuillan, 2020) illustrated in the woven textile forms by Ahonen (2023), Buso et al. (2023), Elonsalo (2023), Ferrell (2024), Konings (2024) and McQuillan (2020) as seen in Figure 22-24. However, research in this field has faced challenges due to the requirement for advanced facilities, which limits accessibility, particularly in resource-limited settings (Ahmad et al., 2023). Additionally, the current linear model separates textile and garment production, often extending across months and multiple locations, which makes integrated design processes difficult to achieve.

Figure 22. *In Ferrell’s (2024) thesis, she constructs draped garments on Jaquard looms*

Figure 23. *In Konings’ (2023) thesis, she explores 3D weaving for Jaquard looms*

Figure 24. *McQuillan (2020) explores 3D weaving for Jacquard looms*

Collaboration between designers and technicians

Collaboration to create cohesive textile and garment designs is possible between designers and technicians working in weaving mills. While designers do not have to be technicians themselves, the success of this method depends on the willingness of the weaving mills to welcome collaboration and to adapt their schedules, which can be difficult due to industry and financial constraints. An example of this collaborative approach can be found in the research conducted by Elonsalo (2023) in her master's thesis, *I weave dogs and clothes: Digital technologies for woven textile-form design.* In her work, she collaborated with technicians from the Turkish weaving mill Vanelli (2024) to develop composite garments.

An alternative approach is to use the resources available at research institutions such as Aalto University in Finland. Aalto University has made significant contributions to the field by merging fashion and textile design education with access to industrial looms. Figure 25 illustrates various research projects from Aalto University and other institutions that provide important insights into the challenges of integrating textile and garment design.

In "Mastering communication with clothing manufacturers", Odmya (2023) explains the reasons behind the limitations of collaboration in the fashion industry. The author highlights how the use of technical jargon and language barriers can contribute to production challenges. The article stresses the importance of effective communication between designers and manufacturers to avoid these problems. Overcoming communication barriers is essential to increasing effective collaboration, which can boost both the sustainability and efficiency of production processes.

The options presented highlight the challenges faced in integrated textile and garment design, particularly with woven fabrics. The designer-as-technician approach offers creative control but is limited by access restrictions. In contrast, the collaborative method utilises available resources but faces logistical hurdles. This study examines these challenges is crucial to improving the accessibility of integrated design in the textile and fashion industries.

This research highlights the collaborative potential of textile-led design, exploring how designers and technicians can work together to connect conceptual ideas with industrial production (Kähkönen, 2023; Stebbing & Tischner, 2015). This collaboration draws on the strengths of both roles and makes the textile-led design process feasible and practical within the existing industry structures.

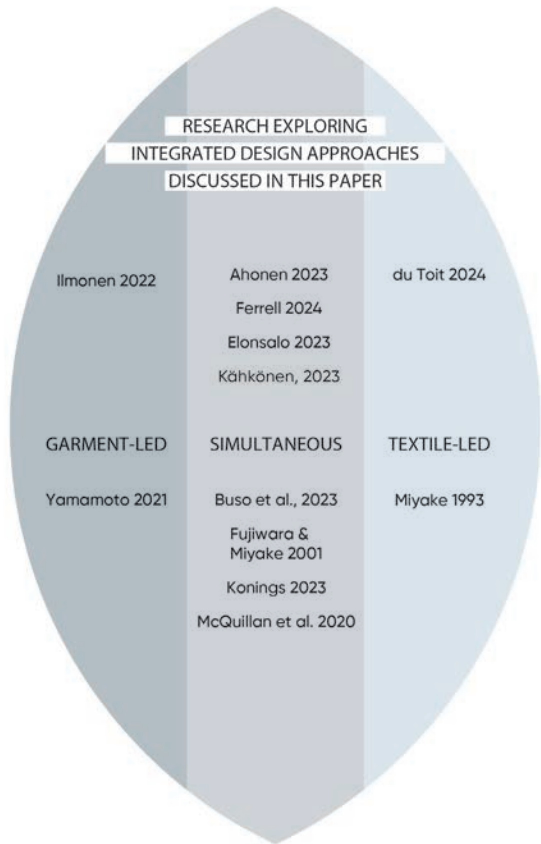


Figure 25. *Integrated design practices*

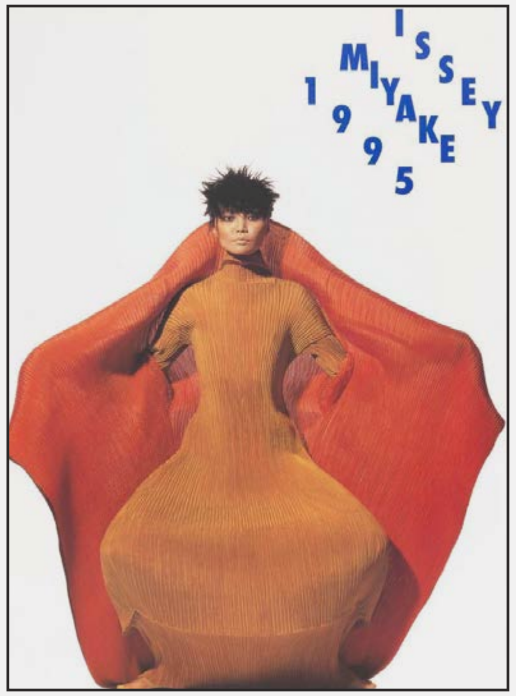


Figure 26. *Issey Miyake's Pleats Please by Penn (1999)*

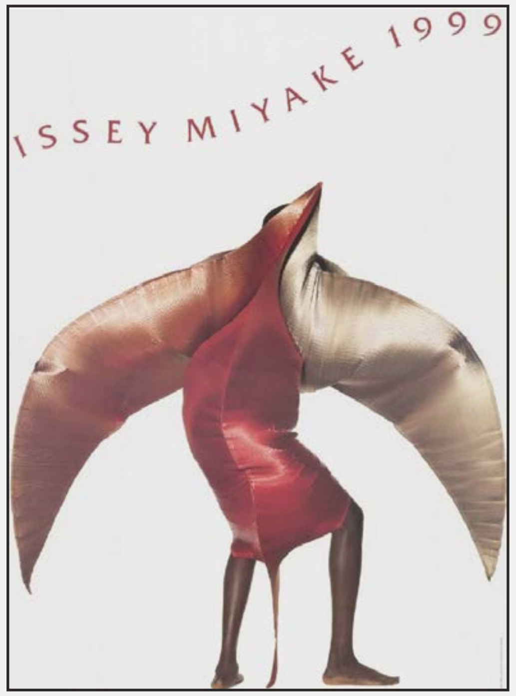


Figure 27. *Issey Miyake's Pleats Please by Penn (1999)*

Figure 28. *Issey Miyake's Pleats Please by Penn (1999)*

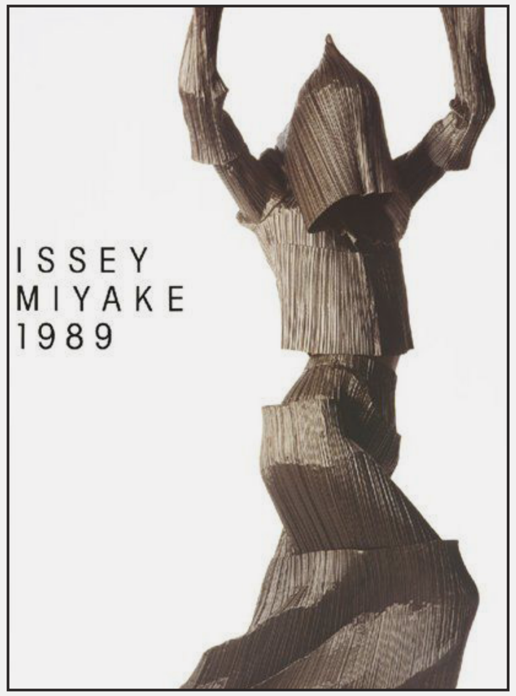


Figure 29. *Issey Miyake's Pleats Please by Penn (1999)*

CASE STUDY: ISSEY MIYAKE'S PLEATS PLEASE

Issey Miyake's (Penn, 1999) Pleats Please collection (Figures 26 - 29), launched in 1993, is an example of textile-led design practising textile thinking. In this collection, Miyake used pleated polyester fabric, which retains its shape permanently (da Cruz, 2004). This innovative material not only gave the garments their distinctive shapes but also influenced their look and feel. Pleats Please (Kitamura & Mitake, 2012) illustrates how the inherent qualities of fabric can inspire and guide the entire production process, displaying Miyake's ability to combine artistry with practicality (da Cruz, 2004).

Miyake's method consisted of enlarging and cutting out the patterns for the garments to three times their final size, using geometric shapes without taking into account the contours of the body. After assembly and finishing, the garments were pleated, transforming flat 2D patterns into sculptural 3D forms. Pleats, Please (Kitamura & Mitake, 2012) is a reverse process that shows how textile properties can determine the form of a garment and influence the design process in unexpected ways (da Cruz, 2004).

Figure 30

CHAPTER 3

FILTERING FOR PRODUCTION

Simplicity is the key to brilliance

– Bruce Lee (1998)

This chapter highlights how constraints function as production filters in the textile-led design process, which is directed towards a project goal. For example, in the case of this research study, the goal is to produce a collection of garments from one piece of fabric and to achieve zero-rate waste.

The role of constraints in this study serves as a mechanism to ensure that practice-based research is consistent with its goals and research questions. Building on the anatomy of prototypes framework proposed by Lim et al. (2008), this research illustrates how the careful selection of design elements that meet project objectives can act as production filters within specific constraints. According to Lim et al. (2008), these filters refine the prototyping process by discarding irrelevant elements, keeping the focus sharp and aligned with the project goals. As a result, the prototyping process becomes highly focused and is characterised by an iterative cycle of creation, reflection and revision.

Rosso (2014) notes that constraints create a productive tension that forces practitioners to think creatively and solve problems within certain limitations. His research challenges the assumption that unfettered freedom is necessary for innovation. Instead, constraints act as catalysts for problem-solving by focusing attention and resources. Yoshizawa (2014), a graduate of Aalto University, demonstrated how production constraints in interior textiles can inspire innovative solutions. Building on Yoshizawa's work, this study integrates Rosso's (2014) theories with Lim et al.'s (2008) framework, using constraints as production filters to guide the textile-led design process towards achieving the project's goals.

Rosso (2014) divides constraints into three categories:

- **Process constraints:** limitations that relate to time, equipment, budgets, and expertise.
- **Product constraints:** factors arising from market demands, customer needs, and project requirements.
- **Self-imposed constraints:** artificial limitations that spark creativity, motivate action or emphasise the project's significance.

Figure 31 illustrates the overlap that defines the focus of this textile-based exploration. This overlap informed the practice-based research. Through a structured and constraint-driven methodology, this diagram illustrates how limitations can promote industrial applications, remain accessible to a wide range of designers and encourage innovative solutions.

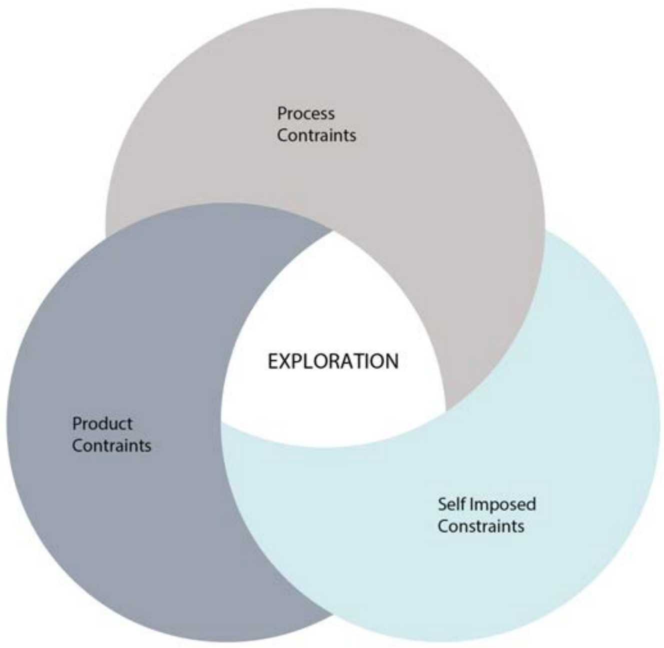


Figure 31. *Scope of textile-led design exploration*

The constraints identified in this study stemmed from the essential elements of textile and garment design, which include material, structure and technique (Salolainen, 2022). These key components have been categorised into three different types of production filters, each of which served to shape the scope and direction of this project, as depicted in Table 1. Table 1 outlines how each production filter aligns with the overall objectives of the study, providing a clearer understanding of the interconnectedness in the design process.

Filters:	Project objective	Aim	Component
Process: Equipment	Feasibility: Ensure that the design ideas are feasible by aligning them with the available industrial production equipment.	Concentrate on ensuring compatibility with small-scale sampling at Aalto and industrial production at Marzotto Wool Manufacturers, taking into account the equipment predominantly used in the industry.	Limitations are determined by the 4-shaft loom, which is widely used in the industry and represents a standard but restrictive setup.
Product: Project requirements	Accessibility: Ensure accessibility by simplifying the design process to basic textile and garment components.	This method makes the process relatable and accessible to practitioners outside the textile field, facilitating effective communication with industry technicians.	The collection will be produced from a single piece of fabric, which will be made from one type of fibre (19 μm wool), one yarn specification (1/64 Nm) with a plain weave structure.
Self-imposed: Motivate action and spark creativity	Personal: Foster creativity and honour material appreciation.	Introduced to spark creativity and focus on personal goals.	Material appreciation inspired a geometric puzzle-piece method for achieving zero-waste, focusing exclusively on geometric shapes in patternmaking.

Figure 32. *Aligning production filters with project objectives*

3.1 PROCESS CONSTRAINTS

By acknowledging constraints such as time, equipment, and budget, the textile-led design process can effectively remain viable for the industry (Rosso, 2014). This approach ensures that design ideas are compatible with the realities of industrial production capabilities.

3.1.1 Equipment

Shaft looms are the predominantly used type of loom in the current linear production model both in small-scale and industrial fabric production. While these looms can be customised for different fabric types, they also have design limitations, particularly in terms of pattern complexity and repeat size (Salolainen, 2022). The number of heddles plays an important role in these limitations; typically, a lower number of heddles results in simpler patterns.

In order to ensure that the study's findings were applicable across the industry while adhering to the project's constraints, a 4-shaft loom was selected, as it is one of the simplest and most limited configurations available.

3.1.2 Software

This study deliberately avoided the use of specialised drafting software to ensure that the results were transferable to the industry as a whole. Instead, the woven structures were created manually, demonstrating that textile-led methods can be effectively implemented without advanced technological tools.

Figure 11. *One fibre one yarn, one structrure, one piece of fabric. 2024*

Photo 11.

3.2. PRODUCT CONSTRAINTS

The product constraints aim to reduce the number of variables involved in creating a piece of fabric. This simplification is important because it makes the results of the research relevant and useful to many people in the industry. By limiting these factors in textile design, this study demonstrates that strict constraints can enhance rather than limit creativity.

3.2.1 One Fibre: Merino Wool (19 μm)

The choice of a particular type of fibre is based on its inherent properties. Merino wool is highly valued for its flexibility, durability, pliability and softness – qualities that synthetic fibres often seek to imitate (Salolainen, 2022). In addition, wool is biodegradable and recyclable in its pure form, which aligns with the project's commitment to environmental sustainability (Salolainen, 2022). Furthermore, the opportunity to work with Marzotto Wool Manufacturers provided access to innovative technology, exceptional expertise and innovative processing techniques for handling Merino wool.

My choice of Merino wool was also influenced by my family's background in wool production in South Africa. This connection shaped my decisions and enhanced my appreciation for wool's role in sustainable design. My research culminated in the creation of a prototype collection made entirely from 100% high-quality wool, highlighting Marzotto Wool Manufacturers' expertise in sustainable wool production.

3.2.2 One Yarn: 1/64 Nm

The project focused on using a single type of yarn to meet the fibre constraints. Wool is spun into 1/64 Nm yarns, which are then manipulated in two main ways to increase design options:

- **Plied yarns:** Plied yarns are made by twisting two yarns together and setting the twist, a process that ensures the twist remains stable and does not relax. Plied yarns increase strength and durability, making them ideal for warp applications (Salolainen, 2022; Sinclair, 2014).

- **Over-twisted yarns:** Over-twisted yarns are made by twisting two yarns together without fixing the twist, allowing them to relax when exposed to heat or moisture. This property is intentionally used to achieve special effects, such as unique textures and shrinking properties, as shown in Figures 33 and 34 (Salolainen, 2022; Sinclair, 2014). Overtwisted yarns allow textile designers to alter the behaviour and feel of the fabric without changing its structure or composition (see Figure 35). By using these yarns in certain areas, the textile can automatically shape the garment.

Figure 33. *Plied yarn*

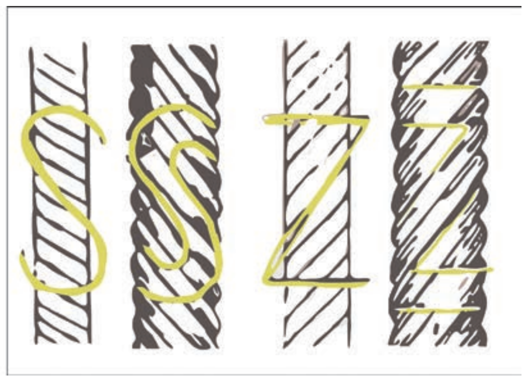


Figure 34. *Overtwisted yarn*

Figure 35. *Overtwisted yarn effect*

3.2.3 One Structure: Plain Weave

The project used plain weave, which is the simplest and most versatile weaving structure. In plain weave, each warp yarn alternates over and under each weft yarn, as illustrated in Figure 36 (Salolainen, 2022). Its straightforward construction makes it compatible with all types of looms and suitable for a wide range of applications. Although plain weave has a simple structure, it offers considerable design flexibility. By adjusting the warp threads, multiple layers can be created, unlocking innovative design possibilities beyond its basic form.

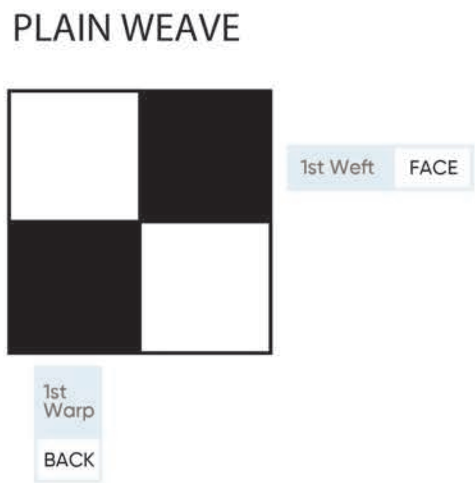


Figure 36. *Plain weave*

3.2.4 One Piece

Using a single length of fabric to create a full collection offers significant economic and environmental benefits.

Advantages:

- **Streamlined production:** Producing one piece of fabric simplifies the production process, optimises resource use, reduces costs and improves efficiency (Laitala & Klepp, 2011).
- **Transportation efficiency:** Shipping a single piece of fabric shortens lead times, decreases transportation costs and reduces environmental impact while simplifying logistics (Laitala & Klepp, 2011).
- **Minimum order quantities**: Ordering one piece of fabric makes it easier for designers to meet minimum order requirements, thereby increasing accessibility.
- **Cross-collection use:** The fabric's neutral design allows leftover material to be seamlessly incorporated into future collections, which reduces waste.

Disadvantages:

- **Limited versatility:** Relying on a single piece of fabric creates challenges in maintaining both visual and functional versatility, which are essential factors for successful collections.
- **Cohesion:** The solution is for the textile-led to prioritise versatility so that it can be adapted for a variety of garment types while ensuring cohesion across the collection.

3.3 SELF-IMPOSED CONSTRAINTS

During my internship at Marzotto Wool Manufacturers, I developed a profound respect for the extensive resources and materials involved in fabric production. This realisation led me to commit to minimising waste in my own work. As part of this commitment, I also set myself the goal of creating woven fabric using entirely biodegradable fibres, with wool standing out as a natural option.

This approach aligns with Rosso's (2014) theory, which suggests that working within constraints can foster a commitment to reducing material waste while also encouraging creative problem-solving.

Issey Miyake's (Penn,1999) *Pleats Please* garment collection, launched in 1993, inspired me to explore sustainable design. I was also influenced by Ilmonen's (2022) work, which was part of her master's studies at Aalto University, titled *Same same but different: Sustainable possibilities of transformable design.* Her collection includes zero-waste garments made from square shapes. As I experimented with double-weave structures, I searched for solutions in my designs. I created prototype samples by sketching geometric panels, developing zero-waste layouts, and refining contemporary designs, which led to functional prototypes.

3.3.1 Zero-Waste

I decided to limit the pattern-making to geometric shapes (Figure 37) from a single piece of fabric in order to achieve zero waste. However, limiting the pattern pieces to geometric shapes introduced an additional constraint. This restriction eliminated the possibility of shaping the garment through traditional pattern cutting and prompted creative thinking about how the fabric itself could determine the shape of the garment. The design process was both challenging and rewarding.

Although I was initially unaware of extensive research in this area, Rissanen's (Qwilt & Rissanen, 2011) groundbreaking work on zero-waste design further informed my work.

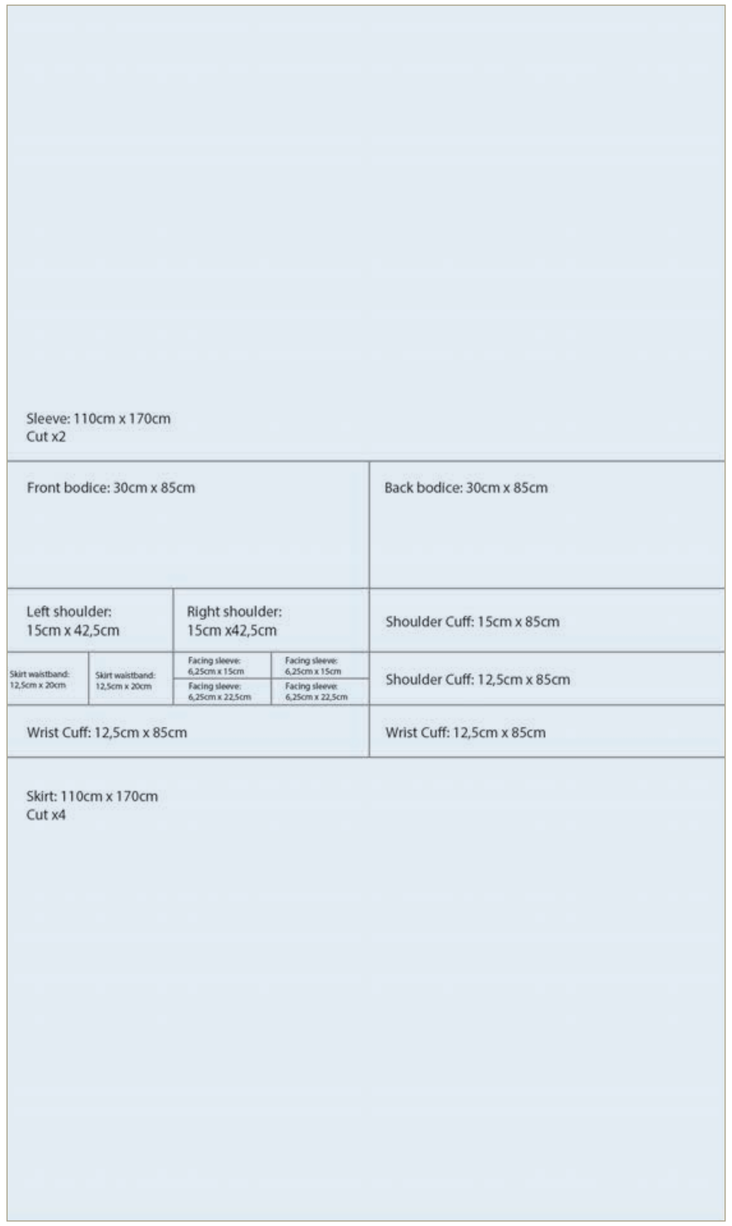


Figure 37. *Geometric puzzle piece approach to zero-waste*

Figure 38.

CHAPTER 4

TEXTILE-LED DESIGN PROCESS

The simpler the design, the more powerful its impact.

– Dieter Rams (2021)

Chapter 4 builds on the theoretical insights gained from the literature review to implement the textile-led design process. In addition, the implementation is carried out through iterative textile and garment prototyping, ranging from small-scale sampling to industrial production. The textile-led design process is explored within the parameters defined by overlapping production filters. This alignment ensures that the textile-led design process is in line with the research objectives (Koskinen et al., 2012).

The textile-led design process is based on the principles of garment-led design, which is the accepted linear model in the fashion industry. Figure 39 and Figure 40 shows how the textile and garment processes differ within this garment-led framework. However, the study focuses only on the relevant stages rather than the entire textile and apparel supply chain.

Figure 40 also illustrates that the design, sample, toile and prototype phases required multiple iterations to solve problems and refine the result. Once the prototype achieved the desired goals, the process may move on to the final garment phase. It is important to note that this research study has not yet resulted in a final product but aims to illustrate the possibilities of textile thinking in a textile-led process.

Lastly, although the textile-led approach concentrates on materials, garment prototypes play a meaningful role as feedback mechanisms. They help to refine and improve textiles by evaluating their adaptability and performance in practical applications.

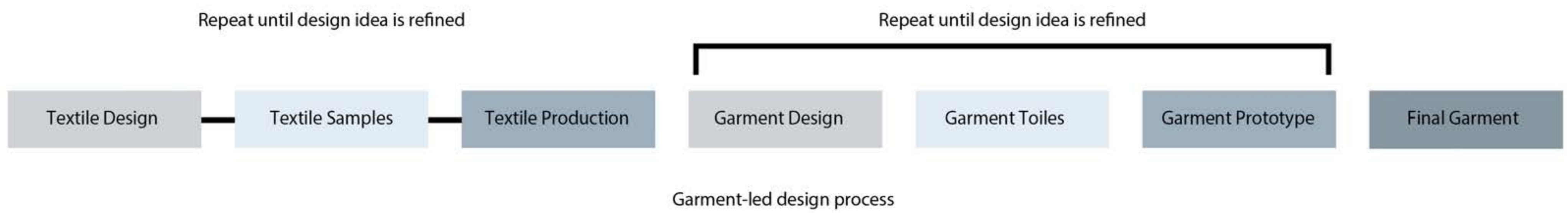


Figure 39. *Garment-led design process*

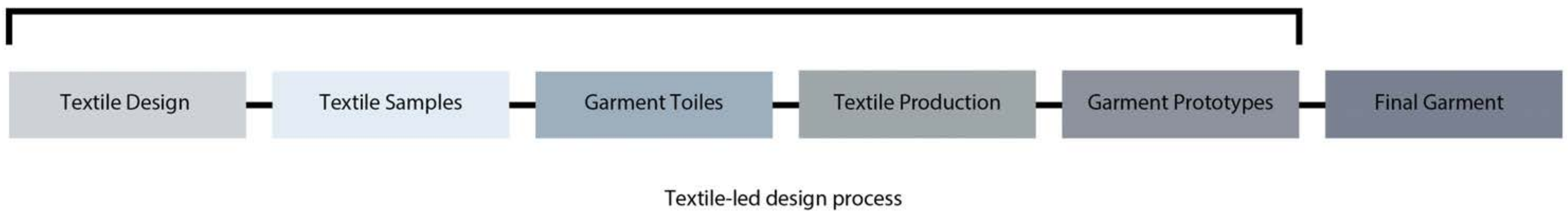


Figure 40. *Textile-led design process*

4.1 TEXTILE DESIGN

One of the aims of this study was to achieve zero-waste, which is why the design focused on geometric shapes. There are various techniques for shaping fabric to fit the curves of the body, including drawstrings, gathering, smocking and draping. For this study, I used drawstrings and weaving with overtwisted yard as a shaping mechanism.

Drawstring casings have a long history dating back to the 1700s (see Figures 41– 46). These figures illustrate the various historical applications of drawstring casings in garment shaping, showing how they conform to the contours of the body. They also illustrate the evolution of drawstring casings, which serve both aesthetic and practical purposes.

A drawstring casing typically consists of two pieces of fabric stitched together to form a tube through which a drawstring can be threaded. Alternatively, this casing can be made by folding the garment fabric itself or by attaching a separate strip of fabric to the garment.

By applying textile thinking, the drawstring casing construction technique can be integrated directly into the fabric on the loom. This approach eliminates the need for a separate construction after the fabric has been produced. In order to achieve this, the conceptual idea must be translated into a practical design that is suitable for industrial production while adhering to production constraints.

Figure 41. *Drawstring casing shaping the waist from the Silverman/Rodgers Collection (1815–1820)*

Figure 42. *Drawstring casing in a French corset from the MET Museum (1908)*

Figure 43. *Drawstring casing as bag closure from the Met Muse-um (1920)*

Figure 44. *Drawstring casing shaping the sleeve by Cecile Bahnsen (2020)*

Figure 45. *Drawstring casing shaping the ankle by Ruzalb de Mura (2010)*

Figure 46. *Drawstring casing shaping the waist Roksanda (2018)*

The drawstring casing consists of three key components, each created using variations of plain weave structures as seen in Figure 47: (1) forming a tube, (2) inserting the drawstring, and (3) closing the tube. Figure 48 illustrates how a woven structure is assigned to each part of the process, ensuring that all three components work cohesively to create a functional drawstring casing directly on the loom.

1. **Forming the tube:** In order to create the tube for the drawstring, a double plain weave structure is utilised. In this structure, the warp is divided into two separate layers: one for the top of the tube and the other for the bottom.

2. **Inserting the drawstring**: In the middle of the tube, the loom is programmed to open the shed to create a space in which the drawstring can float freely between the layers without attaching to either. This design ensures that the drawstring can be easily pulled through the casing.

3. **Closing the tube:** In order to close the tube, the structure directs the loom to briefly join the top and bottom layers at designated points. This process secures the tube while maintaining the functionality of the drawstring casing. The loom is programmed to continuously replicate this structure, resulting in a final textile design that incorporates the drawstring casing throughout the fabric.

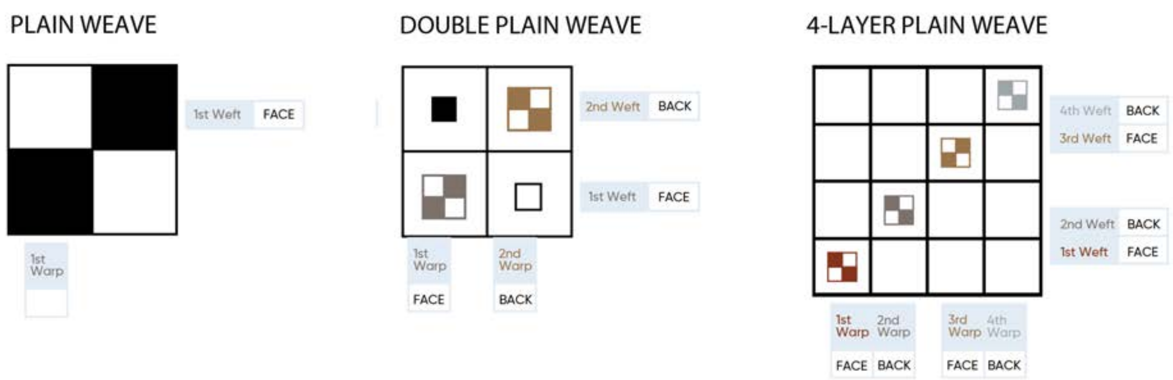


Figure 47. *Plain weave variation*

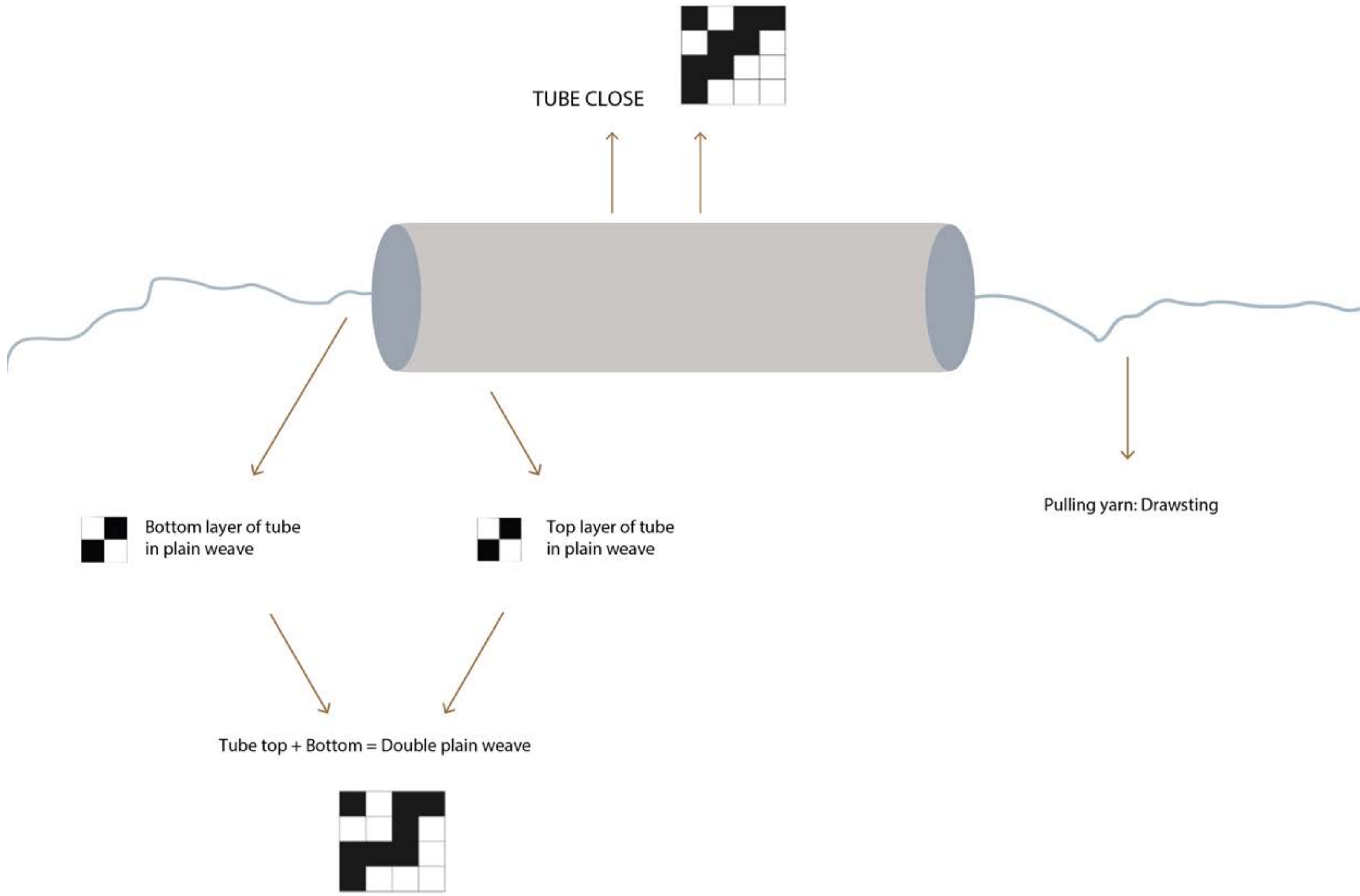
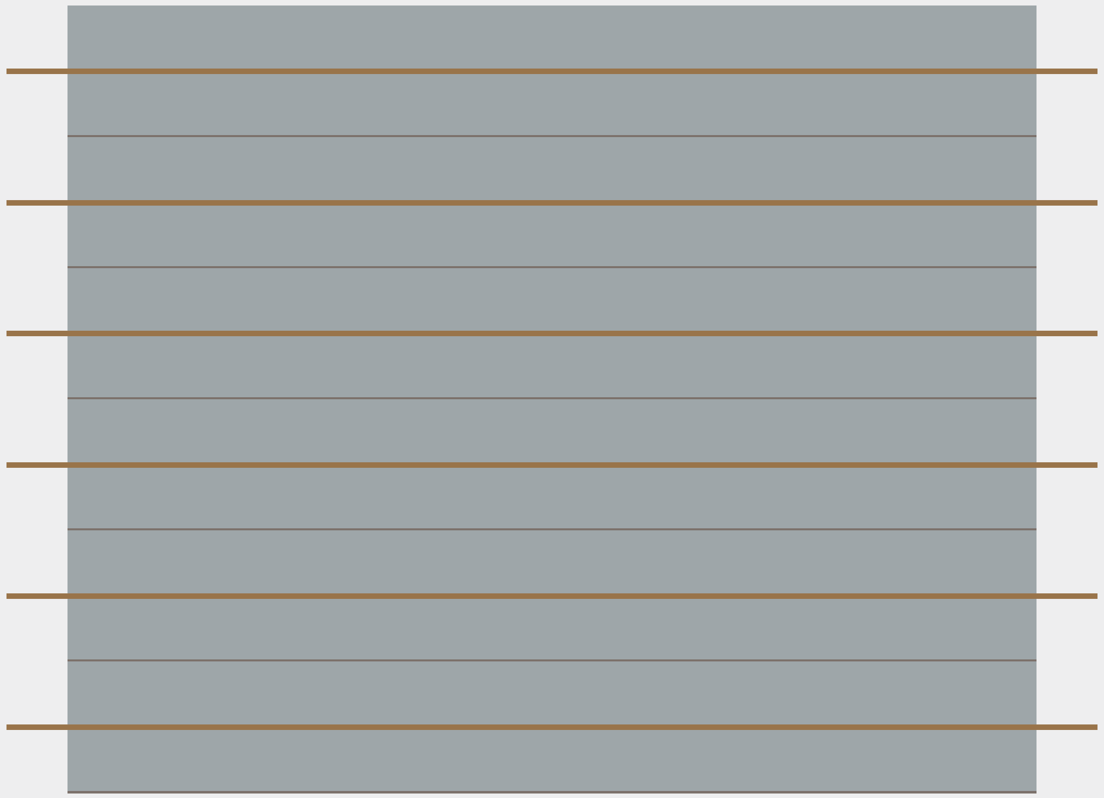


Figure 48. *Functional drawstring casing*

Variability

The drawstring integrated into the fabric introduces a variable element, making it the only aspect of the process and material that is not fixed. This interplay between fixed and variable elements allows for creative exploration and engagement. The drawstring can adapt, manipulate and transform the fabric, providing opportunities to examine how materials interact with it. This interaction shapes both the form and functionality of the garment.



Pattern repeat

Figure 49. *Product card- double plain inlay struction*

Fibre

19 µm 100% Virgin Wool (RWS)

Warp yarn

2/64 Nm S-Twist

Weft yarn

Single yarn:1/64 Nm

Plied yarn : 2/64 Nm

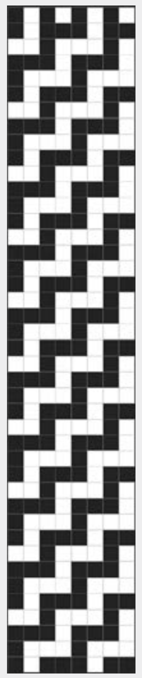
Overtwisted yarn S or Z: 2/64 Nm

Drawstring Weft

PES Tape yarn

Structure

Double plain inlay structure



4.2 TEXTILE SAMPLES AS COMMUNICATION

Clear communication is essential when collaborating with a technician; therefore, providing an accurate sample that effectively conveys the design vision is important (Figure 50). This sample helps convey the message without lengthy explanations.

For this project, I wanted the final garment to be made from a lightweight summer fabric that was transparent, sheer and delicate. These qualities challenge the traditional perception of wool as heavy and warm. However, wool naturally regulates temperature, keeping the wearer cool in summer and warm in winter. Recognising these properties demonstrates how an understanding of textile qualities can inform the design of wool for specific purposes.

Figure 50. Photographic detail, samples as communication

Sampling Stage 1: Manual Shaft Loom

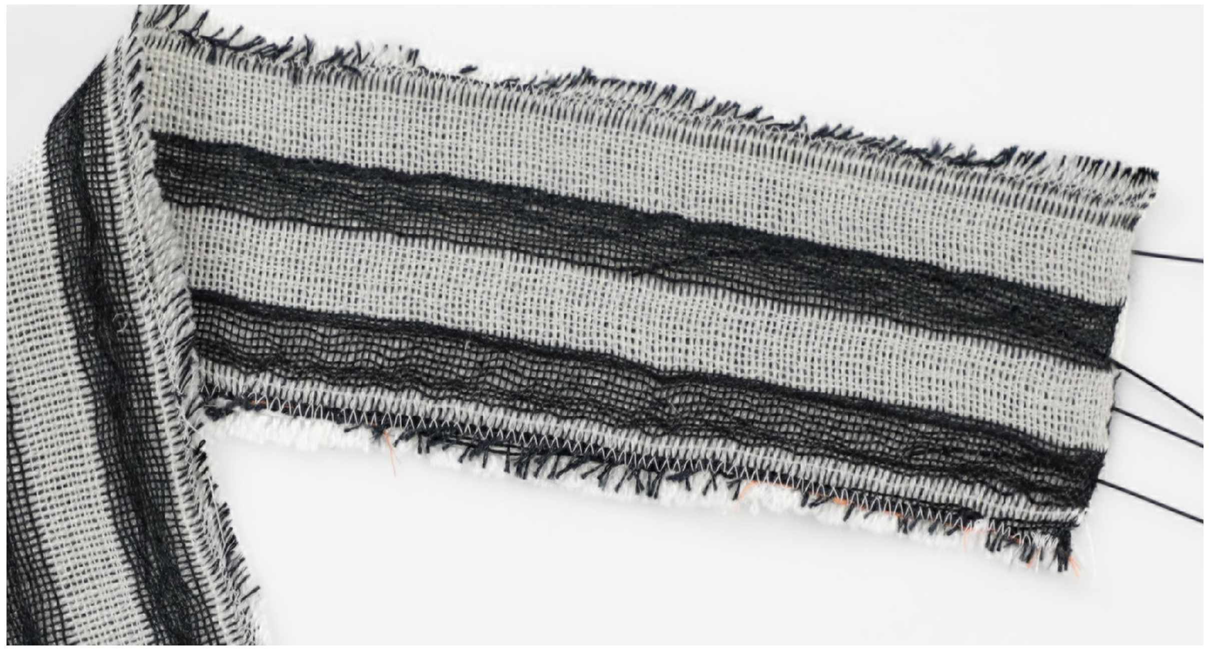


Figure 51. Double plain inlay structure. Manual shaft loom

The first sampling stage used the manual shaft loom at Aalto University. In order to differentiate the layers of the double weave structure that forms the tube, I used a warp with two colours (see Figure 51). The hands-on process of operating the loom – including manually controlling the opening and closing of the sheds – enhanced my understanding of textile techniques and the function of the bindings. However, the warp setup on this loom did not correspond to the specifications outlined in my production filters. Both the warp yarn and the warp density are shown in Figure 51, which differs from the industrial shaft looms at Marzotto Wool Manufacturers. Therefore, this sample may not have achieved the aesthetic qualities or accuracy required to represent the final fabric.

Sample Stage 2: TC2 Hand-Operated Jacquard Loom

Figure 52. *Double plain inlay structure. TC2 hand-operated electronic Jacquard sampling loom*

For the second phase of sampling, the TC2 Jacquard loom at Aalto University was used. Although this loom is usually used for complicated designs, it was chosen because its warp setup is better suited to the production filters. The warp yarn is cotton but still finer, and the warp density is similar to that of the industrial system at Marzotto Wool Manufacturers. I wove two samples on the loom, each using a different yarn variation. The first sample (Figure 52) utilised plied yarns, while the second sample (Figure 53) consisted of overtwisted yarns.

Both samples were woven with exactly the same yarn, 1/64 Nm. However, the difference in the sample illustrates the difference between overtwisting the yarn and not overtwisting it. I realised that both methods allowed me to use the textile to shape the garment. By strategically using overtwisted yarns in selected areas, I could use their shrinkage properties to shape the panel rather than relying solely on drawstrings. Each method has its advantages and disadvantages.

Figure 53. *Double plain inlay structure - overtwisted yarns. TC2 hand-operated electronic Jacquard sampling loom*

Using overtwisted yarns is more time-efficient as there is no need to manually pull drawstrings. However, this approach produces a fixed result: once the fabric has shrunk, it cannot expand again. Ideally, when using overtwisted yarns as a shaping mechanism, the garment and textile must be developed simultaneously while prototyping. The designer needs to be more involved and have access to an industrial weaving mill to create prototypes effectively on the loom.

On the other hand, the drawstring method encourages collaboration between designers and technicians so that prototyping can take place outside the facility. However, this method is more labour-intensive and therefore more time-consuming. Despite these factors, the study focuses primarily on the drawstring method while also including experiments with the overtwisted technique on one garment.

Since the density in the samples in Figure 51 and 52 still did not accurately represent the intended lightweight final fabric. In order to improve the accuracy of the sample, the density was refined by dividing the warp into four layers. Separating the warp into four layers not only solves the density problem but also significantly expands the design possibilities. With four layers, two seperate fabrics featuring the double plain inlay structure was woven simultaneously, resulting in two interconnected fabrics with drawstring functions attached only at the sides as seen in Figure 54. This innovation creates new possibilities for seamless garment creation and sparks exciting possibilities for future exploration.

Figure 54. *4-layer plain inlay structure. TC2 hand-operated electronic Jacquard sampling loom*

However, weaving four layers requires an 8-shaft loom, which exceeds the constraints of the set design parameters. In order to align with the production limitations, the structure was adjusted to utilise only two layers. The resulting 4-layer sample in Figure 55 accurately embodies the desired density and design concept and is sent to Marzotto Wool Manufacturers for industrial replication on a 4-shaft loom. Chapter 6 discusses the potential of using four layers for more complex designs, highlighting possibilities for future research and development.

Figure 55. *Density of a double plain inlay structure compared to a 4-layer plain inlay structure. TC2 hand-operated electronic Jacquard sampling loom*

Sample Stage 3: Industrial Jacquard

The final pattern was woven on the industrial Jacquard loom at Aalto University's weaving studio. A test was carried out with the four-layer version of the double plain inlay structure to ensure that the structure, density and overall result matched the vision for industrial production. In addition, a digital print test was performed on the sample to explore how the fabric integrated with the surface design, opening up exciting possibilities for future developments (see Figure 56).

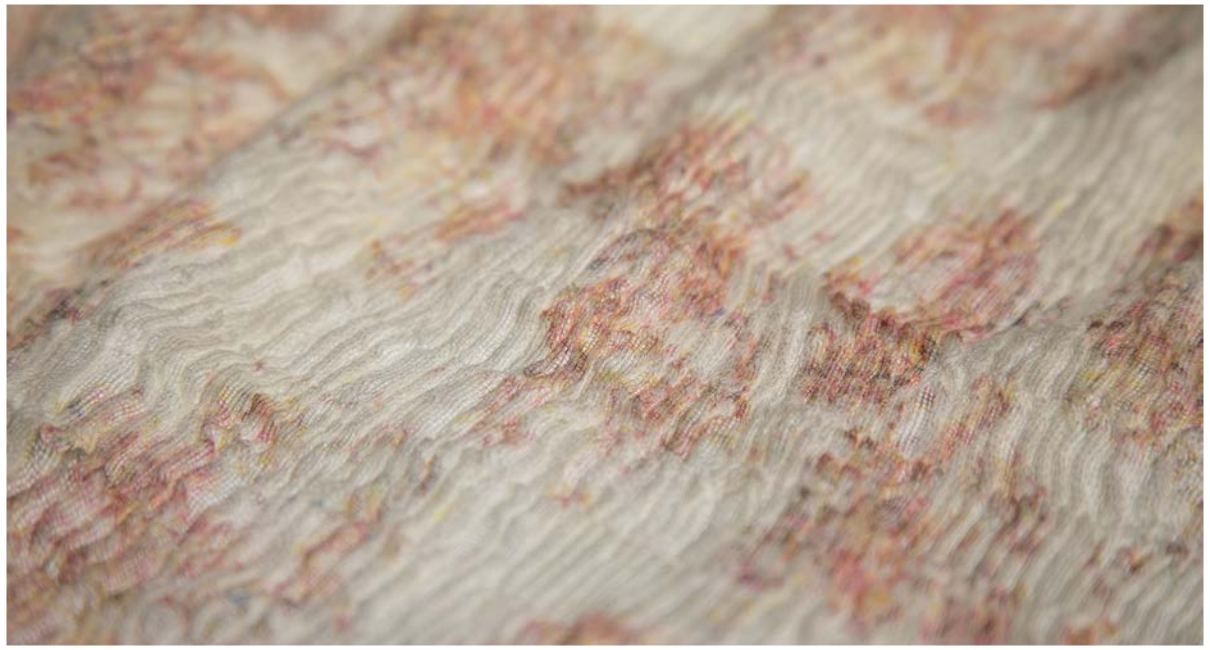


Figure 56. *4-layer plain inlay structure with overtwisted yarns. Aalto University industrial Jacquard loom*

4.3 GARMENT TOILES

There are many reasons why garment toiles, also known as mock-ups, were an essential part of the textile-led design process. Firstly, toiles served as a valuable tool for evaluating whether the textile design was suitable for garment production. The toiles allowed me to experiment with the drawstring casing to create garment shapes. This experimentation helped identify the potential design or construction problems before the industrial fabric was finalised. Toiles were also used to make an accurate estimate of the fabric required for garment prototypes.

By prioritising the properties of the textile as a guiding principle, I have found that constraints can stimulate innovation, resulting in impactful and resourceful design outcomes. Engineering the properties of the fabric from the outset allows for greater adaptability and functionality of the final garment.

Steps In Developing Garment Toiles

Step 1:

Typically, toiles are made from a fabric that closely resembles the final material. As a replica of the final fabric, two pieces of fabric are layered to represent the top and bottom layers of the tube, which will later be woven as two separate layers on the loom. These layers are sewn together at intervals to ensure that one tube is complete before starting on the next (Figure 57). During this process, the drawstring is inserted between the layers to simulate its intended functionality.

Figure 57. *Manually replicating double plain inlay structure*

Step 2:

Illustrations were used to depict the design idea. These illustrations help to clarify how the texture and characteristics of the textile shaped the overall design of the garment.

The workflow began with sketching ideas, progressed to drafting the geometric panel pieces and culminated in the creation of the zero-waste layout plan. If any step in the process did not align, the entire process was revisited. This iterative approach illustrated in Figure 58 ensured that each step supported the others and that the final design met all necessary production requirements.

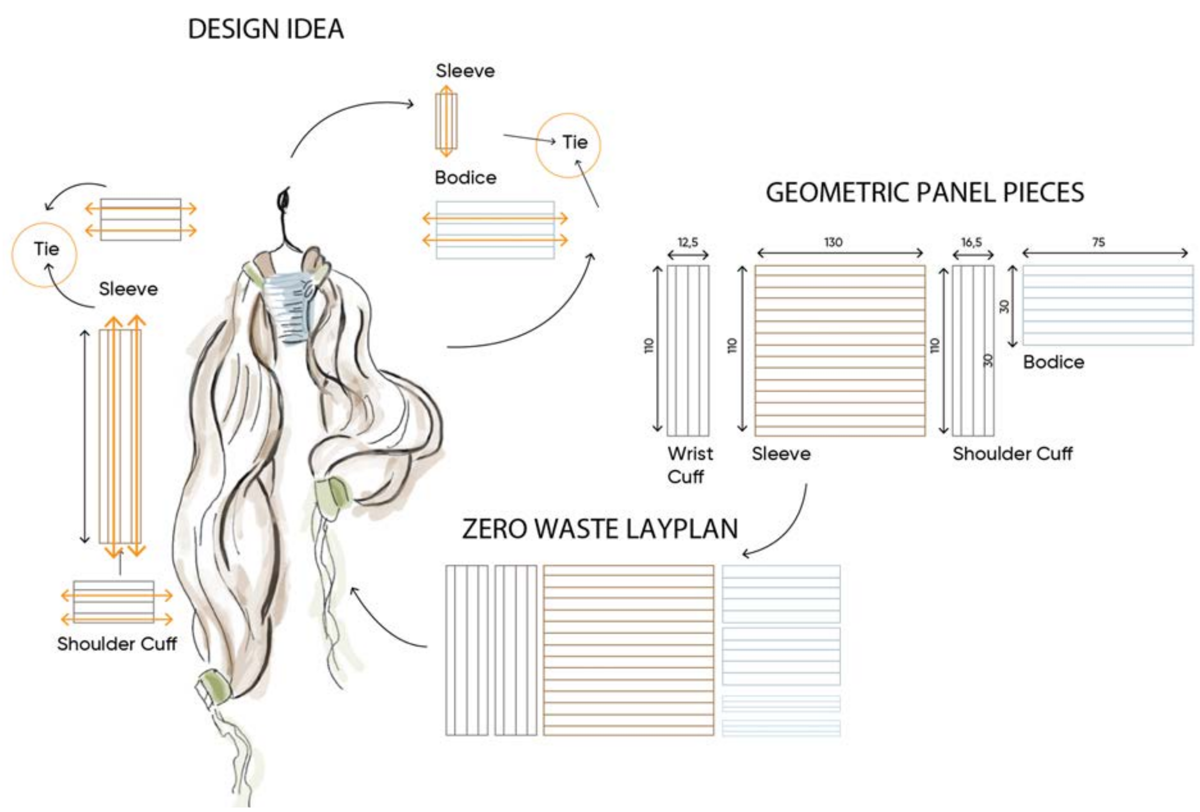


Figure 58. *Iterative design process*

Figure 59. *Toil development in Iterative design process*

Step 3:

The geometric panel pieces were cut from the replicated fabric according to the zero-waste lay plan, and the hems and seams were finished. The drawstrings in the tubes of each panel were meant to connect with the corresponding drawstrings in the adjacent panels and be tied together. However, I failed to notice that the direction of the tubes in the shoulder panels did not align with the direction of the tubes in the bodice and sleeve panels. I had to sew the panels together instead of using the drawstrings for attachment. Therefore I revisited and refined the design idea in Figure 60.

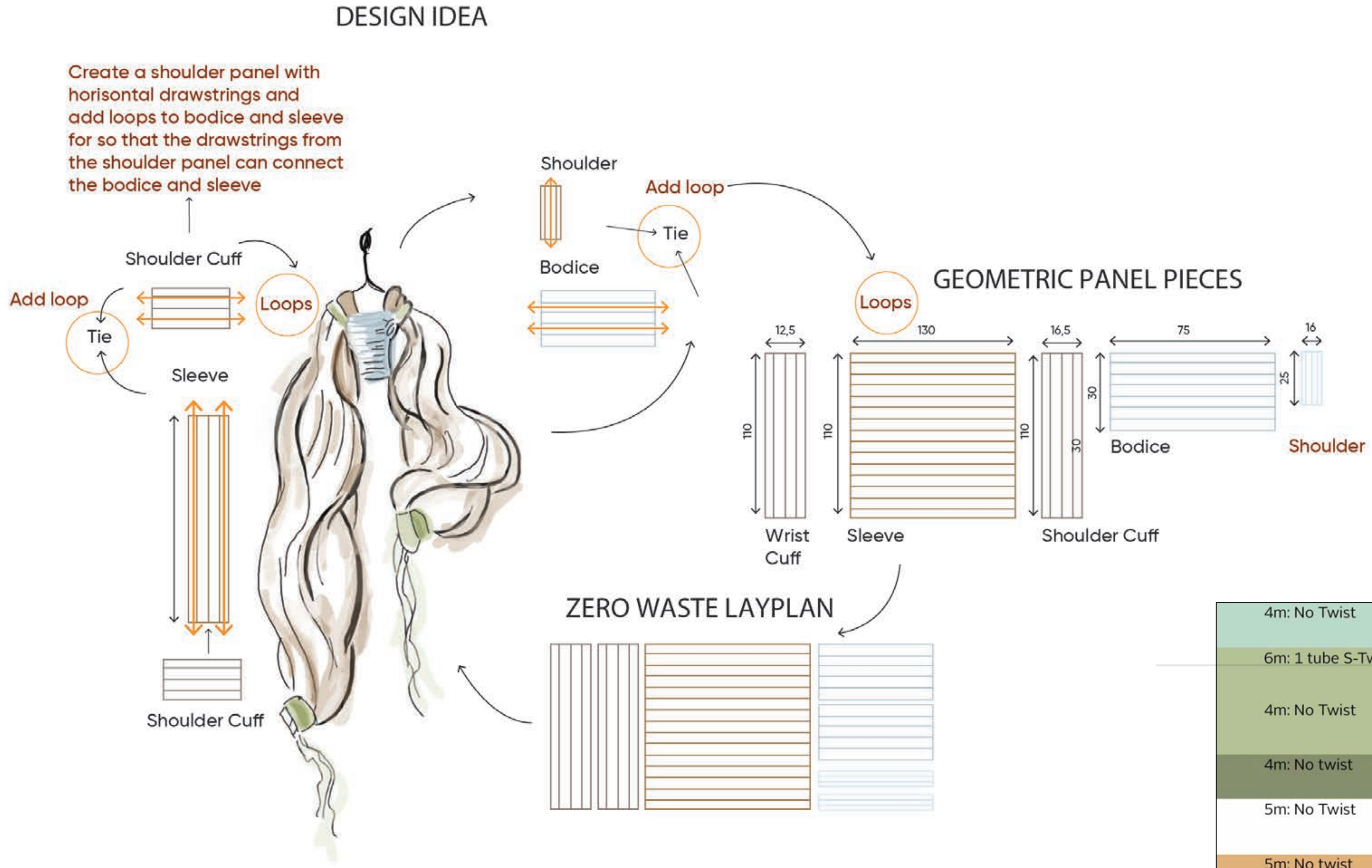


Figure 60. *Refine design idea*

Step 4:

After finalising the garment designs, the amount of fabric required for each item was calculated to specify the total meters needed for each colour. This information was then compiled into a fabric requirement sheet, which was sent to Marzotto Wool Manufacturers as seen in Figure 61.

Figure 61. *Fabric Estimate: 65m*

Toile Collection

Figure 62. *Toile collection*

4.4 REFINED DESIGN IDEA

In this phase, aesthetic choices were evaluated, and different options were considered to optimise the properties of the textiles. As seen in Figure 63 and 64, the design sketches were refined, and pattern measurements were adjusted according to the layout plan by building on the previously developed textile thinking skills. This involved carefully fine-tuning the measurements, adapting the designs and experimenting with colour combinations to ensure a consistent and coherent garment collection.

Figure 63. *Original design ideas*

Figure 64. *Refined design ideas*

4.5 INDUSTRIAL TEXTILE MANUFACTURING

After the sampling and toile phase the fabric was woven at Marzotto Wool Manufacturers, a renowned weaving mill in Valdagno, Italy. Marzotto Wool Manufacturers has been a leader in the textile industry for 150 years, specialising in wool production. The entire textile production process at Marzotto Wool Manufacturers is geared towards minimising environmental impact.

The materials used to weave the fabric are fully traceable, thanks to Marzotto Wool Manufacturers' transparent supply chain. This Italian mill processes RWS-certified wool, ensuring traceability back to the specific farms where the sheep were shorn. I collected the fabric in May 2024 at Marzotto Wool Manufacturers in Italy and brought it back to South Africa to begin the prototyping process (Figure 65).

Figure 65. *Marzotto Wool Manufacturers – Fabric collection*

4.6 GARMENT PROTOTYPES

As in Miyake's *Pleats Please* (Miyake & Sato, 1993) reversed garment construction process, all seams were finished prior to the assembly of the garment. Therefore, the garment prototyping process began with enlarging and cutting of geometric panels to three times their final size, without taking into account the contours of the body.

Next, the hems and side seams were finished, and each panel was prepared for assembly. This step allowed the drawstrings in each panel to be easily pulled and tied to the corresponding yarns in adjacent panels during the garment construction process. Once assembled, the panels were shaped to display the functionality of the textile's drawstring mechanism.

In industrial settings, the final prototype precisely represents the finished garment, ensuring no unexpected variations during production (Lim et al., 2008). This study aimed to develop products that adhere to industry standards. Although these garment prototypes closely resemble the final products, they are still considered works in progress.

Figure 66 illustrates the reverse process used to create each garment prototype, using the bodice from Look 1 as a specific example. The same method was used consistently for all garment prototypes.

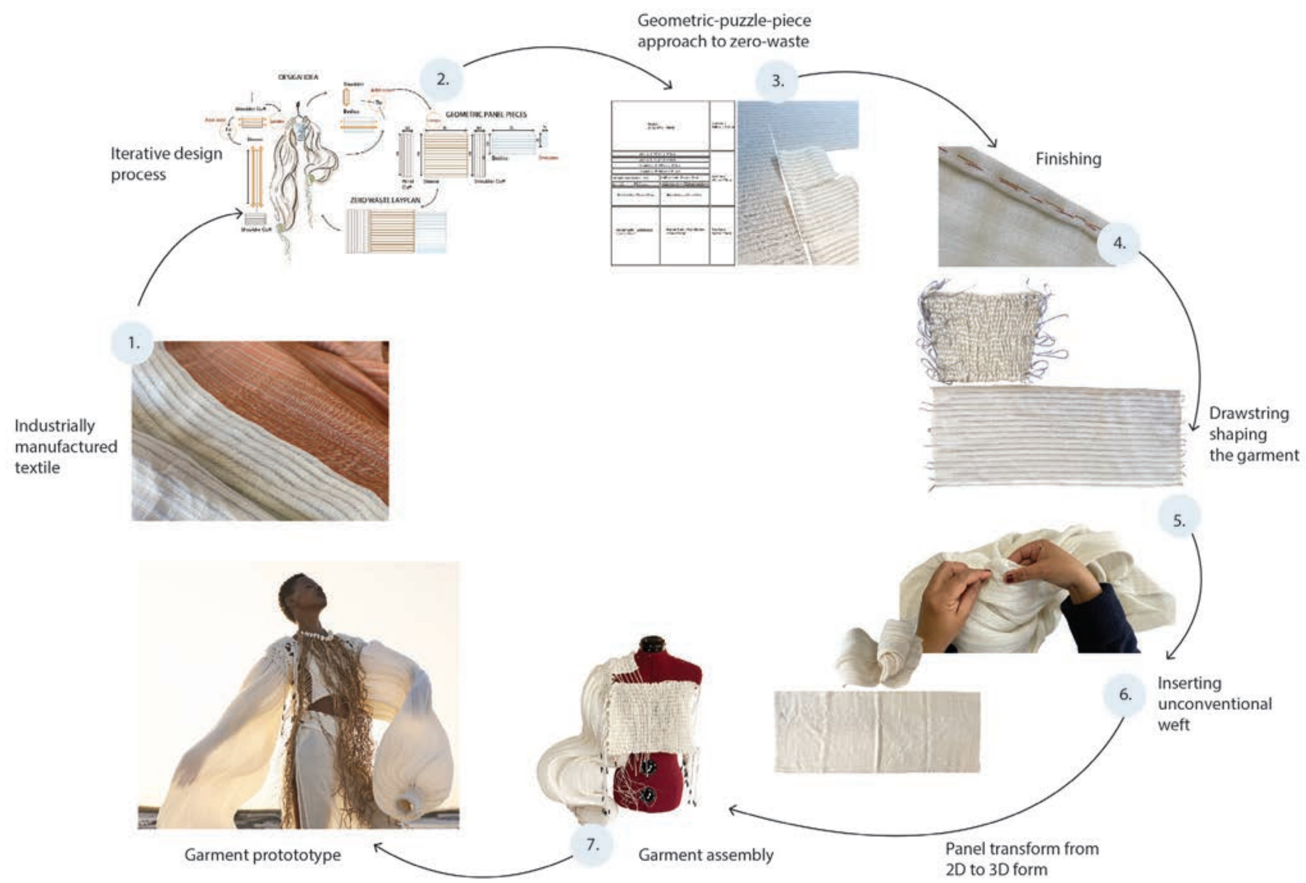


Figure 66. *Iterative prototyping process*

Figure 67.

CHAPTER 5

FINDINGS

Good design is as little as possible. Less, but better, because it concentrates on the essential aspects, and the products are not burdened with non-essentials. Back to purity, back to simplicity. Question everything generally thought to be obvious.

– Dieter Rams (2021)

For this research, a piece of fabric was produced in collaboration with Marzotto Wool Manufacturers using textile thinking in a textile-led design process (Figure 68). The following practice-based process illustrates how textile thinking accumulates with experience. Look 1 is a simple double inlay plain woven structure in a geometric square. With the application of textile thinking and creativity, interaction with unconventional materials such as drawstrings and overtwisted yarns increases complexity toward Look 9.

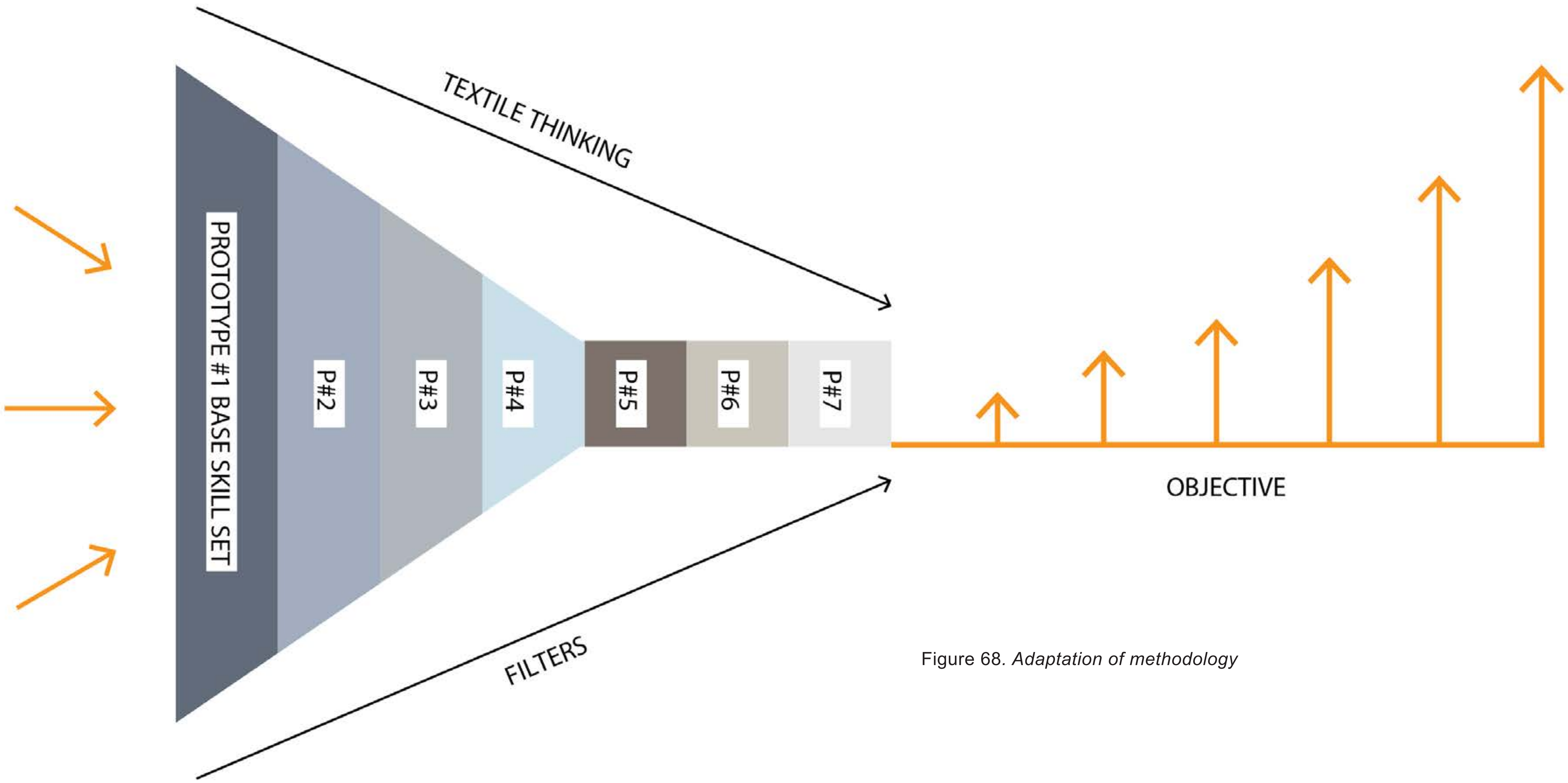


Figure 68. *Adaptation of methodology*

LOOK 1

A square piece of woven fabric is a versatile tool for meeting essential needs. The square can provide shelter and protection from the sun, reflecting a fundamental understanding of textile craftsmanship. This simple yet effective cloth can be draped, stretched, or wrapped to provide cover and shade. Through the lens of textile thinking, it represents the ingenuity and adaptability that can arise from even the most basic fabric.

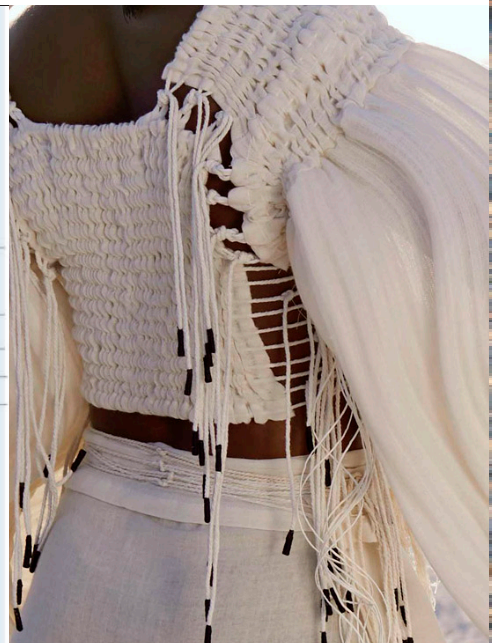
Figure 69. *Photographic detail with zero waste layout plan. Look 1.*

Fabric: 100% Merino wool (RWS) (19 μm)
Kimono: Double plain inlay structure
Functionality: Transformable and adjustable

LOOK 2

The three-dimensional movement of the sleeves is due to the flexibility of the woollen fabric, which reacts to the rigidity of the boning. Look 1 has adjustable drawstrings that allows the wearer to customise the sleeves to create different styling options. When the sleeves are gathered at the wrists, they create a structured cuff. If, on the other hand, the drawstrings are released, the sleeves hang in low drapes, enhancing movement. Additionally, the wearer can choose to adorn one shoulder or both shoulders or even forgo sleeves entirely, offering complete control over the silhouette and overall aesthetic. It is worth noting that one garment, such as the skirt, can have a simple two-dimensional shape within the same design constraints, while another, such as the top, can have a complex three-dimensional shape. Depending on the designer’s intention, both designs can be realised.

Figure 70. *Photographic detail with zero waste layout plan. Look 2.*



Fabric: 100% Merino wool (RWS) (19 µm)
Bodice & trousers: Double plain inlay structure + Drawstring (cotton twine) & Boning strip
Functionality: Transformable and adjustable

LOOK 3

In Look 3, the bodice and trousers embrace comfort and versatility, making the garments suitable for a wide range of body types and personal styling preferences. The trousers feature elasticised hips and a flexible crotch, ensuring a perfect fit that moves with the wearer. The ankle ties add a shaping element, allowing the fabric to be gathered for a palazzo-style appearance or left loose for a flowing wide-leg silhouette.

The off-the-shoulder cropped bodice is designed to accommodate a range of shoulder widths for a customisable fit. The sleeves can be gathered at the wrist for a more structured look or draped all the way to the floor for a high-drape effect.

I utilised the 2/64 Nm S-Twist warp yarn and exposed the fabric to heat and moisture. The hot water caused the warp yarn to shrink by 25%. which resulted in a textured effect on the bodice.

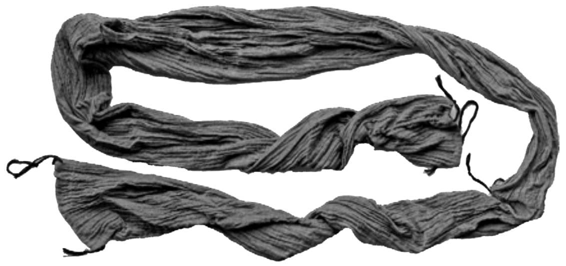


Figure 71. *Photographic detail with zero waste layout plan. Look 3.*

Fabric: 100% Merino wool (RWS) (19 μm)
Bodice and trousers: Double plain inlay structure + Drawstring (cotton twine) & Untwisted viscose
Functionality: Transformable and adjustable

LOOK 4

The bodice and skirt were constructed by cutting geometric panels, hemming the edges, and partially inserting viscose drawstrings into the tubes of the bodice and waistband of the skirt. This design allowed for shaping and adjustment, offering flexibility in the garment's structure while maintaining a sculptural aesthetic.

Figure 72. *Photographic detail with zero waste layout plan. Look 4.*

Photo 21

Fabric: 100% Merino wool (RWS) (19 µm)
Bodice & skirt: Double plain inlay structure
+ Drawstring (untwisted viscose)
& Recycled aluminium wire
Functionality: Transformable and adjustable

LOOK 5

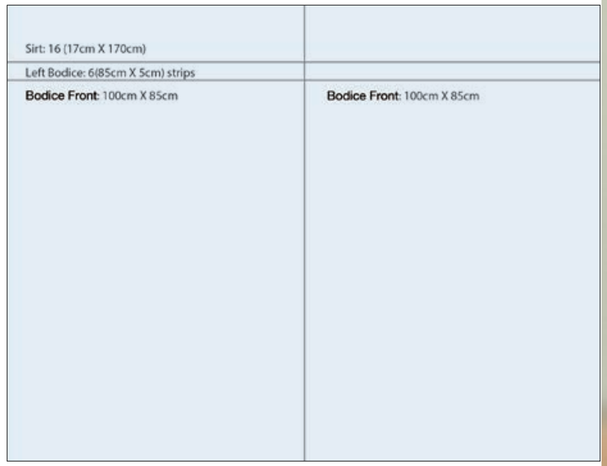
The sweater has paper yarn drawstrings incorporated into the tubes, which allow the wearer to adjust the garment's shape based on personal style preferences.

Figure 73. *Photographic detail with zero waste layout plan. Look 5.*

Fabric composition: 100% wool (RWS) (19 μm)
Sweater: Drawstring (paper yarn)
Functionality: Double plain inlay structure
+ Transformable and adjustable sweater

LOOK 6

The bodice consists of paper yarn drawstrings that are inserted and knotted between neighbouring panels. This creates a versatile design that offers numerous styling options, as shown in Figure 55. The skirt consists of three layers, each made up of four geometric sections of fabric. These sections are attached to an elongated waistband that is tied around the waist for adjustability and versatility.



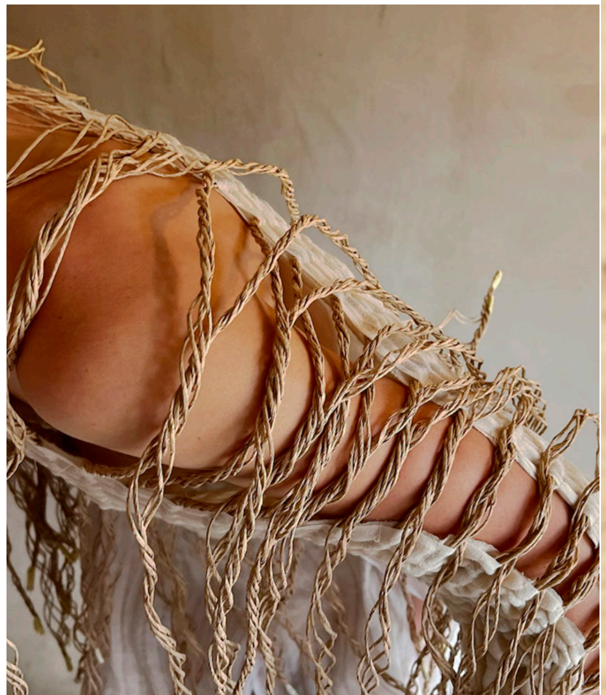


Figure 74. *Photographic detail with zero waste layout plan. Look 6.*

Fabric: 100% Merino wool (RWS) (19 μm)
Bodice & skirt: Double plain inlay structure + Drawstring (untwisted viscose & cotton yarn)
Functionality: Transformable and adjustable

LOOK 7

The bodice features cotton yarn drawstrings that are inserted and tied between adjacent panels, creating a transformable adjustable design that allows the wearer to adjust the bodice according to shoulder and bodice measurements. The skirt consists of two panels that are draped and stitched onto a base skirt. The untwisted viscose strings emerges below the skirt to act as an underskirt.

Figure 75. *Photographic detail with zero waste layout plan. Look 7.*

Fabric: 100% Merino wool (RWS) (19 µm)
Bodice & skirt: Double plain inlay structure + Drawstring (untwisted viscose & cotton yarn)
Functionality: Transformable and adjustable

LOOK 8

The bodice was draped and hand-stitched onto an underbodice with an adjustable drawstring at the back for a custom fit. The skirt was made from two large geometric squares, allowing for the drawstrings to be pulled selectively to create the desired silhouette. In order to ensure stability and maintain the shape, a recycled perspex rod was inserted along the side seams.

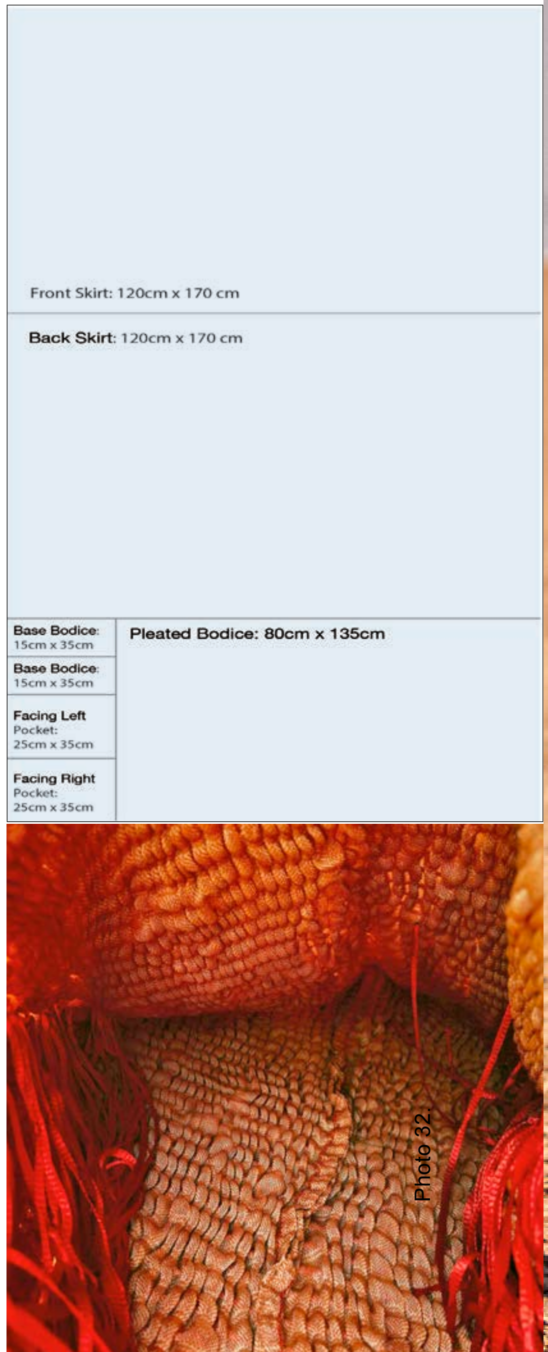


Figure 76*. Photographic detail with zero waste layout plan. Look 8.*

LOOK 9

The fitted skirt features a distinctive design with partially attached geometric strips that cascade from the waist, allowing the fabric to flow freely for a refined look. Every third strip is pleated into a dart to shape the waist while leaving extra room for the hips. The skirt has a concealed drawstring waistband for an adjustable fit.

The bodice is a geometric square with rectangular strips sewn on to provide a sturdy foundation and is fitted with a drawstring. Recycled copper wire and cotton twine act as decorative drawstrings, adding sculpted shapes to the bodice. The twine extends over the skirt, creating a unified silhouette that enhances the overall artistic appeal of the outfit.

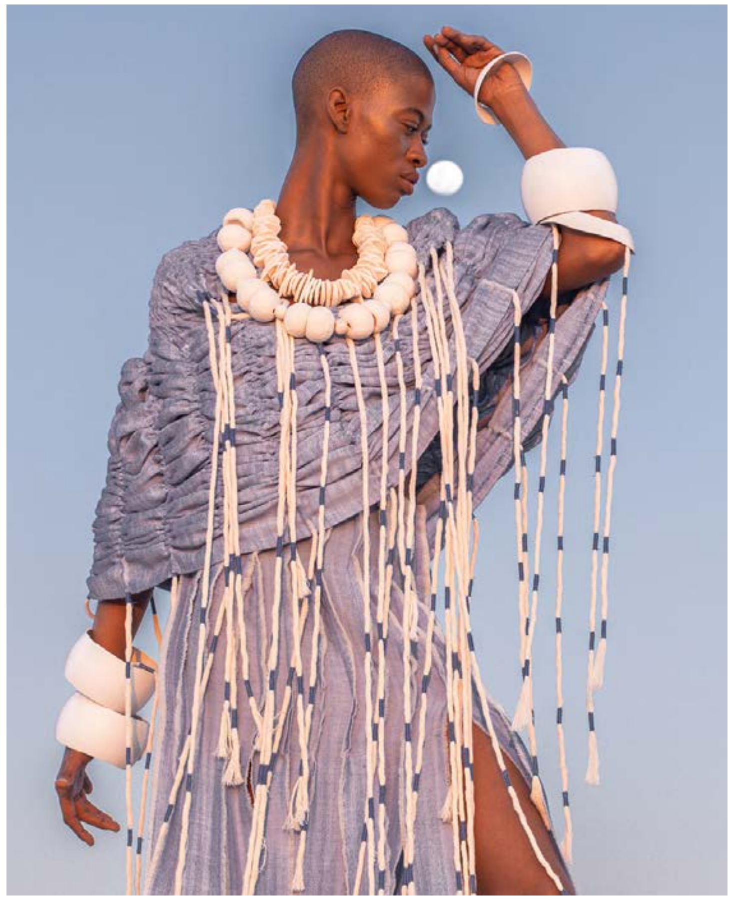


Figure 77*. Photographic detail with zero waste layout plan. Look 9.*

Bodice+Arm Pieces+Skirt Waistband: 20x(6,7cm x 42cm) strips			
Skirt: 30x(6,7cm x 170cm) strips			
Face Front Bodice corset: 42cm x 25cm	Lining Front Bodice corset: 42cm x 25cm	Face Back Bodice corset: 42cm x 25cm	Lining Back Bodice corset: 42cm x 25cm

Fabric: 100% Merino wool (RWS) (19 μm)
Bodice & skirt: Double plain inlay structure + Drawstring (cotton twine) & Recycled copper wire
Functionality: Transformable and adjustable

Toile Collection

Figure 78. *Prototype collection*

Challenge: Variability

The introduction of the drawstring variable added an element of unpredictability to the study, leading to unexpected and challenging encounters. Interacting with the materials through hands-on experience with materials aligns with Albers' (1972) theories on textile thinking. Albers (1972) notes that the unconventional drawstring materials allow the textiles to rise above their typical state and transform into art through their interaction with the fabric, which is evident in the above prototyping process.

However, the variable drawstring made the process challenging. For example, preparing the sleeve panels of Look 2 required considerable effort, as each boning strip needed to be secured in a protective casing to prevent it from pushing through the low-density weave (Figure 70). Inserting the boning drawstring into a sleeve was a slow and tedious process, and the effect of the boning on the wool panel only became apparent after assembly, limiting real-time adjustments

Initially, the design paired the trousers in the green circle with the bodice in the red circle, but the boning disrupted the intended silhouette. In order to address this, I reconsidered Look 2 and Look 3 by pairing the trousers with a different top and matching the bodice with a new skirt. This experience demonstrates how a small variable, such as a drawstring, can significantly affect the fabric's behaviour and aesthetics, confirming the need for flexibility and experimentation in a textile-led process that practises textile thinking. Additionally, this reverse process shows how the properties of textiles can influence a garment's form and impact the design process in unexpected ways (da Cruz, 2004).

Figure 79. *Variability*

Challenge: Communication

Communication was one of the primary challenges in collaborating with the technical team of Marzotto Wool Manufactureres. For example, in Look 3 (Figure 71) the original design specified overtwisted yarns in the crotch area to accommodate the stretch. However, the final product did not match this design due to confusing instructions given to the production team.

For example, in the technical sheet provided to Marzotto, the instruction mentioned "overtwisted yarn". However, the mill referred to this process as a "false twist", leading to potential confusion regarding the same effect. As a result, the fabric was delivered without the intended twisted yarn in the crotch section. As a solution, hat string was added to the drawstring tubes to shape the pelvic area. Although this adjustment took extra time, it brought the design of Look 3 closer to the original vision.

This experience illustrates the importance of clear communication between designers and manufacturers, as misunderstandings can negatively affect the production process and outcome, and a sample or toile that accompanied the technical sheet could have resolved the confusion.

Challenge: Density

The initial goal of this study was to develop a lightweight, sheer, and pliable fabric. However, creating an entire collection from a low-density weave was challenging. While most garments did not require sewing, I aimed to increase the versatility of the fabric by experimenting with sewing techniques, as demonstrated in Figure 80. After some wearing, the low-density weave of the fabric exhibited some seam slippage. Reinforcing the seams during sewing could solve the problem but would affect the overall composition of the design. Ideally, a fabric with a higher-density weave should be used in the seam area. The corset base was found to have the same problem, requiring a denser fabric to provide better support and durability.

Drawing inspiration from Issey Miyake's Pleats Please collection (Penn, 1999), which uses fabrics of varying weights and densities, could effectively have solved the problem. Either increasing the weaving density or using double two-ply yarns could increase the strength of the fabric without altering other key elements while remaining within the set constraints.

Figure 80. *Density*

Challenge: Maintaining 3D Shape

The construction of three-dimensional shapes in as can be seen in Figure 81 presented several challenges. First, it was complicated to maintain symmetrical shapes while sculpting. Second, the sculptural design required high precision and careful manipulation. Lastly, the sample provided with the technician sheet had a cotton drawstring, which the mill replaced with a polyester tape yarn due to insufficient instructions from my side. The slippery nature of the polyester tape undermined the fastening method, negatively affecting the skirt's appearance.

This change proved to be time-consuming as each tape yarn had to manually removed. Additionally, the knots frequently came undone because of the yarn's slippery texture, leading to the skirt's shape adjustments. This experience highlights the importance of industrial sampling for assessing material compatibility and the need for improvements in textile development to be aligned with design and production requirements.

Figure 81. *Maintaining 3D shape*

Challenge: Calculation

Experimentation with unconventional materials for the drawstrings began during the toile phase and continued into prototyping. These materials notably influenced the behaviour of the wool fabric, necessitating a re-design of some garments.

For example, in Figure 82, the boning that initially acted as a drawstring during the toile phase created a high-draped garment that was uncomfortable to wear. In addition, the sculptural quality of the fabric overshadowed the design, resulting in a lack of harmony between the textile and the garment. Therefore, the boning strips were separated in the prototyping phase. By removing the individual strips and placing them in protective sleeves, damage to the delicate fabric was prevented. This adjustment significantly improved both the appearance and functionality of the garment (Figure 83). The geometric patterns of the fabric were draped and sewn onto a base skirt that fastened at the sides, creating a more cohesive integration of the textile with the garment. This experience highlighted the importance of accurately replicating fabric properties during the toile phase in order to increase the accuracy of the final garment.

Figure 82. Toile Look 7

Figure 83. Prototype Look 7

Unexpected Encounter

During the toile phase, one of my initial rough sketches featured a circular centrepiece as part of the design in Figure 84. However, because I struggled to translate this sketch into a viable garment, I decided to change the concept into a sculptural accessory (Figure 85). After further evaluation of the toile, I chose not to pursue the circular accessory for the final collection.

While prototyping another concept, the unintended creation of a form that resembled the original circular design provided a potential solution. This unexpected outcome illustrates how the iterative nature of textile thinking allows ideas to resurface and evolve throughout the textile-led process while practising textile thinking. It demonstrates that knowledge and creativity accumulate during hands-on exploration, often leading to unexpected and innovative outcomes.

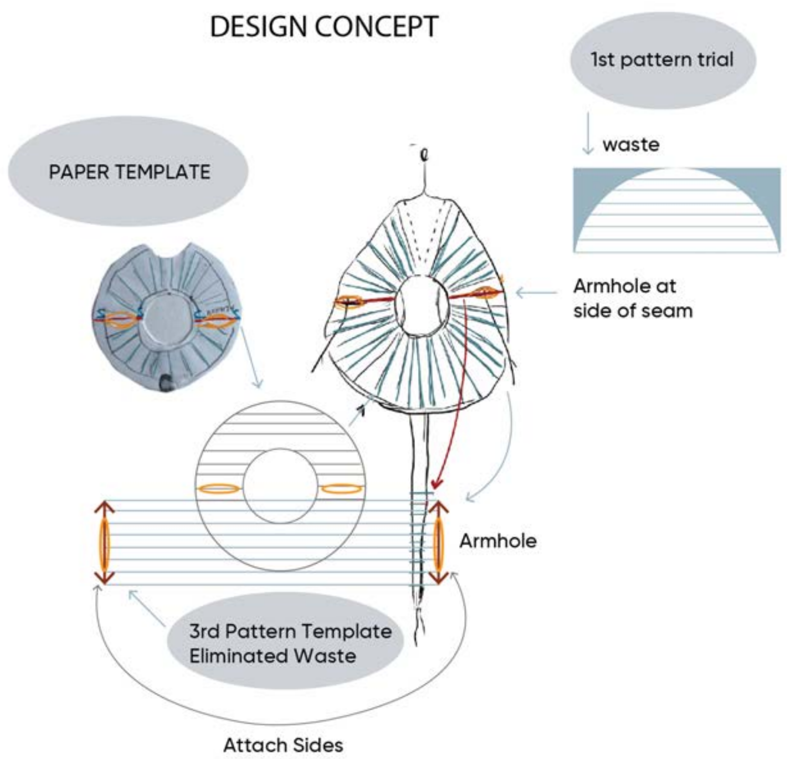


Figure 84. *Unexpected encounter Look 4*

Figure 85. *Process of unexpected encounter Look 4*

Successful Encounter

Constructing Look 6 was straightforward, and I faced no significant challenges. In addition, the prototype matched the fabric exactly, so I only had to make minor adjustments during construction. This success emphasises the importance of Lim et al's (2008) theory that the final prototype must be an exact replica of the finished garment, leaving no room for unexpected variations during production. When creating garments from woven fabric for the first time, the results can often be unpredictable. In this case, however, the close match between the toile and the prototype eliminated unpredictability, demonstrating the importance of detailed planning and consistent replication in the prototyping process.

Figure 86. *Successful encounter. Look 6*

5.3. FUTURE PERSPECTIVES

This section highlights the potential future perspectives on research directions for designers in a textile-led design process while practising textile thinking and using production constraints as design inspiration. While this thesis included only one round of prototyping, more rounds are needed to determine the optimal number to achieve the desired outcomes.

Potential future perspectives

Further research could examine how these interventions could be integrated into the traditional linear model of the fashion industry. In collaborations such as the one with Marzotto Wool Manufacturers, learning Italian weaving terminology could enhance communication and strengthen partnerships. This concept can also be applied to other collaborations between designers and textile mills. Future studies could focus on the creation of seamless garments using a double-weave inlay structure, which requires an 8-shaft loom. In my preliminary research, I showed that a 4-layer inlay structure could successfully integrate yarn and fibre (Figure 87-88). By incorporating the shape of the garment into the fabric, I strategically altered the fibre properties to create functional features. When exposed to moisture, the yarn reacts to shape specific areas of the garment. In addition, considering the fibre colour during cultivation could eliminate the need for dyeing and optimise resource consumption. This approach could also be applied to architecture, interior design and wearable technology, broadening its impact. It demonstrates how textile thinking can create new design possibilities for woven garments while simplifying the design and production processes.

In order to improve the textile-led design process across the industry, further research is needed to enhance textile durability, optimise drawstring designs, and reduce the time required for garment construction. Overall, textile-led design and thinking offer exciting opportunities for collaboration and a critical re-evaluation of existing design practices.

Figure 87. *4-layer inlay structure. Utilising overtwisted yarns to shape the garment*

Figure 88. *Dress woven on the loom with overtwisted yarns*

Figure 89

CHAPTER 6

DISCUSSION AND CONCLUSION

6.1 DISCUSSION

This study aimed to address the disconnect designers encounter in the linear model that hinders sustainable development by applying a textile-led approach and practising textile thinking. The practical component of this study involved partnering with a mill to produce one piece of fabric using a single fibre, a single yarn and a single structure. The objective was to simplify production and demonstrate how working within constraints can enhance integrated design when a clear and effectively communicated goal is defined.

The study explored a possible new paradigm for designers, suggesting that involvement from the early stages of the production model can significantly influence its trajectory. The literature review highlighted the value of hands-on experience in textile production that cultivates a mindset known as textile thinking. Textile thinking is more than just practical creation; it also combines theoretical knowledge with practical application guided by intuition. However, it is also clear that this approach can be challenging for those without prior experience or basic knowledge and, for this reason, can also be exclusionary.

This study began with a practical exploratory phase aimed at creating a lightweight, sheer and pliable fabric. Initially, I investigated the inherent properties of wool as a fibre to achieve the desired result. My tests included weaving with single, plied and overtwisted yarns. I then researched finishes for the design and selected a 100% RWS Merino 19-micron yarn that offered optimum flexibility. The intrinsic quality of a flexible yarn was necessary, as the flexibility contributes significantly to the pliability of the fabric.

Through the research I have shown how a designer can use a textile mindset within a textile-led design process considering a range of factors – such as fibres, yarn, structure and the final fabric – to achieve specific outcomes. By setting clear goals upfront and having a deep understanding of the textile process, the designer can provide early insights that influence the production stages towards these goals. The study shows that, as Groth (2017) suggests, during the design process, designers switch back and forth between the act of creating – interacting with the materials – and imagining possible outcomes. This iterative movement between design and imagination enables the designer to acquire embodied knowledge. This knowledge not only informs the creative process but also deepens the understanding of the imaginative realm.

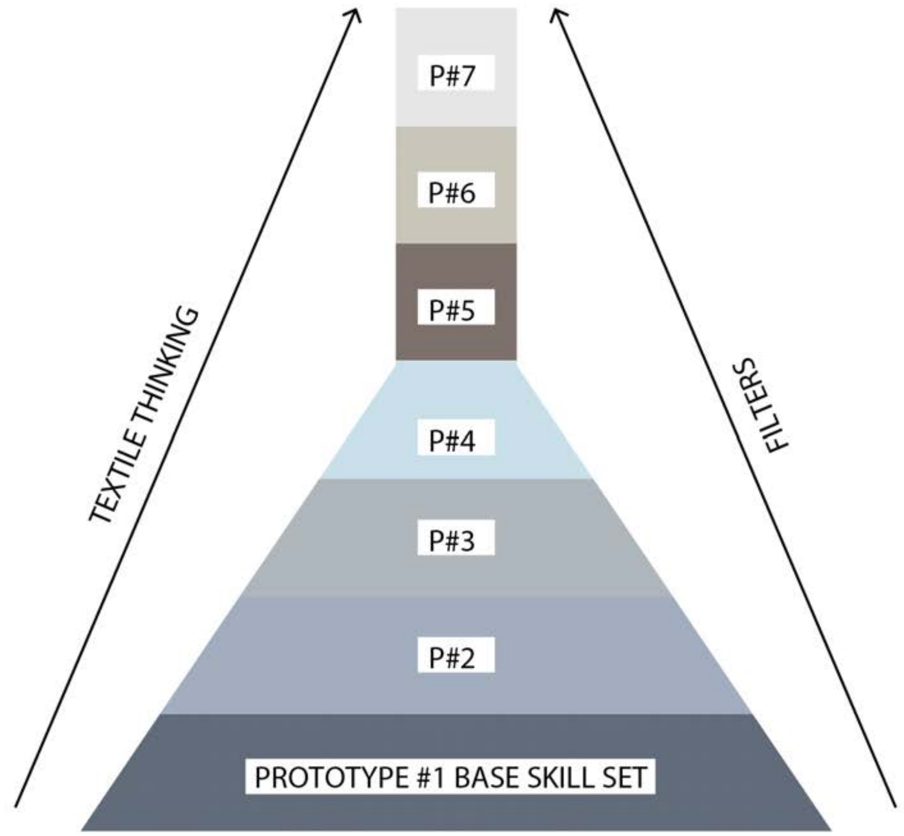


Figure 90. *Constraints stimulate textile thinking*

A series of strict design constraints were established to illustrate the potential of textile thinking within a textile-led design process. These constraints not only shaped the approach but also led to unexpected outcomes, demonstrating that constraints stimulate creativity and textile thinking (Rosso, 2014; Figure 90). Rosso's theory (2014) that constraints can foster creativity proved beneficial in this context. These limitations made it necessary to draw on experience and look for new ways to use a single fibre, a single yarn and a single structure to create a single piece of fabric. The inspiration came directly from the material itself, similar to Issey Miyake (Miyake & Sato, 1999). By recognising limitations, the textile-led design process can remain practical for the industry (Rosso, 2014).

During the prototyping process, geometric shapes were used in the design to minimise waste, specifically the use of drawstrings and overtwisted yarn as shaping mechanisms. In the experiments with overtwisted yarns, it was found that these yarns can be used to shape fabric panels by taking advantage of their shrinking properties. This method differs from using drawstrings alone. Both methods have their advantages and disadvantages.

A key factor in the study was the importance of keeping ideas simple. The language barrier between the Italian-speaking technician and myself, an English speaker, emphasised the need for clear communication and practical solutions. Simple designs can be effectively communicated since both parties understand materials and garment construction. However, it is crucial not to underestimate the impact of language barriers. The effectiveness of using samples or toiles to facilitate communication between designers and manufacturers—especially in cases where there are discrepancies in technical terminology—should not be overlooked. Additionally, it is important to consider the designer's production knowledge.

Creating prototypes from the final fabrics can be challenging, as the toiles made from replicated materials in this study showed significant differences. This experience emphasises the need to produce prototypes using final fabrics to enable efficient sampling and design testing, saving time, money and resources. A second round of prototyping could help resolve issues encountered in the first collection and ensure accurate evaluations of fabric requirements and colour palettes, all while minimising waste.

Being involved in the practice-based research of this study from the very beginning allowed me to influence the outcome, a situation that differs from designers who typically concentrate solely on fabrics or clothing. This experience highlighted the benefits and challenges encountered by textile-led designers practising textile thinking and the various tasks they manage.

6.2 CONCLUSION

This research investigated the obstacles designers face in garment-led design processes that hinder sustainable development. Using a textile-led approach and embracing textile thinking, I partnered with a mill to produce a single piece of fabric made from one type of fibre, one yarn and one structure. The aim was to streamline production and show how limitations can improve integrated design while encouraging zero-waste practices.

The thesis addressed the following questions:

1. How does textile thinking inform and impact a textile-led design process from fibre to garment?

2. How can constraints in a textile-led approach be used as a design tool to promote innovative solutions?

This study offers valuable insights into the impact a designer can achieve by applying textile thinking to a textile-led process. It illustrates how a textile-led design approach can link textile design to garment construction, providing a scalable and sustainable method for industrial production. By simplifying production, this approach addresses the environmental challenges currently facing the fashion industry.

Thanks to the support of Marzotto Wool Manufacturers, the sponsor of this research project, I was able to explore textile thinking and investigate how a textile-led design process could operate on an industrial scale. This partnership facilitated connections with wool and aligned my professional goals with sustainable material innovation, effectively bridging the gap between my background and design objectives.

The design practice employed in this thesis allowed for direct engagement with materials and techniques. As a textile and fashion designer, I oversaw everything from weave structures to garment patterns and post-weaving finishings, focusing on overall quality and aesthetic appeal.

During this journey, I rekindled my connection with fibre, fabric and garments. I immersed myself in a textile-centred design process, exploring wool from its origins on my farm in South Africa to the creation of a complete zero-waste collection. In order to achieve this, I adopted a textile-focused design approach and developed nine looks featuring 100% sustainable Merino wool garments.

This study examines how designers can approach future design using textile thinking and a textile-led design process. A strong commitment to sustainability drove this research, which was informed by personal experiences growing up in the Karoo, a semi-arid region in South Africa, where the negative impact of the fashion industry on the environment is evident. By adhering to specific guidelines and prioritising accessibility, a textile-led design process can remain applicable in resource-limited environments such as South Africa.

These findings can have broad applicability across the industry. While the focus was primarily on woven textiles and garments, the knowledge gained can benefit the entire textile and fashion industry. By applying textile thinking and a textile-led design approach, designers can address sustainability goals early in the supply chain, helping to reduce the industry’s environmental impact.

My experiences have profoundly shifted my view of the textile and garment industry. I now see textiles and garments as interconnected elements rather than distinct components. In my design process, I consider not only how textiles are made but also how they can enhance and support the garment itself. My focus on textiles has increased as I have come to understand them as the “hidden art of fashion” (Black, 2006, as seen in Leppisaari, 2022, p. 437). This new perspective has deepened my appreciation of textiles and motivated me to reduce waste, respect materials and ensure that the garment effectively showcases the textile.

Figure 92

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Figure 92

LIST OF ILLUSTRATIONS