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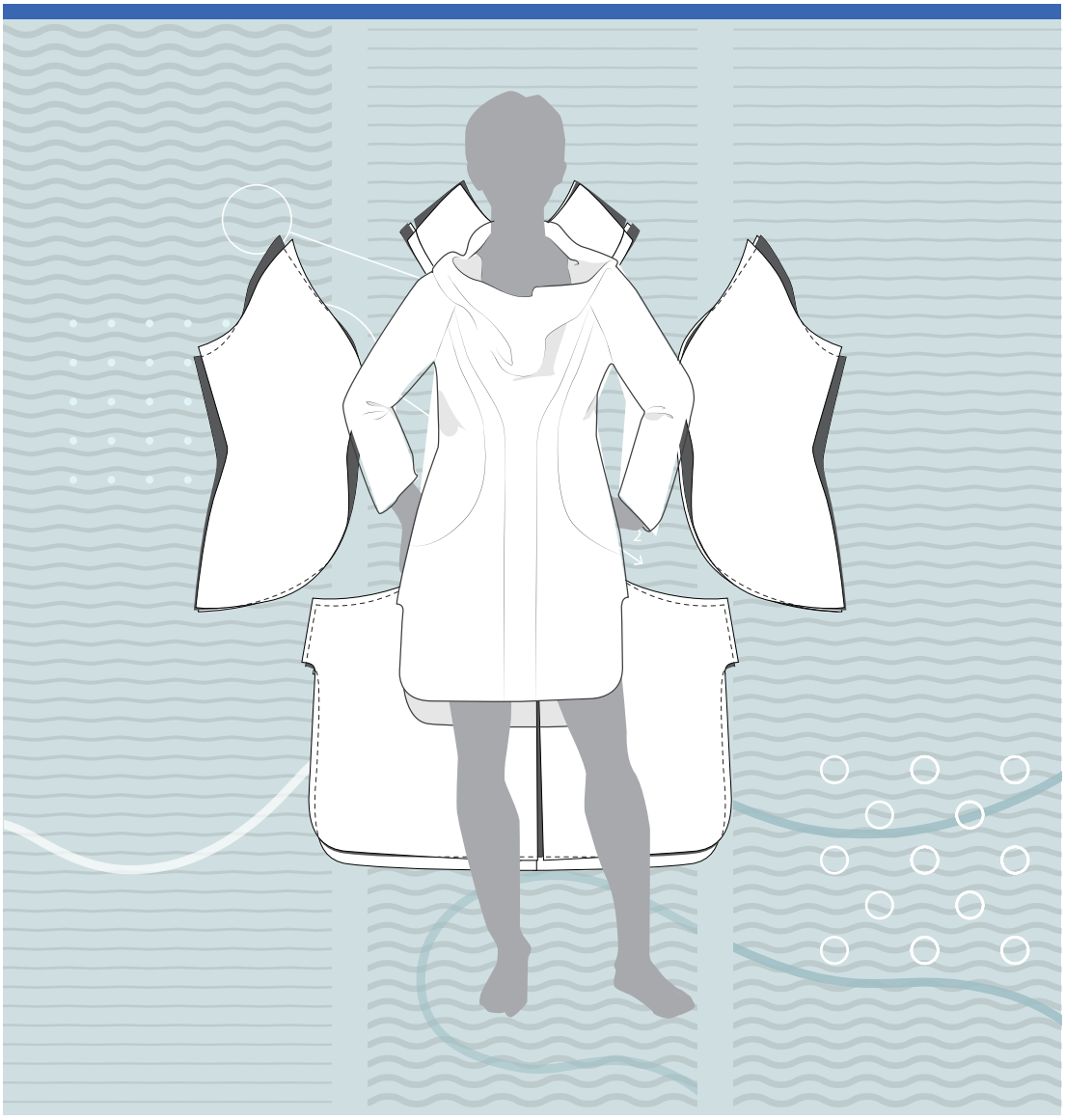
Veronika Svensson Glitsch

Fit step in ready-to-wear clothing

Towards a reduction of garment disposal in view of sustainability



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A PhD dissertation in
Culture Studies

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Preface

I am grateful to have been given the first PhD grant from the Department of Traditional Arts and Traditional Music, Faculty of Humanities, Sports, and Educational Science at the University of Southeast Norway. The Department of Traditional Arts and Traditional Music has since its foundation back in 1984 had a long educational tradition of teaching handcrafts techniques with different materials. The courses are practice-based in both subjects of Traditional Arts and Music. The master's programme in Traditional Arts aims to enhance both the practitioner and her theoretical competence. The education at the department is one of the pillars of the PhD programme in Cultural Studies, where I have been a PhD student.

I would like to thank my supervisors, Liv Merete Nielsen (main supervisor), Janne Beate Reitan and Kirsti Bræin (both secondary supervisors), for their excellent guidance and support during my work on this thesis. My husband deserves a particular note of thanks for never losing faith in me and encouraging me to keep working till the end.

I hope you enjoy your reading.

Veronika Svensson Glitsch
Rauland, 2020

Abstract

Sustainable development in clothing production is my motivation for this thesis. When reviewing the literature on why clothing items are discarded before they are worn out, the two most frequently mentioned reasons for clothing disposal in several surveys are fit issues and lack of quality. This thesis addresses women's problems with the fit of ready-to-wear clothing: clothing design manufactured multiples of one design. The common practice today in the production of ready-to-wear clothing is to make a prototype fitted to the hourglass shape, which is widely accepted as the ideal body shape for women. This prototype is graded into sizes using a sizing table. The sizes are not based on the anthropometric measurements of the target consumer group, and the grading is done in a linear and schematic fashion that does not take into account different proportions for different body shapes that represent the size range of the target population. Because of this practice, only a minority of women find well-fitting garments among ready-to-wear clothing.

The research problem for the thesis is ***Why are clothes disposed of before they are worn out?*** This question is investigated with a literature review that reveals the need for better fit in ready-to-wear clothing. My background as both a designer and tailor has given me the possibility to use critical utopian action research as an approach for conducting a case study with the research question: ***How can the cut of a prototype be graded to fit different female body shapes?*** In the case study called ***Anorak:VG***, different body shapes are constructed inside the cut of one prototype during grading. Through the case ***Anorak:VG,*** an additional step, the ***fit step,*** in the working process of the product development of ready-to-wear clothing is created. This additional step, in which the pattern pieces of a prototype are graded individually from size to size and adapted to different body shapes, builds on earlier research in which suggestions are made for changes in the sizing systems and the grading of block patterns based on anthropometric data. The specific contribution of this research is showing the importance of using ***the actual seam lines*** in one prototype in the adaption to different body shapes and proportions in order to achieve good fit. Graded block patterns based on anthropometric data are

recommended; however, their use alone is not sufficient. If the clothing producers of ready-to-wear clothing build their sizing tables and grading on anthropometric data from their target population and add the fit step to their production process, it is more likely that the majority of women in a target group will be offered well-fitting clothing in ready-to-wear clothing stores.

In general, clothing today has a too-brief user period, resulting in an unnecessary amount of garbage. One could speculate whether well-fitting clothing is more likely to be worn often than ill-fitting clothing. One could also speculate if well-fitting clothes are more likely to be favourite garments to which the user has an extended emotional attachment. Emotional attachment to a garment makes it more likely for the owner to want to extend its life cycle by repairing or mending it. From a sustainable development perspective, an extended user period of clothing could be achieved by applying the fit step in the textile and clothing sector.

Sammendrag

Abstract in Norwegian.

En bærekraftig utvikling av klesproduksjonen er min motivasjon for denne avhandlingen. Ved gjennomgang av forskningslitteratur om hvorfor klær ikke blir brukt til tross for at de ikke er utslitt, viste flere undersøkelser at de to hyppigst nevnte årsakene til dette, er problemer med passform og mangel på kvalitet. Denne avhandlingen tar utgangspunkt i kvinners problemer med passform på masseproduserte klær (ready-to-wear clothing). Vanlig praksis i dagens produksjon av ready-to-wear bekledning er å utarbeide en prototype som tilpasses en timeglassfigur; hvilken innen klesindustrien regnes som idealkroppsformen for kvinner. Prototypen blir så gradert til de ulike størrelsene i den aktuelle størrelsestabellen. Disse størrelsene er ikke basert på antropometriske kroppsmål fra den aktuelle forbrukermålgruppen. Graderingen blir gjort på en lineær og skjematisk måte som ikke tar hensyn til ulike proporsjoner og kroppsfasonger som representerer spennet i størrelse hos målgruppen. Denne graderingspraksisen bidrar til at kun et mindretall av kvinner finner plagg med riktig passform blant ready-to-wear klær.

Forskningsproblemet for avhandlingen er ***Hvorfor blir klær kastet før de slites ut?*** Dette spørsmålet er undersøkt med en litteraturstudie som viser behovet for bedre passform i ready-to-wear bekledning. Min bakgrunn som både designer og skredder har gitt meg muligheten til å bruke kritisk utopisk aksjonsforskning som en tilnærming til å gjennomføre en case-studie med forskningsspørsmålet: ***Hvordan kan snittet til en prototype graderes for å gi god passform til ulike kvinnekroppsformer?*** I case-studien, kalt ***Anorak:VG***, blir en prototype utviklet der ulike kroppsfasonger er bygget inn i snittmønsterdelene under graderingsprosessen. Resultatet av undersøkelsen ***Anorak:VG*** er et tilleggssteg; 'the fit step', for arbeidsprosessen under produksjonen av ready-to-wear bekledning. Dette tilleggssteget; 'the fit step', hvor snittmønsterdelene til en prototype blir gradert individuelt fra størrelse til størrelse og tilpasset forskjellige kroppsformer, bygger på tidligere forskning som påpeker behov for endringer i størrelsessystemer og gradering av grunnformer basert på antropometriske data. Det spesifikke bidrag fra denne forskningen viser viktigheten av å bruke ***selve designet og sømlinjene*** til en prototype

under tilpasningen til ulike kroppsformer og proporsjoner for å oppnå god passform. Grunnformer gradert basert på antropometriske data kan med fordel brukes, men er ikke tilstrekkelig for å gi god passform. Om produsenter av ready-to-wear bekledning bygger sine størrelsestabeller og gradering på antropometriske data fra sin målgruppe og inkluderer 'the fit step' til produksjonsprosessen, er det mer sannsynlig at en majoritet av kvinner vil bli tilbudt klær med god passform i ready-to-wear klesbutikker.

Generelt har klær i dag en altfor kort bruksperiode. Det er rimelig å anta at klær med god passform vil brukes oftere og til de er utslitt enn klær med dårlig passform. Velsittende klær har potensiale til å bli yndlingsplagg som brukeren har en større følelsesmessig tilknytning til. Følelsesmessig tilknytning til et klesplagg gjør det mer sannsynlig at brukeren ønsker å forlenge livstiden til klesplagget ved å investere i reparasjoner. Dersom målet er å oppnå en bærekraftig utvikling, kan brukstiden til klær utvides dersom tekstil og bekledningssektoren innfører passformsteget (fit step) i produksjonsprosessen.

Contents

Introduction – The field

The textile industry and sustainability

The textile industry represents one of the largest economies in the world. The textile industry also has a dark side when viewed from the environmental and human perspectives. The high amount of textile waste annually shows that there is an ongoing overproduction and overconsumption of clothing around the world. More sustainable clothing production is desirable due on one hand to the significant environmental impacts of the textile sector and on the other hand to the unacceptable working conditions to which the majority of textile workers are exposed (Fletcher & Tham, 2015; Fletcher, 2016; Gwilt & Rissanen, 2011; Laitala, 2014). In the case of Norway and other similar countries, the textile industry has largely moved out of the country. Countries with cheaper labour and less stringent environmental regulations dominate today's textile industry. The majority of the textile industry is based on increased volumes and high speed in production paired with low cost. This puts pressure on environmental standards and working conditions. High speed and low cost in clothing production also affect the quality of clothing. Conventional textiles cause toxic emissions during their life cycle both during the production phase and when the textiles are laundered or discarded. In addition, a huge amount of energy and water is needed in the textile life cycle, which also causes environmental problems (Fletcher, 2016). As Fletcher states about the fashion industry:

> Indeed perhaps no industry has better perfected the cycle of invention, acceptance and discard of a continually changing series of temporary modes of appearance, than fashion. Nor has any sector so successfully de-linked a cycle of change from physical need or function. In the fashion context rarely does a new item better protect our bodies physically or offer enhanced functionality; rather we buy afresh to make visible our identity both as an individual and part of larger social groups, showing our currency, our 'value', through our changing dress. (Fletcher, 2016, pp. 59–60)

The starting point of this thesis is the resource exploitation that exists in today's textile industry, as viewed from a sustainable perspective. I find it a waste of human and natural

resources to produce clothing of low quality that is hardly worn before it is thrown away. I find it questionable to produce clothing of low quality when it is possible to produce sustainable clothing of high quality for durability.

As clothing in many parts of the world is quite cheap to produce, it is easy for Westerners to buy a lot of clothing and just pick from the pieces available the ones that fit the best. In Norway, clothing prices have dropped since 1995 (Andersen, 2007). In 2007 the prices for clothing in Norwegian krone were the same as in 1984, while salaries have increased, and in 2007 the Norwegian krone was worth less than in 1984 (Andersen, 2007). From 2007 to 2015 the price of clothing in Norway has fallen a further 16.5% (SSB, 2016a, 2016b). Low prices combined with an extensive selection of clothing allows for a comprehensive purchase-and-discard mentality. On average, the textile waste per inhabitant in Norway annually in 2011 was 24 kg of fabric. Around 10 of those kilos came from household waste. What remains comes from the service sector and industry (SSB, 2011). Clothing imports to Norway have increased drastically in the last 25 years. In 2010, imports were 119% higher than in 1990. In 2015 Norway imported clothing amounting to 15 kg per capita (SSB, 2016b). The two leading recycling and reuse companies in Norway, Fretex and UFF, collected about 13,000 tons (10.5 %) of clothes in 2007 (Germiso & Tajet, 2007, p. 8). The remaining textiles, around 110,000 tons (89.5 %), were burned or ended up in landfills. By comparison, the consumption of textiles in the United Kingdom (UK) in 2004 was estimated at approximately 35 kg, which is more than double that of Norway, and is equivalent, per inhabitant annually, to 2.15 million tons. The disposal of clothing and textiles annually in the UK in 2004 was about 2.35 million tons, out of which 1.8 million tons (74%) ended up in landfills (Allwood, Laursen, Malvido de Rodriguez, & Bocken, 2006, p. 16). Americans discarded 13.1 million tons of textiles in 2010 according to the US Environmental Protection Agency (EPA). This means that the average American threw away about 37 kg of textiles in 2010, which is a bit more than in the UK in 2004. More than 11 million tons of discarded textiles ended up in landfills in the US in 2010 (Wallander, 2012). These concrete numbers show the scope of textile consumption. As I interpret the numbers, all these textiles cannot possibly be worn out when they are disposed of. These

huge quantities of clothing require a corresponding amount of resources. The world's resources are limited, and such massive consumption of clothing poses a challenge to creating a sustainable society. As Kate Fletcher states:

> Categorically we need a different approach. Industry and its systems are designed for efficiency. New ideas emerging from existing systems will always be efficiency-focused, incremental, predictable. We need to break free from existing ways of thinking and address, without timidity, that which governs the sustainability potential of the fashion sector: the scale, pace and summative character of growth and consumption. (Fletcher, 2016, p. 22)

Research on the issues of the overconsumption and overproduction of clothing can help us to create solutions that show a possible move towards sustainable textile production.

There is willingness in academia to use sustainable development as a fundamental motivation behind research in general. In 1999 at the World Conference on Science, co-organized by the United Nations Educational, Scientific and Cultural Organization (UNESCO) and the International Council of Science (ICSU), the following mandate was adopted:

> The sciences should be at the service of humanity as a whole, and should contribute to providing everyone with a deeper understanding of nature and society, a better quality of life and a sustainable and healthy environment for present and future generations. (Waas, Verbruggen, & Wright, 2010, p. 630)

Sustainable development requires research as a generator of new knowledge. Research for sustainable development, according to Waas et al. (2010), has to be based on dynamic and holistic approaches focusing on the linkages between biological, chemical, economic, geological, physical, political and social systems in order to search for dynamic and cross-systemic explanations (Waas et al., 2010, p. 630).

> Sustainability science focuses on the dynamic interactions between environment and society, is problem oriented, and is grounded in the belief that knowledge should be 'coproduced' between science and society. (Waas et al., 2010, p. 630)

In this thesis I will join in the focus on sustainability in research that has already been established at a large number of universities worldwide (Waas et al., 2010, p. 629). In common with universities around the world, the United Nations (UN) is also aiming to achieve sustainable development: the UN decided in 2015 on new global Sustainable Development Goals and presented its vision of a world in which consumption and production is sustainable (United Nations, 2015, p. 7). Sustainable development is included as a distinct reason and motivation for this research project.

My research in this thesis is situated in the discourse of fashion and sustainability that is extensively described by Kate Fletcher (Fletcher, 2014, 2016; Fletcher & Grose, 2012; Fletcher & Tham, 2015). Though regarding this thesis, I will use the term 'clothing' and, when possible, not blend it with the term 'fashion'. This is because the two terms often are used as synonyms for each other (Laitala, 2014, p. 11) but still can have quite different meanings. Barnard states that: '(…) clothing sounds like or has connotations of, the sort of thing one wears every day and is mundane (…)' (Barnard, 2007, p. 3), while he defines fashion as: '(…) modern, western, meaningful and communicative bodily adornment, or dress. It is also explained as a profoundly cultural phenomenon' (Barnard, 2007, p. 4). Wilson gives the following definition of fashion: 'Fashion is dress in which the key feature is rapid and continual changing of styles. Fashion, in a sense ***is*** change, and in modern western societies no clothes are outside fashion (…)' (Wilson, 2003, p. 3). Fletcher writes about the difference between fashion and clothing:

> Fashion and clothing are different concepts and entities. They contribute to human well-being both functionally and emotionally. Clothing is material production; fashion is symbolic production. Although their use and looks sometimes coincide, fashion and clothes connect with us in different ways. Fashion links us to time and space and deals with our emotional needs, manifesting us as social beings, as individuals. (…) Clothing, in contrast is concerned chiefly with physical or functional needs, with sheltering, shielding and protecting. Not all clothes are fashion clothes and not all fashion finds expression in garment form. Yet where the fashion sector and the clothing industry come together (in fashion clothes) our emotional needs are made manifest as garments. (Fletcher, 2008, pp. 119–120)

As this thesis focuses on clothing production, both clothing and fashion clothing are covered. This means that regarding the clothing production process, I do not differ between the production of clothing and the production of fashion clothing. Fletcher describes fashion based on values:

> (…) as a practice that is integrated and affirmative to our material, social and cultural lives and which can be experienced both inside and outside a marked-driven cycle of consumer desire and demand and as a collective activity, involving complex flows of information and influence between businesses, groups and individuals. Framed in this way – as part of the process of life – fashion becomes dynamically interconnected with sustainability (another life process) and a key part of the relationship between material and human culture and ecological flourishing. (Fletcher, 2014, p. 144)

This brings us to the concept of sustainable. This thesis aims to contribute to the field of clothing production and sustainability.

Sustainable development

The concept of ***sustainable*** is increasingly applied in a multitude of contexts, making its meaning rather unclear and inflationary. The understanding of sustainable development to which I refer in this thesis is the definition presented in ***Our Common Future*** (1987), also called the Brundtland Report of the World Commission on Environment and Development, chaired by the former prime minister of Norway Gro Harlem Brundtland. Its definition of 'sustainable development' became widely used and recognized:

> Humanity has the ability to make development sustainable to ensure that it meets the needs of the present without compromising the ability of future generations to meet their own needs. (World Commission on Environment and Development, 1987, p. 24)

According to the Brundtland Report, sustainable development is further elaborated in this way:

> Yet in the end, sustainable development is not a fixed state of harmony, but rather a process of change in which the exploitation of resources, the direction of investments, the orientation of technological development, and institutional change are made consistent with future as well as present needs. (World Commission on Environment and Development, 1987, p. 25)

In this thesis I build upon the Brundtland Report´s definition of sustainable development. Based on the problems caused by the textile industry as seen from a sustainability perspective, I find it necessary to support change in clothing production. This change, to which I want to contribute with my thesis, should be, as the Brundtland Report says, consistent with future as well as present needs. So, what are ***humans' present*** and ***future needs*** in terms of clothing? Besides the necessity of responsible dealings with the natural resources and human labour that produces our clothes, clothing plays a role in most people's lives. Clothing concerns all people, similar to food and shelter, and is part of the basic needs and basic communication between people. People dress themselves daily and make active choices about which clothes they will wear and which not.

Wearing clothing is one of the oldest cultural expressions that most people perform every day (Gradén & McIntyre, 2009, p. 23). Every time people put on a clothing item, they make a choice about what to carry around with them close to their skin. It is reasonable to think that most people have an idea about what they would prefer to wear or at least what they absolutely would not feel comfortable wearing, for example, at work Monday morning. We choose our clothes based on various considerations, such as function and expectations. The clothing we prefer ***not*** to wear in a particular situation can be as interesting as the clothing we have chosen to wear (Gradén & McIntyre, 2009, p. 23). Through the ages fashion has changed, as has the value of clothing. Today in the Western world clothes are cheaper than ever, and it is easy to buy more and more clothing items and let them fill up our wardrobes or discard them after just a short period of usage. Even with modern technology in textile production, it is still costly to produce clothing, and Western clothing prices do not correspond to these costs. Many workers suffer because of the missing connection between production cost and sale price (Morgan,

2015). However, the human need to fit into a particular social group, and the need to look 'right' for that purpose, is too strong for people to wear clothing until it is worn out even though it would be the right thing to do based on labour and environmental issues. As Kate Fletcher states:

> To choose what we are and what we do with clothes daily is to have the power to alter the fashion system. The confining and captivating parts of our fashion experiences become a new view on what is possible. (Fletcher, 2016, p. 23)

These thoughts lead to the question I would like to examine. Is there something to be done from the view of a designer and tailor in the field of ready-to-wear clothing production which can facilitate a longer period of use for clothing items? As my professional expertise is that of a clothing designer and tailor, I will examine this question from the view of my profession. An important perspective in this text is that it is 'from within' practice that I as designer-tailor am questioning and generating knowledge from inside of the field (Dunin-Woyseth & Nilsson, 2012, pp. 38–39).

Research problem and research question

The overarching research problem is how garment disposal can be reduced to meet sustainable challenges. I have formulated a research problem that is investigated through a literature review: ***Why are clothes disposed of before they are worn out?*** On the basis of this review, the research question is formulated: ***How can the cut of a prototype be graded to fit different female body shapes?*** This question is being investigated through a case study.

My overarching research problem on how garment disposal can be reduced can be examined from diverse angels. The focus of my research does not include investigations on capitalism and economic systems, the financial aspects of clothing production or how to shift from masses of ever-cheaper clothing of low quality to fewer, more expensive clothing items of high quality. Nor will it touch on the role of fashion and the ongoing

changes in trends – what's 'in' or 'out' – or other aspects of the production of clothing beyond fit in clothing. My research is not about the development of new textile materials or the finishing of fabrics. I will not cover strategies to meet different target groups or ethnic or social and gender perspectives. These are, of course, important aspects of the question of the overconsumption of clothing, but it is not where my expertise and professional knowledge lie and will therefore not be a part of the research in this thesis.

Reasons for garment disposal

In this chapter I will investigate through a literature review why clothes are disposed of before they are worn out.

Previous research, presented below, gives some answers as to why clothes are disposed of before they are worn out. Studies investigating why people stop wearing their clothes can explain why the disposal of clothing is so high in countries such as Norway, the UK and other comparable wealthy countries. As will be discussed below, there are some differences between men's and women's clothing consumption. The main difference between men and women in terms of clothing is that men find it easier than women to find garments that fit their body. There are many reasons for this: men's fashion over the last decades has had a looser fit than women´s clothing. Female bodies also change more in size and shape throughout life than male bodies. Ready-to-wear clothing, factory-made clothing that is not tailored to a particular person, is offered in fewer styles for men than for women and often offered in a bigger range of sizes than women's wear. I will therefore concentrate on women's clothing. By studying the factors leading to clothing disposal, I will discuss what clothing designers and tailors working in ready-to-wear clothing production can do in their practices to facilitate the optimization of the user period.

My path through the literature in the field

I will start this review through the literature in the field by reviewing problems with fit as a reason for the disposal of clothing. This is followed by addressing the current practice on sizing systems, grading and ease, concluding with designers' research related to pattern construction and fit in clothing. These topics constitute the field in this thesis. In this review I have been looking into the literature to answer my research question of why clothes are disposed of before they are worn out. This research problem controls the selection of my review through the literature in the field that presents the state of the art in the actual field.

My starting point for my path through the literature in the field is this question What is it about clothes that causes them to be either worn out or, alternatively, not to be worn until they are disposed off? I have chosen to focus on fit in clothing with the practice of pattern construction in mind. This is because the practice of pattern construction is one part of the question 'What is it about clothes that causes them to be either worn out or, alternatively, not to be worn until they are disposed off?' in which I have my expertise and am therefore able to contribute the most to the production of new knowledge.

Problems with fit as a reason for the disposal of clothing

In ***Consumer Reuse and Recycling of Post-consumer Textile Waste,*** Domina and Koch (1999) describe their survey concerning the reasons for the disposal of clothing (see Fig. 1). The survey was sent to 1000 randomly chosen households from the telephone directory in central Michigan in the US. Of 396 people responding to the questionnaire, 88% were women, whose average age was 38 years (Domina & Koch, 1999, pp. 348–349). The respondents could select multiple reasons for their disposal of clothing during the previous year, and the question was why they would choose to give away clothing to different organizations, pass it on or use it as rags. Therefore the total percentages exceeded 100%. Fig. 1 shows one of the most mentioned reasons was that the garment did not fit. But the table also shows that the respondents do not want to waste garments. The most frequently chosen reason for discarding shows the respondents' aim to find ways to reuse or recycle discarded clothing (Domina & Koch, 1999, p. 351).

	Methods of textile disposal [a]						
Reasons for discard	**C %**	**SA %**	**RO %**	**GS %**	**PO %**	**R %**	**MR %**
Not wasted	**69**	**78**	**78**	**82**	**70**	**64**	**69**
Did not fit	**71**	**75**	**64**	**87**	**82**	**28**	**49**
Valuable	**75**	**- [b]**	**41**	**76**	**76**	**-**	**35**
Convenience	**45**	**65**	**-**	**63**	**37**	**34**	**-**
Out of style	**50**	**57**	**41**	**-**	**-**	**28**	**41**
Tired/bored	**-**	**-**	**-**	**62**	**32**	**-**	**-**
Damaged	**-**	**-**	**-**	**-**	**-**	**91**	**46**
Helps needy	**-**	**86**	**86**	**-**	**-**	**-**	**-**

[a] C = consignment; SA = Salvation Army; RO = religious organization; GS = garage sales; PO = passed on; R = rags; MR = modified and reused.
[b] (-) = not applicable.

Figure 1. Methods of disposal of textiles and reasons for disposal. Source: Domina and Koch (1999).

One could speculate whether behind the wish to not waste useable clothing there are reasons the respondent did not want to wear the clothing herself. Here there can be hidden reasons about bad fit that the respondent might not be able to formulate.

Collett, Cluver and Chen (2013), in ***Consumer Perceptions the Limited Lifespan of Fast Fashion Apparel***, focus on finding out why 'fast-fashion' clothing, inexpensive clothing produced rapidly and based on the most recent fashion trends, has such a short user period. A qualitative study was conducted consisting of a survey and interviews with 13 female students at a university in the Pacific Northwest of the US. After 13 interviews the researchers obtained redundancy in the findings, and therefore the interviews were ended. The students had started a master's programme in design and/or marketing. These students were selected as informants because they had had personal experiences with the use of fast fashion and were educated to work as professionals in the clothing sector. The informants were asked to bring five fast-fashion clothing items they no longer used to the interview. Part two of the interview contained questions about the factors that came into play when the informants stopped using the fast-fashion clothing they had brought with them. The reasons for disposal mentioned by the informants were coded and summarized. Through the 13 interviews, 451 reasons were mentioned. Of these, 184 reasons related to quality, 171 reasons related to fit issues, 47 reasons were related to style and 49 reasons were related to the user being tired of the garment (Collett et al., 2013, pp. 63–64).

The results of this study show that lack of quality together with problems around fit are the two main reasons for the disposal of fast-fashion clothing items. Fast-fashion garments are associated with low price, and the huge amount of clothing disposed of every year in countries such as Norway and the UK could be indicative of the fact that people in high-consuming societies more often buy many cheap garments than few expensive ones. If the price is low, it is easier to quickly pick a piece of clothing, maybe without trying it on first, and accepting the lack of good fit; however, these items are more likely to remain unused at home.

In ***Sizing Up the Wardrobe—Why We Keep Clothes That Do Not Fit,*** Bye and McKinney (2007) discuss why the respondents in a study keep clothes in their wardrobe that do not fit. Three hundred people, randomly selected from a mailing list of 2000 from an image consultant company in the south-western US, were sent a questionnaire. Of these, 46 women responded to the questionnaire. The informants were asked to write the number of garments they had in their wardrobe that they could not use because the garments did not fit their body. Fifteen per cent had 0 clothing items that did not fit, 37% had 1–10 clothing items that did not fit, 17% had 11–20 clothing items that did not fit, 15% had 21–50 clothing items that did not fit and 16% could not report the number but gave estimates such as 25%. Of the 46 respondents, 85% sorted clothing from their wardrobe once a year (Bye & McKinney, 2007, p. 487). On the question of why the respondents kept these non-fitting clothing items, the answers fell into four categories, including investment value (most mentioned), weight management, sentimental value and aesthetic object (Bye & McKinney, 2007, p. 488). I interpret this study as meaning that clothing items to which the owner has an emotional connection are more difficult to dispose of than clothing items towards which the owner is neutral. This applies both to favourite garments that are worn out and garments never used or worn only a few times.

Klepp (2001) did a study, described in ***Hvorfor går klær ut av bruk? Avhending sett i forhold til kvinners klesvaner*** [Why do clothes come out of use? Disposal in relation to women's dress habits], on clothing disposal in relation to women's dress habits. She focused on fashion and wear and tear as arguments for the disposal of clothing. In the study, 24 women in Norway aged around 40 years were interviewed about their clothing habits. Klepp (2001) personally selected informants from among her social network. This made it more likely that the informants wanted to give their time and effort to participate in the survey. She chose women living in bigger cities and in the countryside and from different professions. The informants were asked to collect clothes they no longer used or that they wanted to get rid of. Six months later, these clothes were documented and the reasons the respondents gave for no longer using them were recorded. Fig. 2 shows the total result of the reasons the respondents gave for disposal, organized into the following six

categories: 1) situational obsolescence, 2) functional obsolescence, 3) quality (technical) obsolescence, 4) psychological obsolescence, 5) not used and 6) preservation.

	Type of obsolescence	*Percentage of total number of registered reasons*
1	Situational (The owner has developed new consumer needs, such as changed body size, has other similar clothes, or clothes have too narrow use area.)	19%
2	Functional (New and better products have come to the market.)	1%
3	Technical or quality-related (The product is worn out, ruined or is uncomfortable in use.)	35%
4	Psychological (The owner is tired of the product and wants something new, does not use that style anymore, or clothes that seem outdated.)	31%
5	Never used (Product not suitable for purpose. Often bought on impulse or received as present.)	13%
6	Museal (The owner takes the product out of use and keeps it for other purpose, does not want to use it in order to not to ruin it.)	1%
Total		100%

Figure 2. Reasons for disposal as percentage of the number of reasons and as percentage of the amount of clothing. Source: Klepp (2001). English version source from Laitala and Boks (2012, p. 126).

Klepp (2001) did not put special emphasis on fit issues as a reason for disposal, but in reviewing the report I have extracted the most relevant examples in terms of fit issues. Fit problems may lie behind other reasons for disposal. For example, Klepp describes a yellow trouser suit which has had several owners, but no one has worn it. The respondent is not able to tell what is wrong with it, and since it has not been worn for many years, it could be out-dated in fashion. But why did its first owner not wear it? SIFO, a Norwegian governmental institute that conducts consumer research, tested the garment and concluded that the jacket is too narrow through the shoulders and is therefore uncomfortable in use. Klepp defines this as a technical error of the trouser suit (Klepp, 2001, p. 175). One could speculate whether lack of good fit for the first owner of the yellow trouser suit made her not wear it. Such fit problems can be due to the quality of the pattern construction or the proportions of the garment not fitting the body shape of the first owner.

Other reasons for disposal from the study that could be indicative of having something to do with fit are as follows:

- Situational obsolescence: The respondent has changed in size, 17%.
- Quality (technical) obsolescence: Uncomfortable in use, 6%; failed repair or changes, 1%. The subcategory in category 3 (Quality (technical) obsolescence), ***Uncomfortable in use,*** represents 6% of the reasons for disposal. This category is described as discomfort related to both the cut and the materials.
- Psychological obsolescence: Not (anymore) becoming/flattering, 5%.
- Not in use: Never used, 9%; used only a few times, 10%.

Summarizing these reasons, it is reasonable to think that as much as 58% of the reasons may have something to do with the garment not fitting the user's body.

Klepp mentions several aspects of fit related to body shape. On the basis of her study, she claims that the user period is affected, becoming shorter, for clothes that have a low tolerance for changes in body shape. When the garment does not fit properly, it invokes the user's attention. A garment that needs to be corrected feels uncomfortable in use. Obvious corrections are needed when the skirt is too tight to walk in, the blouse slips out of the trousers or the straps fall down from the shoulders and the like (Klepp, 2001, p. 133). She concludes that there is a need for more technically oriented textile research in which the body's interaction with clothing is put into focus. In previous research, the body has been less a focus; though, as this study shows, it plays a significant role as it relates to both wear and tear and changes in body shape as reasons for disposal (Klepp, 2001, p. 174).

An interesting result of Klepp's study from 2001 is a response to a commonly claimed reason for disposal, namely, that clothes go out of use due to changes in fashion. Her study shows that clothes that were discarded because of out-dated fashion were older (8.05 years) than the clothes that were discarded because of wear and tear (7.5 years).

This means that clothes, if they are actively worn, are worn out before fashion has changed so much that they are discarded because of out-dated fashion. This may be because garments can be left unused for years and then discarded because of out-dated fashion (Klepp, 2001, p. 162). My assumption is that fit issues can be a major reason that clothes are kept unused for many years. Even if the reason for the disposal after years lying unused in the wardrobe is out-dated fashion, the reason for not wearing the garment when it was still in fashion may be lack of good fit.

In four articles (Laitala, 2010, 2014; Laitala & Boks, 2010, 2012) about clothing design for sustainable use through social and technical durability, a survey is described in which respondents answered questions about garments they no longer wear. This information was used as a source for designers promoting the sustainable use of clothing. In 2010 a questionnaire was sent to 1300 households in Norway. Of the 546 responses received, 77% were from women (Laitala & Boks, 2012, p. 128). The survey focused on consumers' experiences of and opinions about their clothing habits, focusing on routines of maintenance, disposal and environmental initiatives. The 546 responses received are not directly representative of the Norwegian population since, among others, the age range of 25 to 39 was overrepresented, and the cases were not weighted (Laitala & Boks, 2012, p. 128). Respondents were asked what needed to be different if they were going to use their clothes several times (see Fig. 3) (Laitala & Boks, 2012).

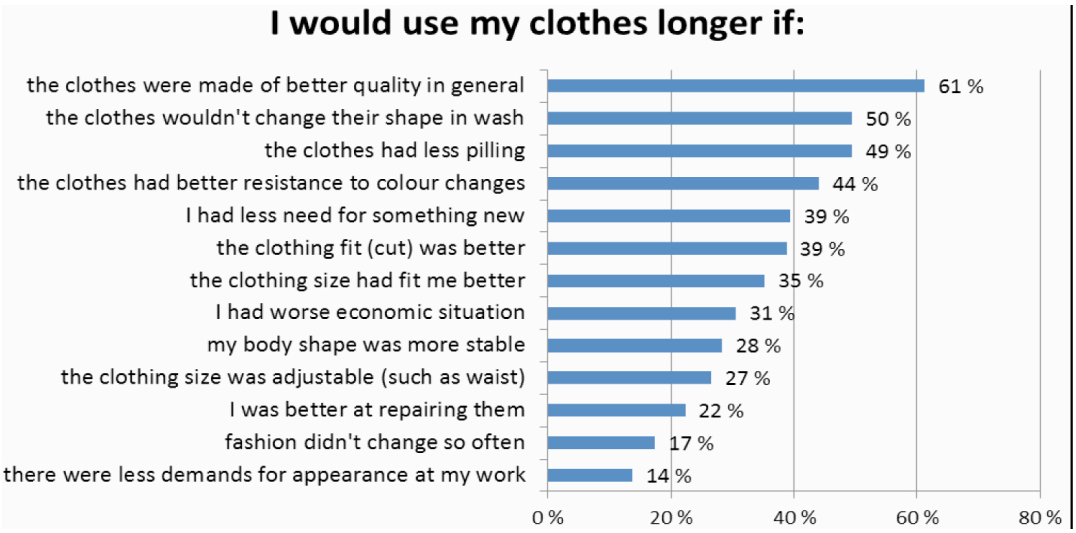


Figure 3. Percentage of respondents agreeing to each statement as the second part of the sentence 'I would use my clothes longer if...'. Source: Laitala and Boks (2012).

Certain statements are interesting in relation to fit issues as a reason for disposal: the clothing fit (cut) was better, 39%; the clothing size had fit me better, 35%; my body shape was more stable, 28% and the clothing size was adjustable (such as waist), 27%. Also here, as in Klepp's (2001) survey, a large percentage of the statements may be associated with fit issues related to the respondents' experience with ready-to-wear clothing.

The research also included a qualitative study in which 16 households were interviewed about reasons for the disposal of clothing. The households collected garments that had gone out of use over a period of six months and filled in a list of their clothing acquisitions. The respondents were then interviewed about the reasons why the garments went out of use. In total, 619 garments were registered. The respondents gave up to five different reasons why a garment was no longer used. These reasons were categorized into 63 subcategories, which were then divided into seven main categories:

1) Size and fit issues (too large or small, outgrown, fit at specific areas, etc.): 19%;
2) Changes in garment (such as abrasion, colour changes, broken zipper or staining that cannot be cleaned): 49%;
3) Fashion or style changes (either fashion or individual style changed): 5%;
4) Functional shortcomings (such as unpractical, electrostatic or too cold in the area to use): 6%;
5) Situational (does not fit with other clothes, no occasions to use it or have several similar or better garments): 8%;
6) Taste-related unsuitability (for example dislike of style, colour or design): 11%;
7) Other or unknown: 2% (Laitala & Boks, 2012, p. 130).

The reasons for disposal for men and women (see Fig. 4) were relatively similar except in terms of fit issues, which were more than twice as often mentioned as an argument for disposal for women than for men (Laitala & Boks, 2012).

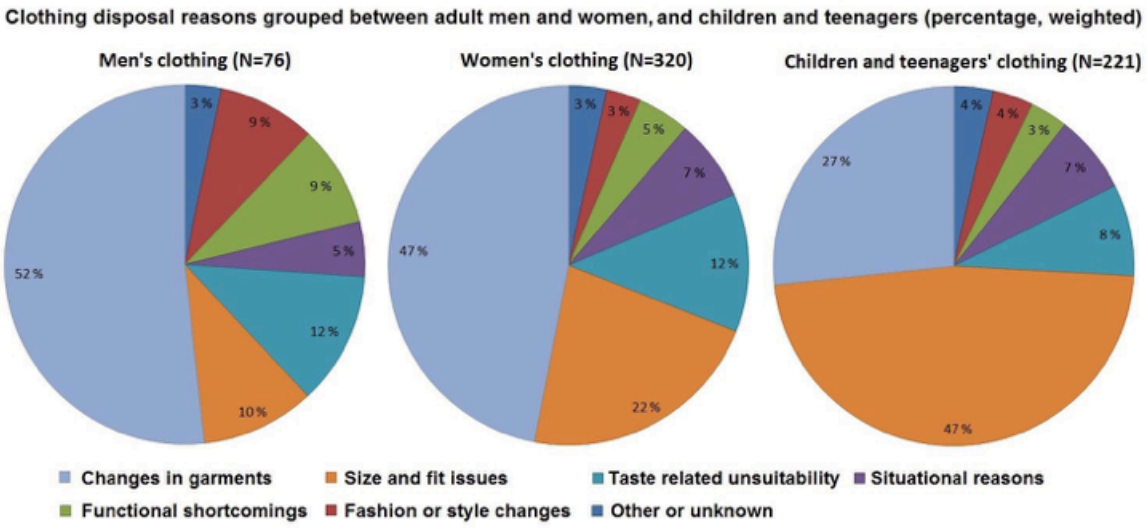


Figure 4. Reasons for disposal in groups of men, women and children/teenagers (N = number of clothing items). Source: Laitala, Boks and Klepp (2015).

During the qualitative interviews with the respondents from the 16 households, the respondents had difficulties putting into words why a garment that is not worn out has gone out of use. This clearly parallels the previously described survey conducted by Klepp (2001). Often, respondents state that they just do not wear the garment or do not like it. When urged to elaborate, the respondents gave varied answers; some said that the garment does not suit them, that it is difficult to combine with other clothes, that it feels out-dated or that the respondent did not like the colour or patterning (Laitala & Boks, 2012, p. 131). These responses can, in my own experience with customizing clothing by body shape for my customers and students, often hide fit issues, but these are not apparent to those unskilled in tailoring, and therefore they use other expressions. The survey also shows that 18% of the clothes that were out of use had never been worn or had only been worn once or twice (Laitala & Boks, 2012, p. 131). My assumption is that the reasons for a garment never being used, or used only a few times, can be about lack of good fit for the respondent.

Laitala and Boks (2012) conclude that there is a major design challenge in women's clothing, namely, the adaptation of clothing to different body shapes. Not many ready-to-wear garments on the market today are well-fitting on different bodies while being

flexible enough for continued use when weight and body shape change. Laitala and Boks (2012) claim that a greater focus on this issue by designers and clothing manufacturers would enable the production of clothing that could be used for a longer period. They refer to studies on clothing sizes and fit showing that patternmakers usually make a prototype of a small size to use for grading into larger sizes. However, it has been shown that there is greater variation in body shape among women who wear large sizes and that it is also this group that reports the most problems with fit (Laitala & Boks, 2010, p. 12).

These surveys on reasons for the disposal of clothing show that fit issues are quite often mentioned as reasons for disposal. As I argue, fit issues may lie behind an even larger proportion of the reasons for disposal. It seems that the sizing system used in the production of ready-to-wear clothing does not correspond with the sizes and body shapes of a representative target population. To find out more about this, I will explore the origin of sizing systems and how grading practices and applying ease to patterns affect the fit of clothing. The aim is to determine whether there are possible changes to be made in these practices that can make it more likely for a larger portion of the population to find well-fitting garments among ready-to-wear clothing. One could speculate whether this in the long term will affect whether and how long a garment is being used.

Sizing systems, grading practice and ease

The Industrial Revolution led to the first mass production of clothes on a large scale. This created a need for profitable systems for the industry to produce well-fitting clothes for a population with a large variation in size and body shape. Variation in body shapes involves a variety of proportions and body postures that affect how clothing fits different bodies. The complexity surrounding dress sizes is larger than that for other supplies related to body size, such as furniture or bikes, which ergonomically fit a wider range of users (Ashdown, 2007, p. xvii).

The current practices in the production of ready-to-wear clothing use sizing systems

developed by individual companies. These sizing systems are based on individual choice and grading practices. They are not standard sizes designed with the average measurements from a target group from a current population area. Producers want to provide a range of sizes; however, they also want to avoid confusion among consumers who are looking for an appropriate size. The consumer may perceive clothing negatively if she has to try on many different sizes to find one that fits. This is often cited as the reason manufacturers usually have a smaller range of sizes. However, too few sizes may lead to consumer dissatisfaction because she cannot find clothes that fit her. The challenge of developing a sizing system is that it should not have too many sizes but also not too few (Petrova, 2007).

According to Petrova (2007), usually, manufacturers copy existing size tables or use size tables they have developed based on the desired target group. Size tables are often adjusted by trial and error, but the size designation – that is, small, medium, large – remains the same. This leads to mismatches between the size designations from different manufacturers. It is also not clear whether a size designation refers to a body measurement or a measure from the garment, such as whether the waist size is the size of the garment at the waist or the size of the consumer's waist. Companies may prefer to use their own size tables rather than standard sizing systems because they are afraid of losing their signature if they are using the same size table as other manufacturers. In this context, it is important to point out the difference between body measurements and garment measurements (garment sizing). The amount of design ease, or the ease that is added to a pattern to alter its silhouette or general shape, a designer chooses to put into a garment does not affect the body measurements for which the garment is made. This is where manufacturers can show their individuality even if they use the same sizing systems as other companies (Petrova, 2007, pp. 60–61).

However, poor equivalence among sizing systems is not the only reason clothes often do not fit the target group; it may also be because of inadequate pattern construction. How a garment fits the body depends on how and where wearing ease is placed in the

garment; ease should not be the same for all sizes but rather customized to the different sizes. It is not common practice for manufacturers to use a fit model for each size. Usually there is one fit model used to fit a prototype of the base garment, and then changes are transferred to the pattern before handing it over to be graded. Thus, ease and garment fit to body shape is not adjusted to different body shapes and body sizes (Petrova, 2007, pp. 81–82).

From a historical perspective, the development of standard sizes arose from the need for large numbers of military uniforms around 1700. The 18th-century Age of Enlightenment, with an interest in science and mathematics, also gave rise to attempts to turn pattern construction and grading into mathematical systems. Until the mid-1800s, it was common for a tailor to measure the customer over the top of his or her clothing or take measures of the customers clothing (garment measurements). Early documentation of measures taken straight from the body for use in pattern construction is in the handbook for tailors by JG Bernhardt of Dresden, dating from 1810 to 1820. By 1860, several conditions were in place to enable mass-produced ready-to-wear clothing. Along with stable measurements (cm/inch), the practice of taking body measurements, graded block patterns and the mechanical and technical needs were set for the mass production of clothing (Aldrich, 2007, p. 21).

Towards the end of the 19th century, clothing for men was being produced in ready-to-wear versions, but the tailored upper parts of women's fashion of the time were still tailored individually. Gradually made-to-measure clothing, which was made by taking a few measurements and could be ordered without a fitting by a tailor, came on the market for women. In the early 1900s, woman's fashion changed to less structured garments with a looser fit, worn without a corset underneath, making it easier to mass produce ready-to-wear clothing for women (Aldrich, 2007, p. 38).

With the development of ready-to-wear clothing came the need for a fixed schema of measurements for various sizes. The first American large-scale anthropometric survey for

women (and children) was conducted between 1939 and 1941. In the post-war period in the UK, the recovery of the industry also focused on developing an improved sizing system for the clothing sector. Surveys of British body measurements were carried out, and in 1953 the British Standards Institution (BSI) published a set of body measurements based on these surveys. However, companies and manufacturers wanted to continue using their own sizing tables, so the BSI allowed significant tolerance for deviations from the standard. The International Organization for Standardization (ISO) began work on an international standard for sizes of clothing in 1969. In the beginning, this work was all about finding a consistent size designation for the labelling of clothing (Aldrich, 2007, p. 46). During the second half of the 1900s, a European sizing system for the northern European body type was developed by the Comité Européen de Normalisation (CEN). This and other sizing standards are optional for use by manufacturers (Aldrich, 2007, p. 47).

The concept ***standard sizes*** is often used with regard to sizing tables that are not developed to a standard. To qualify as a standard sizing system, a standard must be published by a governing organization that works with standards. The two leading organizations that have been active in the development of standards for sizing tables for clothing are ASTM International (until 2001 known as the American Society for Testing and Materials, founded in 1898) and the ISO, founded in 1947 (LaBat, 2007, pp. 88, 92).

Since body shapes and sizes vary so much between population groups, there is no point in creating current size charts for the entire world population. However, there should be a standard for ***how*** to develop sizing tables based on anthropometric measurements from different population groups. This is a part of the work the ISO is conducting. First, there is a need for common agreed-upon definitions and terminology for the various objectives to be included in a sizing chart, as follows:

- *Control dimensions/key dimensions*: Body dimensions used to classify the population into groups.
- *Primary control dimensions:* Divides the population into size groups for the task that

is considered to be most important for the particular garment type.

- ***Secondary control dimensions:*** Size groups are divided into subgroups now by the second most important measure for the construction of the actual garment.
- ***Tertiary control dimensions:*** If required, the size group is divided into several subgroups for appropriate measurements for the garment.
- ***Size range:*** Control dimensions are related to specific body measurements that vary between a fixed minimum and maximum that constitutes the size range.
- ***Accommodation rate:*** Part of the population that is selected to fit into the size range. Often this is not everyone in a population, so parts of the population have measurements that are beyond the range of a sizing system.
- ***Size scale:*** Control dimensions divided into a scale of sizes.
- ***Size interval/step size/size grade:*** Size scale has variable or fixed steps between sizes.
- ***Secondary dimensions:*** Dimensions needed for the construction of the garment along with the control measurements in each size group.
- ***Drop:*** The relationship between the dimensions used to identify body types.
- ***Size designation (labelling):*** The term for the size of the garment.
- ***Sizing system/size roll/tariff system:*** Size charts showing the dimensions for each size (Petrova, 2007, pp. 63–65).

When a standard sizing system is developed for a population, it is important that proper measurements be taken on a representative part of the population. LaBat (2007) claims that most standard size tables available today are based on measurements that are not representative of the relevant population group. To illustrate this LaBat (2007) uses the US as an example. In 1939–1940 the US Department of Agriculture sponsored an anthropometric survey to be used for developing a size chart for women's clothing. In total, 10042 women in eight states were measured. These women were white, volunteer participants in the survey, and the large majority were in the age group 18–30 years, therefore not constituting a representative part of the US population, including Hawaii's population. The US Department of Agriculture published the results of the survey ***Women's Measurements for Garment and Pattern Construction*** (LaBat, 2007, p. 94). This was not a standard, but in 1958 it was used by the Mail Order Association of America (MOAA) to develop a standard that was published as a voluntary product standard by the National Bureau of Standards (NBS) as ***CS 215-58 Body Measurements for the Sizing of Women's Patterns and Apparel***. MOAA used these standard sizes in their production of clothing but experienced no reduction in complaints about dissatisfaction with fit. They

therefore took the initiative to improve the sizing system. NBS published a revised version of CS 215-58 but did not carry out a new anthropometric survey. Instead measures were adjusted based on, among other things, health surveys from 1960 to 1962 showing that women were taller and heavier than in 1940. NBS released their revised version, Voluntary Product Standard PS 42-70 ***Body Measurements for the Sizing of Women's Patterns and Apparel***, in 1970. In 2001, ASTM International published a standard ASTM D5585 ***Standard Table of Body Measurements for Adult Female Misses Figure Type, Sizes 2–20***. This standard was also not based on new anthropometric measurements. Instead, samples of sizing tables from different manufacturers were compared along with some data from anthropometric studies from the military. The cited reason that new anthropometric data were not obtained was the high cost of such research, especially when the measurements are done manually (LaBat, 2007, pp. 94–95).

The common practice for the production of ready-to-wear clothing is to start with a garment's key dimension, for example, bust width. Then the anthropometric measurements of the bust width from the actual target group is found, and the range of bust widths is divided into 10 sizes, with similar intervals between the sizes. This practice has nothing to do with developing a sizing system based on the anthropometric measurements of a target population from size to size (Gupta, 2014). Gupta (2014) claims that this way of developing sizing systems leads to satisfactory fit for only 20% of the target group.

The Textile Clothing Technology Corporation ($[TC]^2$) performed several international surveys on sizes using body scanning and software to develop sizing systems according to body measurements. This work resulted in the systems SizeUSA, SizeUK, SizeGermany, SizeKorea and SizeMexico. These sizing systems are representative of the actual populations. These new anthropometric studies show that the current standards in sizing systems are not equivalent to the population's body measurements. Body measurements of bust, waist, hip, high hip, abdomen and stomach were, with help from the software, divided into seven different body shapes of hourglass, rectangle, diamond, oval, tubular,

triangle and inverted triangle (Fig. 5). In comparison with ASTM D5585, characterized by the ideal hourglass figure, SizeUSA data showed that only 8% of women have an hourglass figure, while 80% have a rectangle, triangle or inverted triangle body shape (LaBat, 2007, p. 97).

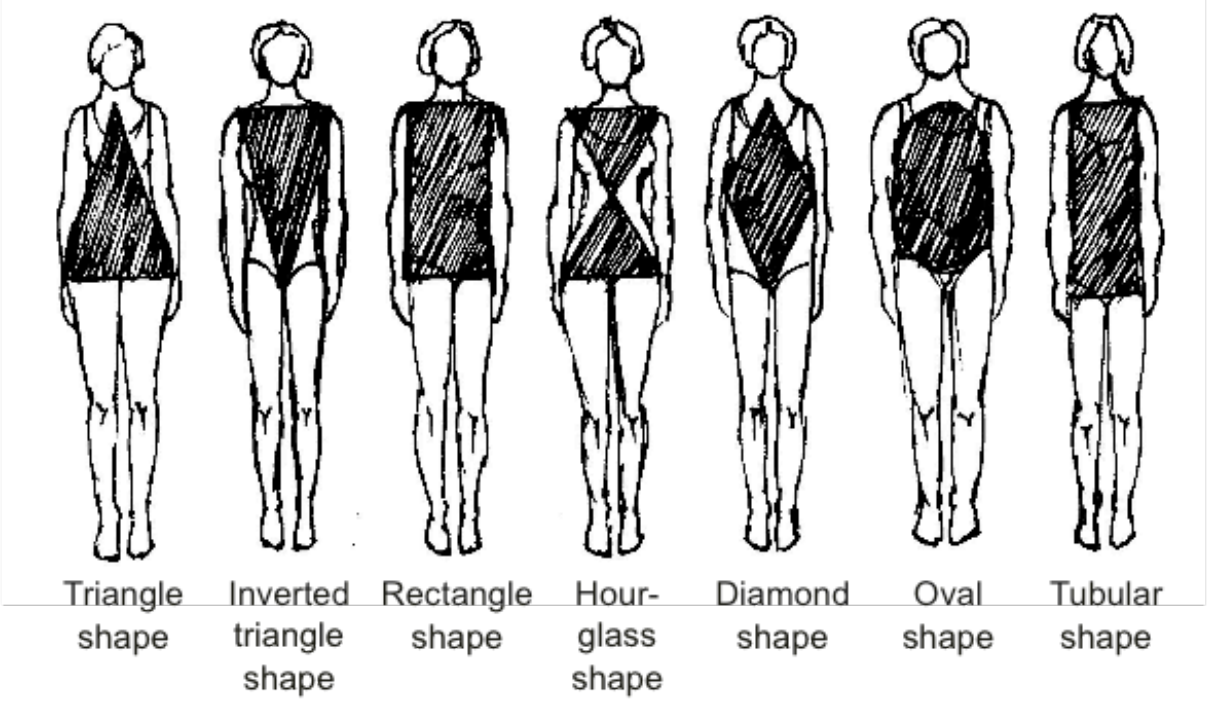


Figure 5. Different body shapes (drawing by the author).

The fact that the sizing systems used by manufacturers of ready-to-wear clothing are mostly not representative of the actual population (Ashdown, Lyman-Clarke, Smith, & Loker, 2007, p. 370) leads to many people not being able to find appropriate clothing for their body shape and size in ready-to-wear clothing stores. On the subject of clothing sizes and size labelling, Laitala, Klepp and Hauge (2011) and Laitala, Hauge and Klepp (2009) described their research conducted in Norway, Sweden and Finland. Their research questions were which consumer group has the greatest difficulty finding clothes that fit their body and preferences and the implications of the current sizing systems for consumers (Laitala et al., 2011). A questionnaire was distributed via the Internet, for which respondents checked off the answer that best matched their reality. The topics of the questions in the study included experiences with and opinions about dress sizes and experiences of their own bodies. Of the 2834 people who responded to the Internet

survey (1958 Finns, 497 Norwegians, 331 Swedes and 48 from other nationalities), 81% of the respondents were female. In addition to the quantitative survey, qualitative in-depth interviews were conducted in Norway with eight people, three men and five women (Laitala et al., 2009). Here the aim was to interview people who had atypical body types according to the sizing systems used for ready-to-wear clothing. Respondents were asked what dress size they normally wore and were asked to describe their physique, weight and height. They were then asked whether they experienced it as easy to find clothes that fit their style, size and body shape (see Fig. 6). Respondents who felt it was difficult finding clothes that fit their body shape were divided into groups by gender and by size/ body shape, as shown in Fig. 7 (Laitala et al., 2011).

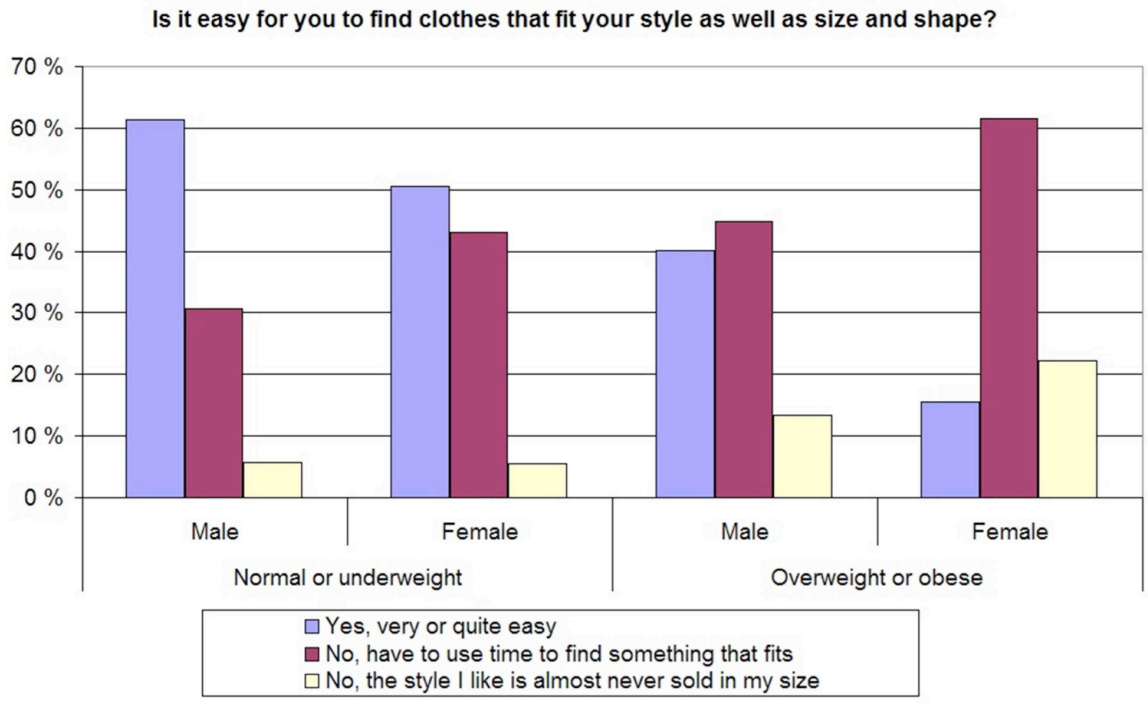


Figure 6. Is it easy for you to find clothing that fits your style, size and body shape? Source: Laitala et al. (2011, p. 30).

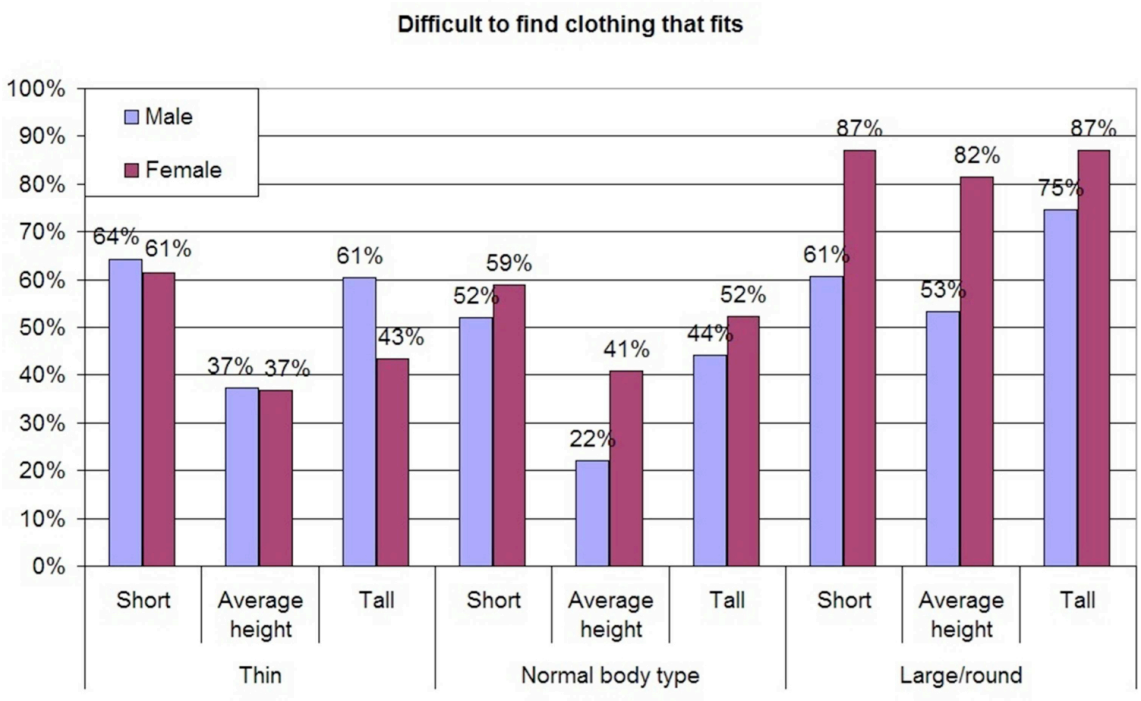


Figure 7. Percentage of respondents that have difficulties finding clothing that fits. Source: Laitala et al. (2011, p. 30).

As Fig. 7 shows, women have greater difficulty finding suitable clothes than men. Men with normal height and weight and thin women of average height find it easiest to find clothes that fit them. Women with a rounded or large body shape and thin and short men have trouble finding clothes that fit. The groups of respondents who find it difficult to find clothes of appropriate size also report that they rarely or never find the appropriate clothing in addition to style that meets their preferences. For example, a large young woman feels she must dress like an old lady, and a big man may only be able to find among formal outfits black suits that fit him (Laitala et al., 2011, p. 32).

Laitala et al. (2011, p. 35) observed that women who found it easiest to find clothes that fit their body weighed less than the average weight for women. For men, those in the average weight group found it easier to find clothes. Laitala et al. (2011) claim that it seems consumers that are close to the leading body ideals find it the easiest to find suitable clothes for their bodies (Laitala et al., 2011, p. 35).

To determine whether there were specific parts of the body that were most problematic to fit in mass-produced ready-to-wear clothing, respondents were asked to describe their arms, legs, chest, waist, hip circumference, shoulders and balance between upper and lower body. An analysis of the results showed that respondents for whom parts of their body deviate from what is considered to be normal or ideal had trouble finding clothes that fit. Out of the men who experienced difficulty finding suitable clothes for their body shape, a total of 81% of the male respondents, 71% described their arms and back as short, 68% described their shoulders as narrow, 67% described a large hip measurement and 65% a large chest. Of the women who experienced difficulty finding clothes that fit their body shape, 85% described themselves as having a big belly or waist, 80% a large bust, 79% short arms, 78% a large hip measurement, and 75% broad shoulders (Laitala et al., 2009).

LaBat and DeLong (1990) conducted a study, described in ***Body Cathexis and Satisfaction with Fit of Apparel,*** in which respondents discussed how satisfied or dissatisfied they were with how ready-to-wear clothing fits their body. The selected respondents consisted of 107 women since women experience more problems with ready-to-wear garments than men. The interviewees ranged between 19 and 40 years of age and were recruited from among students in Fashion Design from the University of Minnesota in the US. In addition to questions about how satisfied or dissatisfied the informants were with the fit of ready-to-wear garments on their bodies, they were also asked how satisfied they were with parts of their body. The results showed that there was more dissatisfaction with the fit of ready-to-wear clothing on the lower body than on the upper body (LaBat & DeLong, 1990, p. 46).

Otieno, Harrow and Lea-Greenwood (2005) conducted a study, described in ***The Unhappy Shopper, a Retail Experience: Exploring Fashion, Fit and Affordability,*** focusing on consumers who wear dress size UK 16/EU 44+. The proportion of women wearing size UK 16/EU 44 and larger is highest in the age group 45 years and older (Otieno et al., 2005, p. 299). In the UK, 250 women answered a questionnaire. The women had mixed

sizes, and the survey contained additional questions for sizes UK 16/EU 44+. Eighty per cent of the interviewees were 18 to 40 years of age. Participants were recruited from two major shopping malls, the Trafford Centre and the Arndale centre in Manchester. Of the women, 37.2% wore size UK 16/EU 44 or bigger, and out of these 65.6% wore UK sizes 16 to 18 (EU 44–46). It is common practice for sizes up to UK 14/EU 42 to be designated as the standard sizes, and consequently there is a large variety of clothes that are not manufactured in sizes over UK 14/EU 42 (Otieno et al., 2005, p. 303).

The informants were asked on a scale of 1 to 4 (where 1 was very easy and 4 was very difficult) how easy or difficult it was for them to find suitable clothes in different categories. A larger proportion of the UK 16 (EU 44) size women had difficulty finding suitable underwear (55.8%), swimwear (50.7%) and evening wear (52.8%). These are typical garments that require a higher degree of fit and that fit closer to the body than comparatively loose t-shirts, baggy pants or skirts with elastic waistbands. Furthermore, the informants were asked whether they could find clothes that were comfortable and well-fitting. Of all the 250 women who responded to the survey, 45.3% responded yes to this question. Of the women who wore size UK 16+, 34.1% answered yes to the question of whether they could find well-fitting clothes. This means 54.7% of all women and 65.9% of women who wear UK 16+ had difficulty finding well-fitting clothes for their body size or shape (Otieno et al., 2005, p. 305).

Respondents in the UK 16+/EU 44+ sizes were asked how they felt when they could not find clothes that fit them well. Of the respondents, 60.7% felt frustrated and mentioned feelings such as dissatisfaction, demotivation, anger, disappointment, sadness, embarrassment over their own size, depression and an experience of feeling less feminine (Otieno et al., 2005, p. 307).

How a garment fits the body is connected with satisfaction and wellbeing. If the wearer is happy with how the garment fits her body, this contributes to mental and social wellbeing, Alexander, Connell and Presley (2005) state. How a garment fits the body and

which cuts are favoured is individual and subjective. A survey conducted by Alexander et al. (2005, p. 57), described in ***Clothing Fit Preferences of Young Female Adult Consumers,*** was distributed to 232 female students at a university located in the US. A total of 223 responses were collected. Using drawings, respondents checked three options for how they preferred different types of garments to fit their body. They also checked what body shape they themselves thought they were, with the options including rectangular, pear shaped, inverted triangle and hourglass figure. They were also asked whether they were satisfied with the shape and size of various parts of their body. Nearly 64% of the respondents replied that they had to change ready-to-wear garments often to make them fit. Another 54% of the respondents were from somewhat satisfied to mostly dissatisfied with how ready-to-wear garments fit their body (Alexander et al., 2005, p. 59).

Informants grouped by different body shapes reported fit issues focusing on different parts of their body. The groups of rectangular, pear and hourglass shaped more often reported problems with the fit around the bust than the inverted triangle shaped. The groups of pear and hourglass shaped reported higher rates of fit issues at the waist, hips, thighs and dress and pant lengths than groups with rectangular and inverted triangle body shapes. The group with the inverted triangle body shape was, among all respondents, most satisfied with the fit of ready-to-wear clothing (Alexander et al., 2005, p. 59).

Respondents who reported fit issues around the bust also seemed to prefer a loose fit through the bust. The same was seen in respondents who reported fit issues around the hips and armholes or neck; they preferred a loose fit in these areas. A close/tight fit was preferred among respondents who reported fit issues around the crotch on trousers and around the waist. The respondents who were satisfied with the size and shape of various body parts wanted a tighter fit through these areas (Alexander et al., 2005, pp. 59–61).

Petrova and Ashdown (2012) describe, in ***Comparison of Garment Sizing Systems,*** a research study in which four size systems were compared. The starting point for the study was issues related to the standard sizes and the reported dissatisfaction of users

who cannot find clothes among ready-to-wear clothing that suits their body (Reich & Goldsberry, 1993).

> For example, Newcomb and Istock (2004) analysed data from the 2003 SizeUSA anthropometric study (http://www.sizeusa.com/) and found that the body shapes targeted by the ASTM (American Society for Testing and Materials) sizing standards for juniors (ASTM D6829-02), misses (ASTM D5585-95R01), and women over 55 (ASTM D5586-01) are not the body shapes most commonly found in U.S. population. (Petrova & Ashdown, 2012, p. 267)

Since it has been shown that the tables of measurements behind the standard sizes do not correspond to the average of the actual population's measurements, Petrova (2008) modified the tables of body measurements for misses ASTM D5585-95R01 to make the measurements correspond better with measurements from the average of the US population (Petrova, 2008).

The study focuses on garment ease in terms of how the garment fits different body shapes and sizes. Common practice is that the same amount of ease is added to all sizes. Previous studies done by the authors (Petrova, 2007; Petrova & Ashdown, 2008) indicate that the ease should vary according to the size. Larger sizes usually require a larger amount of ease than smaller sizes.

> The four sizing systems used in the study were as follows:
> 1) SS: Standard body measurement table (ASTM D5585-95R01) graded with constant ease;
> 2) SE: Standard body measurement table (ASTM D5585-95R01) graded with size-dependent ease;
> 3) MS: Modified standard body measurement table (ASTM D5585-95R01) graded with constant ease;
> 4) ME: Modified standard body measurement table (ASTM D5585-95R01) graded with size-dependent ease (Petrova & Ashdown, 2012, p. 272).

Thirty-two test jackets were made for the survey, eight for each of the sizing systems SS,

SE, MS and ME, and in sizes 2 to 16. For the study, 81 women were recruited, aged 26 to 55 years, who covered the sizes from 2 to 16. The height of the study group was between 160 and 172 cm. Chest and hip circumference were part of the study but no other dimensions. Three fit experts, professionals in fashion design and garment construction for clothing and each with at least 10 years of experience teaching pattern construction and fitting on the body, were engaged for the study. They evaluated the fit of the test jackets using photos (Petrova & Ashdown, 2012).

The jackets fitted the bodies of the research group to various degrees. The results from the study showed fit ranked from best to worst fit as follows:

- ME (Modified standard body measurement table graded with size-dependent ease);
- MS (Modified standard body measurement table graded with constant ease);
- SE (Standard body measurement table graded with size-dependent ease);
- SS (Standard body measurement table graded with constant ease) (Petrova & Ashdown, 2012, p. 282).

Schofield and LaBat (2005) discussed the relationships between grading, sizing and anthropometric data, examining how the grading of different sizing systems affects the size fit for different body shapes and sizes. Women often blame themselves if they are having trouble finding clothes that fit them. When they find that ready-to-wear garments do not fit them, they find errors and deficiencies in their own body shape and size instead of blaming the sizing system (LaBat & DeLong, 1990). Large-scale anthropometric studies have been carried out in an attempt to make the sizes of ready-to-wear clothing fit the US population better. Schofield and LaBat (2005) believe that this does not provide the whole solution to fit issues in relation to standard sizes. To develop a standard sizing system that fits the current population, body measurements and the measurements that underlie grading to different sizes should be based on anthropometric data from large-scale anthropometric studies. Schofield and LaBat (2005) conducted a study to examine whether this was the case. The authors found little documentation on how the tables of measurements that are approved as standards were developed and what measurements are used in grading practices. Therefore, the authors studied 40 tables of measurements

from 1873 to 2000 and compared the measurements for the upper body and the grading within the different sizing systems (Schofield & LaBat, 2005, p. 14). Schofield and LaBat (2005, p. 19) found the following:

A) Constant intervals between sizes became more prevalent during the second half of the 1900s, and the six tables of measurements from 2000 that were included in the study all had constant intervals between the sizes. This is convenient for the patternmaker doing the grading, but it departs from the anthropometric measurements.

B) All vertical measurements increase as the sizes increase. Therefore, women who are not similarly tall as they are wide must either select size for their height or for their width.

C) The differences between gauge measurements (hip circumference minus breast circumference and breast circumference minus waist circumference) are constant for all sizes in the measurement tables from 2000. In previous measurement tables, the difference between gauge measurements was ranged depending on the size. The US Sizing Standard 1958 operated with three hip circumferences defined by the difference between the breast circumference and waist circumference. Presumably, a constant difference in all sizes was chosen because the number of sizes can then be reduced.

D) All measurement tables from 2000 used three different measures for grading – 1 inch for the smallest sizes, 1 ½ inches for medium sizes and 2 inches for the larger sizes. This system of grading was also used in the US Sizing Standard from 1970. Former measurement tables graded with different measurements also depended on the size.

The findings of Schofield and LaBat (2005) all show a reduction in fitting to different body shapes while also finding higher efficiency in the work of grading sizes and a more streamlined system compared to fitting to anthropometric measurements. If the

standard sizes can fit a large group of women, the grading should follow the women's body dimensions (Schofield & LaBat, 2005). This is possible, but then grading practices must be changed, and each size must be graded separately. Today software exist that can handle grading even without constant, linear or proportional rules for the grading (Schofield, 2007, p. 190). If the grading is done individually for each size and based on anthropometric measurements, it will be possible to have garments that fit equally on the body for all sizes. This is not the case in today's practice (Schofield, 2007, p. 193).

Salusso, Borkowski, Reich and Goldsberry (2006) describe how they have worked out suggestions for greater diversity in sizes on the basis of measurements from a research group. The authors focused on women aged 55+ because of the high difficulty among this group of finding suitable clothes in stores. Salusso et al. (2006) used a database from a survey from the ASTM Institute for Standards Research in 1990 performed on women 55+ years of age. The database contains 57 body measurements from 6657 women. A data analysis strategy called the Principal Component Sizing System (PCSS) was used as the basis for analysing the data (Salusso et al., 2006, p. 101). The researchers developed a data analysis strategy called PCSS-55+ and were able to classify 95% of the 6657 women into 25 size categories. These 25 size categories contain five height categories. For garments where height has no significant impact on the fit, this can be reduced to five size categories. For garment types such as tight-fitting trousers, where the length of legs and the body affects the fit, keeping the 25 different size categories is recommended (Salusso et al., 2006, p. 108). The authors conclude that a variation in size according to body shapes that are measured on a real test group would make mass-produced ready-to-wear clothing more viable and sustainable (Salusso et al., 2006, p. 109).

The results of research surveys on different aspects of the fit of clothing, such as sizing systems, grading and ease, can point to possible alternative procedures to be made in tailoring practices for the mass production of ready-to-wear clothing. Changes can be made towards a better fit for the majority of a particular target group. The next section presents a deeper exploration of actual grading practices. How the grading is done is

crucial to whether ready-to-wear clothing will fit the different body shapes representing a clothing producer's target group.

Grading practice

Pattern grading is the practice of increasing and decreasing a pattern to create different sizes in a size range in the production of ready-to-wear clothing. Apparel grading is the process of how to increase and decrease a prototype pattern or base-size pattern. The increasing and decreasing is done according to a set of body measurements and proportional relationships. The goal is to develop a range of sizes for production. A grading system is developed from sizing specifications. Ideally, anthropometric measurements are the base for the sizing specifications. According to Schofield (2007), each size in a size chart should be based on anthropometric data for precisely that specific body size. Then the increases used during the grading to create each new pattern should be based on the size charts developed from anthropometric data (Schofield, 2007, p. 152). Further, Schofield describes the current method of grading patterns. There is reason to question the actual relationships between anthropometric measurements, sizing systems and grading in today's practices in clothing production. Schofield (2007, p. 152) writes that apparel companies often do not have access to appropriate anthropometric measurements. This leads to grading practices that rely on flawed reasoning and varying prior practices, resulting in clothing that may not fit a person who has the measurements given for the actual size on a size chart (Schofield, 2007, p. 152). In ***Pattern Grading for Women´s Clothes: The Technology of Sizing,*** Cooklin (1990, p. 8) notes that 'a pattern grading system cannot be fundamentally correct if the principal propositions have not been derived from authoritative data obtained by scientific methods' (Schofield, 2007, p. 152).

Schofield (2007, p. 153) describes the structural assumptions that form the base of the grading process. Her study shows that these structural assumptions, such as proportional rules and set increments, are not based on anthropometric measurements. She

compared a block pattern for the upper torso graded with traditional grade rules with a block pattern graded based on her findings. Based on this comparison, she describes the current criteria and goals of grading and presents improved criteria and goals for grading and for evaluating graded patterns (Schofield, 2007, p. 153).

To better understand the current practice of grading a prototype and show the basis for my own research, I will explore Schofield's (2007) study more deeply. Before the end of the 1800s there was no demand for sizing systems as the overall practice was for a dressmaker or family member to fit clothing directly on an individual. Pattern-drafting systems were developed between 1820 and 1840 (Kidwell, 1979). In these first systems, the bust measurement was input to different formulas to calculate the other measurements that were needed. The first mass-produced paper patterns from the 1860s also took the bust or waist circumference as starting point for a size (Kidwell, 1979). This initial measurement was used to derive all other measurements using proportional dressmaker systems. These proportional dressmaker systems were based on assumptions about the relationships between body measurements rather than on anthropometric measurements and human dimensions.

The first fitted ready-to-wear clothing items for women came on the market late in the 1800s. The pattern grading system that was used for these garments was based on a fixed proportional relationship between lengths and circumferences (Schofield, 2007, p. 157). According to Cooklin (1990), this idea of a fixed relationship between lengths and circumferences was the incorrect assumption that led to clothing that fit only very few women. When the first anthropometric measurements became available, from a US study in 1941, with a few small exceptions, the clothing industry did not take up the use of size charts or grading based on anthropometric measurements (Schofield, 2007, p. 157).

Today patterns are graded using automated computer-based grading techniques. The manual grading practice has been digitalized but remains basically unchanged. Skilled

people with extensive knowledge about grading and patternmaking for garments are still needed. The grader understands what changes from size to size are expected in a size range (Schofield, 2007, p. 157).

The process of grading begins with the pattern pieces for the prototype of a garment. The prototype is either fitted on a human fit model or on a dress form. Usually a company chooses the fit model based on the kind of body size and shape they want to represent to their target market. According to Workman (1991), the typical size of a fit model is UK size 8–10, with a bust circumference between 34 ½ and 35 inches (EU size 36–38, bust 87.5–91 cm). The prototype that constitutes the base size is usually not the smallest size in the actual size range but rather somewhere between the small and medium sizes in the anticipated range. Before grading a pattern it is important that the prototype is fitted well and that the corresponding seams are correctly matched. If not, errors in the pattern pieces will be reproduced and possibly magnified during the grading into the full range of sizes (Schofield, 2007, p. 158).

Next in the grading process, the zero point of reference on each pattern piece is decided. All increases and decreases are made relative to this zero point. Then the cardinal points are chosen. Cardinal points are points at the edges of a pattern piece, usually dart points or corners, to which grading increments are applied (Schofield, 2007, p. 158). Whether or not the same interval is used for the bust, waist and hip girths and changes are made by the same amount for all sizes should be determined. Common practice today is to always use the same increments for these girths, and this is usually taken for granted. This increase is called the ‘grade’ (Schofield, 2007, p. 158).

Now there are several decisions to make which rely on the experience and ability of a skilled grader. To keep the same fit of the prototype to the body in all sizes, the grade interval must be divided into appropriate amounts for each pattern piece (Schofield, 2007, p. 158). The terms ‘grades’ or ‘grade breaks’ refer to the amount of decrease or increase for the three major girths – bust, waist and hips – between the sizes in a size

range. The common practice is that a size range is divided into three groups of sizes, and the same amount of decrease is used for the major girths. This makes a stair-step decrease in a size range, that is, the 'grade breaks'. The US size charts use 'grade breaks' of 1 inch (2.5 cm) for the small sizes, 1 ½ inches (3.8 cm) for the medium sizes and 2 inches (5.1 cm) for the large sizes. This schematic use of 'grade breaks' is not based on anthropometric measurements from a target group but rather comes from the fact that grading, until recently, was done manually, and therefore grading had to be simplified to be feasible. Because the 'grade breaks' are smaller for the small sizes and bigger for the large sizes, there is a greater range of sizes to choose from among for small women than for bigger women (Schofield, 2007, p. 169).

The number of women today who fit into the sizes developed using the different grade-break sizes does not correspond with the results from the US anthropometric measurements. O'Brien and Shelton's survey of the US population from 1941 shows that the grade breaks of 1, 1 ½ and 2 inches correspond with the anthropometric measurements of the population in 1941. In that 1941 survey, 53% of the women fitted in the group of sizes with a grade break of 1 inch. An additional 25% fitted in sizes with a grade break of 1 ½ inches, and 22% fitted in sizes with a grade break of 2 inches. The body size of US women changed between 1941 and 1988, when the next anthropometric survey on US Army personnel was published (Gordon et al., 1989). The results from the 1988 survey showed that 29% of women fitted in the sizes with a grade break of 1 inch, 45% fitted in sizes with a grade break of 1 ½ inches, and 26% fitted in the sizes with a grade break of 2 inches. The population groups in Western countries have generally increased even more since 1988, and the distribution of sizes according to the grade breaks no longer corresponds with a population that has a greater number of larger women (Schofield, 2007, pp. 169–170).

Common practice today is to use constant intervals for all sizes within the grade break. However, constant intervals also do not coincide with anthropometric data (Schofield, 2007, p. 170). Sizing intervals are either incremental or relative. Incremental means that

the sizing interval has a constant value that is applied to all sizes, whereas a relative sizing interval means that the sizing interval has different values for each grade break. As described earlier, the body circumference interval increases for each grade break. Thus, the results are different depending on whether incremental or relative sizing intervals are added. Additionally, cardinal points can be graded with incremental or relative sizing intervals. Incremental sizing intervals are used more often than relative sizing intervals, the latter of which are used only for horizontal grade rules such as the shoulder point, sleeve notches, underarm point and side waist point (Schofield, 2007, p. 171).

Schofield (2007, p. 173) has examined whether anthropometric measurements have a direct relationship to the grade rules used in the grading of a block pattern for the upper torso. She defined the following three criteria to determine whether anthropometric measurements can be used to create grade rules:

1. The measurement must be either horizontal or vertical,
2. The measurement must relate to only one grade rule and
3. The measurement must be related to a body landmark.

The first criterion means that garment measurements that do not lie flat on the body cannot be used for grading because the body and garment measurements do not correspond. An example of this is the centre front length, which is measured between the breasts, while the garment span is measured from bust point to bust point (Schofield, 2007, p. 173). The second criterion means that a measurement that spans over two or more cardinal points needs to be divided into grade rules for each cardinal point. Circumference measurements do not give enough information to derive grading data/ information. For example, the common grading practice is to divide bust, waist and hip increases equally between front and back pattern pieces (Schofield, 2007, p. 174). If grading information is derived from anthropometric measurements, it would be better to base the rules on the front arc and back arc body measurements. If this is done,

separate changes can be made to the side seams in the front and in the back. The third criterion means that to be able to reproduce measurements, cardinal points on a pattern should be matched to body landmarks. Body landmarks are physically definable points on the body, such as a bony prominence. Common practice is that many measurements on size charts are not matched to body landmarks. For example, the side seam does not have any identifiable body landmarks.

Schofield (2007, p. 174) found that only five out of 30 commonly used measurements of the bodice are useful for grading information. The five measurements that passed the three criteria and are useful for grading information are the scye depth, front and back shoulder widths, side neck to bust point and bust point to bust point width. The back shoulder width is the only one of these five measurements commonly seen in size charts. Schofield (2007, p. 175) suggests an improvement of the practice and recommends 20 measurements for the upper torso to establish links between size charts and grading. These 20 measurements require the definition of body landmarks.

Schofield (2007, p. 179) gives several suggestions to improve grading practices by basing the practice on anthropometric measurement, some of which I describe here. In standard grading, all sizes use the same difference between the major girths. When the horizontal increases at the bust, the waist and hip are the same; this is called an even grade. This means, for example, that all sizes in a sizing chart usually have the same difference (e.g. 2.5 cm) between the bust and waist circumference. Instead, the major girths – bust, waist and hips – should vary by different amounts from size to size in a sizing chart (Schofield, 2007, p. 181). She argues that

> The use of grade breaks is an artificial structure for sizing charts. These results indicate that use of grades, constant size intervals and constant grade rules may not create garments that fit well across a population. In particular, these results suggest that waist and hip circumferences should increase at different rates from the bust to maintain fit over the range of sizes. At one time there were functional reasons for maintaining an even grade, when all grading was done by hand and needed to be simple enough to maintain quality. Restricting size

> intervals to constant amounts is now unnecessary since grade rule tables are stored in computers. Each grade rule can be a different amount. (Schofield, 2007, pp. 181–182)

Common grading practice is to use identical horizontal components for front and back grade rules. A better fit will be achieved if the front increase is greater at the bust level than the increase at the back. Moreover, a greater increase for the cross-back than the cross-chest is better than the same increase in the front and back chest areas. At the waist the increase should be greater at the front than the back and vice versa at the hips (Schofield, 2007, p. 182).

Schofield (2007, p. 184) developed a test block pattern for the upper torso and graded this pattern with two different grade rules. The TRAD-block pattern (Fig. 8) was graded with traditional grading methods, while the TEST-block pattern (Fig. 9) was graded with grade rules based on Schofield's findings and recommendations for improving grading practice. Two of the most obvious differences between the TRAD and the TEST graded patterns are at the bust and the vertical location of the waist seam. The TRAD set is created to fit a B-cup bra in all sizes, while the TEST set increases up to a D-cup bra for the largest size (Schofield, 2007, p. 188). The vertical length from the underarm level to the cardinal point at the waist decreases by 3 mm for each size on the TRAD set. This is done differently in the TEST set, where the smallest size has the longest vertical length from the underarm level to the waist compared with each larger size.

> Differences in grade rules affect size and shape of all garment elements. For the 1988 anthropometric survey women, especially in large sizes, garments graded using traditional grade rules would not provide good fit in many areas of the body. In particular, the neck of the traditional graded garments would tend to be too wide and the sleeve cap would tend to hang off the shoulder, while the TEST garments should fit more of the population properly in these areas. In addition, the proportion front to back at bust level, the position and shaping for the bust, and the size and height of the waist for garments graded using the TEST grade rules should better reflect the population. Although individual variations will result in some misfit from any set of garments graded to create standard sizes, the garments graded using anthropometric data should fit more of that population

better than those graded on the basis of unproven assumptions. (Schofield, 2007, p. 189)

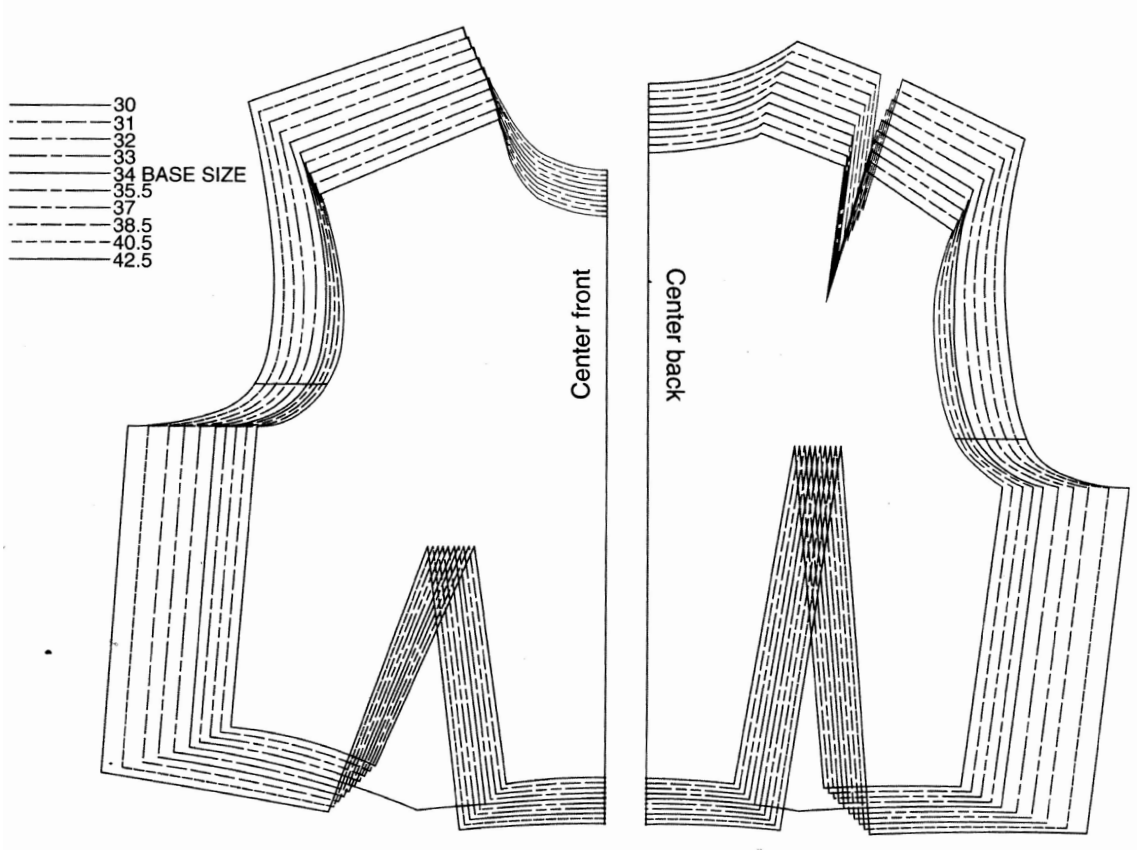


Figure 8. TRAD set of patterns based on traditional grading. Source: Schofield (2007, p. 156).

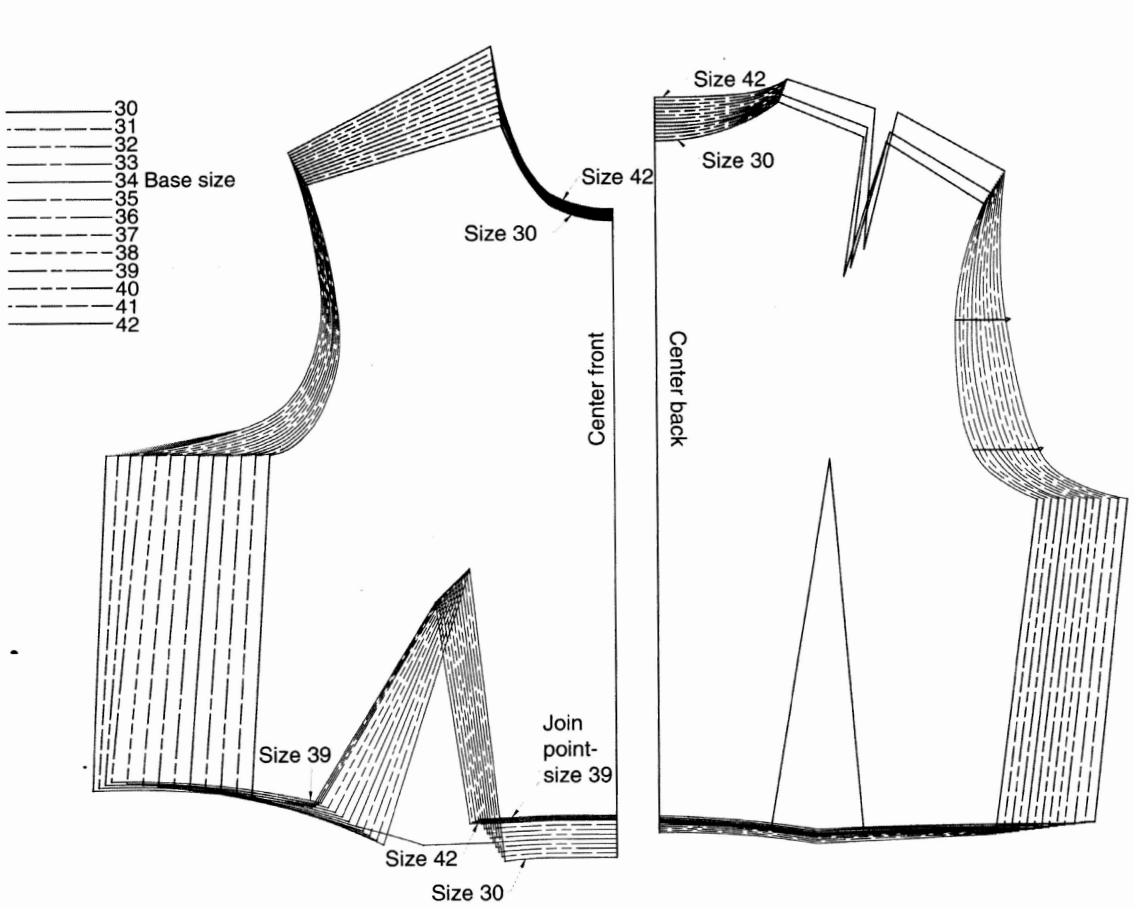


Figure 9. TEST set of graded patterns based on Schofield´s findings. Source: Schofield (2007, p. 186).

The grader's work requires a large amount of skilled, expert knowledge to position and apply the grade rules to the great variety of pattern pieces handed over by the designer. Grading quality is judged by a visual inspection of the nested grade of all pattern pieces. A nested grade means all pattern pieces line up from the same zero point, one within the other (Schofield, 2007, pp. 189–190). Through his expert knowledge, the grader can see at a glance whether or not the grading is properly done. The criteria for visually inspecting a traditionally graded nested grade are as follows:

- Straight lines are parallel;
- Cardinal points are evenly spaced;
- Curved seam lines follow the same shape;
- A straight line can be drawn through matching cardinal points, or a jointed line if grade breaks are used.

If a skilled grader visually inspected the nested grade of the TEST set, it would not pass any of the traditional grading criteria. In contrast, the TRAD set would be accepted as correctly graded. However, garments made with traditionally graded patterns do not fit the majority of the actual population, while garments made with the methods by which the TEST set was graded do fit the majority of the actual population. As previously described, it is understandable that the manual grading of the past required simplification to make the grading process workable. However, today computer grading methods make it possible to use different grade rules for every size (Schofield, 1990, p. 190).

The goals for the work of grading are that the graded garment should maintain the original visual effect, maintain the original style of the design and maintain the look and fit of the original garment (Schofield, 2007, p. 190).

> The goal of grading should be to create a garment for each new size that will provide the same fit as the base size garment. This goal may not be compatible with use of nested grade to judge how similar the patterns are for each size. A set of patterns judged to be an appropriate nested grade by the industry will provide the same fit for women in the size range only if those women have the same proportions as the base size fit models. The goal of maintaining the same standards of fit for all sizes requires that changes used for grading should reflect the changes between real body dimensions over the range of sizes. If any of the proportions change over the range of sizes, then the lines of the patterns in a nested grade will not be parallel. It is necessary to define the existing key criteria and to add another criterion to update the evaluation of a graded set of patterns. (Schofield, 2007, pp. 190–191)

A new way of evaluating whether or not a nested set of pattern pieces are well graded must be developed (Schofield, 2007, p. 192). As the goal of grading is to develop a set of well-made pattern pieces, that is, graded in a way that leads to a graded set of patterns that yields garments which fit all sizes the same way as the prototype fits the fit model, the visual inspection of a nested grade is not appropriate as an evaluation method. Instead the grader should focus on the fit of each individual sized pattern by using grade rules based on measurement data from a representative target group and evaluate the pattern on representative fit models for each size or on realistic dress forms (Schofield,

2007, p. 192). The grader needs to learn to evaluate pattern pieces whose shapes are not familiar. This, of course, is not as clear and simple as the common practice and will be more difficult to carry out. Schofield (2007, p. 193) argues that the required technology is available and that together with research tools can be developed to change grading practices from outmoded to realistic. Such changes affect, of course, many levels in clothing production. The designer, patternmakers and graders need to shift from working with an ideal body shape and proportions to making garments that fit the real population. Schofield (2007, pp. 194–195) believes that most population segments would be served with well-fitted garments by clothing companies if sets of primary body measurements from reliable anthropometric data from the clothing producers' target markets were provided to direct grading information and size charts.

Designers' research related to pattern construction and fit in clothing

In my practice as a designer and tailor I have identified problems with fit, which I have taken a closer look at in the previous text and responded to from the view of a designer/tailor. Before proceeding I will take a look at some related research projects conducted by designers.

Rissanen's (2013) thesis ***Zero-waste Fashion Design: A Study at the Intersection of Cloth, Fashion Design and Pattern Cutting*** has several parallels to my own thesis. The overarching goal in his research is to reduce to zero the fabric waste when cutting the pattern pieces for clothing in fabric. Rissanen's (2013, p. 2) motivation behind the desire for waste reduction is to move the fashion industry in a direction where environmental and ethical considerations are taken. Rissanen's profession and expert knowledge is in fashion design and pattern cutting (Rissanen, 2013, p. 2). In today's practice in clothing factories the fashion designer is not the one doing the so-called marker, that is, the pattern layout, meaning the lay plan for cutting. This process is done by the marker-maker – the person responsible for creating the lay plan for cutting (Rissanen, 2013, p. 3). When it comes to the grading of zero-waste patterns, Rissanen proposes the following five possible grading processes: one-size-fits-most, conventional grading, designing

each size individually, using a different fabric width for each size and a hybrid method (Rissanen, 2013, pp. 123–124). Designing each size individually during the grading of a zero-waste prototype has some parallels to the outcome of the study in this thesis. In this possible grading process for a zero-waste pattern the designer works together with the patternmaker and grader to make sure that the visual aspects of the prototype garment are retained and that the pattern is zero-waste. This grading process might be more time consuming than conventional grading where the grader produces a range of sizes with the patterns of a garment as a starting point (Rissanen, 2013, pp. 124–125). Similar to my study I also propose the designer working together with the patternmaker and grader, but in my case, in order to take into account the different body sizes and shapes that are representative for each size during the grading process. Also, this grading process might be more time-consuming than the conventional grading of a garment pattern. Rissanen (2013, p. 5) argues that the aim of zero fabric waste should be the concern of the fashion designer when sketching the design of a clothing item. Similar to Rissanen (2013), I will take a closer look at one out of several issues in the clothing production. While Rissanen (2013) focuses on the fabric waste from cutting pattern pieces in clothing production, I will focus on the way of grading a prototype according to fit in clothing. Our motivation for doing research is probably the same: to move the fashion industry towards taking responsibility for environmental and ethical issues by changing the practice in clothing production.

With the clothing designer and tailor Rickard Lindqvist's (2015) thesis ***Kinetic Garment Construction – Remarks on the Foundations of Pattern Cutting*** I share the concern of constructing well-fitting clothing to the human body. While traditional pattern cutting is based on the horizontal and vertical measurements of an upright body position, Lindqvist (2015) presents a kinetic method of pattern cutting based on the interaction between '… the anisotropic fabric and the biomechanical structure of the body' (Lindqvist, 2015, p. 7). Instead of working from outside and towards the body, the kinetic garment construction method works from the body outward, offering enhanced functional possibilities for fit in clothing (Lindqvist, 2015, p. 7).

Simoes (2012) wrote her PhD thesis ***Contributions for a New Body Representation Paradigm in Pattern Design: Generation of Basic Patterns after the Mobile Body*** at the University of Lisbon. Simoes (2012, p. xix) made her way from an interest in painting to fashion design. After studying the practice of pattern construction from the year 2000 onward, she did research on the representation of the body in pattern design and the possibility of woven clothing patterns to cater for the movement of the body. Simoes (2012) questions the pattern design discipline that commonly has opted to fit the body in the static, standing position. Instead of continuing shaping patterns for the static body, she argues for providing pattern shapes suited to the deformable moving body (Simoes, 2013, p. 73). As Simoes, the representation of the body in pattern construction, is also my concern when focusing on fit in clothing to different body shapes and body sizes.

The former apparel industry designer and patternmaker and now educator Morris Campbell wrote his PhD thesis ***The Development of a Hybrid System for Designing and Pattern Making In-Set Sleeves*** (Campbell, 2010), therein stating:

> This thesis is an alternative to the design and in-set sleeve pattern making status quo. It is a search for a new combined design and pattern making system to take the place of the many contemporary, and often-times conflicting, pattern making techniques. It is the development of a new system with computer aided design potential to enable the non-technical designer, in the ready-to-wear (wholesale) apparel sector, the ability to produce sleeve patterns without practical pattern making knowledge. (Campbell, 2010, p. 4)

Similar to my approach Campbell (2010, p. 1) is interested in 'the relationship between the designer, the patternmaker and the elements that constitute a multiplicity of in-set sleeves' (Campbell, 2010, p. 1). Campbell (2010, p. 1) as well sees his contribution to knowledge suited for the clothing industry by investigating the research question: 'How might the role of the designer, the tasks of the patternmaker, the many in-set sleeve styles and related fabrics, be combined to create a unique inclusive in-set sleeve design system that is advantageous to the apparel industry?' Through his research project Campbell (2010, p. 4) offers an alternative to the common practice in the clothing industry regarding

design and in-set sleeve patternmaking. He developed a time-saving combined design and patternmaking system with computer-aided design potential to enable employees in the clothing industry to produce sleeve patterns even without patternmaking knowledge (Campbell, 2010, p. 4). An improvement of the current practice in the clothing production is my concern also. Where Campbell (2010) has focused on in-set sleeve patternmaking, I concentrate on how a prototype is graded into a size range to offer well-fitting clothing to the majority of a given target population.

Summing up my path through the literature in the field

The quantity of textiles discarded every year, 30 kg annually per UK inhabitant (Allwood et al., 2006) and 24 kg annually per Norwegian on average, indicates that clothing is not worn out before disposal. Life cycle studies of clothing counting the number of times a garment has been worn show that the clothing is not worn out. Reasons garments come out of use have been gathered from studies in which respondents explain why they have stopped using the discarded garments. Various studies from several countries show the same two main reasons for why women's garments come out of use:

1. The garment does not fit the user's body in the way the user desires and
2. the undesirable quality of the material (e.g. bumps, stretch, holes).

The current practice among manufacturers of ready-to-wear clothing indicates that various international organizations dealing with standards (ISO and ASTM) have developed tables of measurement to standardize sizing. These standards are only partly based on anthropometric measurements. Moreover, the anthropometric measurements used in the standards may be out-dated and not representative of the actual population. Manufacturers often prefer to use their own sizing systems and tables of measurements and do not want to use standard sizes because they are afraid of being too similar to other manufacturers (LaBat, 2007, pp. 102–103). To allow for as many people as possible to find appropriate garments in ready-to-wear clothing stores, grading practices could be improved by working with individual measurements for each size. This is possible

by using advanced computer software to do the grading rather than relying on manual grading systems. The ease in the garment could be adjusted individually between sizes. In this way the garment would appear similar in different sizes. Finally, the cut could be adapted to the typical body shapes for the different sizes, optimizing how the garment suits different body shapes. The factors that affect the fit of clothing based on the presented research can be summarized in the following four significant aspects:

A) The measurements and proportions underlying sizing systems used by patternmakers to make the block patterns

B) The grading practice, that is, increases and decreases to create different sizes, and how and with which measurements the sizes increase and decrease

C) The amount of wearing ease and design ease, and how and where ease is applied to a pattern, affecting how tight or loose different parts of a garment fit the body

D) The pattern construction and cut of the garment and how this can be adjusted to make all sizes in a size range appear the same; this is not the case with the majority of today's mass-produced ready-to-wear clothing

Previous research has been done on A, B and C, sizing systems, grading and ease, respectively. I have not been able to find previous research on D – how pattern construction and cut can be adapted from size to size to provide the majority of a target group with well-fitting clothing. This gap in the field will be the fundament for my research question.

Introduction to the research question for the case study

In this chapter I will follow up the pattern construction and cut of the garment and how this can be adjusted to make all sizes in a size range appear the same; this is not the case with the majority of today's mass-produced ready-to-wear clothing (point D from the previous chapter). The aim of the following case study is to investigate how the cut of a prototype can be graded to fit different female body shapes.

I intend to improve tailoring practices for ready-made clothing in order to offer well-

fitting clothing to the majority of a target group. The overarching goal, as mentioned earlier, is how an alternative procedure in tailoring practices for ready-to-wear clothing can influence a shift towards a more sustainable means of clothing production. In the context of ready-to-wear clothing production, how can clothing be made well-fitting for the majority of a producer's target group? Thus, I attempt to investigate the following research question: ***How can the cut of a prototype be graded to fit different female body shapes?***

Based on earlier research on the subject (Schofield, 2007; Zakaria, 2014), I assume there is a need for different and varying individual changes in shape and cut between the sizes in a sizing system in order to offer a good fit for the majority of a target group. The common practice today is either tailor-made garments for an individual customer or factory-made ready-to-wear clothing. When clothing is tailor-made for an individual customer, a good fit can easily be achieved, but this is not the case for the majority of factory-made ready-to-wear clothing. It is reasonable to think this does not need to be so.

The concept of ***fit*** in this thesis is used for the relationship of the proportions, size, volumes and shape of a garment to the figure and body shape of the wearer. The term ***clothing production*** refers to the mass production of clothing in sizes from a size range. The term ***cut*** refers to the shape of the fabric pieces sewn together to form a garment and forming the style or shape of the garment. A ***prototype*** of a garment style is an example of the garment that is constructed similarly to the final product and uses the final fabrication method intended for the final product. The term ***pattern construction*** refers to patternmaking or the cutting of patterns for garment construction. The ***grading process*** is the practice of how to increase and decrease patterns to create different sizes in the field of pattern construction. By ***well-fitting*** I mean that I, as a designer and tailor, assess good fit according to the functions and criteria that I describe for the clothing item. This assessment is characterized by my professional attitudes and values. As long as the desired functions and criteria for fit behind a clothing item are described, it will

also be clear what 'well-fitting' would mean in a particular case. This means that 'well-fitting' depends on what kinds of functions and comfort are desired. 'Well-fitting' will be evaluated in relation to the values and assessments on fit in the field of clothing design and tailoring. ***Ready-to-wear*** clothing (in French, ***prêt-à-porter***) means factory-made clothing in sizes chosen by the producer or following standardized sizing systems. 'Ready-to-wear' clothing is not tailor-made clothing for an individual customer but clothing design manufactured multiples of one design. ***Clothing producer*** refers to bigger or smaller companies that do mass production of ready-to-wear clothing. These companies usually have a target market. Customers in the target market for a clothing producer represent the ***target group.***

The concept of ***design*** in this thesis is defined as Simon (1996/1969, p. 111) describes the design activity: 'Everyone designs who devises courses of action aimed at changing existing situations into preferred ones' (Simon, 1996/1969, p. 111). Simon (1996/1969, p. 111) sees design as an intellectual activity that makes up the core of all professional training. The ***clothing designer*** in this thesis is seen as a professionally trained person who performs design activity in his field.

This thesis addresses problems around fit in ready-to-wear clothing for women. The research is done by a designer-tailor mainly working on one-of-a-kind-collections and tailor-made clothing. A designer-tailor refers to a person trained both as a clothing designer working in two and three dimensions and as a tailor working with tailor-made clothing for individual customers or working as a tailor in ready-to-wear clothing production. The research conducted by a designer-tailor clearly gives another focus on the research question than if, for example, a grader working in the mass production of clothing, a social scientist or an industrial engineer would have done research on the same research question. The professional experience of the researcher influences the stake for the research in the actual field.

The limitation of the scope is the research being conducted based on the researcher's

own work with pattern construction by the example of one prototype. Clothing designers do not always work with clothes in three dimensions, and tailors can, for instance, work for individual customers, in ready-to-wear clothing production or for a designer developing a couture collection. Using the term designer-tailor about my own professional practice, I am a designer who works with clothing in three dimensions and a tailor working for individual customers. This is significant for the research because my professional experience affects how I work on the production of research data led by the research question.

The original contribution of this PhD project to the body of knowledge in the design/tailor discipline is directly linked to the notion of sustainable development. It is not to be seen separately as a contribution, for example, to the discipline of patternmaking or grading practice. At the same time, my research is a continuation of and contribution to the grading and patternmaking practices. Other interesting topics for investigation could have been how particular clothing companies work on patternmaking and fit in clothing and how to reduce the overconsumption of clothing in Western countries from an economic point of view. I could have focused on presenting the current state of technological development in textile production or on the green wave that in recent years has been visible in the media about more sustainable clothing production. I could go into detail about how bigger and smaller clothing manufacturers work with sustainability in their production. None of these topics have I prioritized in my work on this thesis. However, the original contribution of this project is how the profession of designer/tailor working in ready-to-wear clothing product development can improve the practices concerning fit in clothing, promoted from a sustainable point of view, to encourage a shift towards more sustainable clothing production. I will prove the originality of my contribution to the existing literature in the field of fit in clothing as viewed from the perspective of sustainable development.

Points of departure

This chapter introduces the theoretical points of departure and the methodology this research project is based on. First, I will give the motivations for selecting the specific methods to investigate the research question of how the cut of a prototype can be graded to fit different female body shapes. Then, the research methods that are used in the thesis are presented.

My perspective is that of a practicing clothing designer and tailor; from this starting point, I want to see if it is possible to create a solution that makes it more likely for a piece of clothing to be worn until it is worn out. Earlier research (LaBat, 2007; Petrova, 2007; Petrova & Ashdown, 2012; Schofield & LaBat, 2005; Schofield, 2007) has been done on sizing systems, grading practice and how ease is applied to a pattern. This previous research gives solutions for sizing systems based on anthropometric measurements and grading done individually from size to size, customized to the representative body shape of each size. My own experience with patternmaking and constructing patterns for different body shapes indicates that there are different necessary steps depending on the cut of the garment and that not all of them can be done on a block pattern. There is a need for research on how pattern construction and cut can be adapted from size to size to achieve a better fit for the majority of a target group. As Gupta (2014, p. 61) concludes, 'A case is made out for designers to use recent and accurate data of their target populations to develop new pattern-making and grading systems'. As mentioned earlier, filling this gap is a challenge I would like to take on since in my work as a practitioner, I have specialized in pattern construction and cut fitted to different body sizes and body shapes.

Frame story of the researcher

My professional expertise as a designer and tailor is what I relate to during the work on my research project. I fulfilled 11 years of higher education in textiles, design and tailoring. In addition to this, what gave me even more experience was the work for my own clothing label, where I focused on tailor-made clothing. I have also done a great

deal of practising on fitting clothing to different body shapes during my teaching of design and tailoring since 2005. I would like to introduce my background and education in detail to make transparent and articulate how I am trained and what kind of thinking I will bring with me into the work on this thesis (Fienup-Riordan, 2000; Gullestad, 1996; Griffiths, 2010; Reitan, 2007). Griffiths states, 'Since all research is affected by the selves (relationships, circumstances, perspectives and reactions) of the researcher, making these as clear as possible to the audience is one way of exercising academic virtue and removing bias' (Griffiths, 2010, p. 184). As a clothing designer and tailor, one of my main interests has been to work with the cut of clothing in various ways. I have, for example, challenged myself by asking why a garment should have side seams and shoulder seams when there are so many other possible places and shapes the seams can follow. Another main interest has been constructing well-fitting clothing for different body shapes. By teaching redesign and up-cycling, I have guided hundreds of workshop participants in finding ways to make clothing they did not use fit better to their body. My professional education is at the vocational level based on a trade certificate as a tailor. Within higher education I have fulfilled two half-year courses (Telemark University College, since 2018 University of Southeast Norway) in Creative Machine Knitting and two one-year courses in Visual Arts disciplines (Einar Granum School of Fine Art) and Clothing Design and Tailoring (Oslo University College of Applied Sciences, since 2018 Oslo Metropolitan University) followed by two bachelor's degrees in Norwegian Folk Art, Textiles (Telemark University College, since 2018 University of Southeast Norway) and Fashion Design and Costume Design (Oslo National Academy of the Arts). Finally I defended my Master's degree in Traditional Arts (Telemark University College, since 2018 University of Southeast Norway) with the title ***Environmental Fashion – Everyday Wear for Long-term Use*** [Miljømote – Hverdagklær for langtidbruk] (Glitsch, 2009). My professional experience since 2005 consists of work on my own label – 'Rethink' – involving organic fabrics and the redesign of discarded clothing and 10 collections of women's and men's wear with around 500 individual styles/garments (Glitsch, 2019). Since 2005 I have been teaching design, redesign and tailoring at workshops and courses. Since 2012, I have been a head teacher and responsible for the course 'Design, Redesign

and Tailoring' at the University of Southeast Norway. In addition to my education, my knowledge of patternmaking and how to make well-fitting clothing for different body shapes and body sizes comes from experimenting and testing and trying to find different ways to solve a given design problem as a designer and tailor.

My adolescence was characterized by parents who themselves were young adults in the late 1960s and early 1970s in Germany. They emigrated to Norway when I was six years old and brought me up to think about nature and the environment in every step I take and to be a conscious consumer. Attending Rudolf Steiner High School, my final year project was about today's textile and garment production and describing some environmentally friendly alternatives. Later, as I studied to be a fashion designer and tailor, I had in mind the quite shocking facts I had learned from my earlier readings; I did not want to be just another fashion designer producing clothes the world does not really need. It was at that point that I started to work exclusively with organic fabrics and up-cycling and the redesign of discarded clothing. But just one person sewing tailor-made clothing for individual customers does not change the way clothing is produced. Also, in my opinion, up-cycling and redesign should ideally be a part of wearing a clothing item until it is worn out and not something done to an extremely small portion of all clothing items that are thrown away. I believe that people are able to be most influential in the field where they are experts. In my case, this is the clothing design and tailoring practice. There is a need to change design and tailoring practices in the mass production of ready-to-wear clothing. The target group for which my thesis is written is the clothing producers of ready-to-wear clothing. I would like to inspire them to change their practices on grading prototypes and to implement anthropometric data from their target market.

As my education and practice is as a clothing designer and tailor with an emphasis on fitting tailor-made garments to individual customers' bodies, I do not have education as a grader for the mass production of clothing. This puts me in a position where I can question the grading practice from the outside, without having been trained in one particular grading tradition. One could speculate whether a trained grader would be more locked

into his professional tradition on how to work on grading processes. When working as a grader in a clothing factory, it might be easier to think inside the boundaries of the daily practice, the timeframe given for the work and the possibilities given in, for example, the actual software being used. With no experience working as professional grader on one hand I do not have professional expertise, but on the other hand this might give me a free space where I can think freely around the grading process without thinking too narrowly within given boundaries.

In this thesis I have a dual role since I am both a researcher and a designer-tailor producing the research data and reflecting on the outcome from my study. As a strength when inhabiting these different positions in the course of the study is the insider perspective, both being inside the object of the study and producing the research data myself. In contrast, this can also be seen as a weakness because there can be blind spots – unconsciously taking one's own actions or choices for granted or letting one's own unarticulated values or ideals affect the study. To avoid these obvious pitfalls, I strive to make my values and ideals and previous practice transparent and to include in the thesis the complete production of research data. However, Griffiths (2010, p. 184) states that it is not possible for anybody to be transparent to himself or herself. One will have basic assumptions and perspectives on the world, be in relation to social groups and being caught in political and social contexts. Only part of this will be transparent to us or fully understood by us.

> We are embodied which means, as Merleau-Ponty (1962) pointed out, seeing the world while being unable to see ourselves. Arendth argues that it is to others that we reveal our identities when we act. (Griffiths, 2010, p. 184).

In being self-consciousness while working on this thesis I am aware that, as Griffiths states, '(…) the self is not fully transparent to itself, so enough description needs to be given for the audience to make judgements about his or her social and political positionality' (Griffiths, 2010, pp. 184–185). By being aware of the interaction between my 'self' and my research during the whole process, I strive to conduct unbiased, trustworthy and transferable research.

Methodological points of departure

My research belongs to qualitative research with the method of critical utopian action research (CUAR) (Tofteng & Husted, 2014; Schwencke, 2017), which has much in common with research by design among the making disciplines (Dunin-Woyseth & Michl, 2001; Hensel, 2012). Research by design, or practice-led research by design, was introduced by Archer (1969) and later developed by Frayling (1993). Birger Sevaldson describes research by design as 'A special research mode where the explorative, generative and innovative aspects of design are engaged and aligned in a systematic research inquiry' (Sevaldson, 2010, p. 11). In research by design

> (…) the design researcher is also a practitioner and whose investigations are conducted within a 'first person perspective' combined with a reflexive mode of inquiry that helps make design knowledge explicit. In this mode of research, there is great potential for both reflection and knowledge production, but also for the further development of practice. (Sevaldson, 2010, p. 9)

My following case study, which will be introduced in detail later, is conducted with the CUAR method. CUAR has an active milieu among action researchers in Scandinavia today and is grounded in critical theory, with scholars such as Theodor Adorno and Max Horkheimer and the Frankfurter school (Tofteng & Husted, 2014, p. 230; Schwencke, 2017, p. 361). 'Critical theory represents an intellectual practice working with analyses of modern society within the framework of philosophy, social science and culture' (Tofteng & Husted, 2014, p. 230). Adorno and Horkheimer were concerned with 'the relation between science and democracy and argued that if science is not democratic in its way of investigating the world, it will only confirm an undemocratic reality' (Tofteng & Husted, 2014, p. 230). CUAR was developed by Kurt Aagaard Nielsen, Birger Steen Nielsen and Peter Olsèn as a way to conduct practical research-oriented critical theory with a social foundation (Nielsen, K. A. & Nielsen, B. S., 2006; Schwencke, 2017, p. 362). In traditional research, the researcher can be made aware of problems in the world but does not have the task to bring about changes to address the actual problems. Unlike in CUAR, it is the researcher's task to become aware of a problem and, based on the researcher's findings,

make proposals for changes in the form of new democratic structures in society (Tofteng & Husted, 2014, p. 230).

> There are four sources of inspiration for CUAR: (1) critical theory, with the idea of turning theory upside down in the sense that theory understood as critical thinking should express an understanding of what is in the light of what should be; (2) the work of Kurt Lewin on democracy and participative change; (3) socio-technical action research and the work with organization and social development and (4) future research and the underlining of social imagination and utopian-oriented ideas. (Tofteng & Husted, 2014, p. 230)

As in CUAR, the starting point for my research is a real-world problem, the overconsumption of clothing. With my professional knowledge and experience as a clothing designer and tailor, I constitute one in a multitude of different stakeholders making contributions towards solving the actual problem. My contribution will not be the complete solution to the overarching problem but will illuminate a part of the problem concerning fit in clothing. From the perspective of a clothing designer and tailor and not from the view of an educated grader, I am questioning the grading practice when it comes to offering well-fitting clothing to the majority of a target group. Not being an educated grader puts me in a position where I can examine the case from another perspective, as a clothing designer and tailor. The trained grader might not have put forth this view and offered the particular solutions I do through the view of my different but still closely related profession.

I will discuss the outcome of my case from the perspective of the sustainable development of clothing production. Huckle (2004) discusses critical realism as a philosophical framework for sustainable higher education. He argues '(…) a unified science for sustainability should combine relevant aspects of academic or abstract knowledge with relevant elements of the local (tacit and lay) knowledge that people develop in their everyday lives' (Huckle, 2004, p. 35). Carrying out scientific research on a problem based on people's experiences with clothing sizes and fit in their everyday lives is what I aim to do in this research project. Michelsen (2000), in ***Sustainable Development as a Challenge***

for Universities, argues that research can only contribute to sustainable development '(…) on an interdisciplinary basis and with reference to problems and possible actions in practice' (Michelsen, 2000, p. 73). The focus on sustainable development directly linked to real-life problems is, as I see it, a way to find solutions that can actually work in practice.

The part of critical realism where the goal is to improve practices fits an epistemological perspective on the outcome of my case on an alternative pattern construction and grading method. I have used critical realism as a scientific theoretical point of view epistemologically and ontologically though I have not used critical realism's concepts in the interpretation of my data. As opposed to positivism's empirical realism, where the basic idea is that only that which can be perceived by human senses is reality, critical realism sees the knowledge we have about the world as both fallible and coloured by various theories (Bhaskar, 1979). The world exists independently of our knowledge of it. Reality consists of many causal factors acting simultaneously in open systems (Næss, 2016). The realist element of critical realism contains the idea that there exists both a reality independent of us and our direct observations of it as well as a historically and culturally constructed knowledge about this reality. The conception of reality and the constructions of knowledge about it stand in an interactive relationship with historically and culturally conditioned actions, reflections and practices. Critical realism builds upon the idea that knowledge is socially constructed within a historical and cultural context and is therefore fallible and imperfect. A critical attitude allows the potential for improvement (Næss, 2016).

According to critical realism, the world can be described using causal language. There is an assumption of a real world out there. This assumption is performative and cannot be proved or disproved; we ***behave*** as if the world is real. 'Critical realism mirrors the language and procedures we routinely adopt and the explanations that we create. We use causal language without thinking. Critical realists argue for the use of causal language with thinking' (Easton, 2010, p. 119). Critical realism justifies the study of any situation where 'the process involves thoughtful in depth research with the objective

of understanding why things are as they are' (Easton, 2010, p. 119). This approach of in-depth research seeking to understand why a certain situation is as it is coincides with my approach for this thesis, where my literature study's objective is to understand why clothing is disposed of before it is worn out.

Research method

The research in this thesis is conducted according to critical utopian action research (CUAR) (Tofteng & Husted, 2014; Schwencke, 2017). According to Yin (2012, p. 4): 'All case study research starts from the same compelling feature: the desire to derive a(n) (up-) close or otherwise in-depth understanding of a single or small number of "cases", set in their real-world contexts' (Yin, 2012, p. 4). The starting point being a real-world problem is closely related to critical realism, mentioned earlier in this chapter.

Since my case study is conducted from my professional viewpoint as a clothing designer and tailor, the activity I perform as part of the case study will be seen as part of a design activity. Where a trained grader would do his grading work on the pattern pieces, I do design and tailor work on the pattern pieces. This is because I, as a trained designer/ tailor but without specialist knowledge as trained grader, use the view, knowledge and experience of design and tailoring practice to change the pattern pieces of a prototype in a both designing and tailoring way. As mentioned earlier, this gives me a different approach to the fit and grading process than that of a trained grader.

The methods described under the collective term ***action research*** have been the chosen method for the case study in this thesis. As mentioned earlier, the methodology of action research has much in common with the methodology of ***research by design***. The basic notion in action research, as stated by Kurt Lewin in his ***Field Theory in Social Science*** (1951), is that practical knowledge and theoretical knowledge, to establish a true domain, must inform each other in a concrete context. This basic notion is the same for research using the design method (Hensel, 2012; Groat & Wang, 2002).

Action research is often used for research done in the social sciences and education with regard to learning or teacher practices (McNiff, 2013). In these disciplines it is common to take changes, developed through the investigation, back to the field of investigation and observe how the changes work in practice. In the social sciences, action research can be conducted inside an organization, institution or company. I will adapt action research to my chosen field of investigation and use the research method fitted to my case study. The aim of my case study is to create ways to construct patterns that result in a good fit for all sizes in a sizing system. I will carry out my action research investigation into the practice of pattern construction when grading a prototype into different sizes. The outcome of my investigation will be techniques and practical methods that can then be applied to any production of clothing. This means that I will carry out action research directly on my profession as a designer/tailor and not, as is more common for action research in, for example, the social sciences, look into a practice community and work together with a group of people on a problem they observe in their practice. In other words, the aim of my investigation is not to observe the design and tailoring practices in several factories or to do action research inside a clothing company. The last step carried out in a typical action research process, for example, with a group of teachers working at a primary school, is that the researcher returns to the place after a certain amount of time and observes whether the changes carried out during the first part of the action research project when the researcher was present are still working or whether the original problems are back. Since I will not carry out my case study with the action research method on a group of people but instead on the practice of pattern construction, I will not be returning to observe whether a change is still working. This means that taking changes in practice back to the field of practice, such as a clothing factory, is not a part of my case study. Instead, in my action research I take the outcome 'back' to me as a designer.

As mentioned earlier, critical theory has inspired CUAR. While traditional theory expresses truth about ***what is***, critical theory is about critical thinking on what ***should be***. What should be is a utopian otherness. Utopian criticism comes into action research through critical theory (Nielsen & Nielsen, 2006). In a CUAR process, the researcher begins with

critical reflections on the field of the research project. After these critical reflections that illuminate the current situation, the researcher develops utopian ideas of how the situation could be better (Nielsen & Nielsen, 2006, p. 78). This notion of critical theory doing critical thinking on what ***should be*** has CUAR in common with research-by-design, where the goal is to find out 'how things should be'. CUAR, in the way Nielsen and Nielsen (2006) describe and interpret the method, has influenced my structural thinking about the method in my case study. With my research I seek to conduct critical thinking on what ***should be***, which characterizes critical theory. I put emphasis on how the grading of prototypes ***should be*** done in clothing production to offer well-fitting clothing for the majority of a target group. As with CUAR projects, I have begun with a critical reflection upon the field of the research project; this constitutes the first part of this thesis. After these critical reflections that show the situation today, I develop a research question stemming directly from the critical reflections. I then take this research question with me into a free space where I develop utopian ideas of how the situation could be better.

The free space for the development of utopian ideas is important because everyday life seldom gives possibilities to systematically develop imaginative scenarios about a better future. Without the possibility of productive utopian imagination around a practice, many practical changes would not have happened (Nielsen & Nielsen, 2006, p. 79). Within the boundaries of my research project, I will use a free space as a designer-tailor to cultivate a utopian conception of how an alternative procedure in the tailoring/design practice could be developed to offer a better fit in ready-to-wear clothing to the majority of a target group. An employed designer-tailor would probably not have the opportunity to carry out such a utopian case study during working hours. By working on my case experiment within a free space, I do not need to take into account what clothing producers think of changing their ways of producing clothing or whether or not they are interested in people wearing clothing for a longer period of time. The utopian aspect in the CUAR method makes it possible to think of good solutions to the problems with fit without being limited by whether it is realistically feasible for any clothing producer to adopt. CUAR has the utopian aspect in common with Simon's (1996/1969) definition of

design, where the aim of design is described as the changing of present situations into preferred situations (Simon, 1996/1969, p. 111).

Nielsen and Nielsen (2006, p. 79) point out that an action research process always contains learning from the experiences to which the actions lead. So to make it possible for a subject to learn from experience, the action research process should include the conditions that are needed for subjective learning from experience (Nielsen & Nielsen, 2006, p. 79). To give space for me as an action researcher to learn from the experience derived from the case study I will conduct, the case study will be built up as an experiment – in that I have not carried out this specific kind of process before. I will use different aspects of my knowledge and earlier experience but not repeat any type of process carried out before. This gives me the chance to learn from the action research process, in other words subjective learning, which Nielsen and Nielsen (2006, p. 79) write about.

Robert Jungk was an important inspiration for Nielsen and Nielsen's (2006, p. 81) work on action research in light of their practical interpretation of critical theory. Robert Jungk, as Nielsen and Nielsen (2006, p. 82) see it, describes a way to achieve democratic change by working with social imagination and utopian ideas oriented towards the future. A democratic utopian future perspective is important if the goal is sustainable development and not domination of technocratic planning. Jungk, when writing about normative future research, which according to Nielsen and Nielsen (2006, p. 82) could be called future-oriented action research, says that systematic work on utopian ideas and social imagination is a form of preparation for experiments. The creation of experiments is needed if action is to lead to extensive changes. Experiments make improvements possible through radical change. There will always be fear of uncertainty about the consequences of change, especially if the changes include situations or things never seen before. An experiment done by a researcher through an action research process can reduce the fear of change and the unknown (Nielsen and Nielsen, 2006, p. 83). The producers of ready-to-wear clothing would probably be afraid of losing money if they changed their practices. An experiment that shows possibilities for change in the practice

cannot take away the fear of change, but it may reduce such fear. 'To ask for the general in the local is a special duty for Action Researchers' (Nielsen & Nielsen, 2006, p. 84). The outcome of my case will not exclusively be substantial knowledge about how to change cuts and pattern construction from size to size but rather methodological knowledge about how the tailoring/design practice can develop an alternative procedure in the production of ready-to-wear clothing.

Finally, I will summarize how I apply the CUAR method in my case study. The first part is a critical reflection upon the current situation regarding fit in clothing in clothing production. This critical reflection on the situation today leads to the formulation of my research question for my case study. The second part of the method is the utopian part, where I take the research question into a free space where economic, capitalist and social structure frameworks are put on hold. Inside this free space I will carry out a case study built as an experiment. The advantage of conducting the experiment in a utopian free space is that solutions can occur that would not occur within the scope of reality. The last part of the method is the action research, where I am both designer-tailor and researcher producing the research data for this thesis. Finally, I, as a designer, consider the outcome from my case study.

Summing up theoretical points of departure

Seen from a sustainable development point of view, there is a need for creating alternative procedures in the mass production of clothing. To be able to develop new knowledge about the appropriate steps towards change, I find it suitable to apply the CUAR method in my case study. In particular, the utopian aspect of free space makes it possible to develop imaginative conceptions about changes that are unlikely to appear in the daily practice of a clothing factory. This free space is crucial for trying out changes in a small-scale experiment before adopting the changes on a large scale. My research project is about facilitating a democratic process where the majority of people in a target group are offered clothing that fits their individual bodies' shapes and sizes.

Case study

This chapter describes the case study conducted in this thesis with the research question ***How can the cut of a prototype be graded to fit different female body shapes?*** First, the case is put forth and set in the context of my path through the literature in the field. This is followed by a description of the dress forms used in the study, the design of the anorak prototype, the grading of the anorak prototype and fitting the anorak toiles on the dress forms and customization within an anorak prototype. Then the outcome of the case study is described, analysed and discussed.

Via my path through the literature in the field, as mentioned earlier, I found a gap concerning the fitting of clothing to different body shapes representing a target group. Before describing my actual case study, I will summarize the reflections that have led me to my study. As mentioned earlier, the common practice today is to grade a clothing prototype based on the measurements and body shape of an ideal body. This means that only a minority of consumers can buy well-fitting clothing in ready-to-wear clothing stores. My experience from teaching alteration and the redesign of clothing is that people often buy an ill-fitting clothing item because they could not find a well-fitting option. They do not actually wear the garment but are unable to put their finger on what is wrong with it. Then they bring this never or hardly worn clothing item to my course. They tell me they feel guilty about never wearing it. They may have paid a high price for it, and they try to explain to me why they always take it off again and select one of their favourite garments instead. Often they tell me something like this: 'I really loved the fabric and colours when I saw it at first and just had to buy it, but then it just never felt right when I put it on. Maybe the colours and patterning are just wrong for my skin tone'. Then, when I show them the areas on the garment that do not fit their body shape and pin the clothing item to show how it should have been if the cut and shape were well-fitted to their body shape, they often give me a reaction of surprisingly sudden insight. At once they see that nothing was wrong with the colours or patterning but that everything was about a bad fit to their body shape. They do not have the skills to be able to point

out what was wrong with the fit of the clothing, but, while wearing the clothing, when they are shown the problem and other areas where other proportions, cuts or volumes would have been appropriate, they feel happy to be able to do the required alterations and begin to wear the garment in question.

My path through the literature in the field and my own experiences tell me that there is a lack of knowledge among people that would allow them to point to ill-fitting areas on a clothing item or at least to recognize all the details in the fit of the garment that do not correspond with a given person's body shape. Studies on the reasons for the disposal of clothing, discussed in my path through the literature in the field, show that fit issues top the reasons mentioned by respondents from different studies. After my experience with what people know about fit, one could speculate whether bad fit as a reason for disposal is also hidden under other reasons mentioned by the respondents. Alternatively, fit issues can also contain issues other than merely bad fit for the person – for instance, the person in question has gained weight and therefore no longer fits in the garment. In my experience as a professional tailor, the majority of my customers cannot identify bad fit in detail when trying on a clothing item.

In photographs from the period when clothing was still tailor-made, before mass production, the clothing fits as if cast on the body. Today we are no longer exposed to a lot of people wearing tailor-made clothing. Usually people try on different sizes available in the store and then pick the size that fits the best, whether or not it fits well to their body. As ready-made clothing became cheaper to buy – cheaper, in fact, than the fabric needed to sew the same clothing item at home – home sewing gradually grew less common. When it is not economical to sew one's own clothing, it ceases to be integrated into society; daughters no longer learn to sew clothes for the family from their mothers or grandmothers. Elderly people today can still remember visiting the tailor or seamstress for the fitting of a new garment made for them or how as children they had to stand still for what felt like hours when a family member was fitting clothing to them. Today, when buying the clothing item with the most appropriate size in the store, but

often with a bad fit, the person can still feel that something is uncomfortable or wrong about the clothing item without being able to point to what exactly is wrong. These ill-fitting clothing items are seldom worn, and the person will shop for more clothing items looking for clothing that feels good, which has become affordable as clothes are so cheap. Occasionally people are lucky and find a clothing item that fits well. One could speculate whether these well-fitting clothing items become favourite garments that eventually become worn out; they go through the stages of use, from being worn at work or in social contexts to being worn at home only and at last to being worn, for example, while painting or working in the garden.

Another consequence of people not finding well-fitting clothing in stores is that they start blaming themselves, thinking their body has the wrong shape or wrong proportions and that they should have a body that fits into ready-to-wear clothing. Our bodies are how they are. The sizing systems used by ready-to-wear clothing producers do not match our bodies. Instead they are matched to an ideal body size and shape. The grading of prototypes is done in a linear and schematic fashion, corresponding to the proportions of the ideal body. This means that the sizing systems and grading are not customized to the sizes and body shapes of the clothing producer's target population. It is reasonable to think that this contributes to clothing not being worn out, people experiencing their body as having the wrong shape and natural resources being wasted.

Based on my own experiments with fitting to different body shapes, it is possible to produce clothing items that are perceived as equal in terms of the design of the style and cut while having completely different proportions and body shapes built into the cut patterns. A concrete example would be when a customer brings a picture of a dress worn by a tall, thin model. The customer herself is short and chubby with a stooped posture. The customer wants me to make this particular dress look on her exactly as it looks in the photo. The order from the customer and my challenge as a tailor is to make the dress such that it is perceived to be equal to the one on the tall, thin model but to construct the pattern pieces in a way that offers a good fit for the customer's short and chubby body shape. If I do not succeed, the customer will be disappointed.

The case – Anorak:VG

In this case study, I will discuss whether it is possible to transfer my experience with constructing different body shapes into the same design and cut of a garment from tailor-made garments to the mass production of ready-to-wear clothing. I will concretely examine this by using a practical case, developing an anorak. I have therefore called the case ***Anorak:VG***, adding the initials for my name, Veronika Glitsch. A practical case shows what happens when my practical experience from custom-made clothing is transferred to a case where the purpose is to offer well-fitting ready-to-wear clothing to the majority of a target group. I will conduct case ***Anorak:VG*** on how pattern construction and cut can be adapted to three different body shapes representing a small, a medium and a large woman's body size. In the concrete case, I will compare one clothing prototype that is graded in a traditional way using block patterns with the same prototype graded in a way in which I construct different body shapes into the pattern pieces. To make clear the importance of the method of grading to the fit of clothing, I will choose an anorak prototype where the design and cut follows the figure and does not have a draped or loose and flowing fit but still contains ease of movement with space for other clothing items to be worn underneath. An anorak, also referred to as a parka, with a fitted design covers these aspects just mentioned for the prototype in my case study ***Anorak:VG***. As pattern construction techniques for woven fabric differ from pattern construction techniques for knitted fabric or woven fabric containing stretch material, the effect of my comparative case study is most noticeable if the material used for the prototype contains no more elasticity than that of cotton canvas. To clearly demonstrate the differences between the two grading methods, I will make toiles for both of the grading techniques and document the toiles on dress forms.

To begin, the anorak prototype is graded based on the grading of the block patterns I am using. These block patterns are graded using a common grading method in today's clothing production processes. I will analyse the fit of the anorak prototype on the dress forms based on my professional knowledge and experience. I will do a fitting of the anorak toiles on the dress forms, where I check whether the garment is balanced, whether areas

are pulled into folds and whether there is too little or too much room in some areas according to the cut and design of the prototype. The dress forms I will use for the fitting of the anorak toiles will not be traditional dress forms with the shape of the ideal body but instead dress forms created by castings of real bodies. The choice of realistic dress forms is based on the overarching goal of my research, that is, to offer the majority of a target group well-fitted ready-to-wear clothing.

After fitting the first set of anorak toiles to the three dress forms, the same anorak prototype is graded in such a way that I construct different body shapes into the pattern pieces. Here the goal is to create a fit to the three dress forms that appears equal to the fit of the anorak prototype. The graded patterns are sewn into anorak toiles to show the fit. The anorak toiles are fitted on the same three realistic dress forms. The first three anorak toiles, made using the traditionally graded pattern pieces, are used for performing the fitting of the anorak prototype to the three dress forms. I transfer the adjustments to body shape made during the fitting to the pattern pieces. I construct new pattern pieces for the anorak prototype, now graded individually to fit to the different body shapes of the small, medium and large dress forms. I then make a second set of anorak toiles for the three sizes to show the altered pattern pieces in canvas.

Dress forms

I have chosen to work with dress forms instead of fit models because my case is aimed at the mass production of clothing and not individually tailor-made clothing for individual customers. For clothing production, hiring fit models is more expensive than using dress forms when developing and grading clothing prototypes. In preparing the case ***Anorak:VG***, I tried to access sizing systems that represent an actual current population group. Larger anthropometric measurement surveys for body sizes in several countries have been conducted, for example, in Germany and the UK. The project SizeGermany carried out anthropometric measurements on 13362 men, women and children between six and 87 years old. The aim of these measurements was to track changes through time in body

measurements and body proportions. The results have been available for members of the SizeGermany-Portal since 2009 (SizeGermany, 2015). SizeUK, the UK National Sizing Survey, carried out anthropometric measurements on 11000 subjects. The results have been available for purchase since 2004 (SizeUK, 2015). However, the costs to access these measurements are out of reach within the framework of my PhD project. As it turns out, though, anthropometric measurements from a population group are not crucial to carry out the case ***Anorak:VG***. This is because the outcome from my case can be applied to any sizing and measurement system. The study is about principles, techniques and methods on which to model work, and these do not depend on correct measurements from one particular population group.

After stepping away from getting access to exact measurements that are representative of a given population group and dress forms made based on those measurements, I looked for dress forms that could serve as examples of real body shapes rather than the traditional dress form shapes, which have been modified to be shaped like ideal bodies. The company Kennett & Lindsell in the UK offers dress forms with various body sizes and body shapes made from castings of real bodies. I considered these dress forms to be the most appropriate option in the framework of this thesis.

I decided to use one small, one medium and one large dress form for the case ***Anorak:VG*** to show the different proportions and volumes on a small body shape in comparison to a large body shape, while the medium body shape shows the area in between. Choosing three sizes that are quite different from each other does not cover a size range, but it is enough to investigate the principles of individual adaption from size to size in the pattern construction and cut, and it makes the case feasible within the timeframe of my PhD project. The dress forms from Kennett & Lindsell have the following measurements:

Size large, Kennett & Lindsell ***OS I*** (Fig. 10):

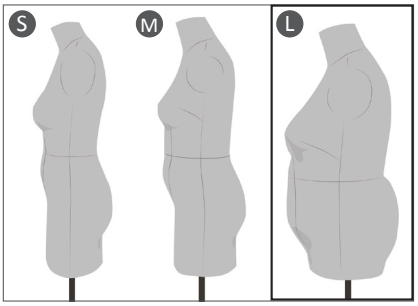
- Bust 114 cm
- Waist 99,5 cm
- Hip 117 cm

Size medium, Kennett & Lindsell ***Concept 2008*** size 16 (Fig. 11):

- Bust 97 cm
- Waist 80 cm
- Hip 104 cm

Size small, Kennett & Lindsell ***Concept 99***, size 10 (Fig. 12):

- Bust 83 cm
- Waist 68 cm
- Hip 91,5 cm



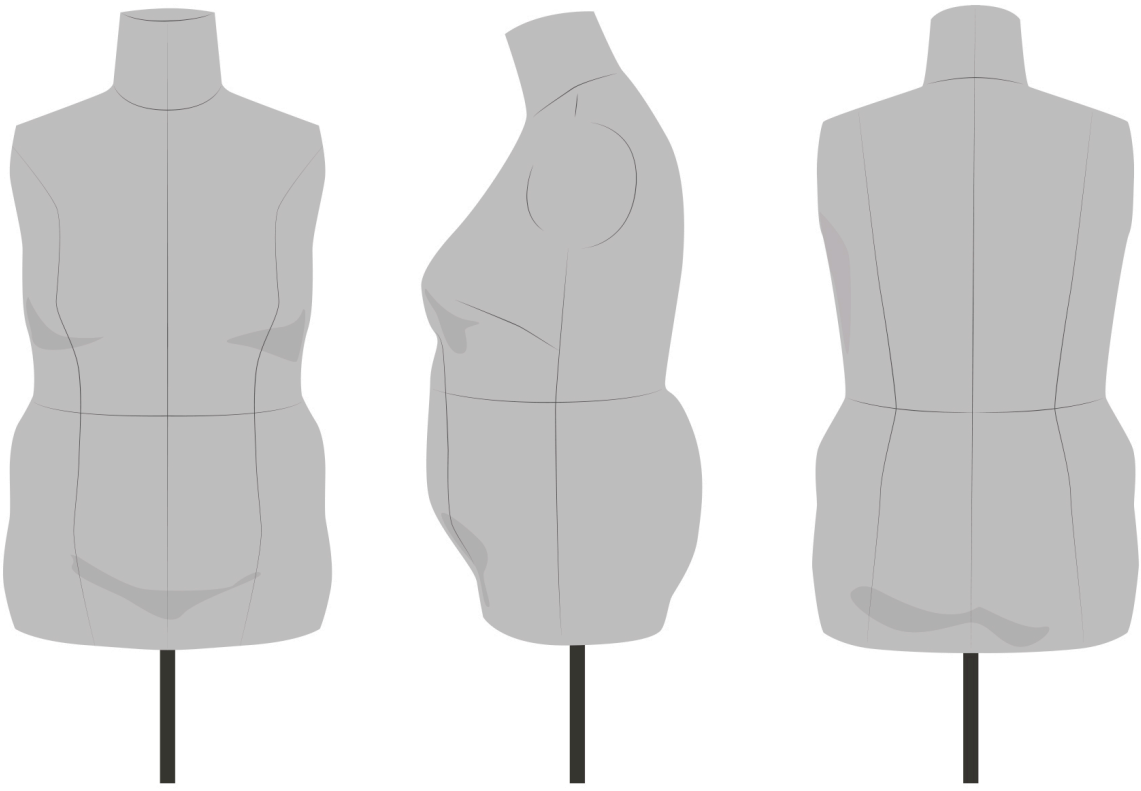
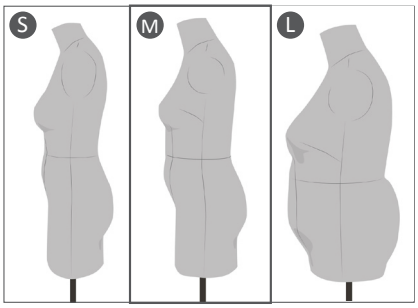


Figure 10. Dress form size large from Kennett & Lindsell; OS I.



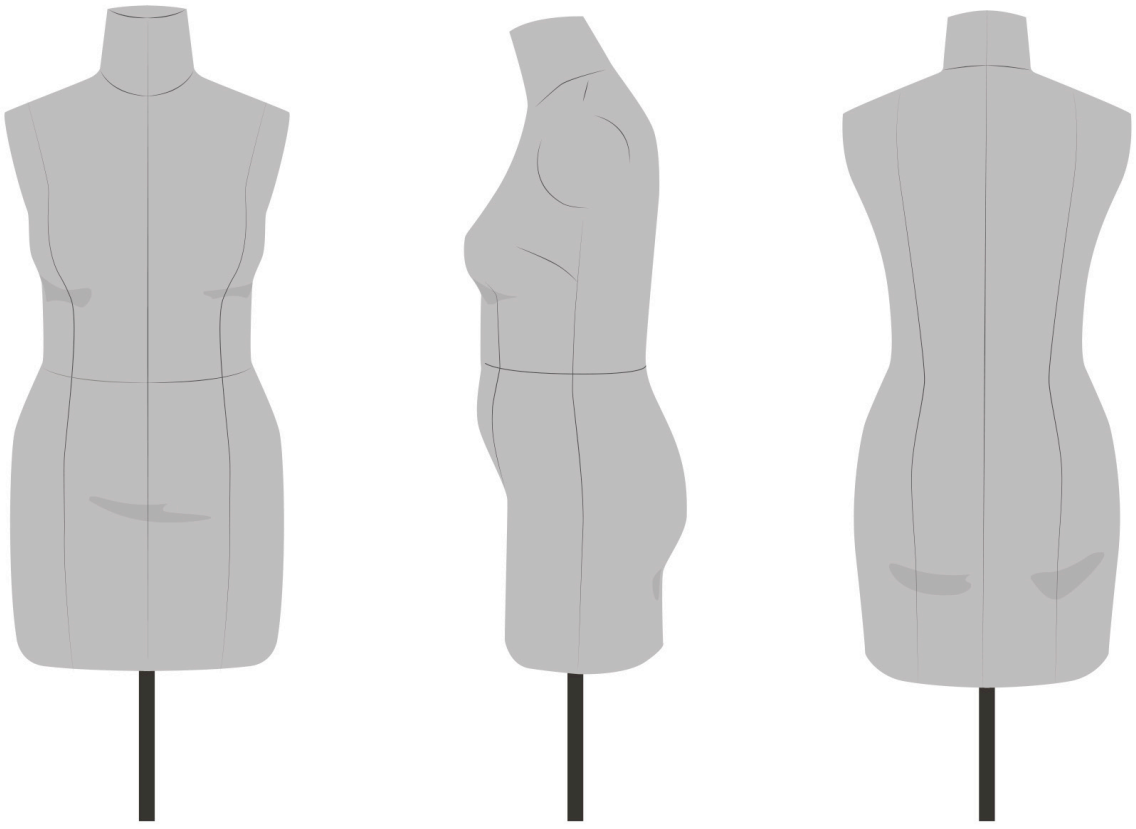


Figure 11. Dress form size medium from Kennett & Lindsell; Concept 2008.

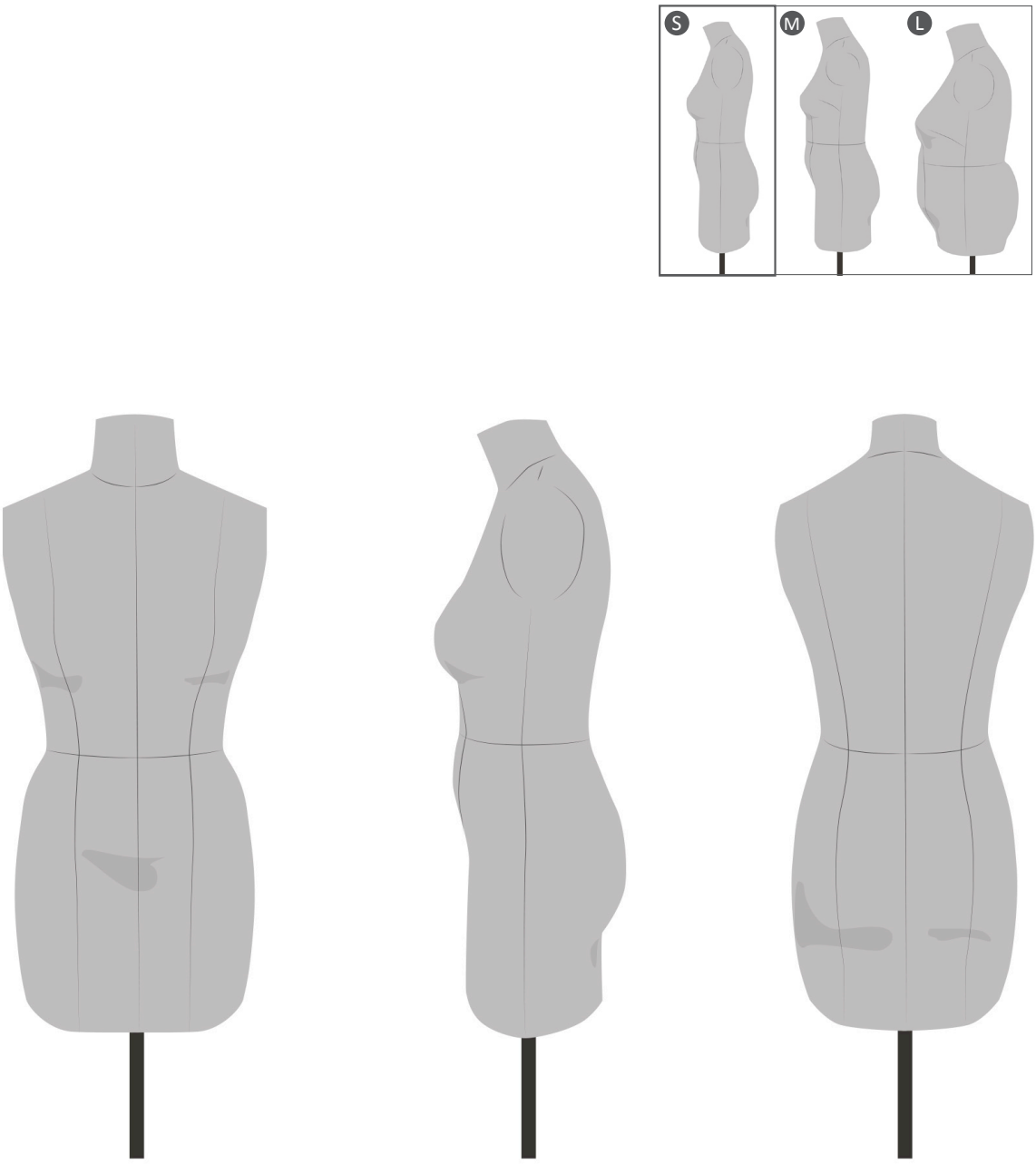


Figure 12. Dress form size small from Kennett & Lindsell; Concept 99.

Design of the anorak prototype

The cut and design of the clothing item used in case ***Anorak:VG*** could have been any since the research is about how the grading is done due to different body shapes and sizes. When the actual designer has designed the style of a clothing item, it is stated where the seams, shape and volumes are placed on the clothing item. At that point the preparation for the grading process begins, where the patternmaker develops a set of pattern pieces that reflects the design of the clothing item. This means that the design of the garment is decided before the grading process begins. I could have chosen an existing cut and design of a garment for this case. The reason why I drew the cut and design myself was because I, as mentioned earlier, wanted the clothing item to contain some specific challenges, as described in the following, for the grading to different body shapes and sizes. I worked with a garment style (Fig. 13) that was supposed to allow room for a sweater underneath, allow movement and have a fit that followed the body shape. This combined different challenges that were interesting to examine on the three different body sizes and shapes. The challenges are about giving enough space for other clothing items underneath but at the same time having a silhouette that follows the body shape. Beyond this specific challenges as just described, I freely designed the cut for the clothing prototype without taking into account the further process of being used for the case ***Anorak:VG***. When designing the seam lines and the shape of the pockets and hood I worked freely in a design process. I did not place any seam lines in special positions to prepare for the further fitting to different body shapes. The shape of a tree with a trunk and branches inspired me. As designer I have an inclination towards rounded shapes. The Y-shape (tree form) that occurs in the front and back of the anorak design is a shape I am fascinated with and have used in different ways in clothing design several times before (Glitsch, 2019).

The clothing prototype is designed for woven material that does not contain stretch fibres. When stretchy materials are not used, it is even more important that the cut and fit be adapted to the representative body shape in a size range. Stretchy materials can help a clothing item more easily fit different body shapes, but it is only a ‘quick

fix'; the proportions and cut and shape should still be optimized to achieve a well-fitting clothing item. For example if a garment contains too little room for a person with the representative bust size the garment is made for, stretch in the material can make it possible for the person with the representative bust size to wear the garment. Still, fabric will be pulled towards the bust, since this area is bigger than the garment is constructed for. This pulling of material may create bad fit elsewhere on the garment. Seen from an environmental perspective, the use of stretch fibres mixed with other fibres should be questioned since elastane, Spandex and Lycra are significant impediments to circular textile systems. These fibres cannot be efficiently separated once mixed with other fibres (Payne, 2015).

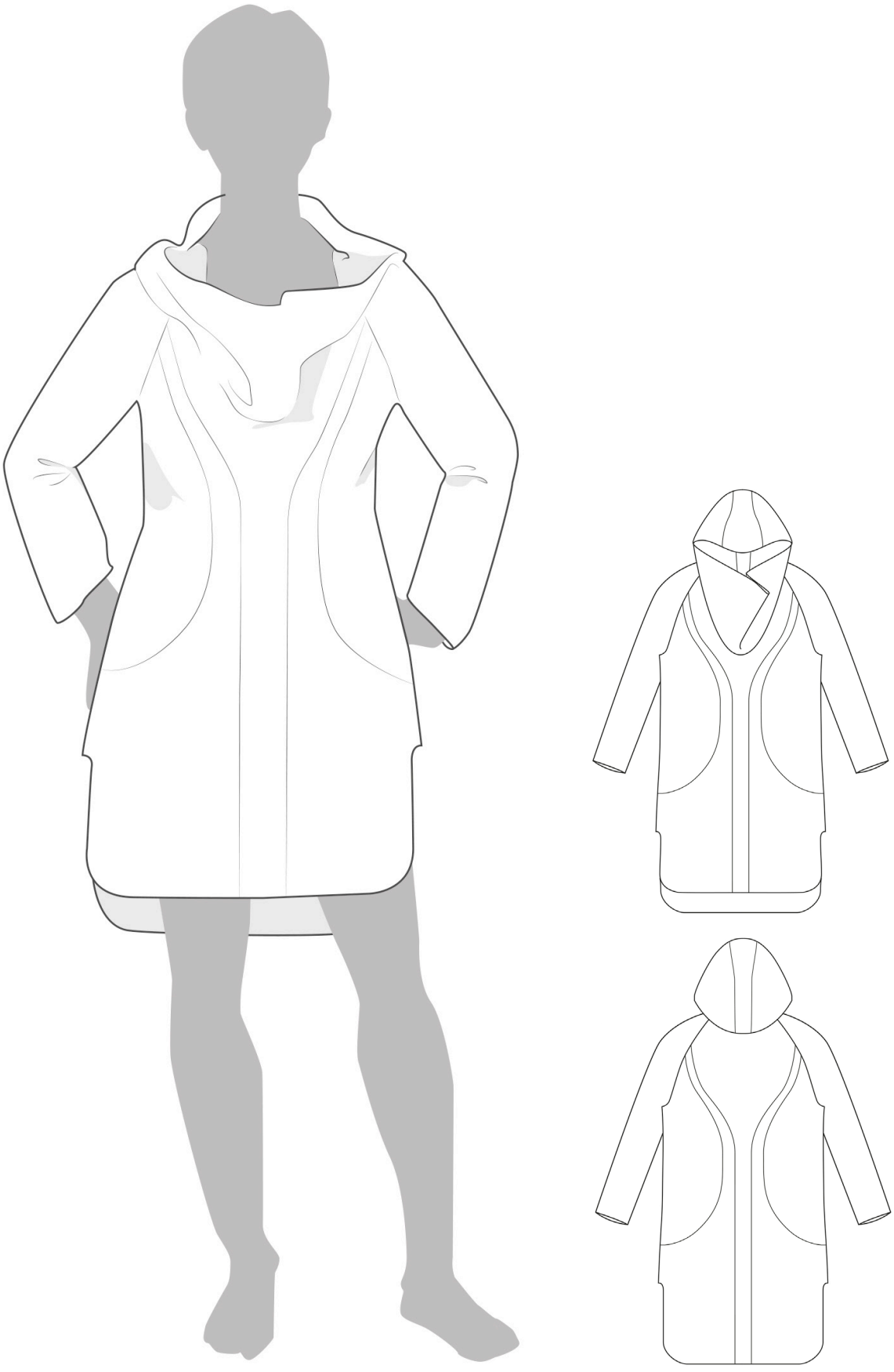


Figure 13. The design and cut of the anorak prototype.

Grading of the anorak prototype

To grade the initial pattern of the anorak prototype, I used the block patterns given in the book ***Mönster och konstruktioner för damkläder*** [Pattern construction for women's wear] (Ersman & Öberg, 2010) (Fig. 14). These are traditionally graded block patterns. For the dress form in size small, I chose the block pattern size EU 36. For the dress form size medium, I selected the block pattern size EU 42, and for the dress form in size large, I chose the block pattern size EU 50. The next step was to draw the cut and style of the anorak prototype based on these three block patterns. I then cut and sewed these three anorak prototype garments in canvas. This shows the anorak prototype in size small, medium and large without adaptions to the body sizes represented by the three dress forms. The grading process could have been done in various ways as there are different traditions regarding how grading is performed, and there eventually was no need to go back to the block pattern for each size. I did it this way to make the process transparent and let the grading of the block pattern be the base for the grading I performed on the clothing prototype for the three sizes.

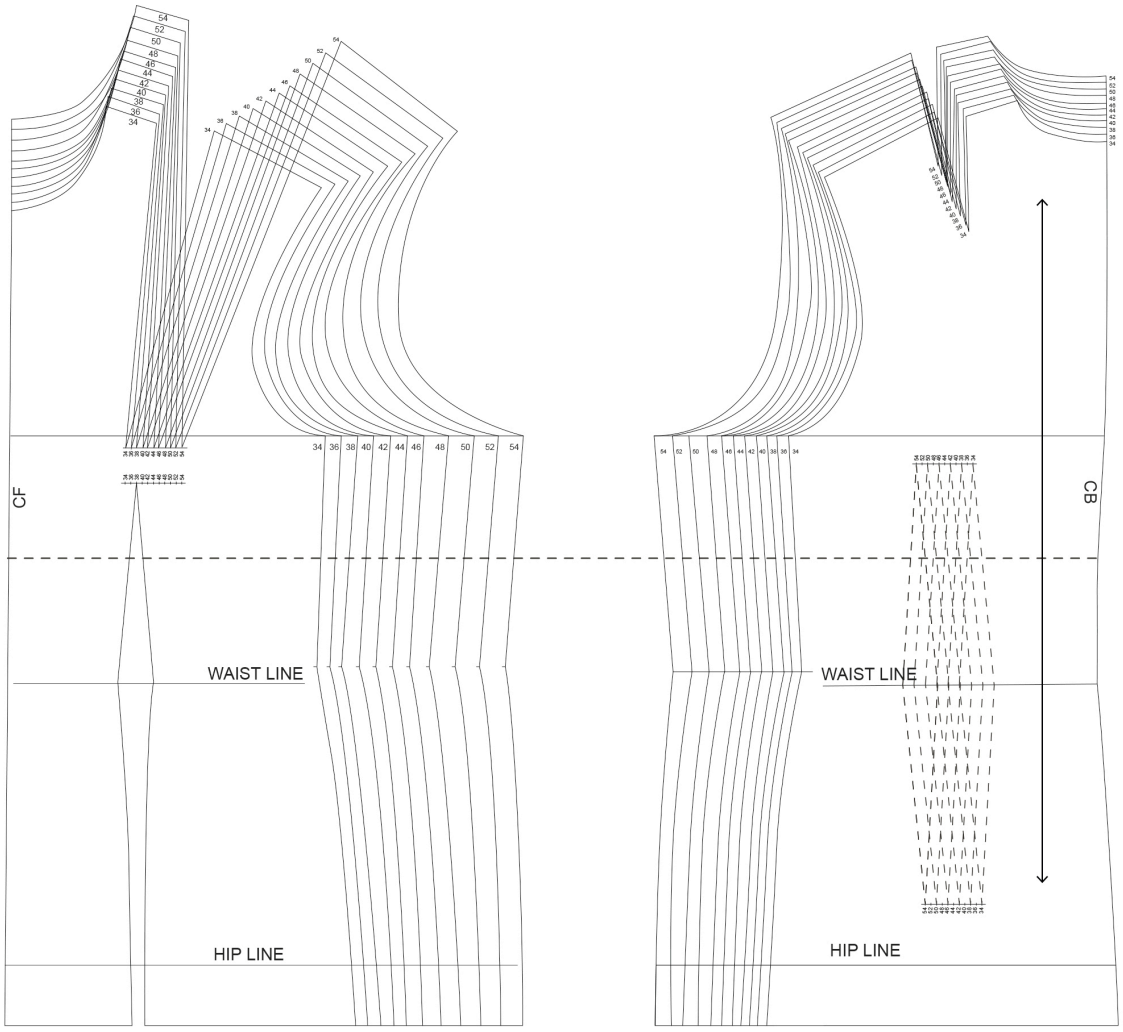


Figure 14. The graded block pattern from Mönster och konstruktioner för damkläder [Pattern construction for women's wear] (Ersman & Öberg, 2010). This block pattern was used when constructing the pattern pieces for the anorak prototype.

Fitting the anorak toiles on the dress forms

I examined the fit of the three traditionally graded anorak toiles on the dress forms. I focused on the torso of the clothing prototype and did not make any changes to the hood or sleeves because the dress forms had neither head nor arms. The pictures I took during the case study are shown in the appendix to this thesis in order to make the case study transparent. They are part of the original material making the research data from the case study. This chapter is illustrated with reconstructions of the case study made by a professional photographer to improve the quality of the images. For these reconstructed

photographs, arms were pinned to the dress forms. Based on what I saw when examining the fit, I made changes to the pattern to better fit the body sizes and proportions of the three different dress forms. The increased and decreased volumes on the pattern pieces are shown with colour codes, see Fig. 15. Below, I describe in more detail my analysis of the fit during the fitting of the first anorak toiles and describe the changes I have made to the pattern pieces. As mentioned earlier, the anorak prototype is designed as an outer garment, designed to give space for other clothing underneath. When putting the toile in canvas on the dress form without other layers of clothing underneath, the moving ease embedded in the cut of the anorak toile hangs in extra folds of fabric here and there. This practice is how I am trained as a tailor, where the fitting of a toile is done on a nude dress form or a fit model wearing underwear only, even when the garment is outerwear. Usually, when the toile is fitted I ask my customer to put the amount of clothing the person wants to be able to wear under the outerwear, just to check the fitting. My impression is that the process is the most honest when the toile is fitted on a nude dress form/person wearing only underwear. The design ease and wearing ease is clearly visible.

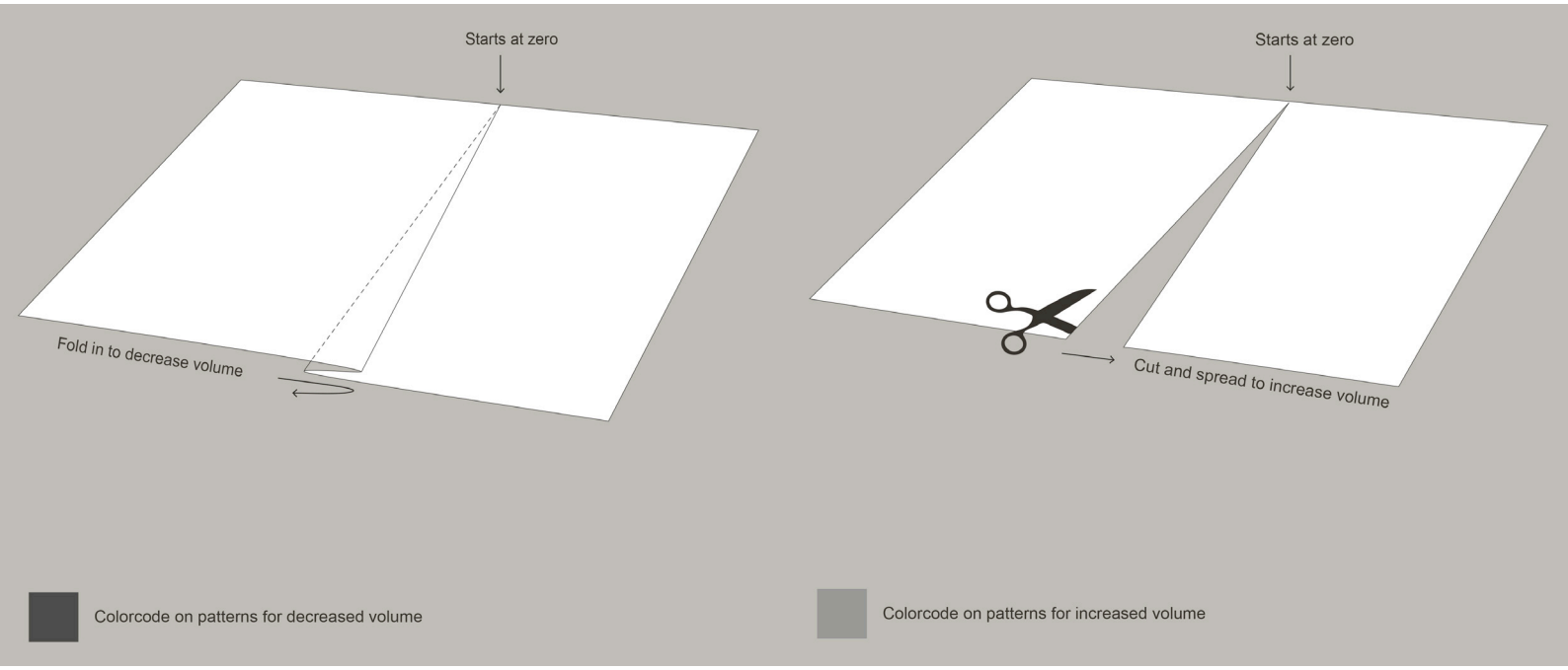


Figure 15. Colour code for the decreased and increased areas on the pattern pieces.

Anorak prototype size small

Fig. 16 shows the pattern pieces for the torso of the anorak size small, traditionally graded. The front pieces for the anorak are shown at the top and the back pieces at the bottom. The pattern pieces are constructed on the base of the traditionally graded block pattern size 36 from Ersman and Öberg (2010).

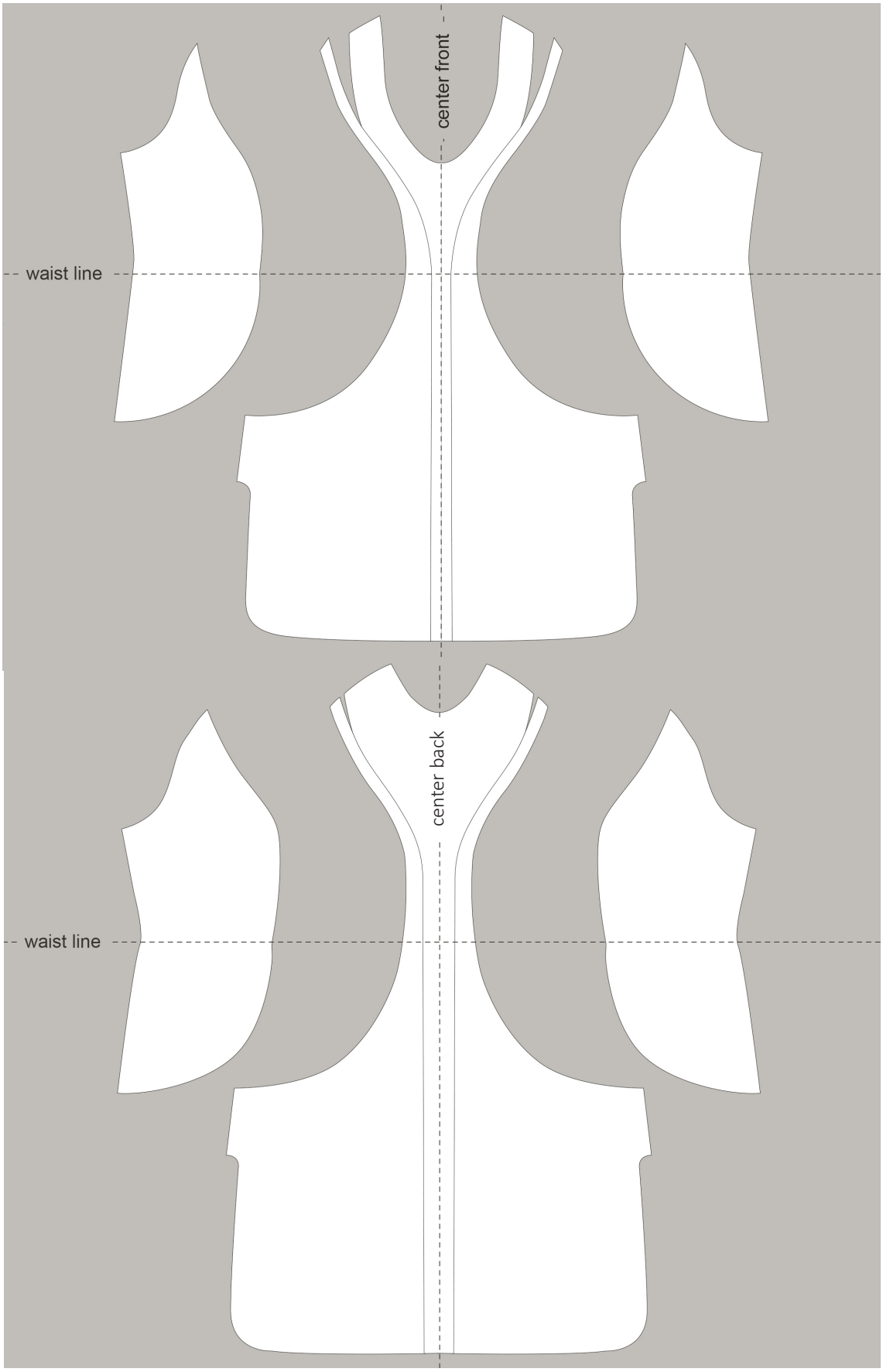


Figure 16. The pattern pieces for anorak prototype size small, constructed with block pattern size 36.

Figure 17. Toile of the anorak prototype size small, traditionally graded.

Fig. 17 shows the toile – front, side and back view – sewn with the use of the pattern pieces of the anorak prototype size small, traditionally graded. I studied the fit of the toile to the dress form and suggest the following changes to the pattern pieces for size small:

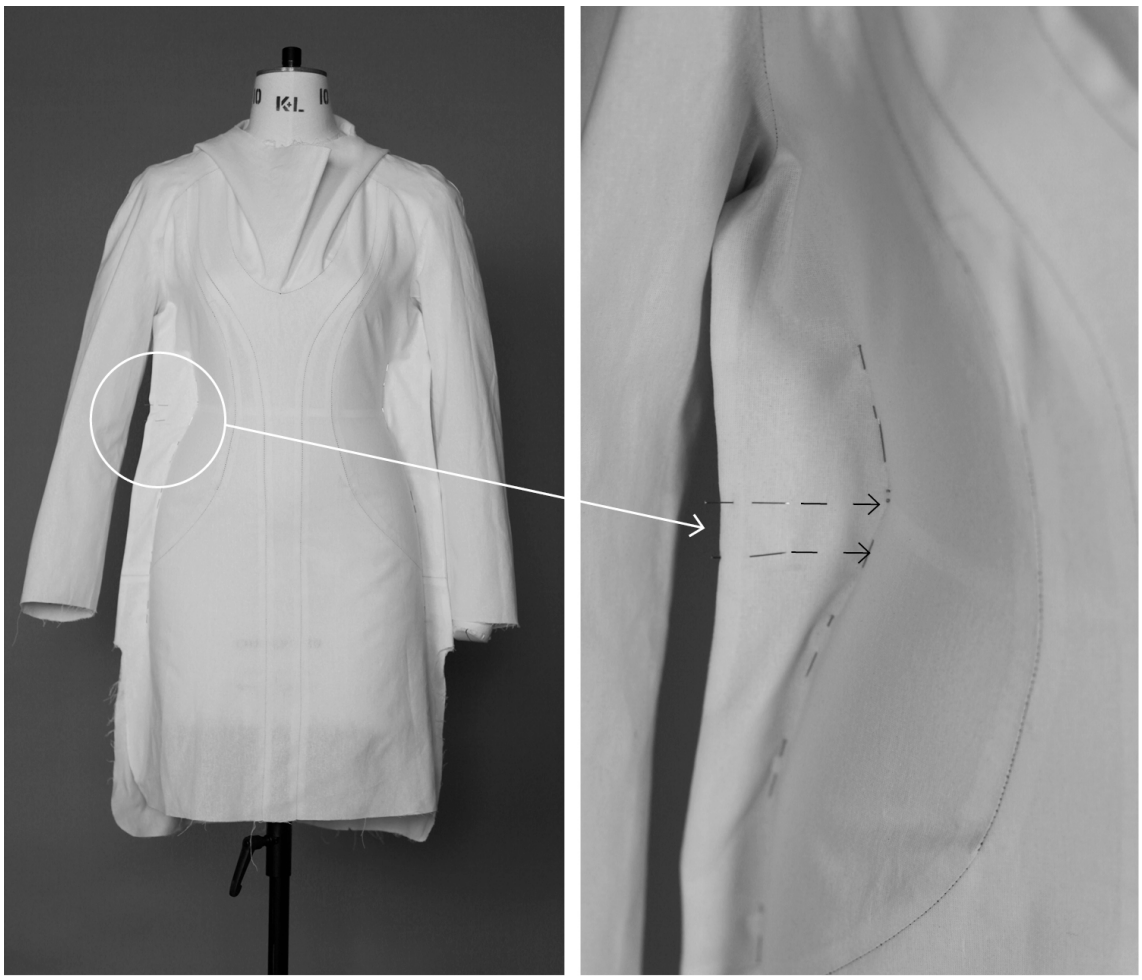


Figure 18. Toile size small pinned close to the dress form.

Fig. 18 shows the toile of the traditionally graded anorak size small pinned close to the dress form to check whether the waistline of the anorak toile is put in the right place for the body shape of the dress form. In my view the waistline on the traditionally graded anorak toile was too low compared to the proportions of the dress form (Fig. 18). The lower horizontal pin close to the side seam (shown with a black arrow on the enlarged image view) shows where I interpret the anorak toile is smallest around the waist. The upper horizontal pin close to the side seam (shown with a black arrow on the enlarged image view) shows where I interpret the dress form is smallest around the waist. According to the design of the prototype anorak, the toile of the anorak is supposed to follow the body shape, with some design ease added, and have its smallest circumference where the body shape is smallest around the waist. The difference between the lower waistline

of the traditionally graded anorak toile and the waistline of the dress form is 2.2 cm. I therefore moved the waistline on the pattern pieces for the anorak up 2.2 cm.

Figure 19. Toile size small is too wide over the waist compared to below the waist.

I considered there was too much design ease in the waist area close to the side seam compared to the design of the prototype anorak. Fig. 19 shows that the toile size small seems too wide over the waist close to the side seam compared to below the waist in the same area. By reducing the width of the anorak 1.5 cm from the side seam and towards centre front by the waistline, the design ease was shaped parallel to the shape of the body with pins. For the exact reduction from the side seam, see the drawing of the pattern pieces in Fig. 22.

Figure 20. The pins show some millimetres taken in from the side panel.

I considered the traditionally graded anorak toile to be slightly too little shaped under the bust area. The pins in Fig. 20 show some millimetres taken in from the side panel under the bust area for a better fit to the body shape.

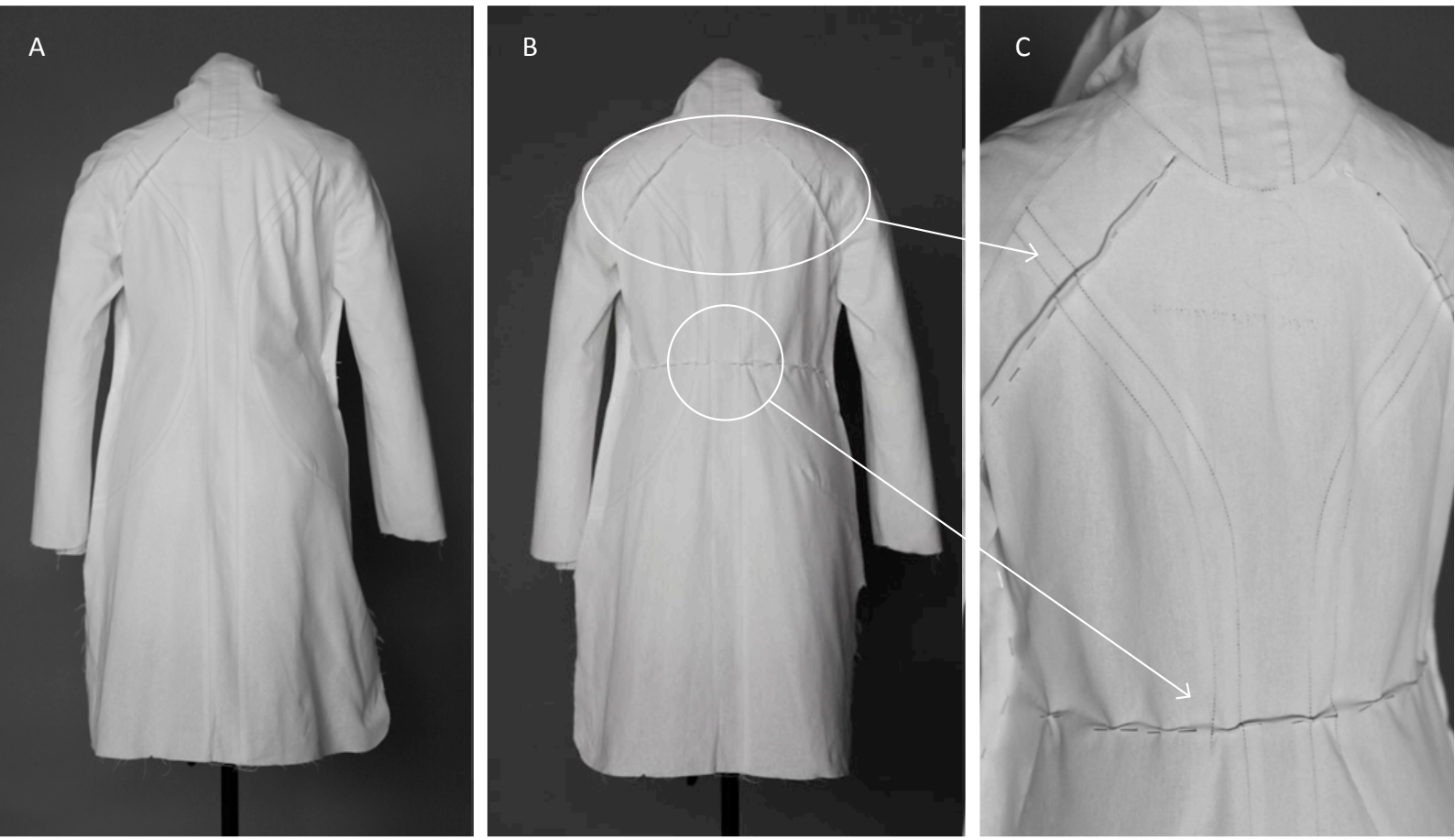


Figure 21. Toile size small. There is too much fabric underneath the shoulder.

There seemed to be too much ease over the upper back on the traditionally graded toile: Fig. 21 (see right side in Fig. 21 image A). Since the anorak design consists of seams that pass this area, I can use these to remove the extra width. Here I suggest removing 1.5 cm from between the back/side panel and the side panel, moving to 0 cm on the neckline and the armhole. The fabric fold that pins away the extra ease in the upper back area, shown on the enlarged image view in Fig. 21 image C, will be folded away on the pattern pieces. This will remove the extra ease in this area but not add any additional seam line.

There seemed to be slightly too much fabric in the waist area in the back (Fig. 21). Since the anorak design has vertical seam lines passing the waist area, I decided to make use of these seam lines when removing this extra width without adding additional seams to the anorak design. To remove this extra width, I removed 0.5 cm extra width in the waistline

area close to centre back. On the side panel this reduces to 0 cm by the side seam. The small fabric fold that is pinned away horizontally by the waistline, shown on the enlarged image view in Fig. 21 image C, will be folded away on the pattern pieces. This will remove the extra width in this area but not add any additional seam line to the anorak design, which will give a better fit without changing the design. To compensate for the loss in length of the back/side panel, I added the same amount (0.5 cm) to the bottom of the pattern panel on the pattern pieces. This changes the shape of the pattern pieces of the anorak toile in a way that makes the clothing prototype better fit the back waist area, avoiding extra fabric laying in horizontal folds over the lower back.

Fig. 22 shows the pattern pieces for the traditionally graded anorak prototype size small (block pattern size EU 36) with my suggestion for the changes made to better fit the body shape of the small dress form. The front pieces for the anorak are shown at the top and the back pieces at the bottom. These adjusted pattern pieces for the anorak size small were then sewn up to a new toile.

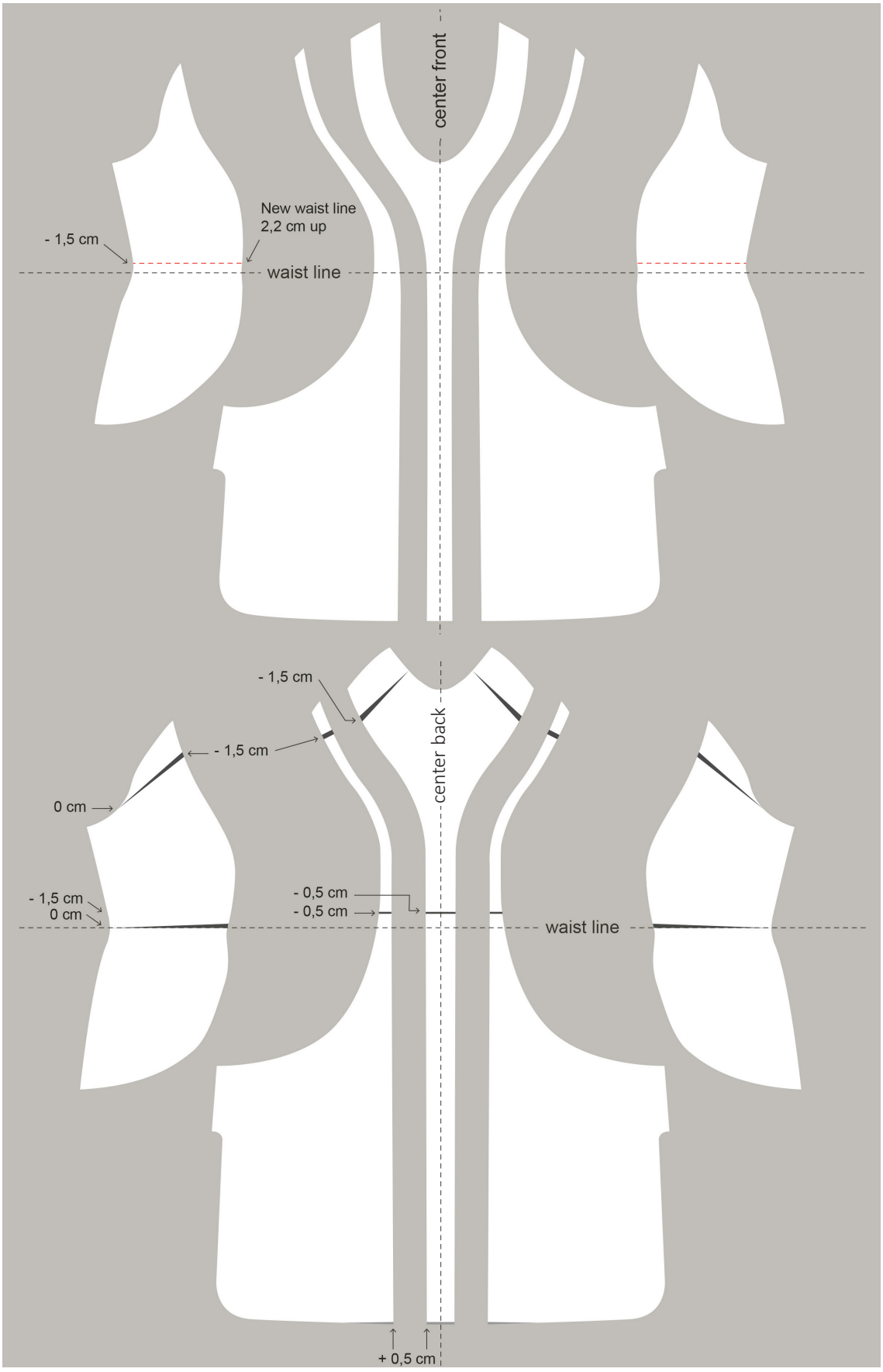


Figure 22. Pattern pieces for anorak prototype size small with the changes made during the fitting to the dress form size small.

Figure 23. Toile size small sewn with the changes made to the pattern pieces.

Fig. 23 shows the anorak toile size small – front, side and back view – sewn with the new set of pattern pieces shown in Fig. 22 after my suggestions for the changes to the pattern pieces during the fitting on the dress form size small are completed on the actual pattern pieces.

Fig. 24 shows the two sets of pattern pieces for the anorak in size small: traditionally graded (shown above in Fig. 16) and after the alterations when fitting the traditionally graded anorak toile to the dress form (shown above in Fig. 22). The dark grey colour and dotted line show the pattern pieces for the traditionally graded anorak size small, constructed based on the traditionally graded block pattern size 36. The white colour shows the pattern pieces for the altered anorak size small with my suggestions, as described above, for the changes made to better fit the body shape of the small dress form.

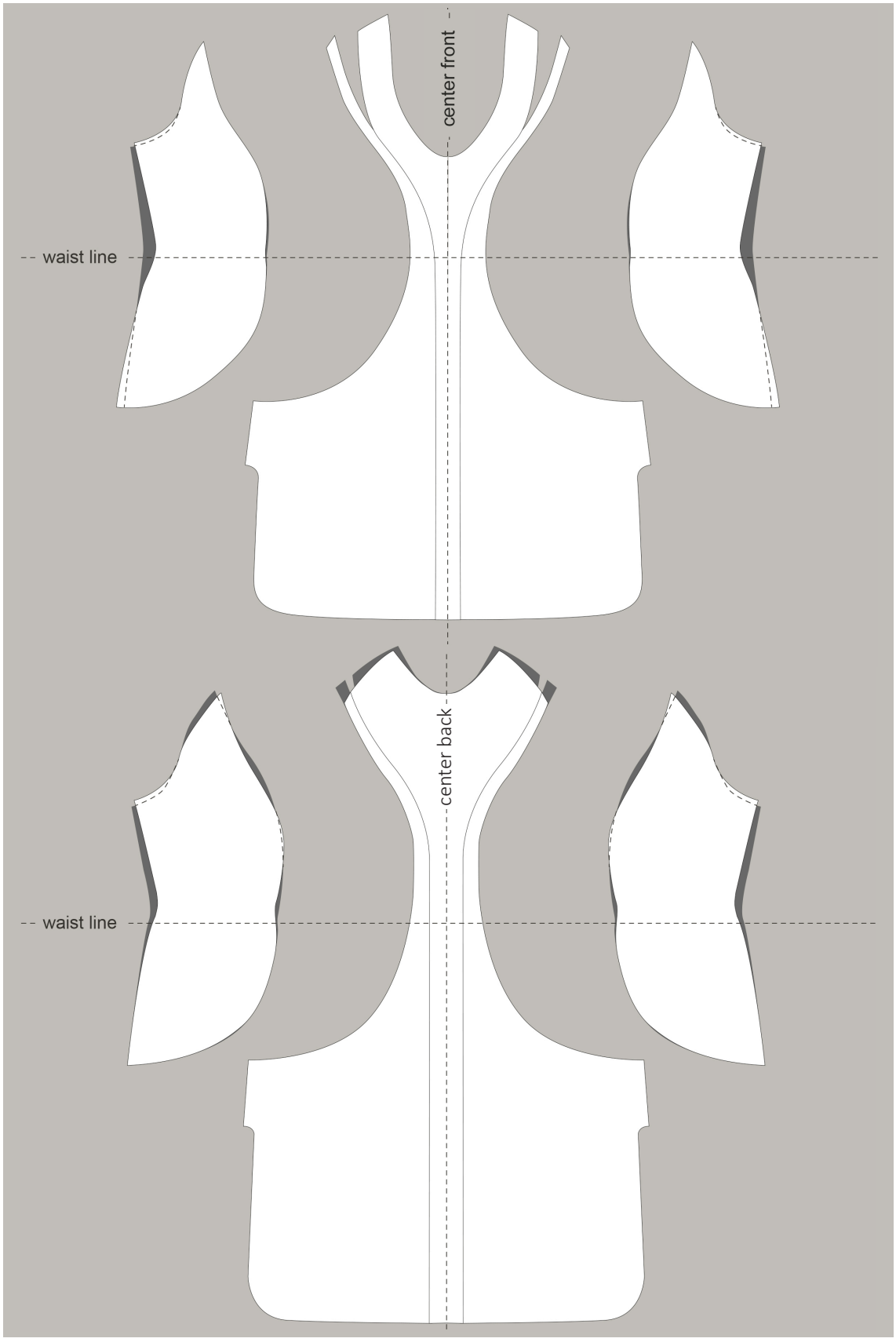


Figure 24. Grey colour and dotted line: pattern pieces for the anorak size small, traditionally graded. White colour: pattern pieces for the anorak prototype size small with the changes made to better fit the body shape of the small dress form.

Anorak prototype size medium

Fig. 25 shows the pattern pieces for the torso of the anorak prototype size medium, traditionally graded. As for size small, the front pattern pieces of the anorak are shown at the top and the back pattern pieces at the bottom. The pattern pieces are constructed on the base of the traditionally graded block pattern size 42 from Ersman and Öberg (2010).

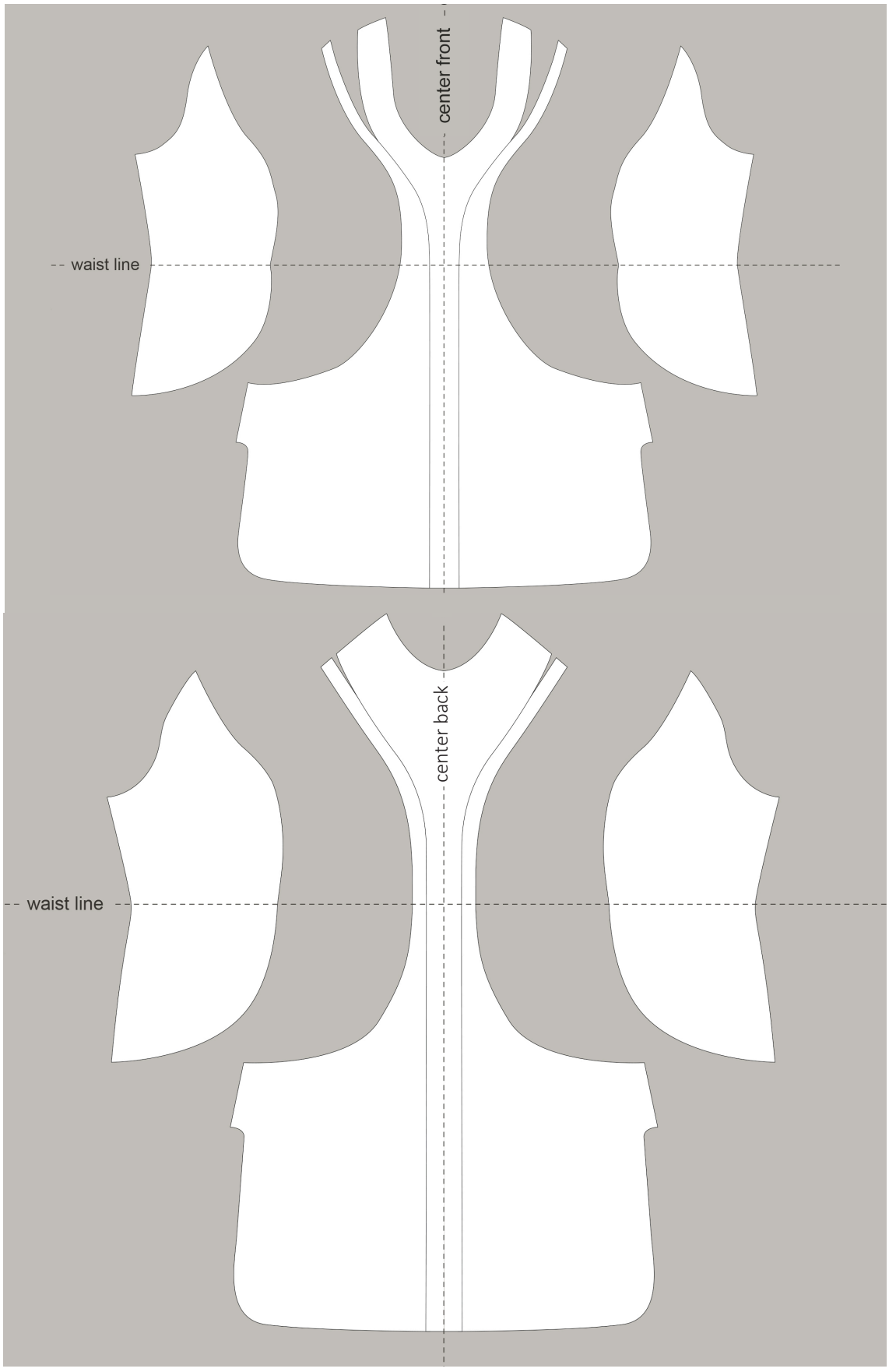


Figure 25. The pattern pieces for the anorak prototype size medium, constructed with block pattern size 42.

Figure 26. Toile of the anorak prototype size medium, traditionally graded.

Fig. 26 shows the toile – front, side and back view – sewn with the use of the pattern pieces of the anorak prototype size medium, traditionally graded. As for size small, I studied the fit of the toile to the dress form size medium and suggest the following changes to the pattern pieces for size medium:

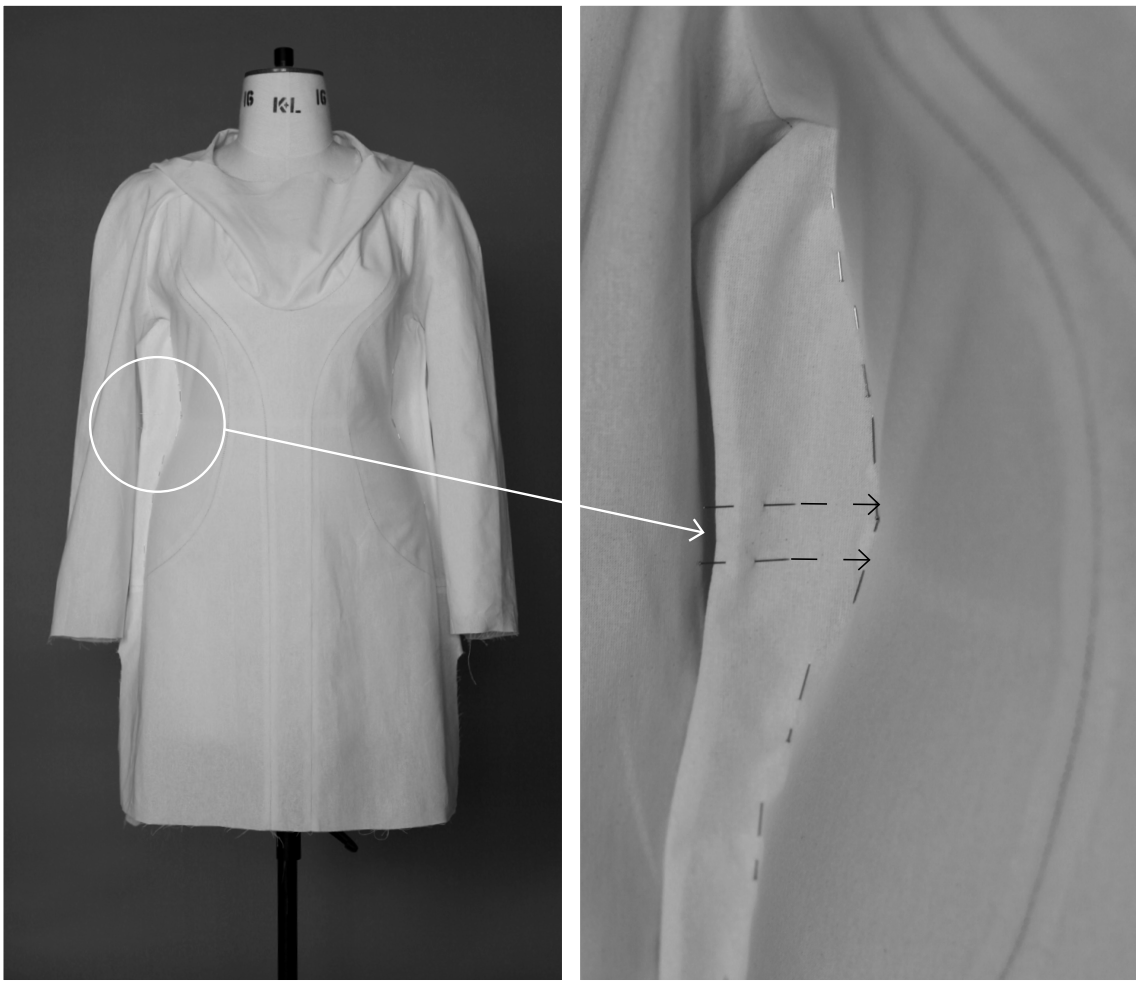


Figure 27. Toile size medium pinned close to the dress form to check the waistline.

Fig. 27 shows the anorak toile size medium pinned close to the dress form to check whether the waistline on the traditionally graded anorak toile is put in the right place for the body shape of the dress form. In my view the waistline of the traditionally graded toile size medium was too low compared to the proportions of the dress form (Fig. 27), as was the case for size small. The lower horizontal pin close to the side seam (shown with a black arrow on the enlarged image view) shows where I interpret the toile is smallest around the waist. The upper horizontal pin close to the side seam (shown with a black arrow on the enlarged image view) shows where I interpret the dress form is smallest around the waist. According to the design of the prototype anorak, as mentioned earlier for size small of the anorak, the toile of the anorak is supposed to follow the body shape, with some design ease added, and have its smallest circumference where the body shape

size medium is the smallest around the waist. The difference between the lower waistline on the traditionally graded toile of the anorak in size medium and the waistline of the dress form size medium is 2 cm. I therefore moved the waistline on the pattern pieces for the anorak up 2 cm (Fig. 27).

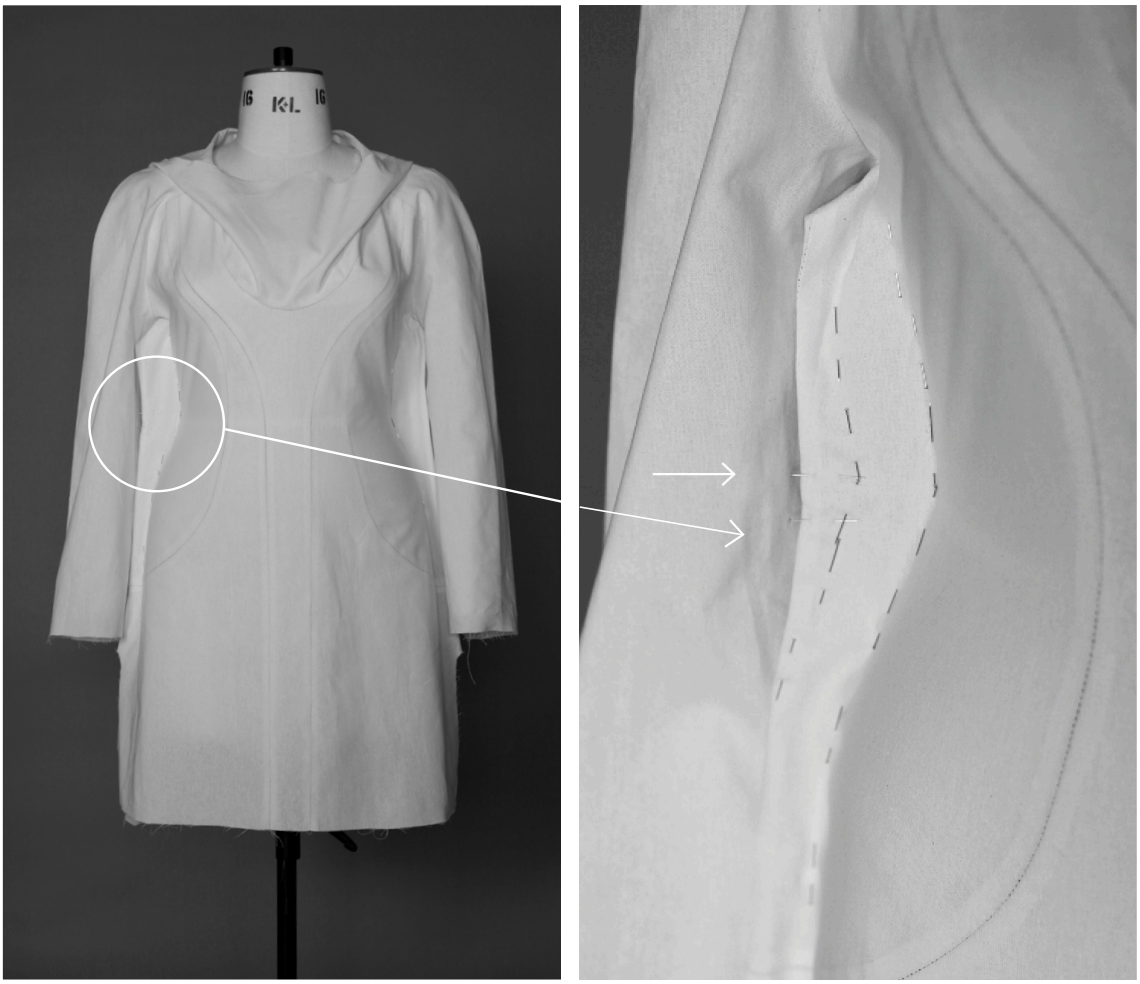


Figure 28. Toile size medium is too wide above the waist compared to below the waist.

As for the anorak in size small, I considered there was too much design ease in the waist area close to the side seam compared to the design of the prototype anorak. Fig. 28 shows that the toile size medium seems too wide above the waist close to the side seam compared to below the waist in the same area. By reducing the width of the anorak 2 cm from the side seam and towards centre front by the waistline, the design ease was shaped parallel to the body shape of the dress form with pins. For the exact reduction from the side seam, see the drawing of the pattern pieces (Fig. 31).

Figure 29. Toile size medium has a little too much fabric below the waist area on the front side.

The traditionally graded anorak toile size medium seemed to have a little too much fabric below the waist area on the front side. Here I tucked away 0.3 cm of the width on the bottom, letting it move out to 0 cm in a vertical line on the outline of the front side panel. This fabric fold that pins away the extra width below the waist area, shown on the enlarged image view in Fig. 29, will be folded away on the pattern piece. This will remove the extra width but not add any additional seam line to the anorak style.

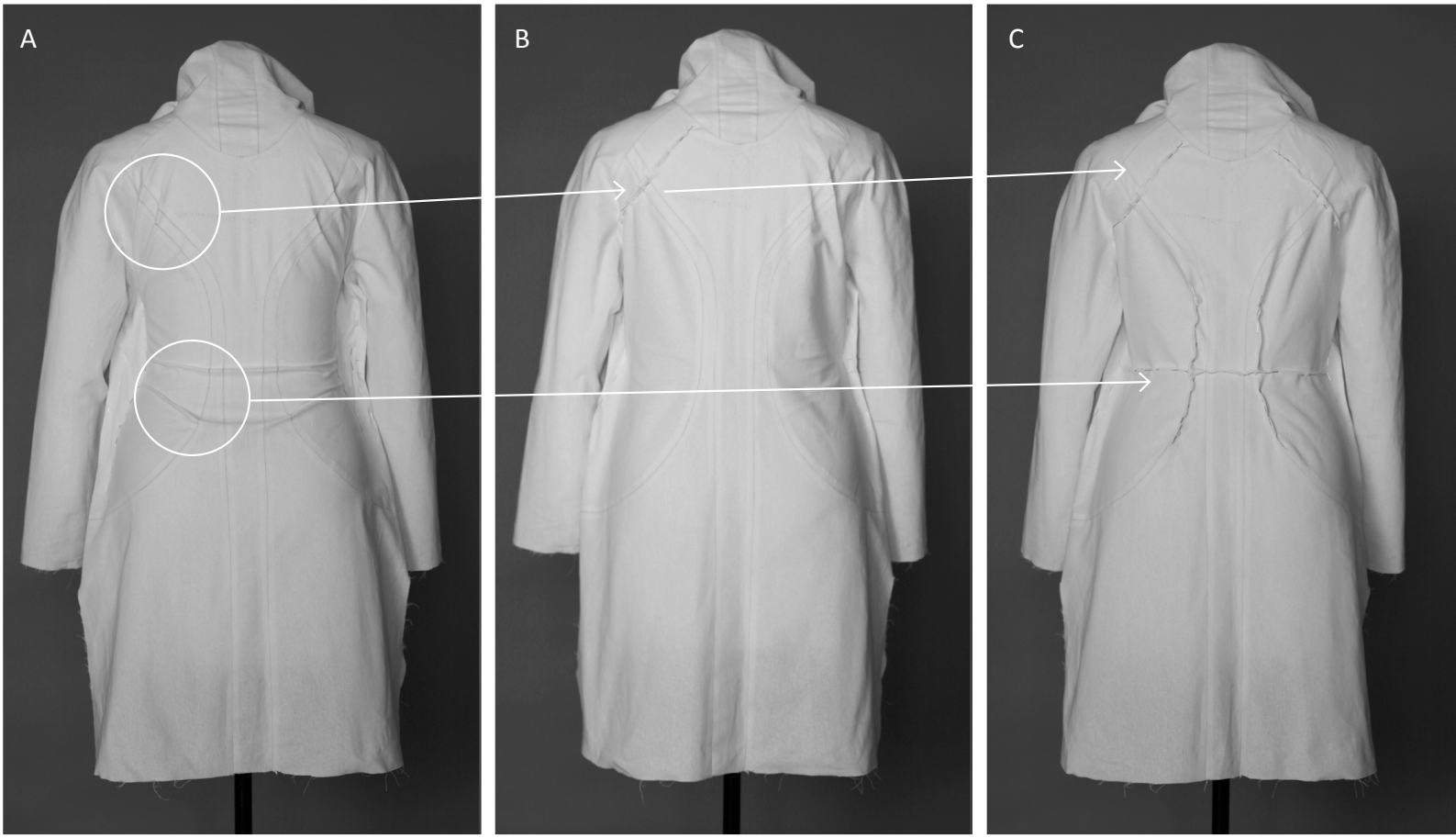


Figure 30. Toile size medium is pinned close to the dress form to do the fitting on the backside.

I pinned the traditionally graded anorak toile in size medium close to the dress form to check the fit on the backside. There seemed to be extra width laying in fabric folds in three different positions, as follows (Fig. 30, A): (1) too much ease over the upper back (the same appeared on the traditionally graded anorak toile size small), (2) too much fabric at the centre back in the waist area and (3) too little room over the lower back area (indicated by the diagonal folds below the waist area on the back side of the toile).

As noted under (1) above, there seemed to be too much ease over the upper back. Here I suggest removing 1.5 cm from the position between the back/side panel and the side panel, moving to 0 cm on the neckline and the armhole (Fig. 30, B/C). The fabric fold that pins away the extra ease in the upper back area will be folded away on the pattern pieces. This will remove the extra ease in this area but not add any additional seam line on the

anorak style.

Similar to what appeared on the traditionally graded anorak toile size small, as noted above under (2), there seemed to be too much fabric at centre back in the waist area. I considered the extra ease to appear in a bigger area than on the anorak toile for size small. I therefore suggest tucking away width both horizontally in the waistline and vertically in the seam lines passing the waistline (Fig. 30, C). As for the size small, I can make use of the vertical seam lines in the anorak design that are passing the waist area when removing this extra width without adding additional seam lines to the anorak style. Horizontally in the waistline position I tucked away 0.8 cm from the back/side panel and 0.8 cm from the side panel, moving to 0 cm on the side seam. Vertically I tucked away 1.3 cm in the waist area from the side panel on the back to obtain a more fitted back (Fig. 30, C).

As mentioned above under (3), I found there to be a need for more space over the backside/lower rear area. To add more width below the waist area, I suggest cutting and playing out the pattern pieces to add more room; see the light grey coloured shapes in the actual area in Fig. 31.

Fig. 31 shows the pattern pieces for the traditionally graded anorak size medium (block pattern size EU 42) with my suggestions for the changes made to better fit the body shape of the medium dress form. The front pieces for the anorak are shown at the top and the back pieces at the bottom. These adjusted pattern pieces for the anorak size medium were then sewn up to a new toile.

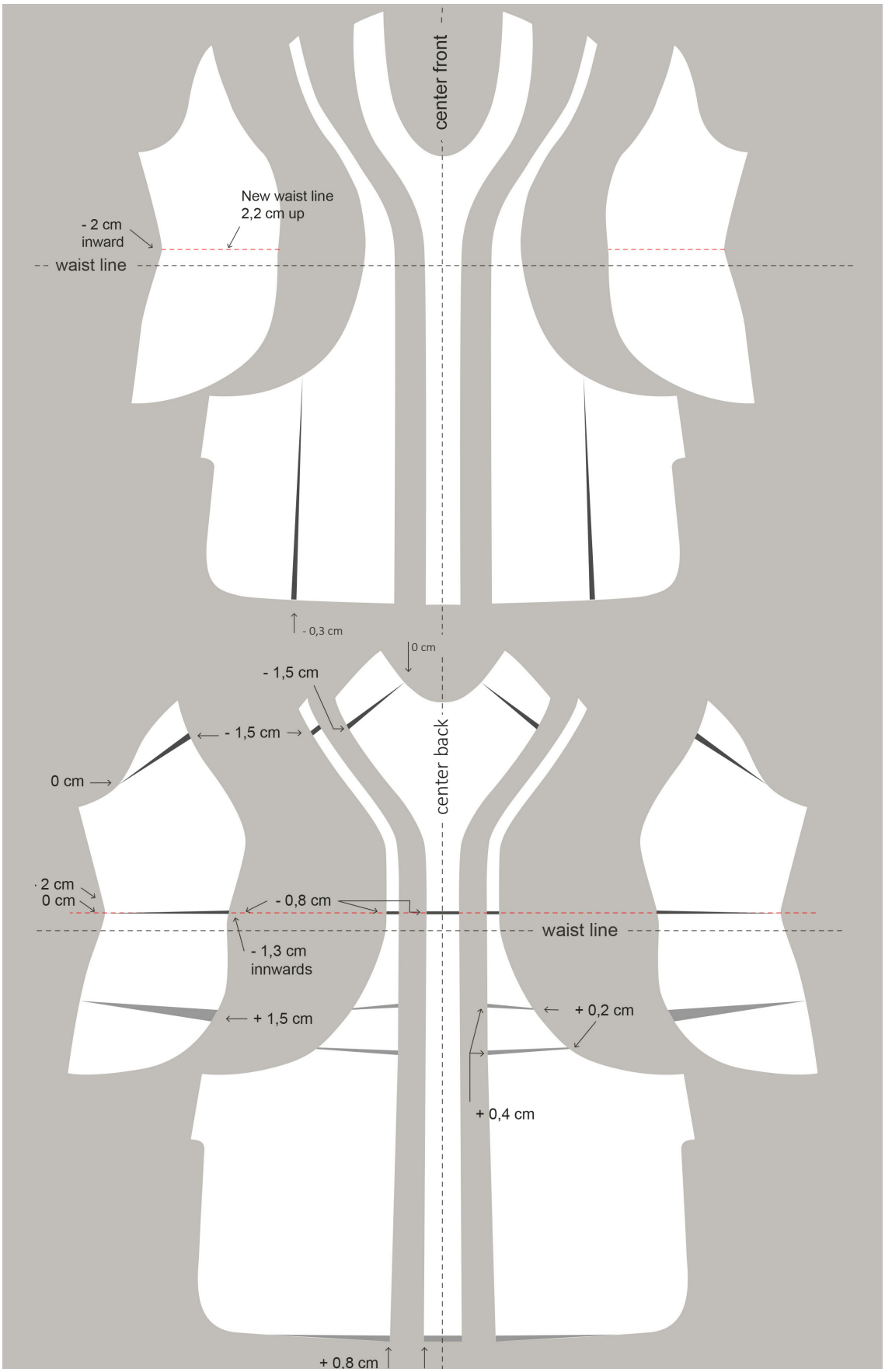


Figure 31. Pattern pieces for the anorak prototype size medium with the changes made to better fit the body shape of the medium dress form.

Figure 32. Toile size medium sewn with the changes made to the pattern pieces during the fitting.

Fig. 32 shows the anorak toile size medium – front, side and back view – sewn with the new set of pattern pieces shown in Fig. 31 after my suggestions for the changes to the pattern pieces during the fitting on the dress form size medium are completed on the actual pattern pieces.

Fig. 33 shows the two sets of pattern pieces for the anorak size medium: traditionally graded (shown above in Fig. 25) and after the alterations when fitting the traditionally graded anorak toile to the dress form (shown above in Fig. 31). The dark grey colour and dotted line show the pattern pieces for the traditionally graded anorak size medium, constructed based on the traditionally graded block pattern size 42. The white colour shows the pattern pieces for the altered anorak size medium with my suggestion, as described above, for the changes made to better fit the body shape of the medium dress form.

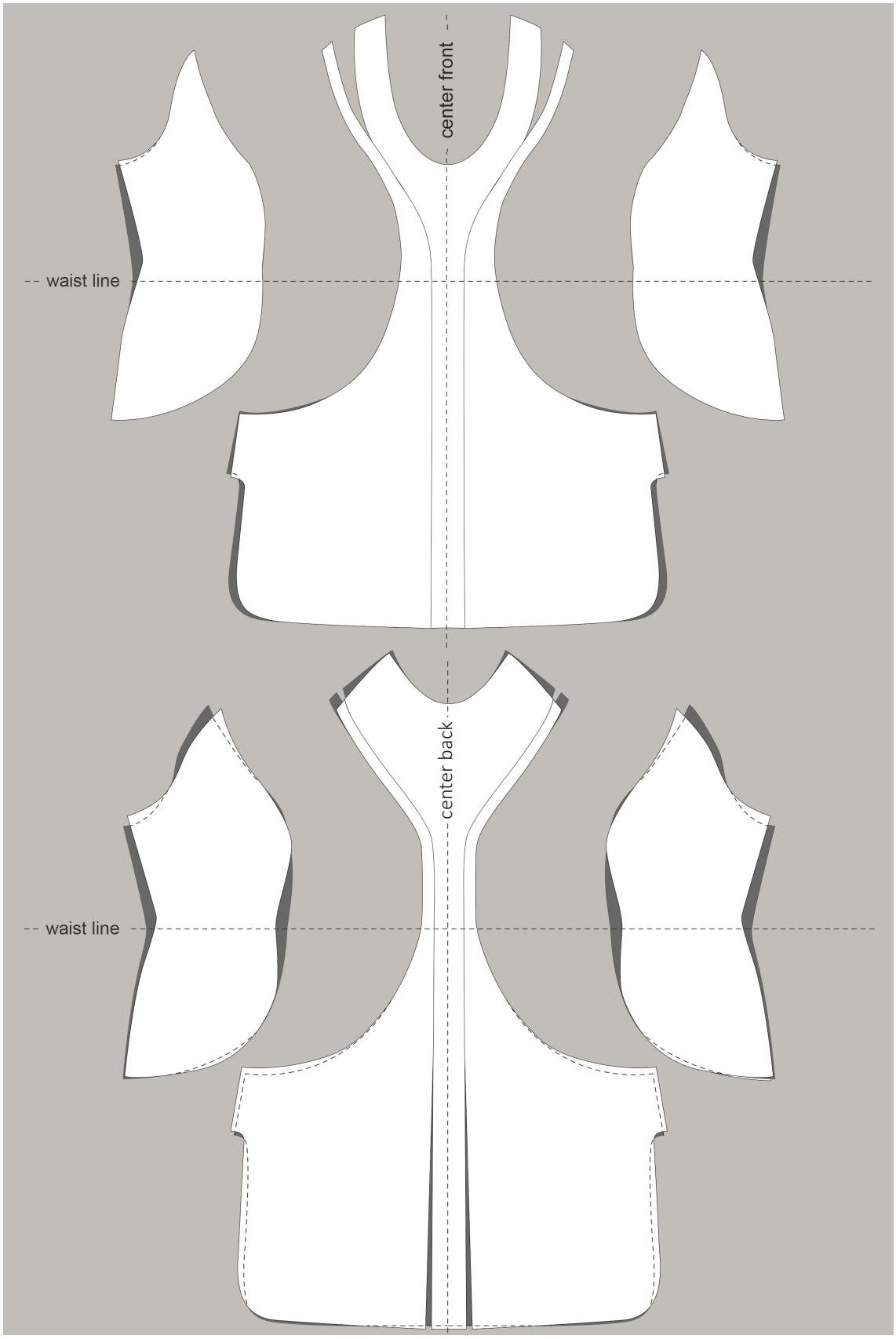


Figure 33. Grey colour and dotted line: the pattern pieces for the anorak prototype size medium, traditionally graded. White colour: pattern pieces for the anorak prototype size medium with the changes made to better fit the body shape of the medium dress form.

Anorak prototype size large

Fig. 34 shows the pattern pieces for the torso of the anorak size large, traditionally graded. As for sizes small and medium, the front pieces of the anorak size large are shown at the top and the back pieces at the bottom. The pattern pieces are constructed on the base of the traditionally graded block pattern size 50 from Ersman and Öberg (2010).

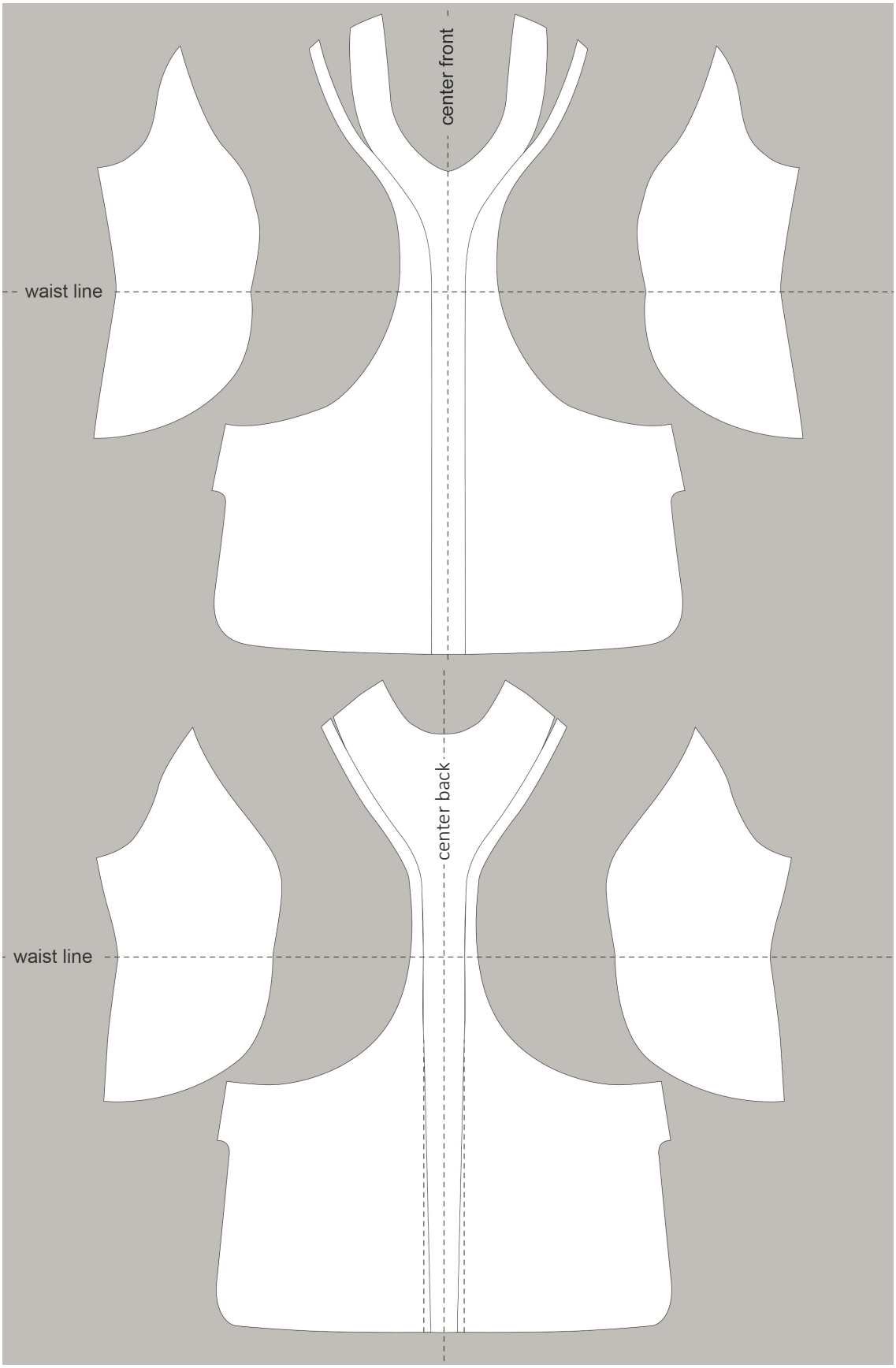


Figure 34. The pattern pieces for the anorak prototype size large constructed with block pattern size 50.

Figure 35. Toile of the anorak prototype size large, traditionally graded.

Fig. 35 shows the anorak toile – front, side and back view – sewn with the use of the pattern pieces of the anorak prototype size large, traditionally graded. As for sizes small and medium, I studied the fit of the toile to the dress form and suggest the following changes to the pattern pieces for size large:

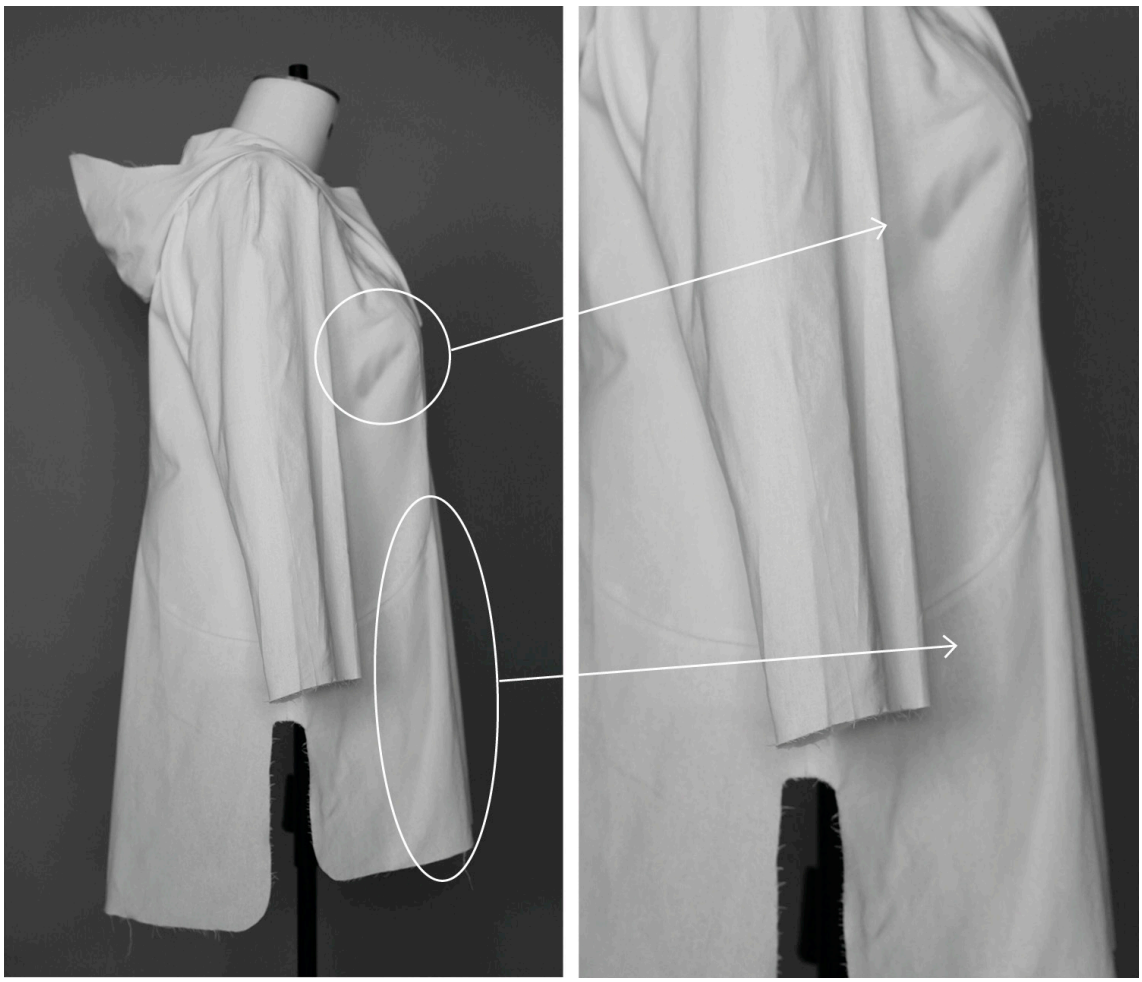


Figure 36. Toile of the anorak prototype size large. There is not enough room above the bust area.

On the traditionally graded toile of the anorak size large I observed the following phenomena that did not appear on the anorak toile of sizes small and medium: there seems to be too little room above the bust area on the toile of the anorak prototype size large, shown on the enlarged image view in Fig. 36. I interpreted this by (1) the fold on the side of the bust area that is pulling the fabric down towards the side seam and (2) the fold gathering the fabric in the centre front area. The lack of room above the bust area seems also to be indicated by the front area of the anorak underneath the bust pulling up and away from the dress form instead of falling freely vertically. My experience with fitting clothing to body shapes with large breasts and/or a large belly/waist or a straight stance where the chest is pushed forward is that more height and width must be put into the block pattern front panel before drawing the desired style of the clothing. I observed

the typical signs that this procedure was needed on the toile of the traditionally graded anorak size large (Fig. 36): the anorak prototype was pulled upwards and tilted outwards in the front, with gathered fabric in the waist area of the back.

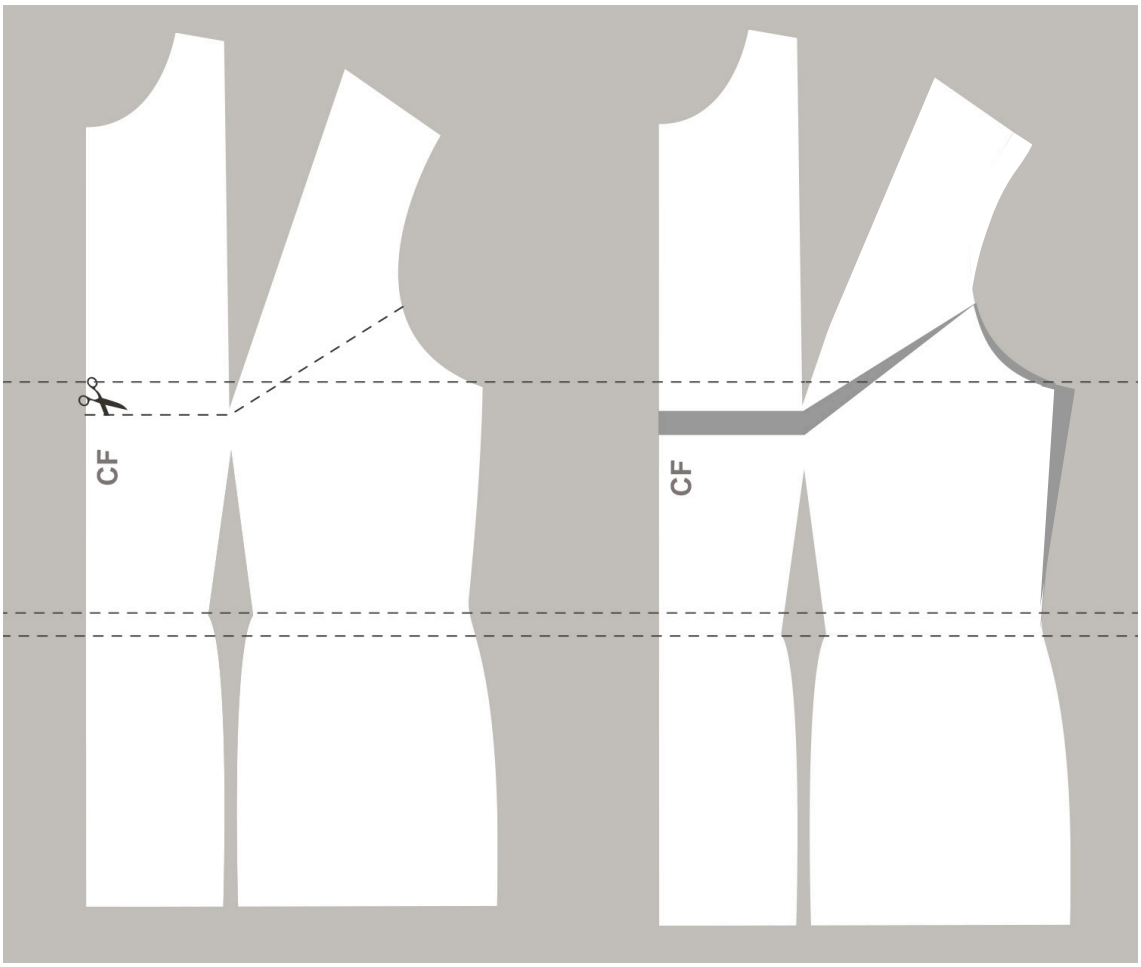


Figure 37. To give more room above the bust area, the height and width must be changed on the block pattern.

Before continuing the fitting and making any other changes to the pattern pieces of the anorak size large, I went back to the block pattern size EU 50 and increased the height from centre front over the bust area by 2 cm and the width at the side seam by 1 cm, as shown in Fig. 37. This gives both increased height for the front pieces of the anorak and an increased volume for the bust through the deepened bust dart.

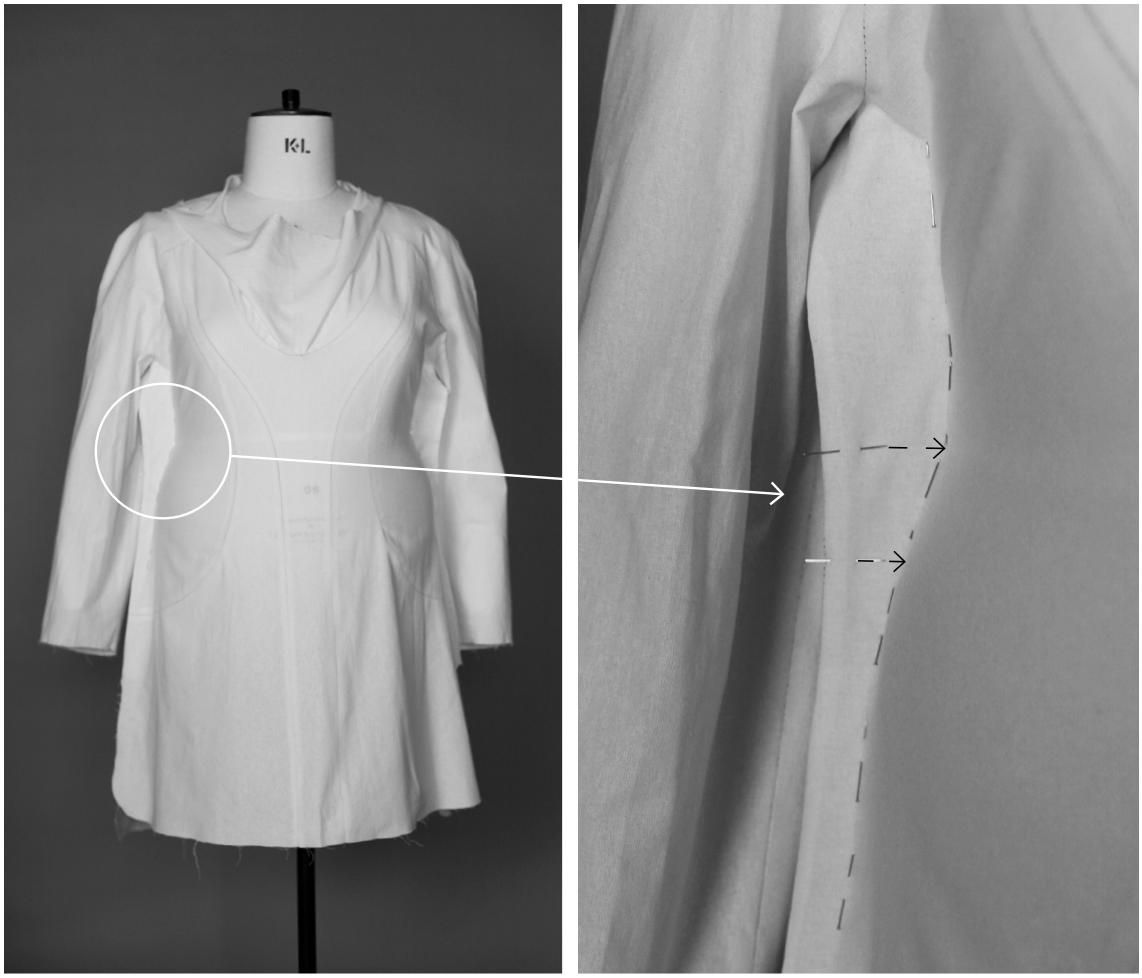


Figure 38. Toile size large is pinned close to the dress form to check the waistline.

Fig. 38 shows that the anorak toile size large is pinned close to the dress form to check whether the waistline on the traditionally graded anorak toile is put in the right place for the body shape of the dress form size large. In my view, the waistline of the traditionally graded toile size large was too low compared to the proportions of the dress form (Fig. 38). This was also the case for sizes small and medium. In my experience it is not uncommon that the upper body height on traditionally graded clothing patterns is too high for a person. There are large individual variations from person to person. The dress forms I use for this case study, which are castings from real bodies, happen to have shorter upper body heights than the traditionally graded block pattern. The point here is to adjust the waistline of the anorak toile so that it is positioned at the waistline of the dress form. The lower horizontal pin close to the side seam (shown with a black arrow on the enlarged

image view) shows where I interpret the toile of the anorak size large is smallest around the waist. The upper horizontal pin close to the side seam (shown with a black arrow on the enlarged image view) shows where I interpret the dress form is smallest around the waist. As mentioned earlier for sizes small and medium, according to the design of the prototype anorak, the toile of the anorak is supposed to follow the body shape with some design ease added and have its smallest circumference where the dress form size large is smallest around the waist. The difference between the lower waistline on the traditionally graded toile of the anorak in size large and the waistline of the dress form size large is 5 cm. I therefore moved the waistline up by 5 cm on the pattern pieces for the anorak (Fig. 38).

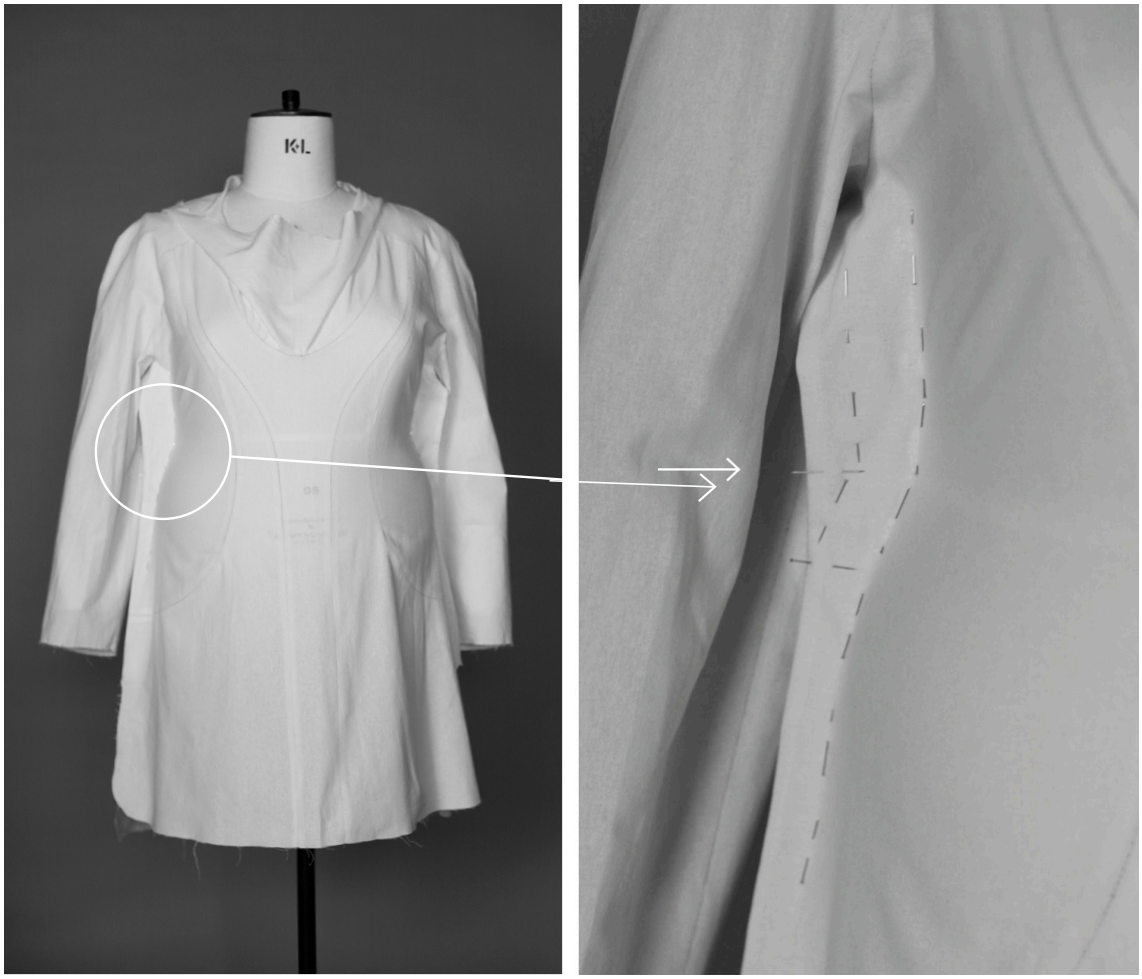


Figure 39. Toile size large is too wide above the waist compared to below the waist.

As for the anorak in sizes small and medium, I considered that the toile of the anorak size large seems too wide above the waist close to the side seam compared to below the waist in the same area, compared to the design of the prototype anorak. The pins show that the width is reduced beginning from the side seam at the original waistline and that design ease is shaped with pins parallel to the shape of the dress form size large. For the exact reduction from the side seam, see the drawing of the pattern pieces (Fig. 42).

Figure 40. Toile size large has a little too much fabric below the waist area on the front side.

The toile of the traditionally graded anorak size large seemed to have slightly too much fabric below the waist area on the front side. To reduce this I removed 1.7 cm of the width on the bottom, letting it move out to 0 cm on the outline of the front side panel. This fabric fold that pins away the extra width below the waist area, shown on the enlarged image view in Fig. 40, will be folded away on the pattern piece. This will remove the extra width but not add any additional seam lines to the anorak style.

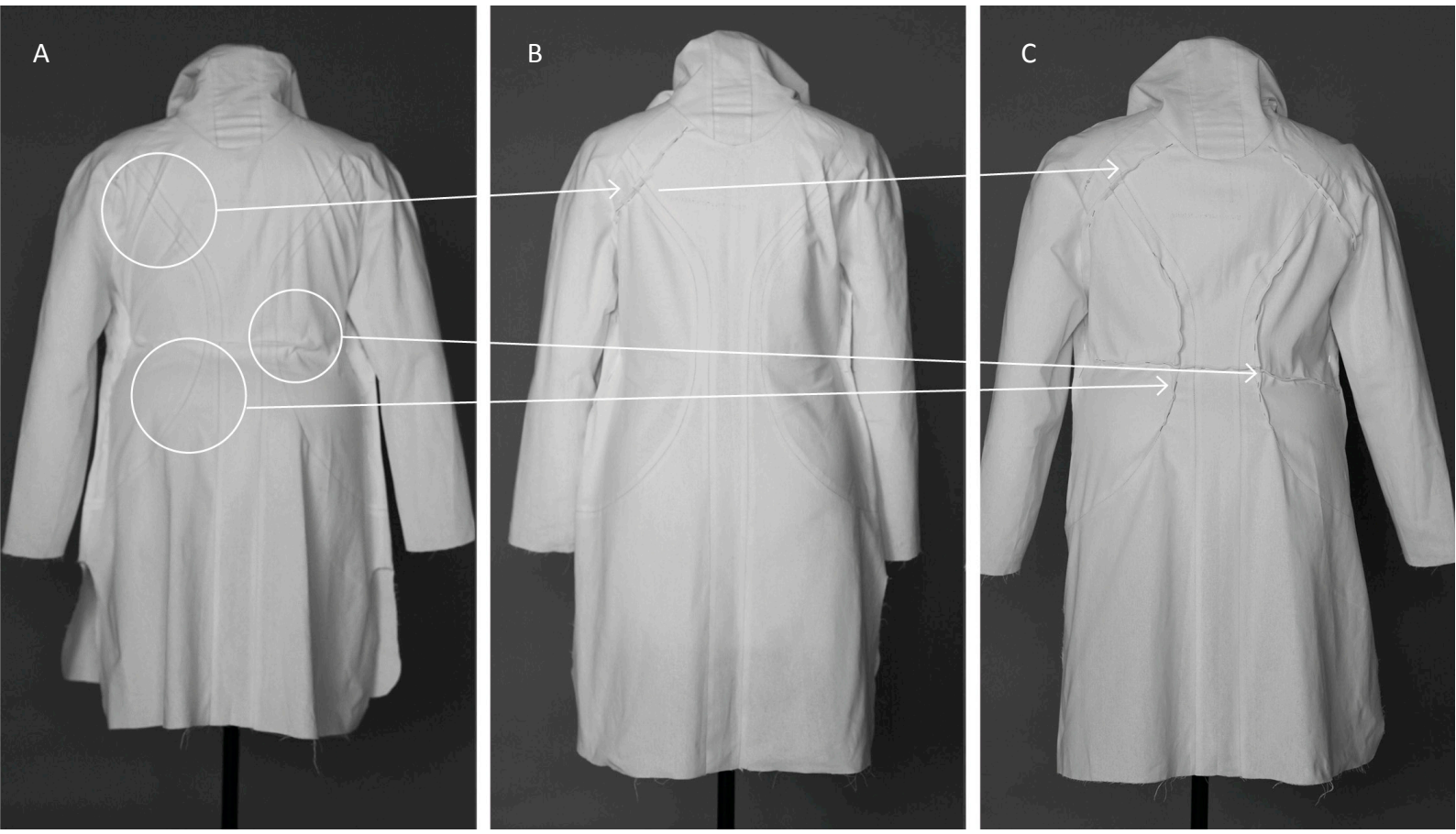


Figure 41. Toile size large is pinned close to the dress form to check the fit on the backside.

I pinned the traditionally graded anorak toile size large close to the dress form to check the fit on the backside (Fig. 41, A). There seemed to be extra width laying in fabric folds in three different positions (Fig. 41, A) which I interpreted as follows: (1) there was too much ease over the upper back (the same appeared on the traditionally graded anorak toils sizes small and medium), (2) there was too much fabric in the centre back in the waist area and (3) there is not enough height over the lower back area. These vertical folds indicate that the centre back area on the lower torso is pulled up and outwards.

As noted above for (1), there seems to be too much ease over the upper back. Here I suggest removing 1.5 cm from between the back/side panel and the side panel in the upper back position, moving to 0 cm at the neckline and the armhole (Fig. 41, B/C). The fabric fold that pins away the extra ease in the upper back area will be folded away on the

pattern pieces. This will remove the extra width in this area but not add any additional seam lines on the anorak design.

Similar to what appeared on the traditionally graded anorak toile size medium, as noted above for (2), there seemed to be too much fabric at centre back in the waist area. As for the traditionally graded anorak size medium, I considered the extra ease to appear in a bigger area than on the anorak toile size small, but I did not see the need to reduce the height horizontally in the waistline position. I therefore suggested tucking away width only vertically in the seam lines passing the waistline (Fig. 41, C). As with size medium, I can make use of the vertical seam lines in the anorak design that are passing the waist area when removing this extra width without adding additional seam lines to the anorak style. I took away 1.5 cm in the waist area from the side panel on the back and 1.5 cm from the attending panel close to centre back to make the anorak prototype more fitted to the back (Fig. 41, C).

I increased the length at the bottom of the anorak in centre front by 1.5 cm, moving to 0 cm towards the sides. The light grey coloured marks in Fig. 42 indicate where I added this length.

As mentioned above for (3) I found there to be a need for height over the lower back area on the anorak. I suggest cutting and playing out the pattern pieces to add more room; see the light grey coloured shapes in the actual area in Fig. 42.

Fig. 42 shows the pattern pieces for the traditionally graded anorak size large (block pattern size EU 50) with my suggestions for the changes made to better fit the body shape of the large dress form. The front pieces for the anorak are shown at the top and the back pieces at the bottom. This adjusted pattern pieces for the anorak size large were then sewn up to a new toile.

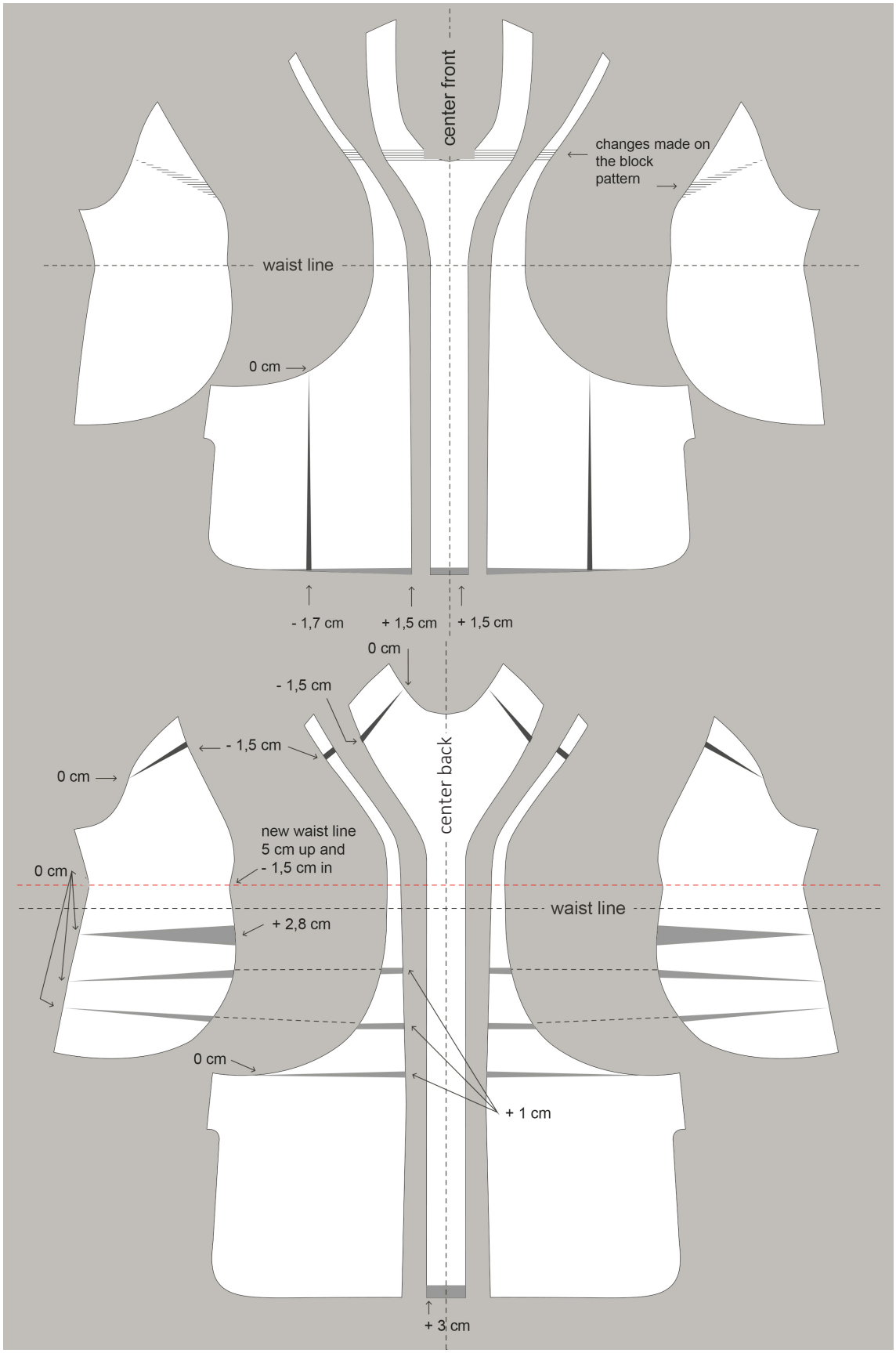


Figure 42. Pattern pieces for the anorak prototype size large with the changes made to better fit the body shape of the large dress form.

Figure 43. Toile size large sewn with the changes made to the pattern pieces during the fitting.

Figure 43 shows the anorak toile size large – front, side and back view – sewn with the new set of pattern pieces shown in Fig. 42 after my suggestions for the changes to the pattern pieces during the fitting on the dress form size large are completed on the actual pattern pieces.

Fig. 44 shows the two sets of pattern pieces for the anorak size large: traditionally graded (shown above in Fig. 34) and after the alterations when fitting the traditionally graded anorak toile to the dress form (shown above in Fig. 42). The dark grey colour and dotted line show the pattern pieces for the traditionally graded anorak size large, constructed based on the traditionally graded block pattern size 50. The white colour shows the pattern pieces for the altered anorak size large with my suggestions, as described above, for the changes made to better fit the body shape of the large dress form.

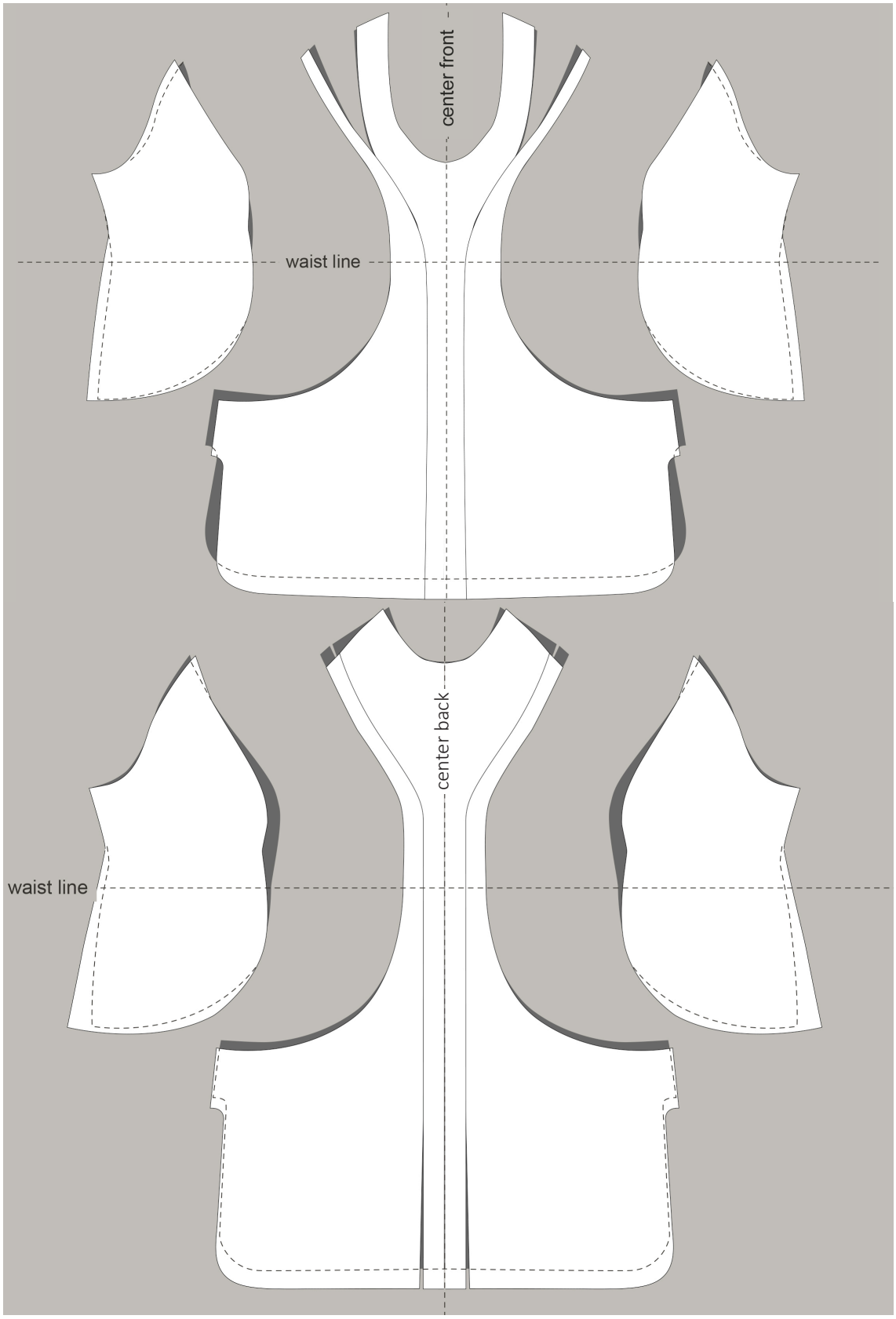


Figure 44. Grey colour and dotted line: pattern pieces for the anorak prototype size large, traditionally graded. White colour: pattern pieces for the anorak prototype size large with the changes made to better fit the body shape of the large dress form.

Discussion of the case study data

I will now critically review the choices I took during the performance of the case study *Anorak:VG.*

Choices during the case study Anorak:VG

When I chose to work with dress forms instead of models, I opted out of the possibility to study the prototype on the body in motion and receive significant feedback from the fit models in relation to mobility and whether the garment tightens while, for example, driving a car. For the tailor, the repeated fitting on the customer is an important part of developing well-fitting garments. Even better is to study the garment over a period of time in use and then adjust the fit of the garment after this. This would have been time consuming, and I considered it to be unrealistic in a clothing production situation. Also, the dress forms did not have arms, so I could not include the fitting around the shoulder and arm. Later when I tried to recreate the different steps during the ***Anorak:VG*** study for the photographer to take pictures for my thesis, arms for the dress forms were used. This can seem confusing for the reader. The choice of not to include the arms and shoulder area in the fitting was to reduce the scope of the study; however, when working together with the photographer on the illustration for the study, we decided to use arms on the dress forms to make the pictures more illustrative.

The design of the anorak was chosen to fit with a sweater underneath the anorak, but I did not place a sweater on the dress form before dressing on the toiles. This can be confusing when viewing the pictures because the toiles have a slightly loose fit on the dress forms to give space for a sweater. I freely designed a clothing prototype based on criteria I considered challenging. The seam lines I designed were chosen for visual artistic expression and not with the fitting of the anorak in mind. The clothing prototype was supposed to give space for other clothing underneath, such as a pullover, but still be fitted to the body shape and not just a baggy, basic t-tunic cut. I could have chosen to design other garment types instead of the particular clothing prototype of an anorak.

Also, I could have made the same case for more than one garment style to show different challenges and ways to make changes in proportions and volumes for the different body shapes in an actual sizing system. However, this would not have added anything substantially new to my case ***Anorak:VG***. It would, however, have added more examples to increase the understanding of implementing the fit step in general. My work with the fitting and grading, though, would still be carried out using the same techniques I use when fitting clothing to a person. As my design of the ***Anorak:VG*** happened to be with several seam lines that wave over the garment, there may be a misunderstanding that several seams that wave over the garment are needed to be able to perform the fit step in ready-to-wear clothing. This is not the case; instead the implementation of the fit step appears different from garment style to garment style depending on where the seam lines are located in the particular garment design.

When I did the fitting of the toiles on the dress forms, I checked whether the garment was balanced, meaning checking whether the garment was tilting forward or backward on the body, whether areas are pulled into folds and whether there is too little or too much room in some areas according to the cut and design of the prototype. When critically reviewing the fitting I did, one could ask whether one of the changes I made similarly on all three dress forms, where I moved folds of extra fabric underneath the shoulders on the backside of the anorak, could be more of an improvement of the cut itself than a fitting to three different body shapes. This change might have been done to the cut of the anorak before I started the fitting on the three dress forms. Also, the fitting of a garment is quite individual from tailor to tailor, so another tailor might have performed the fitting on the three anoraks in a different way. During practice over time I have also developed the way I do fittings of garments, this means that it is not static how the fitting is performed. For the case in this thesis it is not essential how the fitting is performed but rather the fact that fitting is done. It is reasonable to think that in the case of industrial production, the fitting of the different sizes in the actual size range would be done by either the patternmaker or the designer together with the patternmaker or in collaboration with the grader.

Customizing a prototype by example of Anorak:VG

Next, I will discuss what I see as the advantages of grading the various body shapes, representing a size range, within the pattern construction and cut of a prototype. The placement of the seams on the actual prototype matters in relation to where and how to build in the different body shapes during the grading. This will be different from prototype to prototype depending on how the designer has positioned the seams on the actual prototype. Using only block patterns graded based on anthropometric data from a target group, such as Schofield's (2007, p. 186) TEST set of a graded block patterns (Fig. 9), does not provide the same result because the fitting to different body shapes then is limited to the design of the block pattern and cannot utilize the cut and design of a specific prototype. I will substantiate this using two examples to demonstrate why adapting the block patterns to different body shapes and sizes is not sufficient to offer well-fitting clothing to consumers with different body shapes and sizes.

In my professional practice as designer-tailor I have seen that often, especially in the larger sizes, there is too much room above the lumbar region. This was the case for the anorak prototype. If this extra room is removed on the block pattern (Fig. 45, B) using a horizontal tuck that is wide at the centre back and tapering to zero at the side seam, it gives a block pattern with a shaped centre back line and not a straight centre back line (Fig. 45, B). However, if there must always be a seam at the centre back, because the centre back line is not straight, the design of garments will be limited. Now, if the changes for different body shapes and sizes are made inside every style of a garment, after the prototype is made, it is possible to solve the problem of extra room in the lumbar region in different ways. If the prototype has a seam passing the waist area in some way, for example like in the position shown in Fig. 45 (C), the extra room above the lumbar region can be tucked away with a straight fold at the centre back pattern piece and on the side back pattern piece with a tuck going from wide to zero at the side seam. Now the centre back line is still straight and can be cut to fold, so the clothing item has no seam at the centre back.

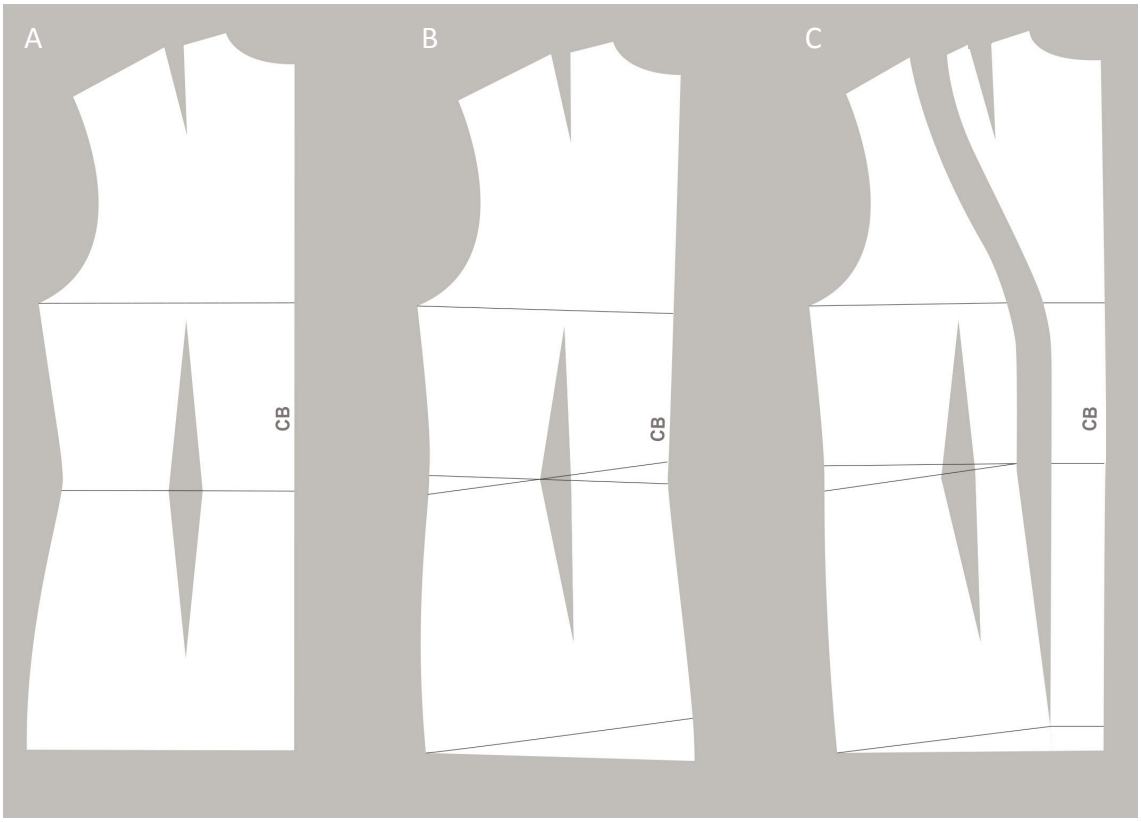


Figure 45. A: block pattern backside with straight centre back line; B: block pattern backside where extra room above the lumbar region is tucked away; C: block pattern backside where extra room above the lumbar region is tucked away, keeping a straight centre back line.

The second example shows a situation that also occurred on the anorak prototype for *Anorak:VG*. There was too much room above the shoulder upper back region. If this extra room were to be removed on the block pattern, it would not be possible to tuck a fold that is wider in the centre of the fold and still keep a pattern piece that is flat and not dented (see Fig. 46, A). Now, if the changes for different body shapes and sizes are made inside every style of a garment, after the prototype is made, it might be possible to solve the problem of extra room above the shoulder upper back region in different ways. If the prototype has a seam passing the shoulder upper back region in some way, for example as in the position shown in Fig. 46 (B), the extra room above the shoulder upper back region can be tucked away with a fold from the seam tapering to zero by the edges of the pattern pieces (see Fig. 45, B). This change to the pattern pieces gives a result in the fabric where no extra seams are added to the style of the garment but the extra room above the shoulder upper back area is removed.

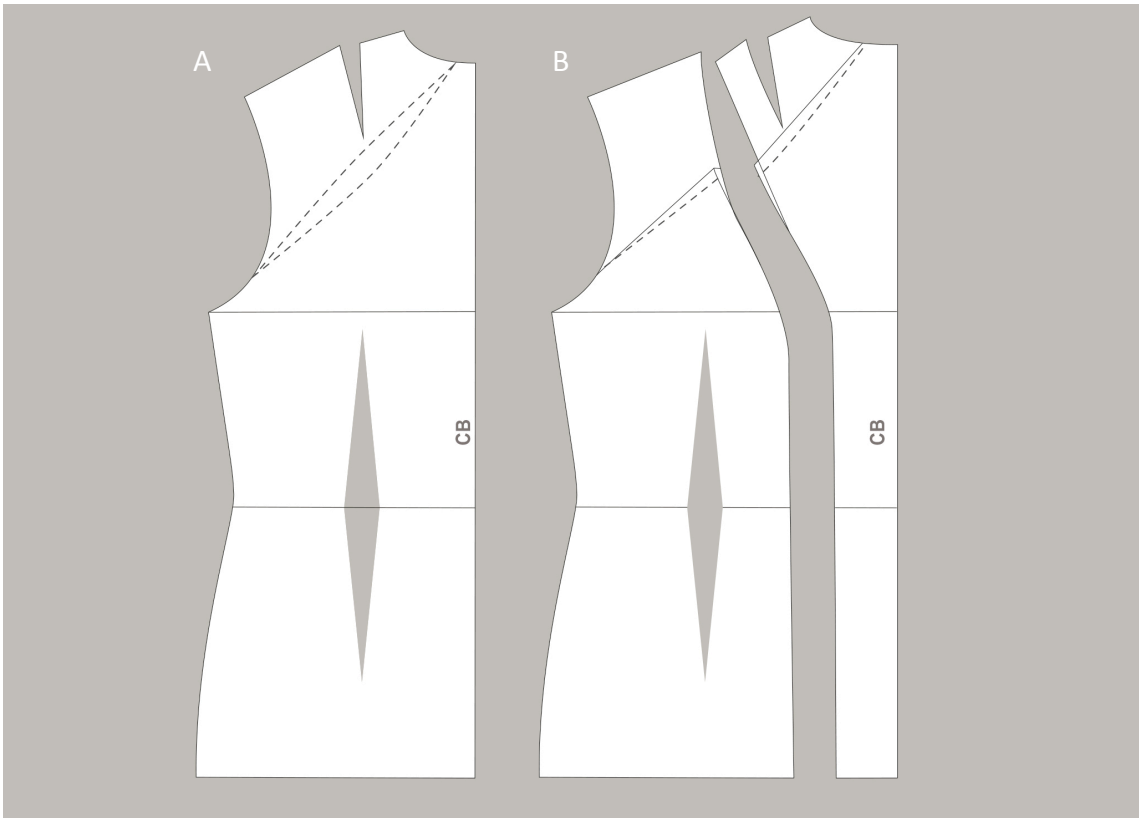


Figure 46.A: block pattern backside where extra room above the shoulder blade region is shown by the dotted line; B: block pattern backside where extra room above the shoulder blade region is tucked away, keeping the pattern pieces flat.

During my case ***Anorak:VG*** on adapting the pattern to the body shape from size to size, I realized that some changes were beneficial to do on the block pattern before constructing the particular style of the garment, while most other changes needed to be done inside the style of the garment. In the case of ***Anorak:VG***, I made one change on the block pattern for size large, increasing the height and width to get enough space for the bust on the front side. The benefit of making the changes inside one style is that it is possible to use the actual cut for making the changes in proportions and body shape. In the case of ***Anorak:VG***, I took advantage of this in two situations. The first was when decreasing the amount of fabric in the waist area on the backside. If I had made this change on the block pattern before drawing the style of the clothing prototype, I would have had a broken centre back line (see Fig. 45, B). This would have caused problems when drawing the style of the clothing prototype later, where a straight centre back line is needed. By decreasing the amount of fabric in the waist area on the backside ***after***

drawing and cutting out the clothing prototype style on the block pattern, it was possible to make the changes without a broken centre back line. This is because I got two vertical seam lines close to the centre back, so I decreased the actual amount parallel to the side/back panel and moved to zero decrease on the side seam on the side panel on the backside (see Fig. 45, C).

Customizing the body shape inside the actual style of a clothing item I suggest as one solution to the problem that Schofield (2007, pp. 191–192) describes in ***Sizing in Clothing.*** She shows an example of a block pattern (TEST block pattern, see Fig. 9) that is graded after using anthropometric measurements from an actual group of people. Here the side seam lines and the shoulder lines do not have the same angle on the front side and on the backside of the block pattern. This gives different grain lines on the two pieces of fabric that meet at the side seam and shoulder seam. The piece of fabric that has the widest angle starting from the grain line will appear too long at the side seam and shoulder seam because woven fabric usually has the most stretch diagonally. When adapting the pattern to different body shapes from size to size while constructing the actual style of a garment, it may be possible to arrange for the same angles for the side seams and shoulder seams and instead adapt the pattern to the body shape and anthropometric measurements elsewhere in the pattern.

My suggestion for the process of clothing production is that adjustments and changes in the construction and grading of the pattern pieces for a prototype, for which I have given examples in my case study ***Anorak:VG***, should be done within the pattern construction and cut for each prototype to maximize the benefits and make the garment appear the same on different body shapes representing a size range. The goal of grading, according to Schofield (2007, p. 190), should be to create a new garment for each size that will provide a fit equal to that of the prototype. This means that the different sizes in a size range based on anthropometric data from a target group will have different body shapes embedded within the cut of the garment. This suggestion requires an additional step in the process of making clothes, which I call the ***fit step***.

The fit step

As I have described in my path through the literature in the field, sizing systems, grading methods and fit in clothing do not correspond with or fit well to actual body sizes and body shapes among populations. This may lead to the early disposal of clothing items as one of two main reasons for the disposal of clothing is fit issues. I have located one of the sources of the problem in the traditional grading practice of today's clothing industry. I recommend methods whereby grading is done based on anthropometric data, but I also suggest integrating the designer's and patternmaker's work during the grading process. This is because then the knowledge of these three professions can benefit from each other. For example, if it would be beneficial for the fitting to add a seam line in some position, the designer could integrate this in her design of the garment style. The goal is to adapt the pattern pieces for a garment to better meet the different challenges of making a good fit inside the style of a garment for different body shapes representing the different sizes in a size chart. The outcome of the case ***Anorak:VG*** is the suggestion to add a step to the ready-to-wear clothing production process. I call this step, which is missing from current production methods, the fit step***,*** and it builds upon two earlier steps in the process. These two previous steps, described below, are also not common practice today, but as I have described in my path through the literature in the field, research has been conducted leading towards these two steps. The first step prior to the fit step is the development and use of a size range based on anthropometric data from the target group of the clothing producer. The second step prior to the fit step involves grading the block patterns. Block patterns should be graded individually from size to size based on representative body shapes and proportions that cover the size range based on anthropometric data from the target group. For my case ***Anorak:VG,*** I did not use a block pattern based on anthropometric data from a target market, like Schofield's (2007) TEST pattern of a bodice, because as far as I know, one is not available in a set of nested pattern pieces on a scale of 1:1. I assume that a block pattern for which the grading was done in the way described above according to Schofield's (2007) study would have resulted in first prototypes that fit the actual dress forms better than the ones I made with the traditionally graded block patterns. Still, my intention is to show that adapting the

garment prototype to the different body shapes representing the different sizes in a size chart should be done in addition to grading the block pattern based on anthropometric measurements.

The fit step is about grading the prototype according to knowledge about how the actual cut can be utilized to build in the different body shapes and proportions of a size range in the target population. Adding this fit step to the process of clothing production does not, as mentioned earlier, depend on having block patterns graded by embedding different body shapes, but I would assume that this would give a better starting point for adding the fit step, meaning that not as many adjustments would be needed during the grading from size to size. The outcome of the case ***Anorak:VG*** shows that the traditional grading of a prototype requires fewer changes for the small size with a slim body than for the two larger body sizes. The largest body size requires the most changes from the traditionally graded prototype. This corresponds with my experience fitting garments to different body sizes and shapes. I assume that if a set of block patterns is graded the way Schofield's (2007) TEST pattern is used, then the changes made to achieve a good fit for different body shapes inside the cut of a prototype would be more evenly distributed across the size range. My case study gives an example of how to implement the fit step. The benefits of adding the fit step in the production of ready-to-wear clothing is that a prototype will look the same on different body shapes that are representative of the actual target group and will offer well-fitting clothing to the majority of the target group instead of only a minority who are closest to an ideal body shape.

Schofield (2007, pp. 189–190) describes the visual inspection of the nested pattern pieces, where the grader sees at a glance whether or not the pattern pieces have been well graded. This visual inspection is based on the traditional method of grading where, for example, lines are parallel and lengths increase systematically. If the purpose is to change the grading practice to better represent the body shapes and measurements from a target population, then the look of pattern pieces that have been well graded is going to change. The skilled expert using her expert knowledge in the visual inspection of

the graded pattern pieces is going to change her practice (Schofield, 2007, pp. 190, 193). This is also connected with the ideal body shape. The whole process of making clothing is usually based on an imaginary ideal body shape. For women, this can be the hourglass body shape. All the choices made during the process of producing a clothing item are usually based on this ideal body shape. If the purpose is making well-fitting clothing for the majority of a target group, I find it reasonable to suggest that the different professions involved in the making of clothing have to readjust their thinking about different body sizes and body shapes representing the different sizes in a sizing system.

Concluding remarks on the case Anorak:VG

The research question for my case was ***How can the cut of a prototype be graded to fit different female body shapes?*** The outcome from ***Anorak:VG*** shows one prototype as an example and the changes made to the pattern construction and cut to better fit three different body sizes and shapes. I have called these changes to the pattern construction made during the grading of a prototype the ***fit step***. By adding the fit step to the process of producing clothing, it is possible to change the traditional grading practice so that the designer, patternmaker and grader are working together, basing their work on anthropometric measurements from a target market. This again would make it more likely that the majority of a target group could buy garments that fit their bodies.

A question that could be raised after reading my description of ***Anorak:VG*** is whether there is a difference between the changes I made to the toiles when fitting them to the three dress forms and the changes that would be made during an ordinary fitting of a clothing item to three different body sizes and shapes. The techniques I used while changing the proportions and volumes to adjust the cut of the clothing prototype to the three different sizes may not differ from the techniques used to fit a toile to a fit model or customer and transfer the changes back to the pattern pieces. What makes a difference is what the three dress forms I worked on represent in my case ***Anorak:VG***. They give examples of what three body shapes could look like representing three sizes

from a sizing system based on anthropometric measurements and body shapes from a clothing producer's target group. If the conditions had been suitable, I would have used dress forms made based on sizes and body shapes that were developed from the 'SizeGermany' or 'SizeUK' sizing systems (SizeGermany, 2015; SizeUK, 2015). Such dress forms would have been representative of target groups in the German or British markets. However, even if I had been able to use such dress forms, what I did in ***Anorak:VG*** would not necessarily have been different from the advanced fitting of a prototype to a dress form or fit model. What makes the difference is the setting and the way of thinking that I have created around the case. What I attempt to make visible is how the grading differs from size to size inside one style of a garment and how to use the actual seam lines of a particular style while changing the proportions and volumes of the resulting garment. In the ***Anorak:VG*** case, I show the traditional grading used today and an alternative way of grading a prototype that accounts for changes in body shapes from size to size in a target group instead of the shape remaining the same, only made bigger or smaller.

During my ***Anorak:VG*** case I used my personal expertise, experience and practical knowledge as a designer and a tailor. This will not cause problems if a clothing producer wants to grade a prototype individually from size to size and uses sizes based on anthropometric measurements from his target group as long as his employed graders and patternmakers have adequate knowledge and expertise in regard to fitting to different body shapes. What I did in my case ***Anorak:VG*** is meant to be an example of a procedure, so the exact way in which I did the grading and how I carried out the changes in body shape on the pattern pieces is not critical.

In my view, the most important outcome of my case ***Anorak:VG*** is the change in procedure from traditional grading based on an ideal body shape to individual grading from size to size in a size range where the body shapes change and originate from body measurements from the actual target market of a clothing producer. What I demonstrate in my case ***Anorak:VG*** is that it is not sufficient to do the grading individually from size to size on the block patterns; this would of course be one step in the right direction if the

goal were to fit different body shapes based on anthropometric measurements. But an even more optimal fit for different body shapes is achieved if different proportions and volumes are built into the pattern pieces using the actual seam lines of every style of a particular garment.

The fit step in perspective

In the following chapter I will discuss my case *Anorak:VG* according to the research question: *How can the cut of a prototype be graded to fit different female body shapes?* I will start this chapter by discussing fit as a crucial reason for the disposal of garments and factor for customization and support systems for sizes and fit. Then I will discuss the possible application of the fit step and potential benefits for companies applying the fit step and conclude with a discussion of the fit step being the next step. I will also discuss *Anorak:VG* in relation to the overarching perspective of this thesis – sustainable development and further developing of the work on fit in clothing.

Fit as a crucial reason for the disposal of garments

Studies on the reasons for discarding clothing, which I referred to in my path through the literature in the field (Domina & Koch, 1999; Collett et al., 2013; Bye & McKinney, 2007; Klepp, 2001; Laitala, 2010, 2014; Laitala & Boks, 2010, 2012), show that fit problems, together with lack of quality, are the main reasons mentioned. There can be several reasons why one specific garment comes out of use. These reasons point to problems that can be explored to provide suggestions for changes in clothing production practices, leading to the optimized use of the clothing over a longer period. Of course there are various other focuses I could have chosen from the same starting point and examined through various disciplines, for example, the question of gender and clothing seen from a sociological view, economic aspects seen through the field of the social sciences or clothing consumption seen from the field of cultural studies. I have, however, chosen to concentrate on fit in clothing seen from the view of the practice of pattern construction in the design and tailoring practices for ready-to-wear clothing.

In my path through the literature in the field I have referred to studies (Domina & Koch, 1999; Collett et al., 2013; Bye & McKinney, 2007; Klepp, 2001; Laitala, 2010, 2014; Laitala & Boks, 2010, 2012) where fit is regarded as a major reason for the disposal of clothing. The studies are mainly conducted in countries influenced by Western consumption

habits. Laitala, Klepp and Boks have a base in Norwegian studies (Klepp, 2001; Laitala, 2010, 2014; Laitala & Boks, 2010, 2012). Collett et al. (2013), and Bye and McKinney (2007) have studied reasons for the disposal of garments in the US. This indicates that the studies I have referred to cover the disposal habits mainly of Western women. I am fully aware that the circumstances may be different in other parts of the world. Still the studies are interesting since Western women are at the forefront of overconsuming clothing. This gives an indication of overconsumption being a part of the Western prosperity culture. It might be a shortcoming that the studies I referred to on problems with fit being a reason for disposal do not cover other parts of the world. Still this does not change the fact that problems with fit are a major reason for the early disposal of clothing – a problem my fit step is a possible solution for.

My students and colleagues often mention rapidly changing fashion as a reason for a short user period when I talk to them about clothing that is disposed of, that is not worn out or that has been worn only a few times. A study by Klepp shows that clothes that were disposed of because of 'outdated fashion' were older (8.05 years) than clothes that were disposed of because of 'wear and tear' (7.5 years) (Klepp, 2001). This means, according to Klepp, that clothes, if they are actively worn, become worn out before fashion has changed so much that the clothes are discarded because of outdated fashion. Thus, garments may be left unused for years and then later be discarded because they are no longer fashionable (Klepp, 2001, p. 162). These findings indicate that there is reason to change the perception that rapidly changing fashion is the main reason for the disposal of clothing that is only worn a few times. The reason that garments are not worn out may be sought elsewhere. It is reasonable to assume that fit issues are a major reason why clothes are kept unused for many years. Even if the reason for disposal after years of disuse is 'outdated fashion', the reason for not wearing the garment when it was still in fashion may be lack of good fit.

In my path through literature in the field, I focused on reasons for disposal where fit issues are addressed in several surveys (Domina & Koch, 1999; Collett et al., 2013;

Bye & McKinney, 2007; Klepp, 2001; Laitala, 2010, 2014; Laitala & Boks, 2010, 2012). For example, 'did not fit' is one of a number of reasons for discarding included in a questionnaire. What is not obvious from an answer such as 'did not fit' is what the respondents considered in selecting this option. One could speculate whether some of the respondents' answers are reflecting clothing items that do not fit well to their body shape and size. The response can also be about, for example, gaining or losing weight or other reasons for why the garment does not fit. In contrast, fit issues may underlie other reasons given for why clothing items are not used or are discarded. Klepp (2001) has focused on changes in fashion as a reason for the disposal of clothing. One of the respondents in her study cannot formulate the reason why she has never worn a certain yellow trouser suit, but by the time of its disposal, it has become out-dated in fashion, which I suppose could be her stated reason for its disposal. She defines it as a technical error in the make of the trouser suit after letting SIFO, a Norwegian governmental institute that conducts consumer research, test the garment and finding that the jacket is too narrow through the shoulders. Poor fit and cut may be the reason that the trouser suit was not used. This demonstrates how a clothing item not fitting the user's body shape may be categorized as 'did not fit' as the reason for disposal but also how it is likely to lie behind other given reasons; this can also be the case in the opposite situation, meaning that clothing categorized as 'did not fit' does not always have to do with a poor fit to the user's body shape and that there might be other reasons hidden behind. However, bad fit for a person makes it more reasonable that an item of clothing is not worn or just worn a few times. Klepp also points out that when garments do not fit properly, the user's attention is invoked. For example, the wearer notices when a skirt is too tight to walk in or a blouse slips out of the trousers or straps fall down from the shoulders (Klepp, 2001, p. 133). She asks for more technically oriented research in which the body's interaction with clothing is put into focus. She concludes that clothes with a low tolerance for changes in body shape shorten the period over which the item is used. With my case, ***Anorak:VG***, I have taken up Klepp's challenge of a technically oriented approach to fit issues, and my fit step provides a potential solution in offering better fit to the majority of a clothing company's target group.

I have chosen to focus primarily on women's clothing, body shapes and sizes related to fit in clothing. This is not because men are exempt from problems with fit but because there are some differences in women's and men's clothing production in terms of the number of sizes in a size range, the number of garment styles that are offered and in men's and women's shopping habits. In general, there are fewer sizes offered for women but a wider variety of garment styles, and women buy more clothing items than men do. When it comes to fit issues, it is more challenging to make a good fit for a curvy woman's body than for a more square man's body. Women's clothing more often has a tight fit than men's clothing, but this varies by fashion. With woven non-stretch material it is more challenging to create a tight fit than a loose fit. The survey on customer experience and clothing habits (Laitala & Boks, 2012) to which I referred in my path through the literature in the field shows that fit issues as a reason for the disposal of clothing is mentioned more than twice as often by women than by men. Laitala and Boks conclude that a major design challenge in women's clothing is the fitting to different body shapes (Laitala & Boks, 2012). The fit step is, however, unisex and can be added to the production steps of men's clothing in the same way as for women's clothing.

As described earlier the construction of sizing systems used by the majority of clothing producers today does not correspond with the sizes and body shapes in the populations making up the target groups for the clothing. The current standard in sizing systems is not equivalent to the population's body measurements (LaBat, 2007, p. 97). I agree with the claim of Zakaria and Gupta (2014, pp. 29–30) that the overall objective of the mass production of clothing should be to produce well-fitting clothing for the majority of customers within a set of fixed sizes. According to Zakaria and Gupta (2014, pp. 29–30), developing a sizing system that is related to our understanding of fitting garments to different body sizes and shapes is the only way to cater to the needs of consumers when it comes to fit in clothing. My fit step is in accord with this understanding of fitting garments to different body sizes and shapes and can inform the development of sizing systems Zakaria and Gupta (2014, pp. 29–30) were asking for to cater to the needs of consumers.

As described in my path through the literature in the field, the ASTM D5585 sizing system, which is based on the ideal hourglass figure for women's bodies, has been compared with SizeUSA data. The results showed that only 8% of women have an hourglass figure, while 80% have a rectangle, spoon or inverted triangle body shape (LaBat, 2007, pp. 94–95). Ready-to-wear clothing made with measurements from standard sizing systems offers only a minority of consumers clothing that fits their body size and shape. Drawing different and representative body sizes and shapes into clothing sizes by employing the fit step will make it possible for the majority of a target group to find well-fitting clothing for their body shape. I also discussed in my path through the literature in the field a study by Laitala et al. (2011) carried out in Finland, Sweden and Norway dealing with the question of which consumer group has the greatest difficulty finding clothes that fit their body and preferences and the implications of current sizing systems for the consumer. Their study showed that women have greater difficulty finding suitable clothes than men. Men of normal height and weight and slim women under the average weight for women of average height find it easiest to find well-fitting ready-to-wear clothing. Short and thin men and women with a rounded or large body shape find it the most difficult to find well-fitting clothing among ready-to-wear clothing (Laitala et al., 2011). Laitala et al. (2011, p. 35) point out that it seems like consumers who are close to the leading body ideals find it the easiest to find suitable clothes that fit their bodies. Not being able to find clothing with the right size and fit is connected to dissatisfaction with the consumer's own body size and shape. LaBat and DeLong (1990) state that women often blame themselves for having trouble finding clothes that fit them. When they find that ready-to-wear garments do not fit them, they blame errors and defects of their own body instead of blaming the size, shape, cut and fit of the clothing. On the contrary, good fit is connected with satisfaction and wellbeing (Otieno et al., 2005, p. 307). The current state of clothing production does not meet the demands of the majority of consumers in terms of size, cut and fit. Moreover, adding the fit step to the production line will possibly have a positive effect on fewer women blaming themselves for having a wrong body shape and instead accentuate satisfaction and wellbeing.

It is common for a wearer to have some favourite clothing items. Klepp (2001) suggests that the consumer wants to wear a favourite garment quite often and is willing to extend the period of use by mending the garment. The garment will go through different stages of use, from being worn at work and in social life to being worn only in private and ending up being worn when doing work such as gardening, where it is ok to get dirty. Because favourite garments go through these different stages and are worn so often, they are naturally worn out before fashion has changed so much that the wearer would feel uncomfortable wearing the item at work or in their social life (Klepp, 2001, p. 162, 2002, pp. 132–133). When looking at what makes one clothing item a person's favourite garment and not another, it is reasonable to think that the wearer likes how that particular garment fits her body in addition to the quality of the material, colour and style of the garment and that the wearer prefers how it makes her look. I assume that the fit of clothing plays an important role in the question of frequent usage. As my main motivation for researching clothing production is to contribute to a more sustainable production of clothing, it is appropriate to focus on what affects ill- or well-fitting clothing to achieve an optimized user period for clothing.

Are there solutions to bad fit?

Below I will present some approaches to solve the problem with fit in clothing, including customization, support systems for fit, stretch fabrics and 3D-scanning and will discuss the relevance of my fit step in this context.

Customization and support systems for sizes and fit

Gribbin (2014) describes several commercial operators that have tried to solve the size and fit problem of just a minority of consumers finding well-fitting ready-to-wear clothing. 'My Virtual Model' offers a website with a customized avatar with the customer's measurements, letting the avatar try on clothes (My Virtual Model, 2017). 'My Best Fit', 'Get My Size' (Get My Size, 2017) and 'My True Fit' (True Fit, 2017) use algorithms together with supporting databases to help customers find the best-fitting

size for their measurements from different brands. Companies such as 'Metail' (UK) (Metail, 2017) and 'UPcload' (Germany) (UPcload, 2017) use simple photo technology when showing customers clothing that fits them. 'Me-Ality', '[TC]^2', 'Bodymetrics' (Bodymetrics, 2017) and 'Styku' (Styku, 2017) offer their customers body scanners and use computer programs to find the best-fitting off-the-rack clothing for their customers. 'My Shape' (My Shape Stylist, 2017) and 'Fitlogic' (Fitlogic, 2017) focus on body shape, seeing it as more important than size and measurements when finding clothing with good fit (Gribbin, 2014, pp. 14–15).

However, focus on the consumer's body shape has not solved the problems with fit; it remains difficult to find ready-to-wear clothing on the market matching the consumer's body shape. This is because most brands still only make clothing for one body shape, the ideal body. Different systems helping people to find those clothes that fit them the best available on the market would probably be more successful if clothing producers were implementing the fit step in their production line. Clothing producers with different target groups implementing the fit step would probably be able to offer a wider range of clothing fitted to different body sizes and shapes. The systems for helping people to find clothing that fits them the best would have a larger differentiated selection. Other challenges for these companies working on offering well-fitting clothing to consumers include error factors in self-reported measurements and taking into account the customer's personal wearing preferences. Gribbin (2014, pp. 14–15) describes 'Made4Me.com' as a pioneer in the mass customization of ready-to-wear clothing. They offered clothing made after self-reported measurements from the customer. It did not, however, work very well because even with well-designed measuring tools, the customers were not able to take or report their measurements in an appropriate way. Also, the pattern alteration process was done in a two-dimensional way with simple adjustments that did not offer a garment that fit well to the customer's body shape. 'Archetype Solutions' also offered customized garments based on a two-dimensional pattern alteration to the customer's measurements. Often, customers who ordered customized clothing were those who had great difficulties finding well-fitting clothing in stores. They had high expectations

when ordering customized clothing and were disappointed when the clothing item arrived (Gribbin, 2014, pp. 14–15). This is because a two-dimensional alteration on what is basically the same pattern does not offer well-fitting clothing to body shapes that differ from the ideal body shape. To succeed in the customization of ready-to-wear clothing, implementing the fit step would probably have made a better starting point for the pattern alteration based on the self-reported measurements from customers. Still, how the pattern alteration is done also counts in terms of how successful the result can be. I would recommend pictures of the customer's body shape – front, side and back view – together with the body measurements when performing pattern alteration for customized ready-to-wear clothing. But still the time consumption for this alteration would be a challenge.

Companies offering customized clothing have difficulties finding producers for custom-fit clothing at reasonable prices since the apparel supply chain is not set up to make one-off garments (Ashdown, 2014, p. 29). An example of such alteration of sizes after collecting anthropometric data is Levi Strauss' jeans fitting system 'Curve ID'. The company behind the brand Levi Strauss has succeeded in developing a new sizing system and offers a method for customers to easily use the system (Ashdown, 2014, p. 30). The company developed software that together with a measuring tape with an electronic readout was used to measure Original Spin blue jeans. This technology was used to accurately control the dimensions of the jeans (Ashdown et al., 2007, pp. 371–372). Zakaria and Gupta (2014, p. 31) write that researchers today are still trying to improve the efficiency of clothing sizing systems. The goal is to let artificial neural networks and genetic algorithms find the right size for a customer's body shape. The development of sizing systems with higher accommodation rates and fewer standard sizes is also a focus (Zakaria & Gupta, 2014, p. 31). Such a model would, according to Zakaria and Gupta (2014), satisfy both consumers and retailers because the manufacturers can produce fewer sizes but still accommodate the majority of the population. As I view it, my fit step is a contribution towards achieving this goal, satisfying both consumers and retailers when manufacturers can produce fewer sizes but still offer well-fitting clothing to the majority of the population.

Gupta (2014, p. 34) states that a thorough understanding of body shapes and sizes existing in the target population is required to produce clothing that really fits the bodies for which it is intended. Since human bodies vary in dimensions, proportions and shape, and humans vary in their perception of ill-fitting or well-fitting clothing, it is complicated to offer good fit for everyone. According to Gupta (2014, p. 59), finding a cost-effective method of providing good fit in ready-to-wear clothing continues to be a challenge – a challenge my fit step is helping to solve.

Stretch fabrics to solve fit problems?

For my case ***Anorak:VG,*** I chose to work with woven 100% cotton fabric that did not contain any stretch material, such as spandex or polyamide. I made this choice because making fitted clothing out of non-stretchy material requires advanced work on wearing ease, volumes and seam lines to give space for the three-dimensional body inside the garment and achieve a good fit. Knitted fabric and woven fabric containing stretch materials are used increasingly more by clothing producers today. It is reasonable to think that the increasing use of stretch material is an attempt to solve the challenge with fit. A diverse array of stretch fabrics are used for undergarments, swimwear, sportswear, casual clothing, tailored clothing and evening wear. Stretch fabrics give good comfort and enhanced performance and fit (Branson & Nam, 2007, p. 268). These elastic clothing items fit a larger variety of body shapes, but this, as I see it, is not a quick fix for all fit problems. Clothing producers are using stretch fabrics increasingly more because it simplifies the fitting process. Compared to woven fabric, stretch materials can potentially compensate for individual variations in body shape with fewer seams and less shaping of the pattern pieces (Branson & Nam, 2007, p. 269). However, stretch material is not a solution for ill-fitting clothing. With my trained tailor's eye, I often notice women wearing a singlet or t-shirt in knitted stretch material where extra fabric is lying in horizontal folds over the lower back; the pull of the material over the bust from the height of the garment in the front causes the extra fabric in the back. Or I see women wearing a top in stretch material where a seam that is supposed to lie underneath the bust is lying on top of the

bust because there is not enough space for the bust in the cut of the garment. Often I see clothing items with shoulders that are too wide for the wearer, making the sleeve top hang down on the arm and causing folds of extra material around the shoulder. The techniques for constructing patterns for stretch material differ somewhat from the techniques for woven fabrics. Generally, elastic fabric stretches more in width than in height. The amount of expected stretch in fabric when the garment is worn is constructed as negative ease in the pattern pieces. This means that the pattern pieces have less width in an area than the body measurements for the same area. When the garment is extended in width, the garment also loses some height. Therefore, the pattern pieces are constructed with extra height in relation to the body measurements. In addition to these challenges in developing patterns for stretch fabrics, elastic fabrics are also usually not as stable as woven fabrics with regard to wearing, washing or dry cleaning (Branson & Nam, 2007, p. 269). This affects the life span of a garment made of elastic fabric. To offer well-fitting garments in stretch materials, I find it as relevant as for woven fabrics to work with anthropometric data for both size range and grading. Well-fitted stretch clothing requires professional knowledge about pattern constructing, fitting and grading as much as for woven fabrics. My fit step can be implemented in the production line for woven fabric containing stretch material and knitted fabric equally beneficially as for woven fabric without stretch.

3D-scanning to solve fit problems?

Gupta (2014, pp. 60–62) sees potential in the fit of clothing where realistic 3D visualizations of bodies are used together with clothing in digital form to provide a better fit for the majority of the target population. If the development of shape analysis technologies to interpret 3D scanned data continues, it will generate detailed data about the anatomical volume and geometry of the body. This will make virtual fit testing instead of physical testing possible. Clothing companies will be able to use databases of 3D anthropometric data on their target population when creating products to match the size and requirements of their customers (Gupta, 2014, p. 62). Bougourd claims that a

more sustainable future with strategies for inclusive clothing design can be reached by making available four-dimensional, real-time scanning technologies. These technologies could provide survey databases with a range of dynamic poses and dynamic sequences (Bougourd, 2014, p. 164). Research on body scanning and advanced patternmaking technology for customizing patterns in three dimensions is ongoing. Companies such as '[TC]^{2}', 'Styku' and 'Human Solutions' have developed body scanners that, together with body measurements, are able to translate a person's shape into a three-dimensional pattern that replicates the shape of the scanned body. If these technologies continue to be developed, it is likely that mass customization in the future will be able to offer well-fitting clothing to customers (Gribbin, 2014, pp. 15–16). Gribbin claims that:

> […] companies that find a way to make a science out of fit, establishing it accurately based on body shape and executing it consistently throughout their supply chains, will be the ones that consumers reward with their business and their loyalty. (Gribbin, 2014, p. 16)

Bougourd sees a more sustainable clothing production in the future using four-dimensional, real-time scanning technologies (2014, p. 164). By adding my fit step in pattern construction during the grading of a prototype, it might be possible to create a more sustainable clothing production in the future.

Software and digital tools can be used to increase the efficiency of sizing and grading in clothing production to provide well-fitting clothing to the majority of a target population. Production technologies can be further developed, such as computer-aided design (CAD), automated custom patternmaking, rapid laser cutting systems and modular sewing systems. This would make the mass production of customized clothing possible (Ashdown et al., 2007, p. 371). The challenge with incorrect self-reported measurements from customers who order customized clothing can be solved by scan-at-home technology, for example, 'Kinect R' technology, or by taking silhouette and profile photographs, which then are transformed into a 3D image by the clothing company. These 3D images of the customer's body shape and size can then be used to create an avatar for the virtual

fitting of clothing (Ashdown, 2007, p. 30). Still, new technology and software and digital tools have to be designed appropriately by experts in the fit of clothing for different body shapes. I agree with Lee, who claims, 'Each of these technologies requires advanced skills and trained workers to maximize their potential' (Lee, 2014, p. 315). Adding my fit step to the process of clothing production will require expert pattern construction knowledge. The outcome from the ***Anorak:VG*** case, the fit step, is a contribution to the work of these experts in developing software and digital tools for sizing and grading clothing.

Possible application of the fit step

In this section I discuss a possible implementation of the fit step in a clothing company's production line followed by a short summary on what the fit step evolved from, which leads to the fit step in the context of sustainable development in clothing production.

Possible benefits for companies applying the fit step

It is reasonable to think that those clothing companies that are more likely to take an interest in implementing the fit step in their production line are companies that already have a focus on fit connected to movement, such as clothing companies in the outdoor, sport and training segment. Changing part of the production line and implementing a new step will entail a cost, as most changing processes do. Companies implementing the fit step will probably benefit from happy and loyal customers finding clothing that fits their bodies. Hopefully the owner of the garment will wear the well-fitting clothing until it is worn out and consequently reduce the disposal of clothing. Moreover, clothing companies mainly or only offering their clothing over the Internet will probably have a great benefit by implementing the fit step in their production line because more customers will fit the clothing they have ordered, leading to a reduction in the number of returns. Fewer returns is cost-saving and environmentally friendly, causing lower emissions from transport. This might make the fit step profitable for the clothing industry by doing something the consumers wants which is sustainable as well as advantageous for them.

Fit step is the next step?

First, in this section I will provide a brief summary on what the fit step evolved from. Then I will discuss the fit step in view of being the preferred next step.

As mentioned earlier, several factors affect the fit of clothes. Based on my path through the literature in the field, I see the following four aspects as significant:

- The measurements and proportions underlying the sizing system on which the patternmaker bases the block pattern;
- The grading practice, that is, how patterns are increased and decreased to create different sizes and how and with which measurements the sizes increase and decrease;
- The amount of wearing ease and design ease and how and where ease is applied to a pattern, which affects how tightly or loosely different parts of a garment fit the body and
- Finally, the cut of the garment and how this can be adjusted to different body shapes, making all the clothing in a size range appear the same no matter how small or big the size.

Based on my professional experience I assume it would be possible for the producers of ready-to-wear clothing to make changes in their practices in all four of these areas (sizing systems, grading practice, ease and cut). It is reasonable to assume that such changes would make it more likely for the majority of a clothing producer's target group to find clothing that fits their bodies. If clothing production is to turn in a sustainable direction, I argue that sizing systems based on anthropometric measurements (measurements of human individuals) of the target groups, from size to size, must be developed – as opposed to today's practice, where the largest and smallest measurements are divided into, for instance, 10 sizes with the same increments between each size. The body does not grow linearly and systematically from body size to body size. The same applies to how the grading practice is done and how wearing ease and design ease are inserted.

Anthropometric measurements from actual target groups must form the basis for individual changes from size to size. For example, 5 cm of design ease does not appear the same in a small size and a big size. The last area that has an impact on the fit of clothing is how the cut is changed to fit the typical body shape from size to size. Nowadays, the general practice is that a prototype in a small size is increased and decreased during the grading process, but how the cut is done under the pattern construction is not customized to better meet the different needs of different body sizes and body shapes. As Zakaria states: 'Clothing manufacturers and retailers should concentrate on understanding their own consumers' different body shapes and sizes in order to achieve better consumer relationship management' (Zakaria, 2014, p. 115). Previous research has been done on sizing systems, grading practice and how ease is applied to a pattern. This research was presented in my path through the literature in the field. Still, there was a need for research on how the cut of the garment can be changed from size to size in a size range so as to be adapted to representative body shapes. In the ***Anorak:VG*** case, I suggest adding a fit step to the process of clothing production, where the cut can be adapted from size to size to achieve a better fit for the majority of a target group. This constitutes, among others, a continuation of Schofield's (2007) research on block patterns that are graded based on anthropometric measurements. Through my case ***Anorak:VG,*** I have created the fit step-way of thinking as a possible strategy where the designer, patternmaker and grader can work together in changing the pattern pieces differently from size to size based on representative body shapes for each size. By thinking about individual fit for each size and the representative body shape for that size, it is possible to offer well-fitting garments for each size in a size range that is based on anthropometric measurements from the actual target market.

As mentioned above, weaknesses in regard to adding the fit step and working with fit in the grading process individually from size to size is that the cost may increase as more working hours are needed for the process compared to the traditional grading generally practiced today. There will also be a need for patternmakers and graders who are trained to work in this new way, together with the costs of developing or adjusting software to

assist the grading process. This proposal of a change where the grading becomes a design consideration is challenging the current manufacturing system for clothing. Rissanen (2013, p. 139) discusses a similar change when zero-waste is a clothing design criterion:

> In zero-waste fashion design and manufacture, the pattern cutter (if separate role from designer), pattern grader and marker planner and maker need to be an integral part of the design process of a garment. Whilst this sounds a simple proposition the current hierarchies and consequent structures in industry pose formidable challenges for this. For example, with off-shore manufacturing the pattern grader and marker planner are likely to be in a different physical location to the designer and patter cutter; in some instances the pattern cutter may be off-shore as well. (Rissanen, 2013, p. 139)

Rissanen is asking for further research on possible solutions for this challenge. However, higher costs in production may be offset by the advantage of happy customers wearing clothing items that better fit their bodies. Good fit might be a strong enough advantage to make people willing to pay more for these garments.

Bellemare (2014, p. 217) introduced the concept of 'Fitthinking', where the goal is to create a context for mass production that better responds to the needs and desires of clients:

> Fitthinking is a new theory based on the results of our own research that aims towards ***lean*** thinking, trying to do better work with less waste. Thus, consumers will buy less clothing and accessories because they are finding products that fit better and last longer. (Bellemare, 2014, p. 217)

Bellemare's goal for clothing production and the concept of 'Fitthinking' are in line with my 'fit step'. Coinciding with Bellemare (2014, p. 217), the aim to improve the working procedures in clothing production regarding fit and achieving less clothing being thrown away before it is worn out and consumers buying less clothing because they find well-fitting clothing for themselves, is what I, through the work in this thesis, wish to contribute to.

My fit step, as the outcome of my ***Anorak:VG*** case, differs from earlier attempts to solve fit problems and makes it possible for the majority of consumers to buy well-fitted ready-to-wear clothing. These earlier attempts were described previously in this chapter and include technology showing people clothing on the market that fits them and the mass customization of ready-to-wear clothing based on a two-dimensional pattern alteration process with simple adjustments. The outcome of case ***Anorak:VG*** is about adding a step to the ready-to-wear clothing production process. This fit step, which is missing in today's production, builds upon two earlier steps in the process. As mentioned earlier these two previous steps are also not common practice today, but, as described in my path through the literature in the field, research is being done leading towards these steps.

1) The first step prior to the fit step is the development and use of a size range based on anthropometric data from the target group by the clothing producer.
2) The second step prior to the fit step is the grading of the block patterns used to construct the pattern pieces for the prototypes. These block patterns should be graded individually from size to size based on representative body shapes and proportions that cover the size range based on anthropometric data from the target group.
3) The fit step is about grading the prototype according to knowledge about how this actual cut can be utilized to build in the different body shapes and proportions that represent the size range of the target population

My case ***Anorak:VG*** is an investigation of how to implement the fit step. The benefit of adding a fit step in the production of ready-to-wear clothing is that a prototype will look the same on different body shapes that are representative of the actual target group if different body shapes are built into the pattern pieces during the grading process, and well-fitting clothing can be offered to the majority of the target group instead of only a minority.

To take the work in this thesis a step further, research could be done in an action research project in where the researcher works together with a clothing producer using a sizing system based on anthropometric measurements from the company's target market and doing the grading differently from size to size based on these measurements. The clothing

producer could, as an outcome of such work, place a mini-collection on the market, and the researcher could conduct a survey on how these clothes are received by customers.

I am open to the idea that different stakeholders can pick up the fit step and use it in the way that suits them. My overarching aim is that adding the fit step described in this thesis will contribute to making a clothing company sustainable and making profit by being preferred by many pleased customers who are able to find and wear well-fitted clothing to their body shape and size.

Fit step in post-growth fashion and sustainable business models

Kate Fletcher describes an interconnection between people's own experiences of sustainability in connection with their clothes and what this experiences could suggest for the textile industry (Fletcher, 2011, p. 165). In Fletcher´s Local Wisdom project, she, among other things, documents the changes people have made to garments to make them wearable longer. Fletcher states that these culturally embedded sustainability activities in fashion at the user level are do-able activities that are in reach for us all (Fletcher, 2011, p. 166). Sustainability, due to Fletcher, potentially can flow from 'how we select, wear, care for and connect with our garments' (Fletcher, 2011, p. 166) and not only from how the garments are designed and produced.

> For what goes on ***after*** production processes are over and the garment has been sold – that is, the personal, variable, myriad use patterns that occur in homes and wardrobes – is also key factor influencing sustainability in fashion, yet is often overlooked. (Fletcher, 2011, p. 167)

To draw a parallel to this thesis, collecting user experiences on reasons for the disposal of clothing was where I started the literature review. The studies I reviewed brought me to the insight of fit problems as one of the main reasons for clothing not being worn – as in Fletcher´s Local Wisdom project, where the people's real life experiences in fashion:

> (…) sketch out the possible shape of a new layer or type of fashion commerce

> based on broader values that profit and sales growth, geared instead towards increasing the quality of fashion experience rather than its quantitative scale. (Fletcher, 2011, p. 170)

Implementing the fit step in clothing production has the potential of 'increasing the quality of fashion experience' by letting the majority of a target group experience wearing well-fitting clothing.

When writing about consumerism, sustainability and fashion, Fletcher (2016) describes fashion outside growth-logic and a 'market-driven cycle of consumer desire and demand' (Fletcher, 2016, p. 86). When thinking fresh, free from the 'current conditions' about fashion and sustainability, an opportunity arises 'to re-appreciate the potential of fashion to nourish and foster other actions (Fletcher, 2016, p. 86). In doing so

> (…) we uncover new perspectives in which to locate sustainability opportunities that change both ***what*** we consume, impacting levels of resource consumption, and ***how*** we consume, altering our practices and ideas and ultimately our relationship with clothing over long term. (Fletcher, 2016, p. 86)

Here I see a parallel to the free space in the CUAR method applied for the case study in this thesis. In the free space I studied the ideal grading of a prototype to offer good fit to the majority of a target group without being slowed by the realization of a grading process and the current conditions in the textile industry. In Fletcher´s book ***Craft of Use Post-Growth Fashion,*** she focuses on the user period of clothing in relation to sustainability in clothing production (Fletcher, 2016). The craft of use is to her all the diverse activities people do connected to the garments they wear. Here lies, according to Fletcher, a key to post-growth fashion, where fashion is not exclusively linked to economic growth (Fletcher, 2016, p. 269).

> In fostering sustainability through effective thought and action, and capturing expressions of this (as in the Local Wisdom project), a set of changed economic

> opportunities begins to emerge. This contrasts sharply with the priorities of today´s fashion industry, which is structurally reliant on economic growth tied to expanding resource use: on making and selling increasingly more units to improve marked share, increase profit and stay in business. Here the economy grows in physical scale (…) and because the planetary ecosystem in which the economy sits is of fixed size; relative to it, the economy grows continually larger. The growth imperative that shapes daily decisions in fashion business (like the vast majority of others) is fundamentally at odds with the finite nature if the resource base and fragile ecosystems upon which we depend for survival. (Fletcher, 2011, p. 172)

Here, Fletcher describes the need for different business models for the fashion industry to achieve sustainability. A sustainable business model defined by Jørgensen and Pedersen (2015) is 'organizational designs where the company's social and environmental effects are an integral part of the company's way of creating, delivering, and capturing value' (Jørgensen & Pedersen, 2015, p. 25). The sustainable business model is built three-dimensional with the parts including creating, delivering and capturing value (Jørgensen & Pedersen, 2015, p. 43). Instead of the current linear economic model, Jørgensen and Pedersen (2015) propose a shift to a circular economy, sharing economy and collaborative enterprise. The authors distinguish between the two following characteristics of sustainable business models: 1) Companies that change their operations in a way that social or environmental problems caused by their business operations are solved. Here the reductions of negative externalities are in focus. 2) Companies that take actions helping to solve social or environmental problems caused by others. Here the focus is on generating positive externalities (Jørgensen & Pedersen, 2015, p. 120). Jørgensen and Pedersen (2015) claim 'that a mark of sustainable business models is that the company's attempts to shed light and reduce shadows helps the business model to function' (Jørgensen & Pedersen, 2015, p. 225).

> The challenge for companies that want to find new ways of combining responsibility and profitability is that producing and selling more products will generally mean that more shadows are cast. A solution to this conundrum could be to build in service dimensions that can lengthen the life of the product while also generating income from this type of service. In this way, enterprises can increase their turnover at the same time as the sales of products decreases. By

> being reorganized to enable service-based delivery, the company can thus capture a portion of the extra value that helps to create and deliver to the customers, and at the same time this might help to reduce the customers' own shadows. This is an example of the positive side effects resulting from responsibility-inducement. (Jørgensen & Pedersen, 2015, pp. 226–227)

It is not necessarily sustainability in itself that leads to a company finding a new market and increased profitability. Instead a sustainable business model can enhance a company's position and give the company a competitive advantage, sometimes even a sustained competitive advantage, in its existing market (Jørgensen & Pedersen, 2015, pp. 157–158). The literature on sustainable business models, such as Jørgensen and Pedersen (2015), does not see an opposite in sustainable actions and profitability in how a company is run. I see the fit step as one of several strategies or actions in a sustainable business plan for clothing producers. Esslinger (2011) sees the designer's role as essential when designing products for a sustainable future.

> Designers have a responsibility to connect and coordinate human needs and dreams with new opportunities and inspirations from science, technology, and business in order for products and their usage to be culturally relevant, economically productive, politically beneficial, and ecologically sustainable. (Esslinger, 2011)

Esslinger (2011) also points out the importance of design strategies towards a sustainable consumption at an early stage:

> Designers, with the help of their business partners, have a strategic opportunity to affect the early stage of the product lifecycle management (PLM) system. In fact, we ***must*** define the strategy in that early stage if we want it to be effective. By changing the industrial process model from one designed to support mass efficiency to one designed to promote socially and environmentally responsive innovation—for example, by incorporating ecological competence and waste reduction or elimination into our process model—we can both increase the value of a company and improve its sales. (Esslinger, 2011)

Implementing the fit step in the design process of garments is one opportunity for the designer to affect the garment's life cycle at an early stage.

Concluding remarks

To optimize the use of resources, based on environmental concerns, I challenge clothing producers to take the necessary steps to meet the demands of the majority of clothing consumers concerning size, cut and fit. With my case ***Anorak:VG***, I demonstrate how a prototype can be changed from size to size during pattern construction in order to offer a good fit for the different body shapes representative of a target group. In my case ***Anorak:VG***, I built upon earlier research done on sizing systems and grading in relation to anthropometric measurements. What is needed to offer the majority of consumers ready-to-wear clothing with good fit is first a sizing system based on anthropometric measurements and 3D body scans. These measurements and body scans should be the basis for calculating a representative body size and shape for each size in the sizing system. Then the grading of a prototype should reflect the changing body dimensions from size to size, such as Schofield (2007, p. 190) demonstrates. But as I have shown with ***Anorak:VG***, grading the block pattern individually from size to size is not sufficient to change the body dimensions from size to size. The changes should be made during pattern construction and grading so that the actual appearance of a prototype can be taken advantage of building in different volumes and proportions matching the actual body shape representing the size.

I am fully aware of that offering the majority of a target group well-fitting clothing will not solve all problems caused by the overproduction and overconsumption of clothing. When customers buy clothing, a number of different motivations may lie behind the action. It could be a wish for something new, just the feeling of happiness while shopping, or wanting to express belonging to a new group of people and thus trying to dress like them, among many other motivations. Still, this thesis points at one aspect of several that can offer a solution to part of the challenges towards a reduction in garment disposal.

The overarching perspective for my thesis is the development of the clothing production industry towards sustainability. A huge amount of clothing is disposed of before it is worn out. Seen from the perspective of how polluting and harmful for the environment current clothing production is, together with the undignified working conditions of textile workers around the world (Fletcher, 2014), changes for the better are needed. The responsibility for pollution caused by the textile sector is usually put on the producers, but the picture changes if the responsibility is placed on the consumers. Consumption in general by households causes 60–80% of the environmental impact on the planet. Consumers living in wealthier countries are responsible for the most significant impacts per capita, Ivanova et al. (2015, p. 1) states. Laitala and Boks (2012) conclude that the results of their survey show a major design challenge in women's clothing: adaption to different body shapes. A greater focus on this issue by clothing designers and manufacturers would make it more likely for clothing to be used for a longer period of time. The fit step is my contribution to clothing designers and manufacturers by helping them in their work on fit adaption to different body shapes. Salusso et al. (2006, p. 109) conclude that variation in size according to body shapes that are measured on real test groups would make mass-produced ready-to-wear clothing more viable and sustainable. Bye and McKinney (2007, p. 497) state that 'Education for consumers regarding proper fit, regardless of size or weight, may also help consumers to make better purchase, consumption, and divestment decisions in the future' (Bye & McKinney, 2007, p. 497). I concur with Laitala and Boks (2012), Salusso et al. (2006, p. 109) and Bye and McKinney (2007, p. 497) and will conclude with an appeal: Let us improve the practice in clothing production; the knowledge needed is ready, and the next step is to try it out in practice!

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List of figures

Glossary

Designer: A designer for clothing in this thesis is one working with garments in two and three dimensions.

Designer-tailor: A person both trained as a clothing designer working in two and three dimensions, performing aesthetic assessments and making choices, and as tailor working with tailor-made clothing for individual customers or working as a tailor in ready-to-wear clothing production.

Tailor: A tailor working with tailor-made clothing for individual customers or working as a tailor in ready-to-wear clothing production**.**

Anthropometric measurements: Measurement of the human individual that can lead to statistical data about the distribution of body dimensions in the population.

Ease: Three kinds of ease are used in the manufacture of patterns: wearing ease, design ease and negative ease. All garments must contain wearing ease to allow space to move within a clothing item. Design ease is any amount of ease beyond the basic wearing ease that is added to a pattern to alter its silhouette or general shape. Negative ease is used for stretch fabrics that have more give and can stretch comfortably around the body. A negative ease garment will have a smaller measurement than the actual body measurements but will still stretch enough to give a comfortable fit.

Grading practice: The practice of how to increase and decrease patterns to create different sizes in the field of patternmaking.

Apparel grading: The process of increasing and decreasing the size of a prototype pattern or base pattern. The increasing and decreasing is done according to a set of body measurements and proportional relationships. The goal can be to develop a range of sizes for production.

Ready-to-wear: Or prêt-à-porter, factory-made clothing in sizes chosen by the producer or following standardized sizing systems.

Size chart: A codified set of body measurements for each size in a range.

Block pattern: A block pattern is a custom-fitted basic pattern from which patterns for many different styles can be developed.

Pattern construction/cutting: Pattern construction/cutting is essentially a series of body measurements creating a three-dimensional shape that fits the human body. A traditional method is through flat pattern cutting, either through scale or the direct measure system. This involves creating a block pattern that fits the human body and adapting and manipulating the block pattern to create the desired shape and design.

Appendix

The following shows the original photographs taken and illustrations drawn by the author during the work with the case study. Earlier in the text reconstructions of the photographs and illustrations are shown made by a graphic designer.

Figure A-1. Dress form size large from Kennett & Lindsell OS I.

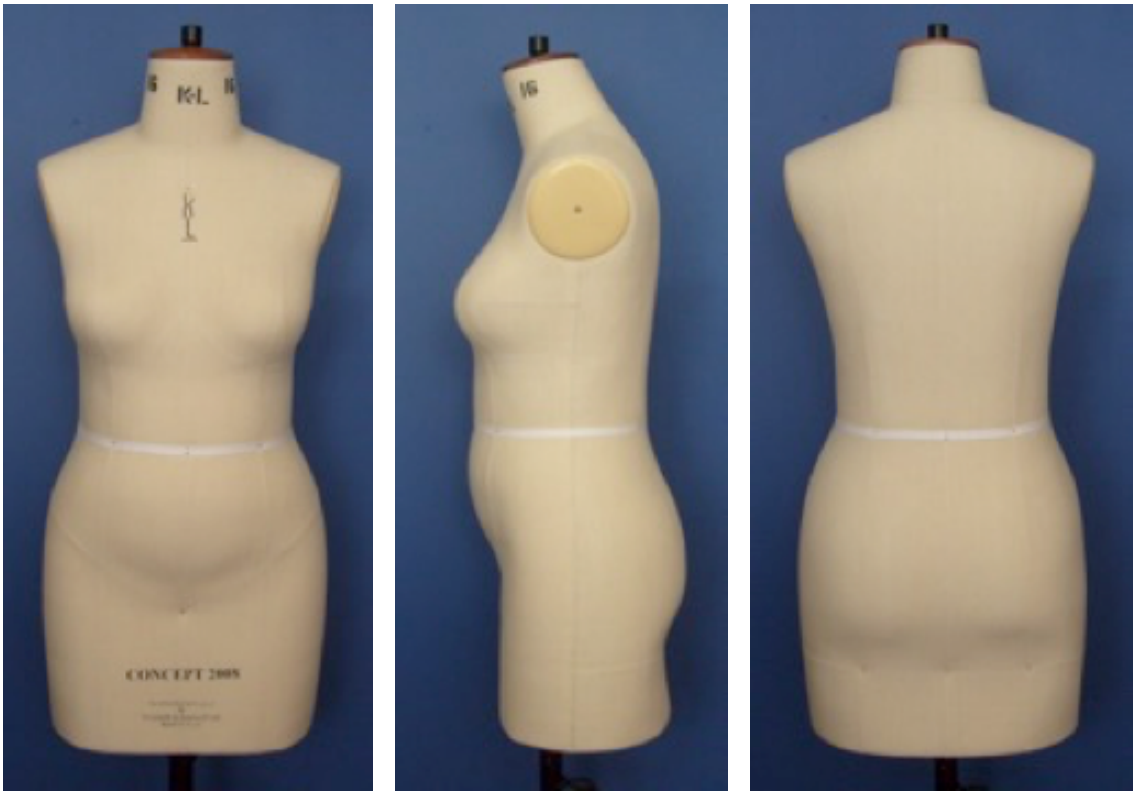

Figure A-2. Dress form size medium from Kennett & Lindsell Concept 2008.

Figure A-3. Dress form size small from Kennett & Lindsell Concept 99.

Figure A-4. Drawing of the design for the anorak.

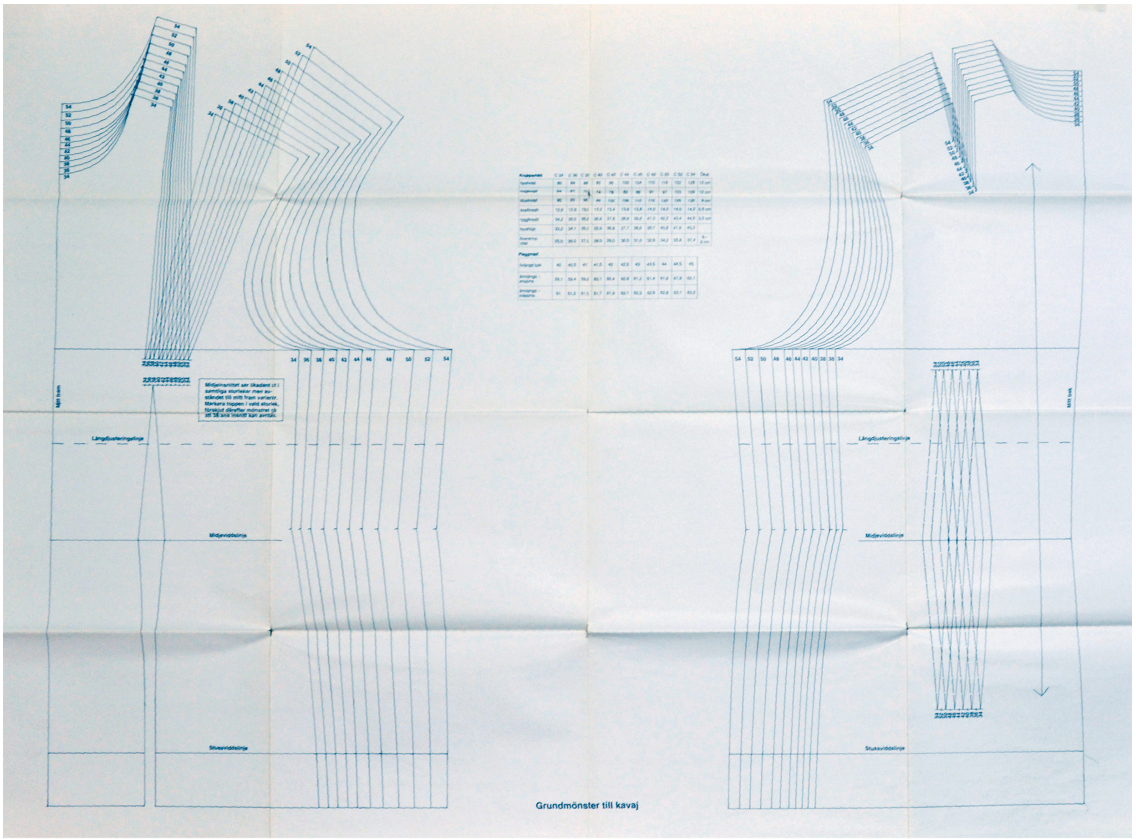

Figure A-5. The graded block pattern.

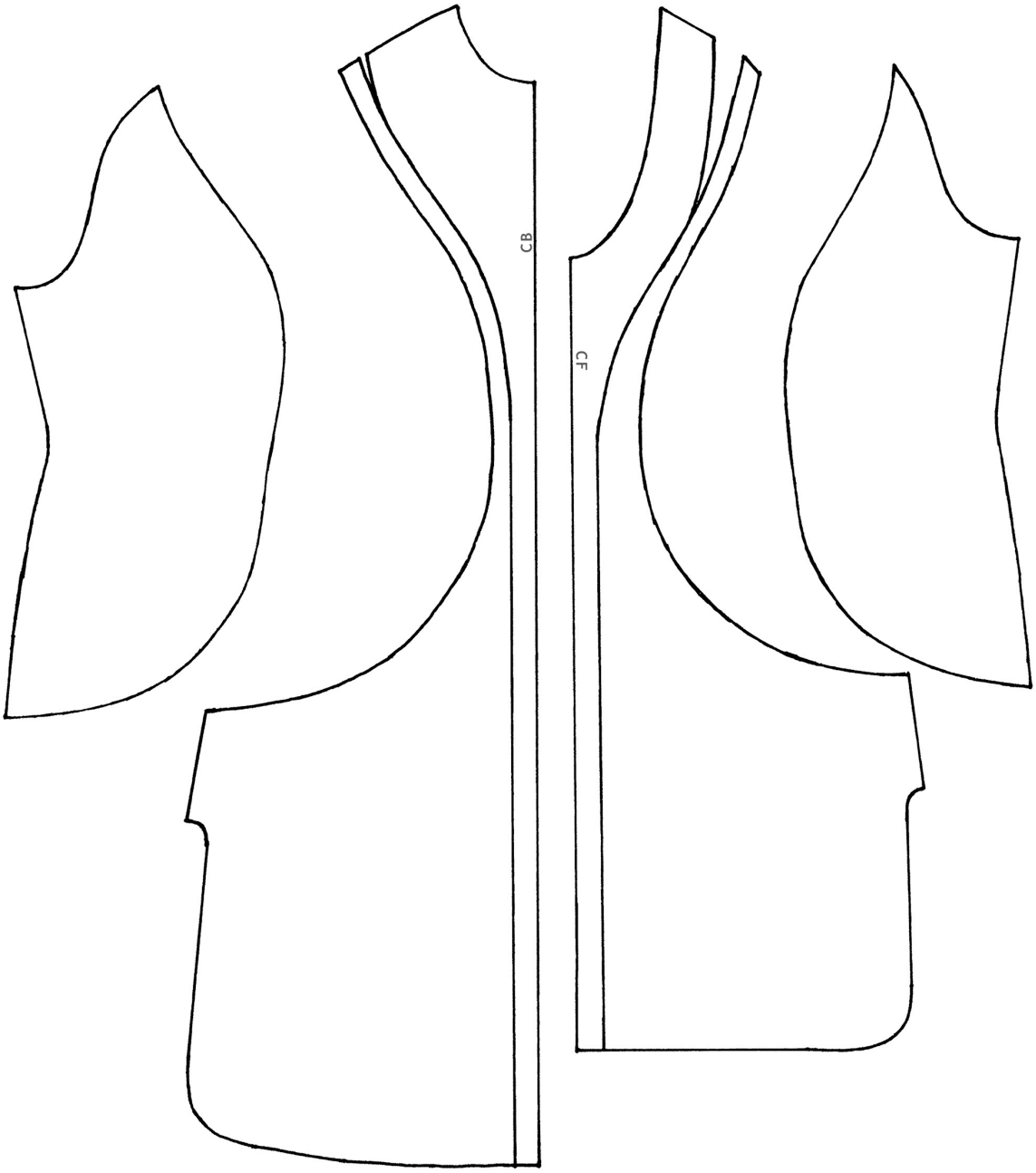

Figure A-6. Pattern pieces for anorak size small constructed with block pattern size 36.

Figure A-7. Toile of anorak size small, traditionally graded.

Figure A-8. Toile size small pinned close to the dress form.

Figure A-9. Positioning the waistline.

Figure A-10. Toile size small with width reduction by the side seam.

Figure A-11. Fitting front underneath the bust.

Figure A-12. Toile size small backside.

Figure A-13. Fitting the back side.

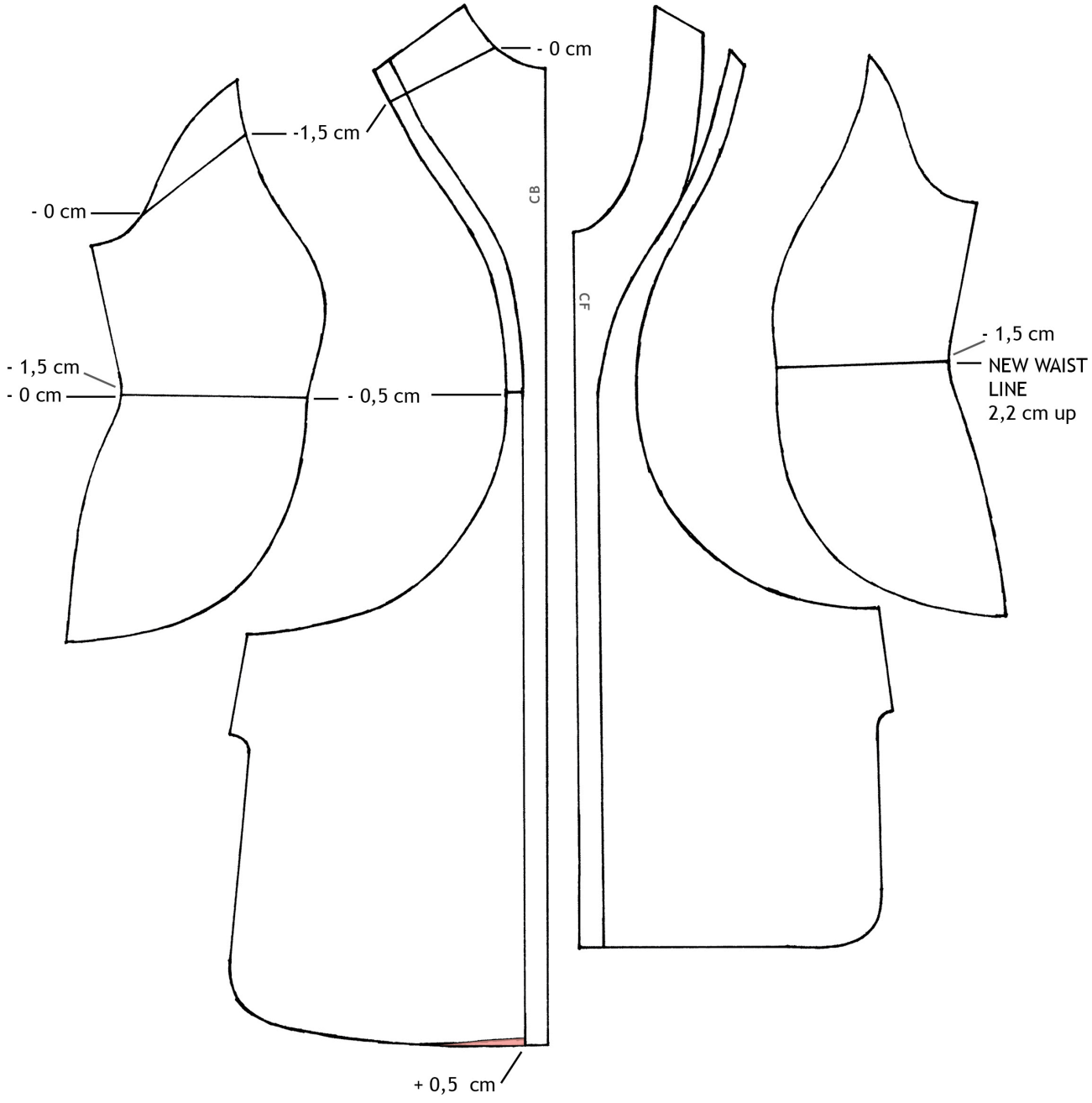

Figure A-14. Pattern pieces for anorak size small including changes during the fitting.

Figure A-15. Toile size small sewn with the changes made.

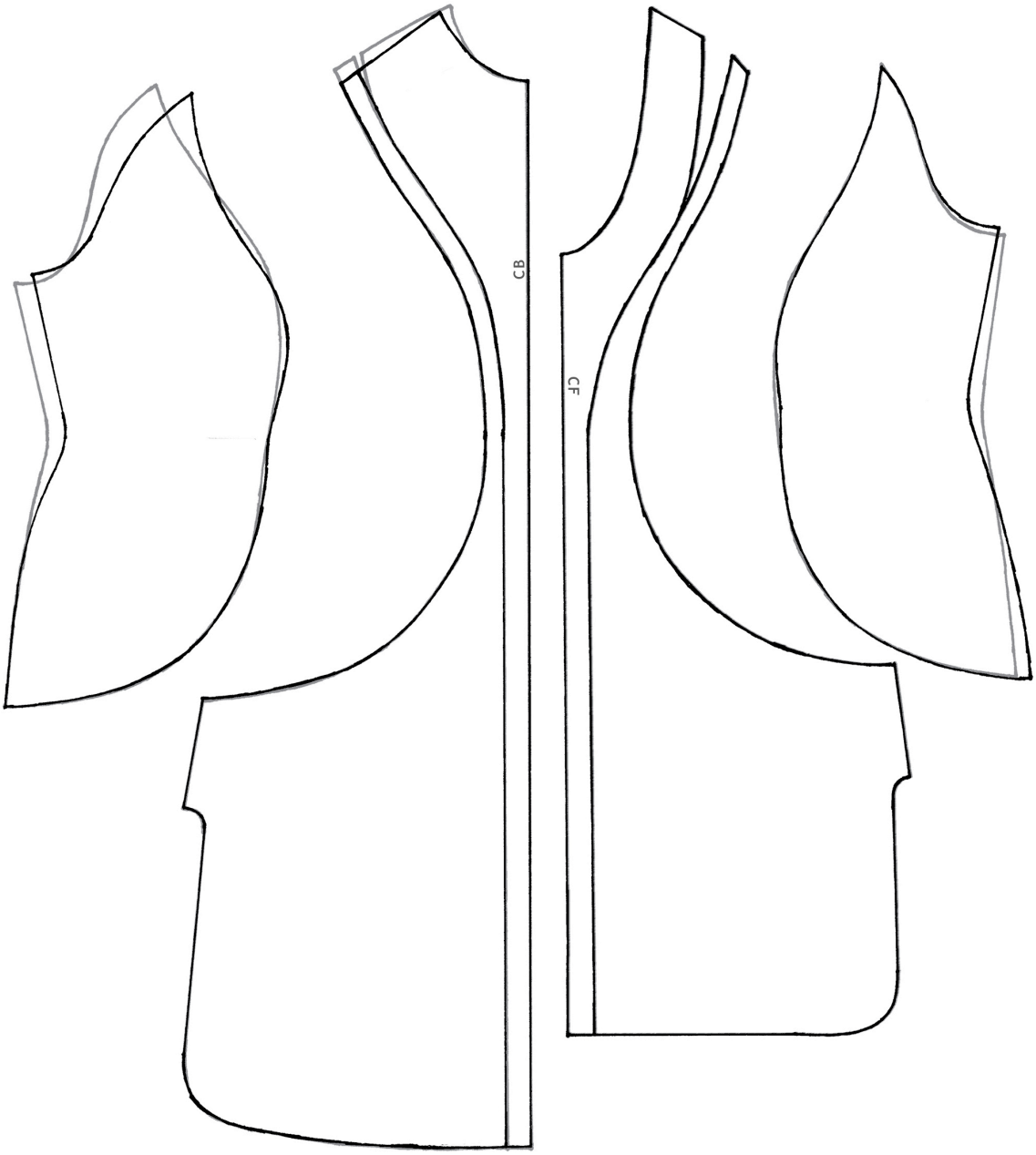

Figure A-16. Grey line: pattern pieces size small, traditionally graded; black line: pattern pieces size small after fitting.

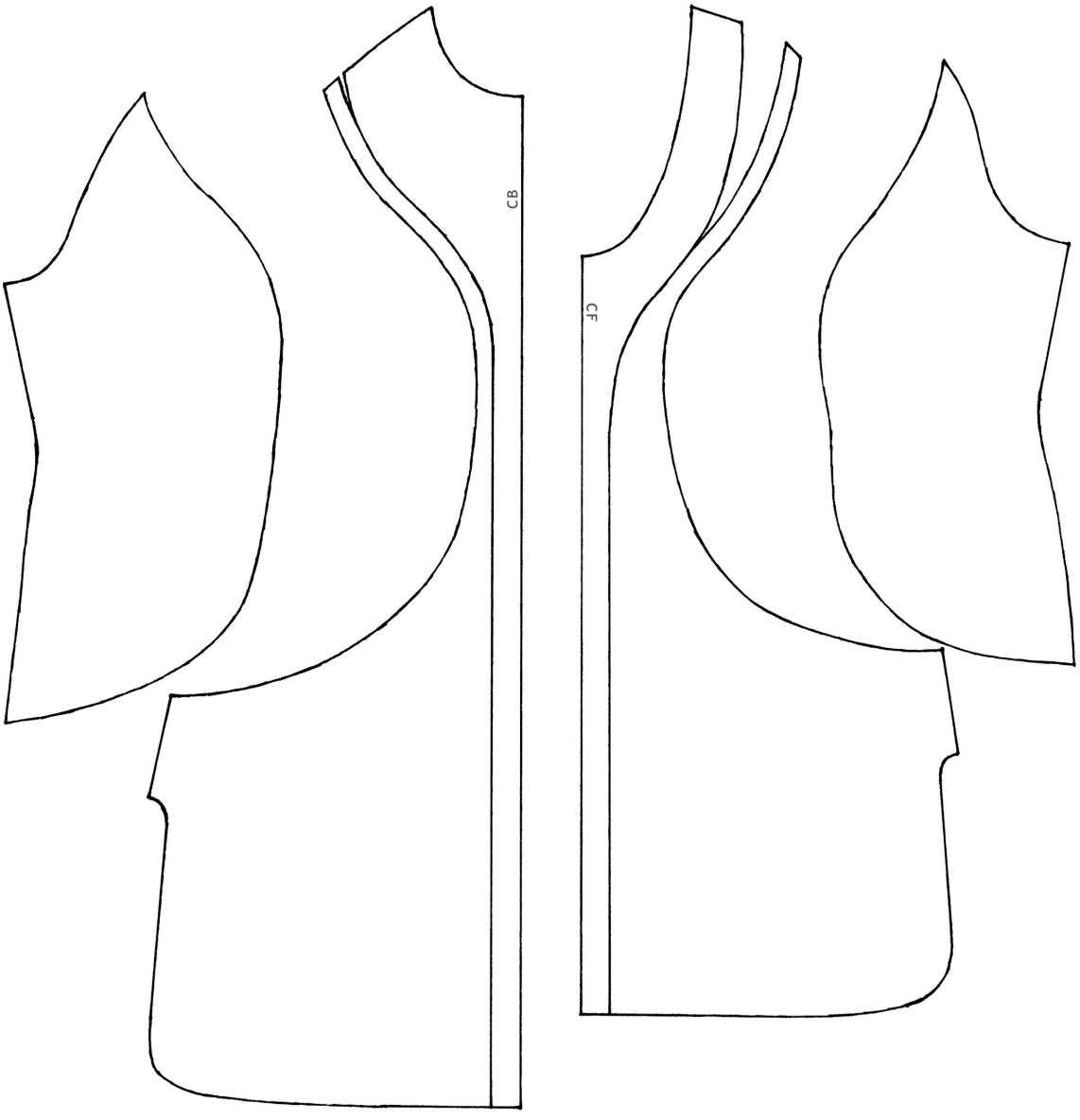

Figure A-17. The pattern pieces for anorak size medium constructed with block pattern size 42.

Figure A-18. Toile anorak size medium, traditionally graded.

Figure A-19. Toile anorak size medium pinned close to the dress form.

Figure A-20. Positioning the waistline.

Figure A-21. Toile size medium with width reduction by the side seam.

Figure A-22. Toile size medium fitting front underneath the waist.

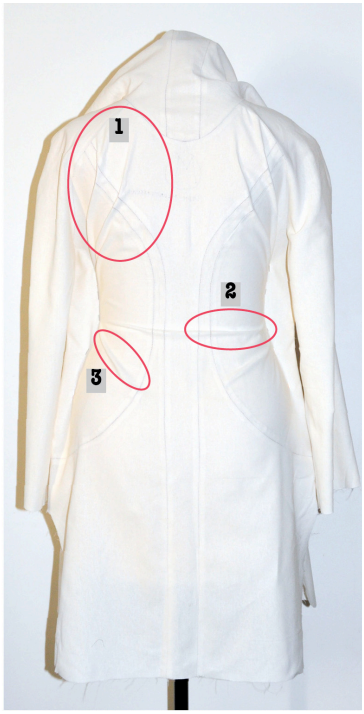

Figure A-23. Toile size medium backside.

Figure A-24. Fitting the shoulder area.

Figure A-25. Fitting the backside waist area.

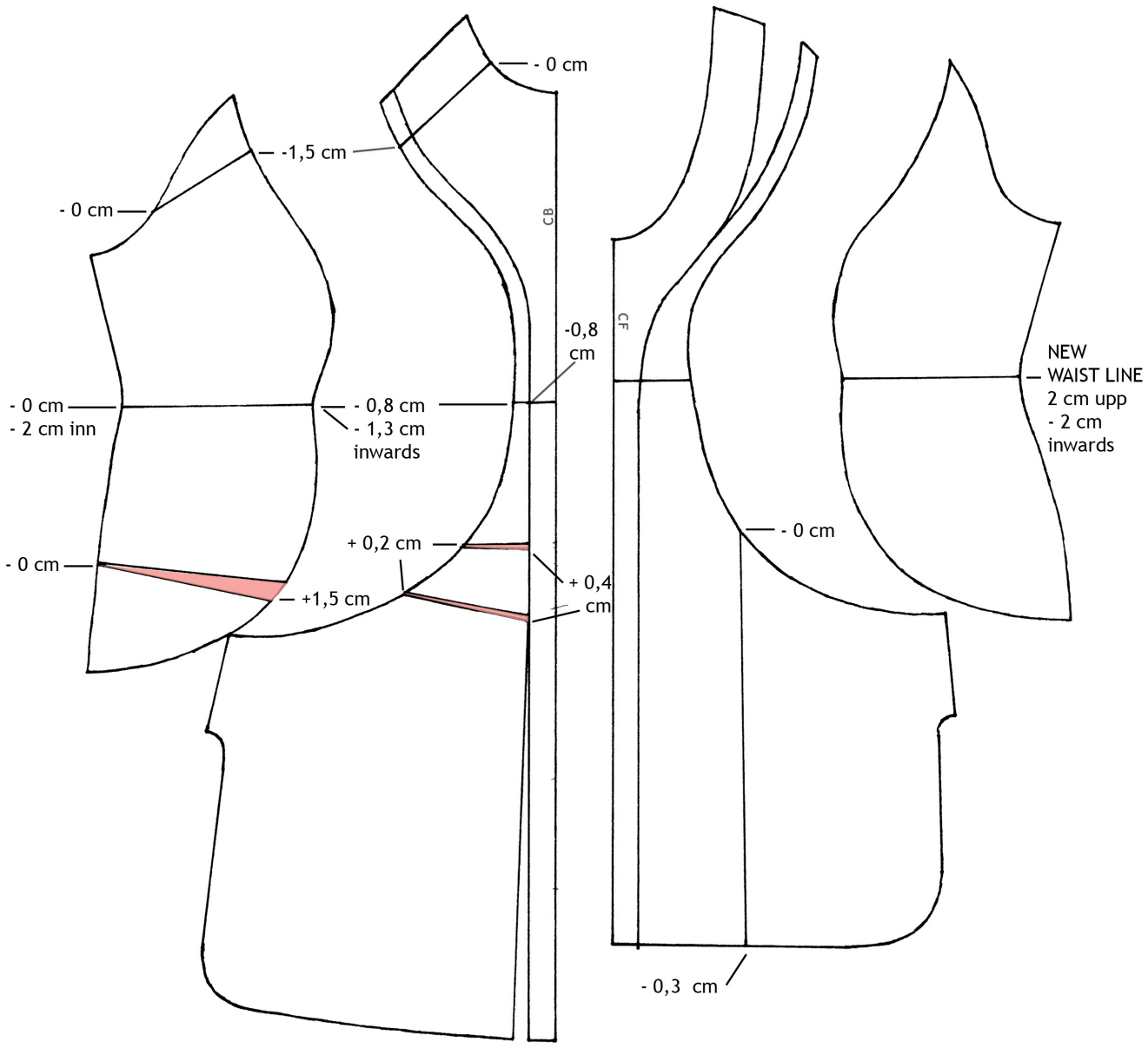

Figure A-26. Pattern pieces for anorak size medium including changes during the fitting.

Figure A-27. Toile size medium cut with pattern pieces including fitting.

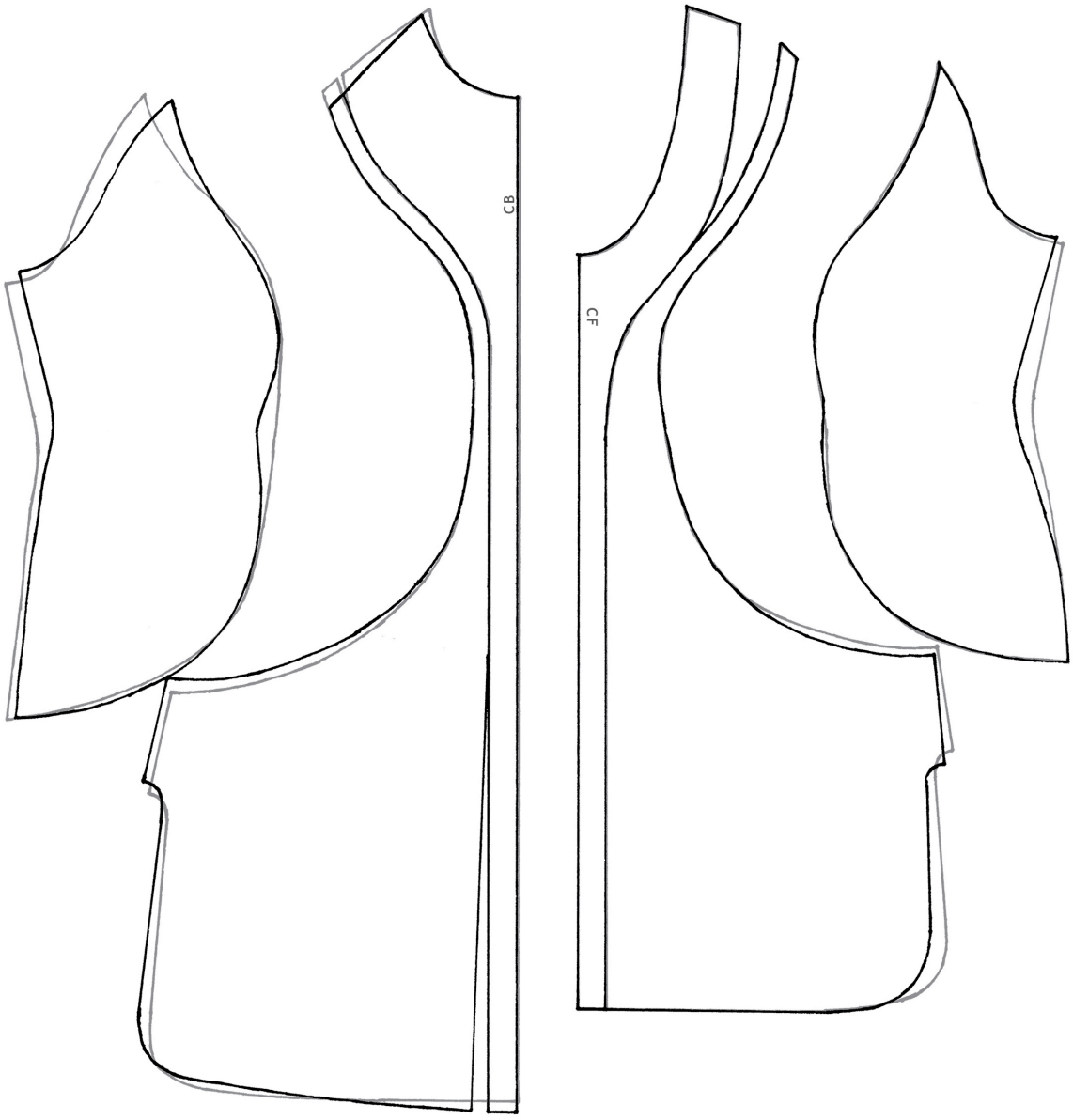

Figure A-28. Grey line: pattern pieces size medium traditionally graded; black line: pattern pieces size medium after fitting.

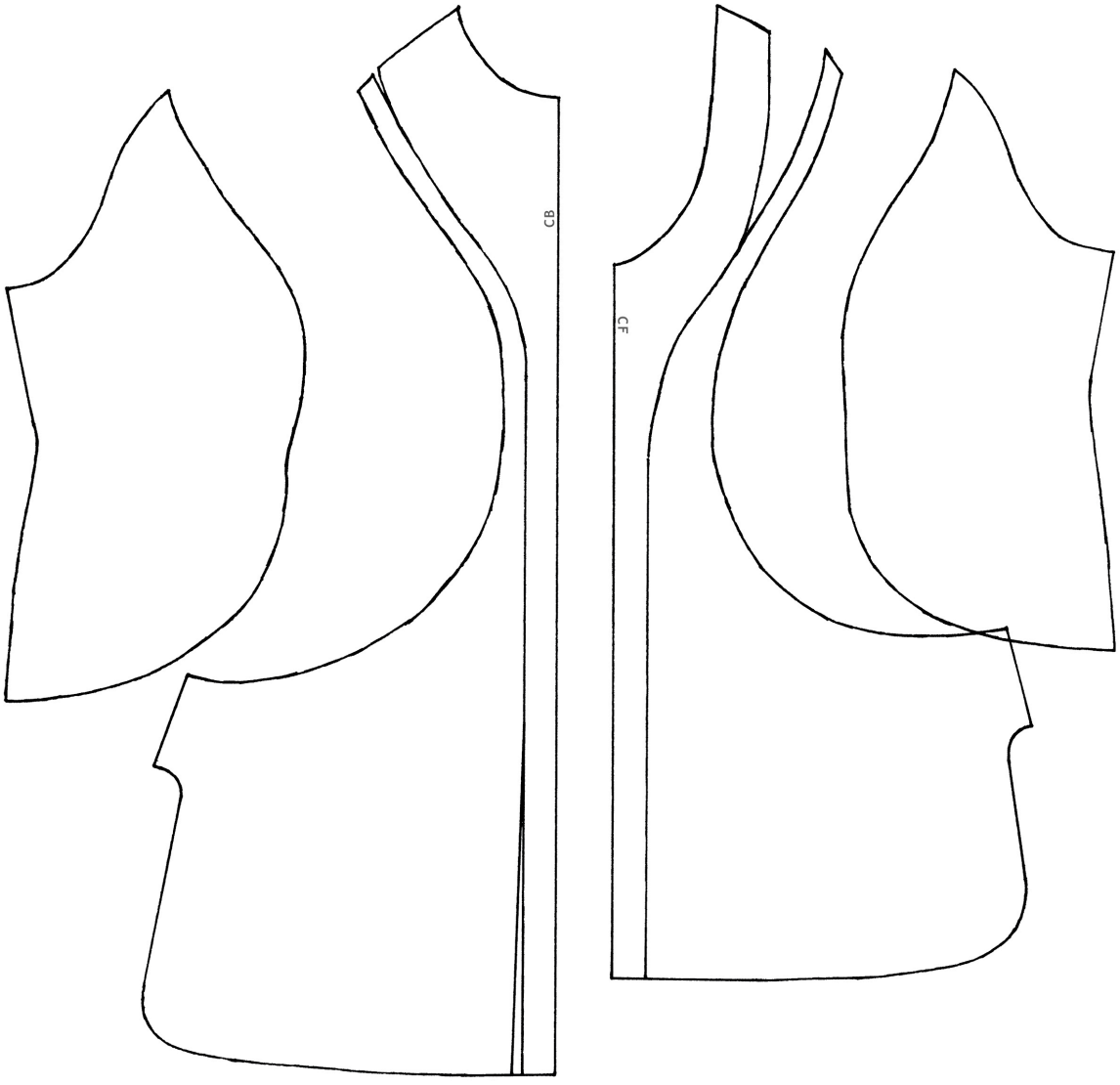

Figure A-29. The pattern pieces for anorak size large constructed with block pattern size 50.

Figure A-30. Toile size large, traditionally graded.

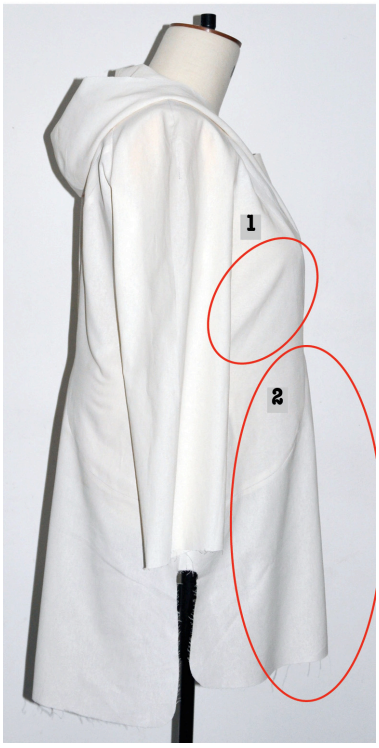

Figure A-31. Toile size large fitting above the bust.

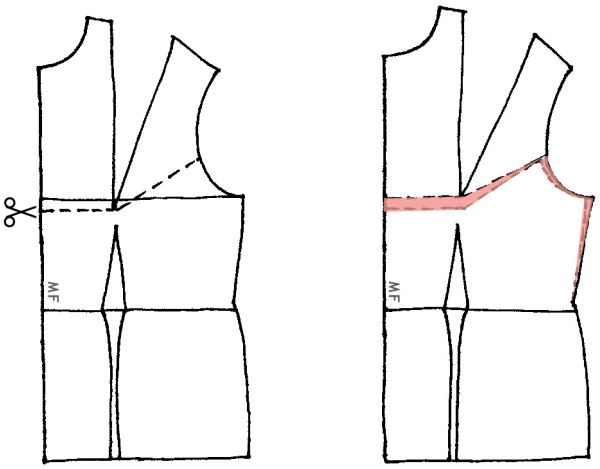

Figure A-32. Changes on the block pattern.

Figure A-33. Toile size large pinned close to the dress form.

Figure A-34. Positioning the waistline.

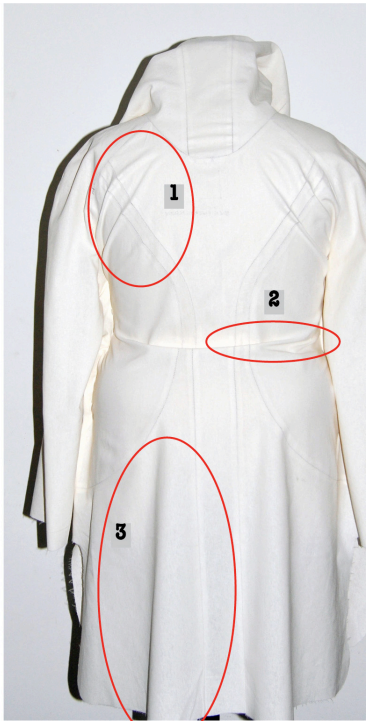

Figure A-35. Toile size large backside.

Figure A-36. Fitting the shoulder area.

Figure A-37. Fitting the backside waist area.

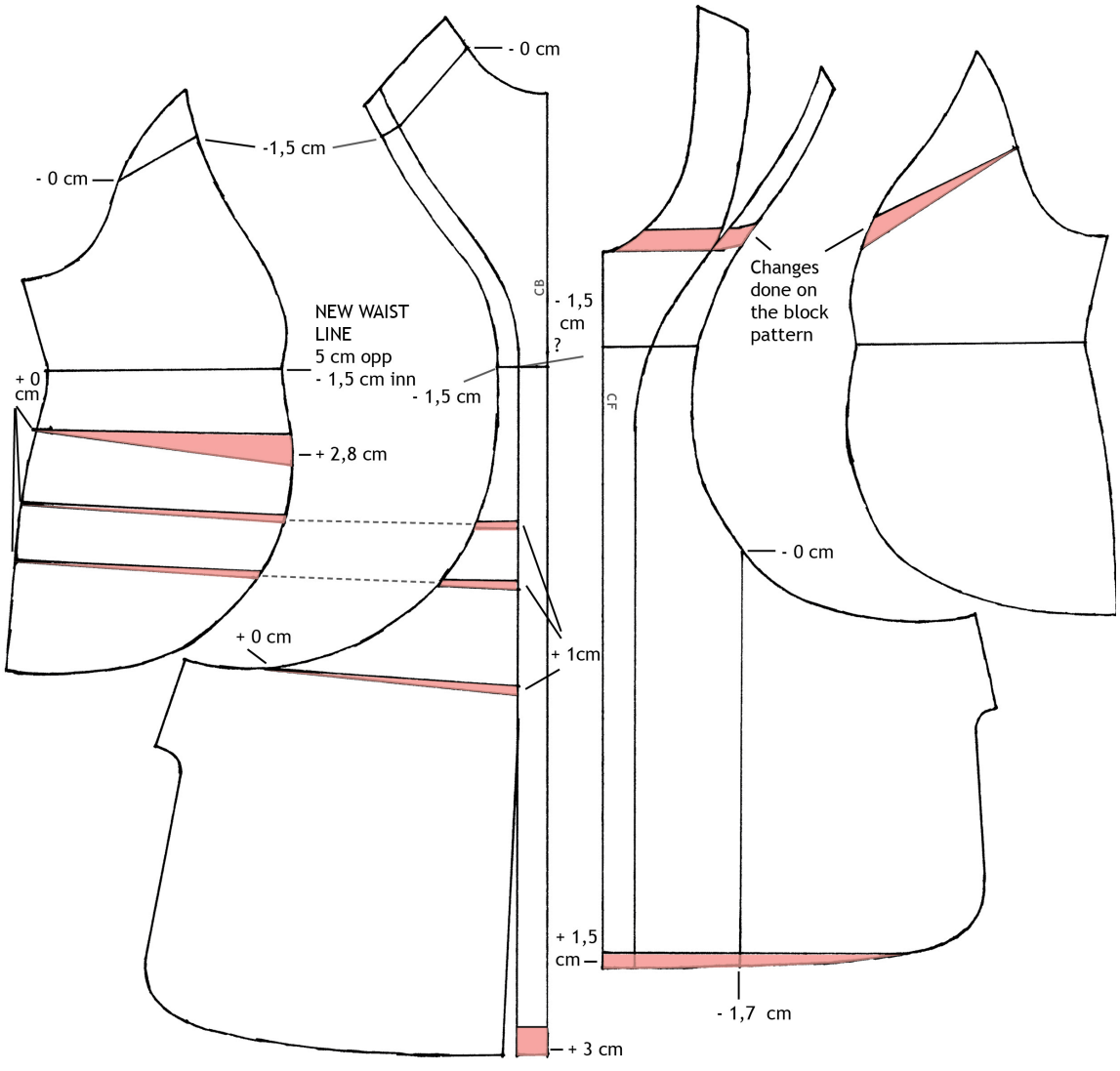

Figure A-38. Pattern pieces for anorak size large including changes during the fitting.

Figure A-39. Toile size large cut with pattern pieces including fitting.

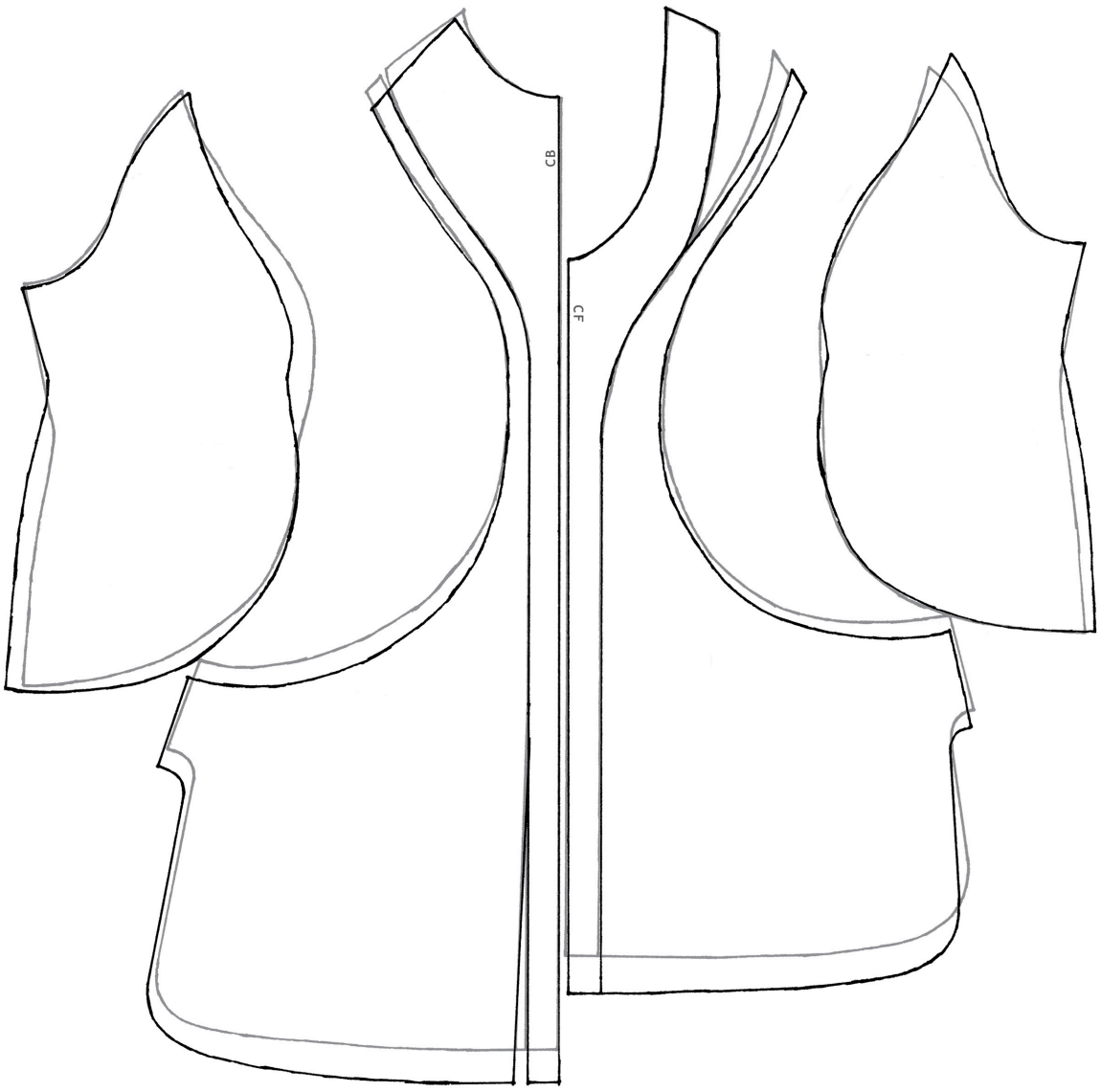

Figure A-40. Grey line: pattern pieces size large traditionally graded; black line: pattern pieces size large after fitting.

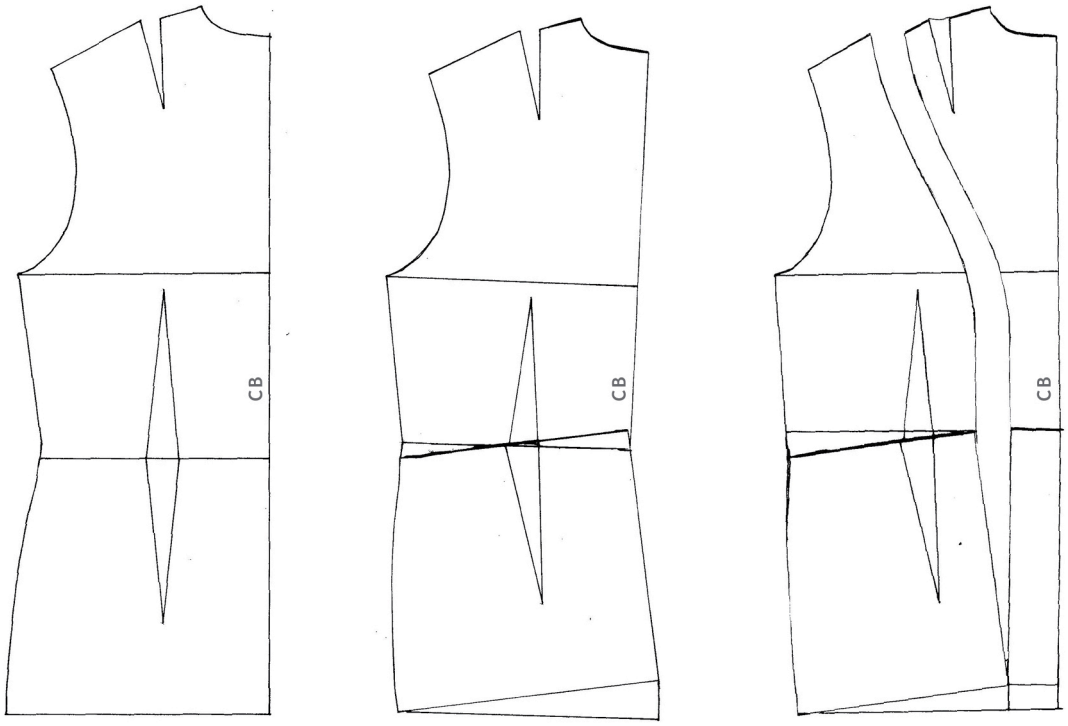

Figure A-41. Block pattern showing construction case around straight centre back line.

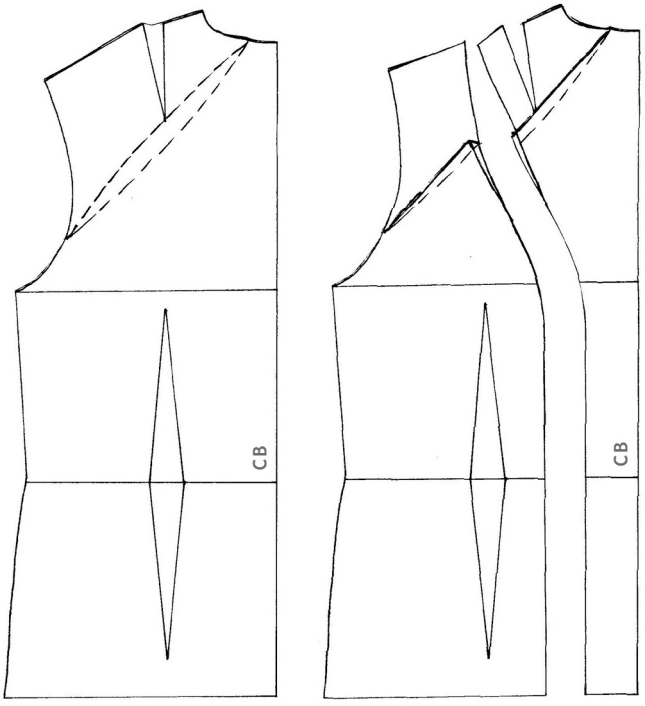

Figure A-42. Block pattern showing construction case shoulder area.

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