The Modern Woman's Business Suit –

An Investigation into Incorporating Freedom of Movement in the Block-pattern Construction for Soft-tailored Mass-produced Womenswear

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THESIS CONTAINS

VIDEO

CD

DVD

TAPE CASSETTE

Contents Page

PART 1

PART 2

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Illustration Index

Abstract

This study is situated in the field of garment construction for mass-produced womenswear, as it is the repeatable and time and cost sufficient method of flat-pattern construction.
In Europe the mass production of womenswear dates from the post World War 2 period. In the 1950s, traditional menswear was adapted and simplified for female customers. As part of the mass production process, garments were constructed on a rectangular pattern base, (as seen in the menswear 'sack' shape in use from the early twenty century onwards) to support the efficient production of the different steps of the industrial production process.

When the Italian designer Giorgio Armani developed jackets in 1975 based on the traditional menswear silhouette but without the stiff plastron (interlining) of menswear tailoring he softened the design of formal attire for both men and women. This silhouette and method of construction had a lasting influence. Even though this 'soft-tailoring' originated for high fashion, it freed women from the restrictiveness of the formal stiffened tailoring techniques. It is now commonplace in manufacturing in contemporary mass-market womenswear. Nevertheless, the flat-pattern construction of mass-produced women's business-wear itself is restrictive to the full range of basic body movements.

Despite the growing number of technical inventions supporting the industrial production processes serving the purpose of reduction in cost and manufacturing time, no obvious attempts have been undertaken to consider today's lifestyle of constant travel and transit. The active body movements which are involved in travelling and transit situations have not been considered when optimising the fit of formal garments. These not only have to fit the upright standing body, but the body performing movements. and therefore should not restrict body movement.

The design of mass-market womenswear consists of three areas in which style decisions can be made: the choice of fabric, the use of colour and the choice of the silhouette of the flat-pattern construction together with the positioning of panels, pleats or darts and additional design elements such as the collar style, pockets, cuffs and fastening. In the context of mass-production, the choice of fabric and colour is very important, but far less attention is paid to the design of the pattern construction.

This research project combines theory and practice research as it approaches the method of flat-pattern cutting for mass-market woven women's business-wear from a historical angle with giving reason for the necessity of modernizing formal womenswear for contemporary standards of life. The practice-based component targets the basic movements which are involved in every-day life, sets them in relation to flat-pattern cutting systems used in the industry and in education, and targets the widening of the range of movement in woven women's business-wear through adding elements to the block-pattern construction which are inspired by traditional sports- and dancewear.

The practical body of work aims to renew the traditional construction principles of flat-pattern construction in order to inform about the possibilities of supporting the performance of every-day movements as an integrated part in the design process of womenswear.

1 INTRODUCTION

The Modern Woman's Business Suit – an Investigation into Incorporating Freedom of Movement in the Block-pattern Construction for Soft-tailored Mass-produced Womenswear - is a project in which theoretical and practical strands are integrated into a combined methodology focusing on block-pattern cutting for mass-market womenswear. Specifically, the study focuses on the fitted jacket, long trousers and the knee-length skirt, situated in the context of selected pattern cutting systems. This project examines the way traditional flat-patterns from six different systems are constructed and compares the fit of the made-up garments during a course of every-day movements. Ideas for new adaptations to the pattern block are then proposed and tested.

Sorber (2003: 27) argues that a pattern can be seen as the connecting point between the two-dimensional fabric and the three-dimensional garment. From its first appearance at the end of the sixteenth century until the present, the flat-pattern has evolved from an adaptation of the shape of an individual body shape to a necessity for the development of the ready-made clothing industry. The patterns themselves are seen as a catalyst between elements of modern life, especially the aspect of mobility, and the design of a contemporary three-dimensional garment.

Block-patterns are the fundamental template of garment construction in the context of mass-production. The basic block for the flat-pattern construction method (as opposed to three-dimensional draping technique), is constructed using body measurements plus ease or tolerance for movement. Block-patterns are then modified into different types of garment construction - in which case they are called 'derived blocks'- and modified into any desired style or silhouette for a fashion-pattern.
Natalie Bray emphasised that,

> *The function of a Block or Foundation pattern is to provide a simple outline of bodice, skirt or sleeve, from which every kind of style pattern can be developed. It must also serve as a map or chart for recording useful information about the proportions, shape and even posture of a figure, average or individual. (Bray, 1964: 9)*

Within the group of block-patterns, different constructions for various garments can be found. Bray (1961: 11) formulates that blocks, such as 'tailoring-blocks' for structured garments or 'trade-blocks' which are, according to Bray (1961: 11) adaptations of the standard or basic block made to suit various requirements of the clothing industry. The different pattern blocks are looked at in detail in Chapter 4.6.

This research looks at soft-tailoring block-pattern cutting which is similar to the tailoring-block, but without using a completely interlined front for a fitted womenswear jacket as is traditional. A traditional tailored-block in combination with the stiff interlining of the front panel would also restrict the flexibility of the fabric for the development of the experimental prototypes. Working with the soft-tailoring block allowed the researcher to looking at more flat-pattern cutting systems and not restrict the research to the systems which use a separate tailoring-block or a basic block for constructing the jacket. As said above, the examination of the stiff-fronted tailoring-blocks with its plastron especially at the shoulder area does not leave enough freedom for the development of practical experiments to inform the design process of woven womenswear in regard to fit for every-day movement, as discussed in Chapter 10.

The initial idea for this project came from the researcher's personal background, having undertaken a BA degree in fashion design at the University of Applied Sciences Bielefeld in Germany, together with the experience gained in the subsequent MA Fashion Design and Technology at the London College of Fashion. The curriculum in Germany is based on the M.Müller&Sohn flat-pattern cutting system which is used predominantly in academic institutions and in the industry. The use of multiple flat-pattern cutting systems practiced at the London College of Fashion (and in the UK generally) opened up a different approach to garment construction. Block-patterns or block-pattern templates are not used in Germany. In Germany the starting point for a flat-pattern is the derived-pattern which is constructed according to the desired style. Because it is not common to use block templates, every new pattern starts with the basic construction, but already considering the desired silhouette. The researcher was trained to start all flat-patterns from the basic construction, but not a block-pattern selected from a range available. Fashionable aspects of a pattern, such as the silhouette, fastening, collar and pockets were directly constructed onto the basic construction. Therefore, the existence and frequent use of block-pattern in England gave a new perspective on flat-pattern cutting for mass-produced clothing in general.

Having been trained in both of the above ways of clothing construction, the researcher became increasingly aware that flat-pattern cutting considers the upright, static non-moving body and not using its full potential as a part of fashion design in order to adapt to an active lifestyle. This finding together with personal experience and observation of the restrictive character of mass-produced soft-tailored womenswear with regard to body movements in everyday life, especially during travel and transit, grounded the initial research questions for this project. These ask, whether there is significant difference in the way flat-patterns for womenswear are constructed by German and British flat-pattern cutting systems and in whether the moving body is addressed or could be addressed through the flat-pattern construction.

Because of the general need for comfort in clothing on the one hand, and the high demand for flexibility and movement on the other, a high proportion of contemporary mass-produced clothing consists of sportswear or shows sports-orientated elements, combined with the use of stretch fabrics. Sportswear makes use of elastic fabrics (often knitted) that allow for tight-fitting garments to adjust to body movements.
Design elements to produce clothing adaptable for different situations consisting of zippers to lengthen or shorten trousers or sleeves are today generally accepted. Even though sociological changes inspire design themes, colour or pattern for collections, the designs seldom relate to increasing mobility through the construction of the garments.

An early attempt on the subject of comfort in clothing can be seen in Garrett's *Ideal Clothing from the Scientific Angle* written in1931 for the Jaeger Company in London. The Garrett's text is part of the Jaeger archive as part of the art and design collection at the Westminster City Council in London. The comfort of the wearer is achieved improving thermal regulation focussing on the textile prosperities but not on the garment construction. As suggested by Garrett (1931), clothing by the Jaeger Company at this time was solely made of wool fabrics for the sake of enabling the perspiration to escape freely and giving access of fresh air without fear of chill because wool enables to hold an adequate volume of air.

For this study, undertaken between 2002 and 2011, the soft-tailoring block-pattern principles are constructed under consideration of the range of movements demanded by an urban life-style on contemporary clothing, aiming for an improved fit for a wider range of movement of mass-produced women's business-wear.

This project partially addresses the situation of being in constant transit and travel situations, which can be seen as synonymous with general movement and the main aspect of urban life.
The researcher developed garments allowing for an expanded range of mobility through their construction, allowing a new perspective on garment construction and the subsequent design process, which to date has been based on the upright standing, non-moving figure. Even though we have become less active in our day-to-day lives, the ease or flexibility for the range of movements which is needed for commuting and travelling is often not sufficient for demands of comfort.
The question emerged whether it would be possible to improve the fit and comfort to accommodate a range of every-day movements in woven womenswear through the construction of the block-patterns for jackets, trousers and skirts.

Former studies by Aldrich, Smith and Dong (1997), discussed in Chapter 11, consider the different dimensions of the tailored womenswear business jacket in five static movements.
In contrast, this project considers the womenswear jacket, trousers and skirt worn and evaluated in fluent continuous movements using the medium of video recording. After a time of critical reflection on aspects of modern urban-life - defined by its demand for mobility and the fact that urban-life cannot be seen without the aspect of constant transit and taking place in public rather than in private, as evaluated in Chapter 3 - the decision was made to see the different every-day movements in their natural flow rather than separate them into static movements. Studies by Kohn and Ashdown (1998) tested the method of video documentation of a fit trial and found it successful for visual fit analysis.
During a period of direct observations, which originated in the researcher's personal experience of the restrictiveness of tailored womenswear during every-day-movements, and reflections on women in every-day situations, it was obvious, that modern women's business clothes regularly showed an ill fit in any other posture than the static upright position. At this point the initiative was taken for the production of a video observation. In order to investigate and to gain valuable visual material on the existing, often poor fit of soft-tailored woven womenswear during travel and transit situations, the method chosen was filming the action and then homing in on specific movements to mimic reality. Although the video tape, preparative to the later video analysis 1 and 2, was produced with low technology, these early observations made a valuable contribution to evaluating general mobility and contributed to the development of the specific movement set for the fit analysis.

The following Figure 1 consists of a picture set, extracted as stills from this preparative video observation. The video is used as first hand information about the restrictiveness and poor fit of woven womenswear during daily travel situations and led to the idea of systematically researching the modern women's tailored business-wear and its production. Furthermore, the video initiated the development of a qualitative questionnaire handed out to working women. By this, the researcher wanted to find out about their views and opinion about what they think is appropriate business-wear and whether these garments fit in their daily travel routine. The investigation focuses on generally accepted women's business-wear garment types, the fitted jacket, the long trousers and the skirt. The analysis part of this project is a visual one. Any emotional aspects of wearing clothing are only mentioned as given by interviewees.

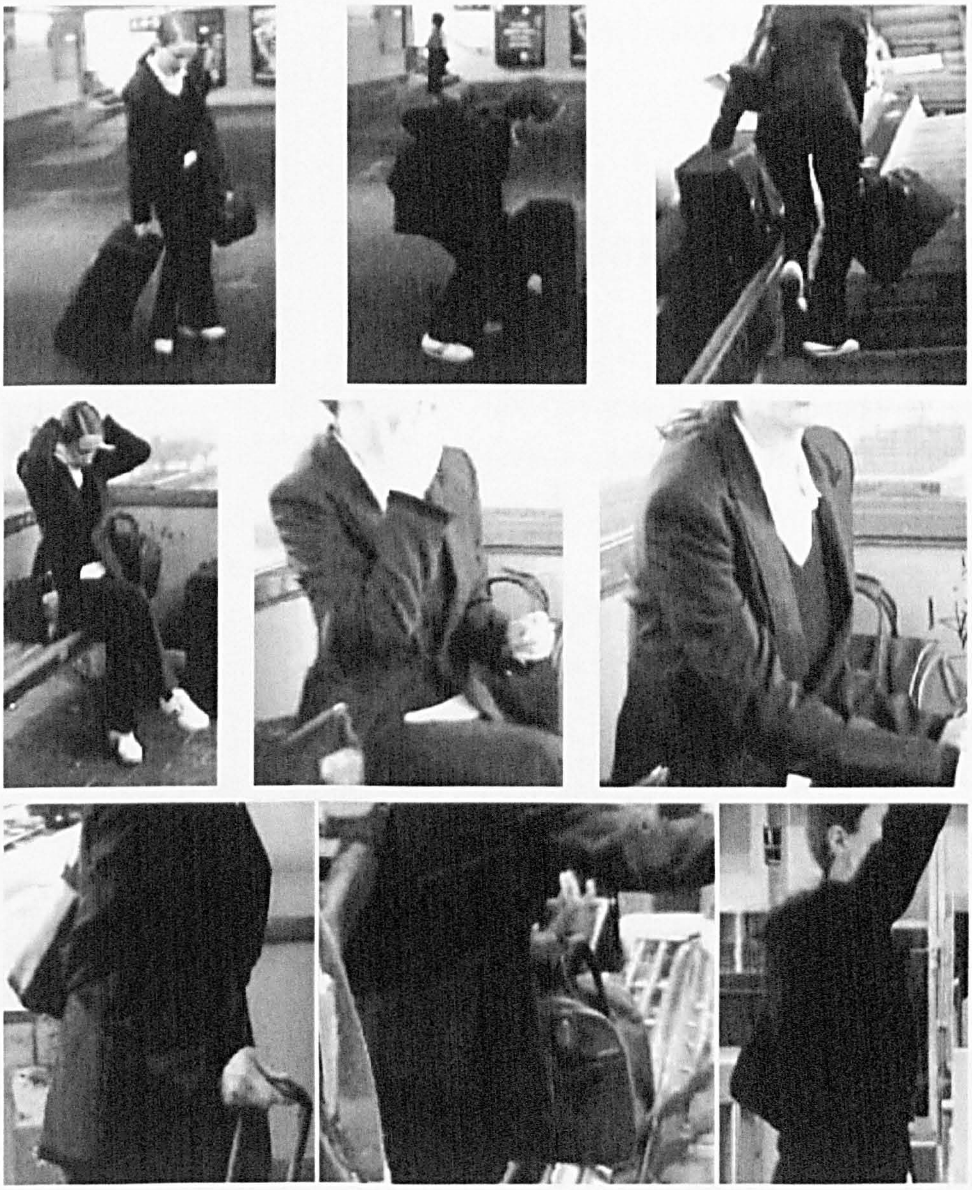


Figure 1, Women's business-wear in daily travel situations

The aim of this first documented observation and the questionnaire is, to define basic every-day movements, to locate areas in the chosen garment types where body movement is restricted and find a better fit for movement and comfort for womenswear through adjustments of the flat-pattern construction for soft-tailored womenswear with regard to industrial production and economic limitations.
This research puts the idea of the moving human being into the forefront and applies existing aspects of clothing construction such as pleats or gussets, onto a block-pattern for tailored womenswear, generally accepted as formal business attire.
Business-wear or soft-tailored womenswear traditionally is made from woven fabrics. Even though stretch fibres are used in woven fabrics to improve comfort, during initial observations, it was decided that the introduction of stretch still did not adequately allow for the full range of movement identified. This research project therefore targets the problem of increasing the range of mobility through the extension of the block-pattern for soft-tailored womenswear.

1.1 Inspiration and Background to the Project

The focus on dynamic elements of life explicit in the Futurists movement gave inspiration to the research. In May 1914 Giacomo Balla launched the first hand written *Il vestio da uomo futurista,* the *Anti-Neutral Clothing Manifesto.* Cox and Norden declare:

> *Balla's deconstructionist approach to fashion should be bold and joyous, a rebellion against the mediocrity of bourgeois conformity and reflective of the glittering, gaudy attractions of a culture in transition, teetering on the brink of the First World War. (Cox, Norden: 2009:10)*

The group of Italian artists who called themselves Futurists, started working around their idea of dynamic sampling in various areas of life in 1909. Their first manifesto, written by Marinetti, was published in the same year. Novis (2001: 10-16) states that the Futurists' ideas are strongly connected to humanism, because they accepted the versatility of the human possibilities and furthermore, requested it.
The aim was to become a 'uomo universale', as being the one who makes full use of his given potential. Crispolti (2001: 34-37) adds, that through implementing this idea, clothing was allowed to carry them out into every-day life, visible for everybody.

Falasca-Zamponi (in Parkins (Edt. 2002: 147) agrees that the typical Futurist mode combined political activism with the artistic aim of transforming the lived environment. Figure 2 shows the manifesto with illustrations of clothing and Figure 3 shows a *Futurist Suit* which consists of sharp-edged fragments in various shades of yellow and red. Falasca-Zamponi (in Parkins ed. 2002: 146+147) articulates that the *Futurist Suit*:

> *(…) was supposed to counter the notorious lassitude of Italians and instead incite them to an active life of high energy. Furthermore, it represented a sign of the new, a solicitation to fantasy and imagination in daily life. As such, it was supposed to liberate Italians from the 'slavery of the body', 'the denial of muscular life, (…).*


IL VESTITO ANTINEUTRALE

Manifesto futurista

Figure 2, Giacomo Balla, *Il vestito antineutrale*, pages 1 and 2, 1914.
Source: Der Lärm der Strasse- Italienischer Futurismus 1909-1918, Norbert Noris (Edt.), Sprengel Museum Hannover, 11.03.-24.06.2001, Enrico Crispolti, Die Futuristische Rekonstruktion der Mode, p 334.

Figure 3, Giacomo Balla's Futurist Suit, ca. 1918.
Source: Workshop Missoni: Daring To Be Different, Estorick Collection of Modern Italian Art in London, opening July 1, 2009

Futurist clothing should illustrate society and behavioural patterns which reflect industrial and mechanical technology and the much faster pace of communication as well as locomotion. Balla converts this idea through assembling a suit from acute angle pieces in different shades of a colour, the aspect of being able to adapt to the pace of modernity by the human body being able to extend the range of movements while wearing clothing, is not addressed in this concept.

Sennett (1994:16) who wrote on the subject of the human body in an urban surrounding, observed that the modern individual is, above all else, a mobile human being. Furthermore, he proves this thesis with the fact that 'the (...) most remarkable point of modern times has so privileged the sensations of the body and the freedom of physical life and the experience of speed'. Sennett stresses this by giving the example of how different travelling today is in comparison to former times. The technologies have motion, whether they are automobiles or public transport, this leads to the fact that urban space is now measured in terms of how easy it is to drive through. Therefore, urban spaces become a mere function of motion, it thus becomes less stimulating in itself; the driver wants to go through the space, not to be aroused by it.

Even though the physical strain is less today, contemporary life demands for a certain flexibility to comfort the use of the various ways of travelling. Sportswear that is adequate and comfortable for physical training is generally not seen as appropriate for formal situations which include travelling to and from work.
Sennett (1994: 255-257) looks at the coherency between urban living and the consequences for the inhabitants of the cities from early examples in the medieval ages until today. In all his evaluation he understands the individual as a mobile human being above all.

In contrast to the above, it is common to present clothing and fashion with a great range of movements rejected. A catwalk presentation lets the models walk, but leaves the upper part of the body static.
Fashion photography shows arranged frozen movements that cannot reflect the various sequences of a performed movement together with any restrictions in the latter caused by the garments. The fabric of the garment is arranged around the certain body shape of a particular position. The movement into and out of this position together with anatomical changes of the human figure is not considered.

Contemporary designers who concentrate on new pattern techniques focus on a changed static silhouette rather than on applying being 'on the move' to garment construction. In an article about the Japanese designer Issey Miyake, Suzy Menkes (1988) wrote for the International Herald Tribune, that at least there was a designer who understood to allow for movements in his designs made from pleated fabric without using body clinging stretch clothing.

Seeling (1999: 504) observes the work of the Tunisian designer Azzedine Alaia which can be seen as significant in the way he uses spiral shaped seams to form the human body. But still, the basis for the designs is the static, sculpture-like, non-moving, body. Figure 4 shows America's first lady Michelle Obama at an official visit in Strasbourg, France in April 2010, wearing a trouser suit by the Tunisian designer Azzedine Alaia, consisting of a fitted jacket and long trousers. The trouser suit is generally accepted as the modern women's business suit.


Figure 4, Michelle Obama wearing Azzedine Alaia, source: www.thefashionistastories.com

In order to evaluate the fit of accepted women's business wear in daily travel in transit situations, the initiative was taken to investigate the origin of business womenswear. Simple styles for female fashion, which are the base for contemporary tailored and soft-tailored womenswear, similar to menswear fashions, can be found from the beginning of the twentieth century.
Simplification of womenswear increased due to wartime constraints. Figure 5 shows a womenswear costume, consisting of a long belted jacket and a long skirt from the First World War.

Figure 5, Practical Clothes, World War 1, Source: Laver (1982:229)

The example of this modification in the general styles of womenswear illustrates the fact that clothing adapts to the varied circumstances in which it is worn.

König (1971: 31, 32) states that fashion has always reflected the time and the circumstances in which it is worn and that fashion can even be an incentive for social changes.

He suggests that it is not primarily revolutions or wars which determined specific fashions, but only that such circumstances question the existing styles.

However, Entwistle (2000: 110, 111) argues that the assumption that fashion reflects the spirit of the times is too simple, but at the same time one cannot say that fashion is unaffected by shifts in social life. Therefore fashionable clothing cannot be reduced to social changes only.

According to Beirendonck who wrote for the catalogue of the *Geland/Mutilate?* exhibition in Antwerp in 2001:

> *It has always been a human trait to use clothing and accessories to give an individual the ideal appearance for a specific occasion. Fashion is charged with providing a symbolic link, connecting the individual to his environment. Today we live in a culture of beauty, where attractiveness and immediate approval is directly related to an active appearance. The reality of modern living is the expectation of activity. Beirendonck (2001: preface)*

1.2 Aim and Objectives

1.2.1 Aim

The principle aim of this research is to develop block-pattern principles which allow for an improved fit for a wider range of movement of mass-produced women's business-wear which can inform the further design process.

1.2.2 Objectives

In order to achieve this aim, the objectives of this research were as follows:

- To classify every-day movements which are involved in travel and transit situations through direct observation

- To investigate anatomical facts of mobility from an observing perspective and in what way these need to be included in the design of block-pattern

- To investigate how far industrial flat-pattern cutting considers the moving body

- To develop qualitative procedures for the evaluation of the fit of a block-pattern to aid mobility

- To develop, apply and question functional techniques within the construction of the block- pattern which allow for a greater freedom of movement

1.3 The Structure of the Thesis

The thesis is structured in Part 1 and 2. After having introduced the thesis in chapter 1, the methodology designed for this specific research project is stated in Chapter 2. The first theoretical Part 1 of this research project looks at women's business-wear situated in the context of pattern cutting systems, from Chapter 3 to Chapter 8.

Having stated that the daily-life of working women involves numerous travel and transit situations, Chapter 4 examines the historic and economic context of clothing and the technical side of flat-pattern cutting.
In order to bridge the historic development of flat-pattern cutting to flat-pattern cutting as part of mass-production, Chapter 5 examines the development of sizing and size-charts and discusses the coexisting of the latter with the mass-production of clothing. From here the literature review moves on to examine flat-pattern cutting in the context of mass-production of clothing in Chapter 6.
In Chapter 7 the fit of garments is investigated.
Chapter 8 is a comparative study on six flat-pattern cutting systems, representing flat-pattern cutting systems in Great Britain and Germany. This involves block-patterns for a womenswear jacket, trousers and skirt constructed following the instructions of each of the six systems with the help of computer-aided-design software for two-dimensional pattern cutting.

After the literature and contextual review of Part 1 of the thesis gave the theoretical underpinning, Part 2 consists of practical prototypes embedded in a photographic documentation, accompanied by video productions. The second practice-based part, Chapter 9, focuses on the comparison between six flat-pattern cutting systems, made-up block-patterns from them for the womenswear jacket, trousers and skirt together with a video documentation focusing on the fit of the garments for every-day movements. The video analysis 1 reflects the idea of evaluating the fit of the garments while being worn. This is rounded up by an investigation into anatomical phenomena, their relation to flat-pattern construction and possible solutions for widening the range of movement.

The evolving practical experiments for amending the existing flat-pattern cutting systems through added folds and gussets were inspired by traditional sports- and dance-wear, in order to inform the design process of integrating a wider range of movement into womenswear is stated in Chapter 10. The experimental prototypes, are evaluated from the perspective of allowing for a wider range of movement.
For comparability to the prototypes from Chapter 9, this consists of a second video documentation, video analysis 2.

The data gathered is discussed in the concluding Chapter 11. This is followed by a summary of key findings, limitations and conclusions, along with recommendations and suggested consequences for further research.

1.4 The Research Design

The following Figure 6 gives an overview of the research design of this research project. The two strands of the research project, flat-pattern cutting for woven soft-tailored womenswear on one side and the basic every-day movements which are involved in travel and transit situations on the other, are illustrated.

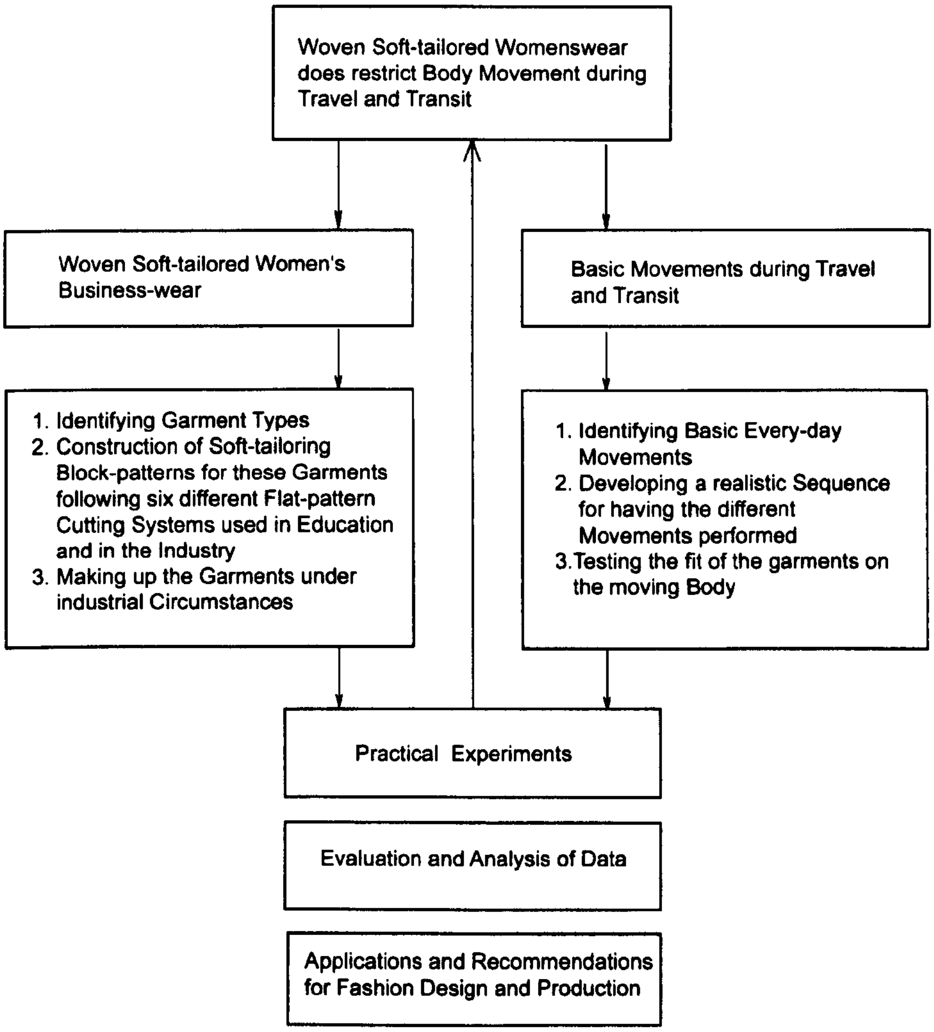


Figure 6, The Research Design

This research study utilises both theoretical and practical approaches to obtaining the fit of block-patterns for woven fabric womenswear comprised of jacket, trousers and skirt to allow for a greater freedom of movement. The thesis is design and technology practice-based research into the fit of block pattern for soft-tailored mass-market womenswear. It consists of 66.396 words written thesis, eighteen prototypes of clothing together with a video and a second set of twelve prototypes with another video.

The thesis demonstrates an integration of theory and practice by investigating woven tailored womenswear and basic everyday movements which inform the development of practical experiments.

The evaluation and fit analysis is undertaken visually from an external viewpoint. Recommendations and applications for further fashion design and production are given.

In order to gain qualitative information to answer the research question whether the range of movement in soft-tailored womenswear can be extended through the flat-pattern construction, the following parameters need to be considered and evaluated:

i. Time frame for Womenswear Mass-production: 1950s – 2012
ii. Geographical extent: Great Britain – Germany
iii. Contemporary Urban Life-style
iv. Female Work-wear
v. Mass-production of Clothing
vi. Flat-pattern Cutting for Woven Womenswear
vii. Fit in Womenswear

These areas are introduced in the following paragraphs.

1.4.1 Time Frame for womenswear mass-production: 1950s - 2011

The research project is set between the post Second World War years and 2011.

The post-war years with their urgent need for ready-made-clothing for most of the Europeans, supported mass-manufactured clothing which had already taken place on a smaller scale since the beginning of the twentieth century. Fischersworring (2007: 304) argued that the industrial production of clothing was in a peripheral stage until 1945. He sees the start-up between 1945 and 1970. Thiel (2004: 341) mentions that the first industrial mass-manufacturer *La Belle Jardiniere* was opened in Paris in 1824.

She names the irrational production procedures and the fact that mass-produced clothing was not much cheaper than made-to-measure clothing as two reasons for the slow success. Aldrich (2007: 1-3) also explains how ready-to-wear clothing began to be available to the mass of the growing urban populations from the middle of the nineteenth century.

However it was the modification of womenswear towards simpler clothing similar to menswear before the First World War that made a mass-production of womenswear possible, as discussed in Chapter 6.3. (Aldrich: 2007, Laver: 1982)

Even though the production of uniforms for the First and Second World Wars was mass-produced, hardly any other types of clothing were mass-produced.
Because of the need for staples of clothing in the post war years, the 1950s can be seen as a time of growing expectancy for mass-market womenswear which in the following years started to take over the fashionable position of made-to-measure clothing. Nevertheless, the wide acceptance of industrially mass-produced garments since the 1950s could only become possible because of certain aspects that had taken place before that period. An important example of this is that the need for uniforms supported size-charts for male people since the First World War. Therefore at some stages, the research has to go back to draw a logical conclusion. Furthermore, the first UK sizing survey for women was undertaken in the late 1940s. It was published under Board of Trade in 1953 which helped a mass-production. More information on this is given in Chapter 8.2.2.1 a section on the flat-pattern cutting system by Philip Kunick who was involved in the sizing survey and who based his construction system on the findings.

1.4.2 Geographical extent – Great Britain and Germany

When interviewed on the 21st of April in 2010, Otto Niemann, who wrote on the historical development of pattern cutting, mentions that pattern cutting, and the teaching of it, is treated differently in the various European countries. Whereas Germany is a country in which one single flat-pattern cutting system is predominantly used. In contrast to this, different systems are used at the same time in Great Britain.

The different approaches for German and British systems poses the question whether there are significant differences in the way structured womenswear block-patterns for mass-production are developed, in a country that relies on a single flat-pattern cutting system and in one that has multiple systems available.
Despite this, the researcher's own personal German background enabled the chosen geographical extent and comparison.
Furthermore the historical background to the development of machinery, for the mass-production of clothing and of flat-pattern cutting systems contributes to general understanding of the different approaches to production.
Niemann (1986: 43) names the written work of the tailor J.S. Bernhardt in Dresden, Germany, from 1810, as the first to give instructions on the development of flat-pattern cutting following individual measurements.

Sorber (2003: 25) mentions the Spaniard Juan de Alcega whose work on pattern cutting was published in 1580. A copy of the second edition of Juan de Alcega's Spanish written book *Libro de geometrica practica y traca el qual trata de lo tocante al officio de sastre* (Eng.: Book of practical geometry and trace, regarded to official tailors), published in 1589 can be seen at the National Art Library of the *Victoria and Albert Museum* in London. A template of this book can be seen in 4.4.1.

Niemann (1986: 44) lists work on the matter that came from J.H. Michel, a German tailor in London, from 1818, from Heinrich Klemm, director of the *Europäische Modenakademie* in 1846 in Dresden and E. Kuhn, tailor in Berlin from 1879. Fischersworring (2007: 52) found that most of the technical inventions in the eighteenth century came from England where the industrialisation was ahead in comparison to any other country. Industrial textile production started off with the invention of the pedal spinning wheel in 1530 for the production of yarn. Woven fabric could be mass-produced at the end of the sixteenth century when Anton Müller invented the fully-mechanical weaving loom. The first manual mechanical knitting frame was already invented in 1569 by William Lee. Beese and Schneider (2001: 12) affirm that with the invention of the steam engine by James Watt, the first mechanical weaving looms powered by steam, were used for the production of cotton socks and gloves. The general automation in the mid twentieth century allowed the increased production of various yarns, textiles and different types of garments. (Fischersworring: 2007)

Even though flat-pattern cutting systems, without which a mass-production of clothing would not have been possible, had been developed in Europe. Aldrich (2007: 36) states that it was the American manufacturers who began to apply standard sizing techniques to their mass-production of clothing as early as at the end of the nineteenth century. Nevertheless, it was not before the beginning of the nineteenth century that the construction of flat-pattern was built on mathematical theories.
Aldrich (2007: 7) names Benjamin Read's book *The Proportionate and Universal Table*, published in 1815, whereas Niemann (1986: 43) suggests the handbook of the German tailor J.S. Bernhardt, first edition published in 1810 as the first publication on a flat-pattern cutting method based on calculated proportions of the body measurements. Such proportional systems are the basis for contemporary pattern cutting for mass-production.

Aldrich (2007: 7) suggested a combination of divisional systems using the proportions of the breast and back length and direct measurements using direct body measurements for specific reference points on the pattern, is still the principal method of constructing basic garment pattern today, as is discussed in Chapter 4.3.3 .

1.4.3 Urban life-style

Entwistle (2000: 106-108) suggests that modernity, beginning with the Industrial Revolution, invokes urbanisation as one of its main developments. She also states the importance for life in a nineteenth century city in protecting oneself from social encounters by identifying others by their appearance.
Furthermore, Entwistle (2000: 118,119) is of the opinion, that fashion became central to the experience of the modern city. Especially within the specific urban environment other aspects such as practicality and comfort are taken into consideration. Bolton (2001: 28) claims that the urban environment is already addressed in designer fashion. Designs which are practically orientated for situations where garments chosen in the morning are worn the whole day through and therefore needs to adjust to various dressing occasions.
Breward and Evans (2005) cite Jean Baudrillard who articulated that fashion has also been seen to embody representative characteristics of modernity, and even of culture itself. Bolton (2001:28, 29) argues that these garments, which are subject to variation as perceived by the person wearing and adjusting them, are individual on the one hand but uniform on the other. A pattern of dress is emerging for individuals sharing similar conditions, which mainly result from contemporary urban experiences.

The fact that human life increasingly takes place on the streets and in public places is still rarely addressed in the construction of garments, but Sweetman, cited in Entwistle and Wilson (2000: 59-65), write about the sociological impact of clothing upon the body in relation to the environment in which it is worn. However, König (1971: 119-126) argues that it is more the imitation of specific group identifications than the surroundings, which leads the individual to wear selected clothing.
Apel (1984: 210+211) who described the influence of working people on contemporary fashion since the beginning of mass-production, argues, that in modern society it is rather the working person, who influences fashion than an elitist group of people.

1.4.4 Female work-wear

This research project targets the soft-tailored womenswear for working women living an urban life-style, as stated in Chapter 3

Entwistle (2000: 112) affirms that the way we perform our identity has something to do with our location in the social world as members of particular groups.

The clothes we choose to wear represent a compromise between the demands of the social world, the surroundings in which we belong and personal desire and taste. As quoted by Entwistle (2000: 123), Finkelstein (1991) argues that fashion is a bond that links individuals in a mutual act of conformity to social conventions. This argument has to be considered while investigating the garment types which are generally regarded as contemporary female work-wear. The working masses have always been the only ones who have worn garments allowing for freedom of movement. Thiel (2004: 380) confirms that this necessity for flexibility went hand in hand with a neglect of the latest fashion trends.

After women got wider job opportunities at the beginning of the twentieth century, the idea of work changed, as women became more emancipated. Beese und Schneider (2001: 65) argue that women tended to see their job purely as a means of earning extra money for the family or, if they were not married, of earning money to buy their endowment prior to starting a family in the post World War 2 years. Entwistle (2000: 124) clarifies that women in the 1950s did not identify with their work, nor did they often find job-fulfilment.

As stated by Thiel (2004: 362) many garments which are worn after the Second World War for work, like sack-shaped jackets, were adopted because women already had to fulfil men's work during the war. As mentioned before the two-piece skirt costume, consisting of a structured jacket and a skirt and also a blouse in the style of a man's shirt, were already useful during the years of the Second World War. Laver (1982: 252, 253) finds that the shortage of material during and after the First and Second World War, had the consequence that the garments themselves became simpler. Whereas Thiel (2004:415) adds, that the only garment which was not directly adopted after the Second World War, was women's trousers. According to Seeling (1999: 62), the only occasions trousers were widely accepted were for sport and leisure activities. Provocative statements such as the actress Marlene Dietrich wearing trouser suits, cannot be seen as fashion for the masses. It was not until the late 1960s that women wearing trousers were seen and also accepted within society.

Seeling (1999:62) contests that, women wearing trousers after the Second World War was only a question of practicality, as they still had to work in professions which had formerly been done by men. Therefore women's trousers could not be regarded as a fashion, but as a necessity. It was not before the late 1970s that wearing trousers or a trouser suit for women is widely accepted in all kinds of professions and that they were industrially mass-produced.

1.4.5 Industrial mass-production of clothing

To investigate the mass-clothing market in general and flat-pattern cutting in particular as one aspect of the product development and manufacture of clothes, this research project investigates industrial methods of clothing production.

Thiel (2004: 341,342) informes that many women were acquainted with mass-produced clothing as the manufacture of simple garments- or underwear. König, Hummel, König and König (1999: 272) argue that the production of fashionable clothing did not necessarily lead to products of lower quality. The standard of production soon increased in quality.
Since the manufacturers were able to produce large quantities of not only practical garments, but also fashionable clothing, a large number of women could afford to buy more garments than before. From that point on it became possible to wear more fashionable clothing at work.

According to König (1971: 237, 238), the era of mass-production can be seen as the last significant change within the social spread of fashion. All former occurrences or fashions were based on the taste of minorities. It had been rather a question of a certain group setting themselves apart from the masses.

As the project concentrates on the industrial surroundings in which the process of flat-pattern cutting takes place, the position of the flat-pattern cutting systems within the whole production process is investigated. A further investigation into general methods of mass-market clothing manufacture, new technical inventions and possible consequences for the methods of pattern making is undertaken in Chapter 6.

1.4.6 Flat-pattern cutting for woven womenswear

Rolf (1979: 63) supports the idea, that the woven cloth is the basic material from which all later forms of costume emerged, from the first wrapping costumes made from the original piece of cloth to the three-dimensional costume. The structure of the thread forms the grain lines of the fabric. The warp direction is the lengthwise grain; whereas the weft indicates the crosswise grain direction.
Patterns cut out of woven fabric are inelastic when cut on the lengthwise or crosswise grain. The grain, on which all pattern pieces are adjusted on the cloth, is an important aspect of flat-pattern cutting.

This research project targets the mass-market, in which time consuming and inefficient design concepts are at variance to the production process, as stated in Chapter 6. One crucial element within this process is the construction of a two-dimensional pattern, a flat-pattern. Modelling the fabric directly around the form is far too time-consuming and expensive. This way of constructing garments does also require a second step in which the draped garment needs to be laid out flat in order to gain a two-dimensional pattern for reproduction.

1.4.7 Fit in woven womenswear

Sorber (2003: 27, 28) finds, that since the nineteenth century pattern cutting has developed new ways to fulfil its main need, to reveal the shape of the body underneath. Groves (1966: 1, 42) points out that it was not before 1849 that the use of a tape-measure for gaining the clients' measurements was mentioned in a Dutch book on recent inventions. The cut of a plain and simple garment became the major claim. Sorber (2003: 23) claims that the resembling of the human shape has undertaken a huge development from the early examples of fitting garments of the sixteenth century until the present day.

In the clothing industry the main demand on the flat-pattern is to resemble the human body of an average size and shape as closely as possible by using a pattern which minimizes a waste of fabric. But still, to reflect the body by its measurements while steadily standing upright, does not necessarily allow for movement while wearing the garments. Furthermore, fit is also of a subjective matter. Therefore the objective perspective for evaluating fit is used for this research.
The evaluation of fit can be found in Chapter 7.

1.5 Conclusion to the Research Design

After setting out the parameters above which form Part 1, Part 2 of the project consists of a practical comparison of six different flat-pattern cutting systems in Chapter 8. The four English and two German systems are chosen according to findings about mass production of clothing and the flat-pattern technique as an important tool for the production process because of its repeatability and efficiency in regard to saving material while cutting out the pattern pieces, as it will be investigated in Chapter 6.

Womenswear jackets, trousers and skirts have been identified by an investigation in female business-wear and outcomes of interviews with working females on which garment types are generally accepted as appropriate for working in, as it can be found in Chapter 3. These garment types are made up following the instructions by the six flat-pattern cutting systems. The resulting 18 garments are then visually compared while being worn during a pre set course of movement, which is based on direct observation on travel and transit situations, in Chapter 9. This practical body of work will help to locate any restriction in body movement while wearing the clothing.

From here the research journey leads to practical experiments on flat-pattern cutting which should be seen as informative for the design of womenswear, incorporating the moving body, reflecting the life-style of working women today. The development of the experimental flat-pattern amendments, the documentation of these being worn while performing the same row of movements as used in Chapter 9, and a fit analysis, can be found in Chapter 10.

The experimental flat-pattern amendments are discussed in regard to the contribution to new knowledge in Chapter 11.

In order to fulfil the aim and objectives and to investigate the parameters of this research, as listed above in Chapter 1.4, the identified methods for investigating are explained in the following Chapter 2.

2 METHODOLOGY

The aim of this research project is to understand flat-pattern cutting as a process which is not isolated from aspects of an urban lifestyle, and its consequences in relation to contemporary clothing; it is rather seen as a logical basis for designing and manufacturing clothing products which stand in a direct relation to an urban lifestyle. This research aim is achieved through critical design, undertaken by visual survey. Saikaly (2005) describes this practice-based type of inquiry as a "designerly mode of inquiry," distinct from well-established research approaches. The ontological and epistemological influence for the methodology for this research project is influenced by critical design and design as research. This research project uses an inductive/deductive frame for incorporating phenomenological and pragmatic and applied research methods. The phenomenological influence is carried out through fieldwork, direct observation, documentation and visual analysis. The pragmatic and applied aspect is investigated through reflective practice and experimental study.

2.1 Overview of the Methodology

The rational for this research project is based on the researcher's personal experiences as a designer, researcher and wearer of soft-tailored womenswear but also supported by general observations. The following combined methodology is developed to suit the observational and experimental character of this research project. It utilises both an inductive and deductive approach. Figure 7 gives an overview of the methodology.

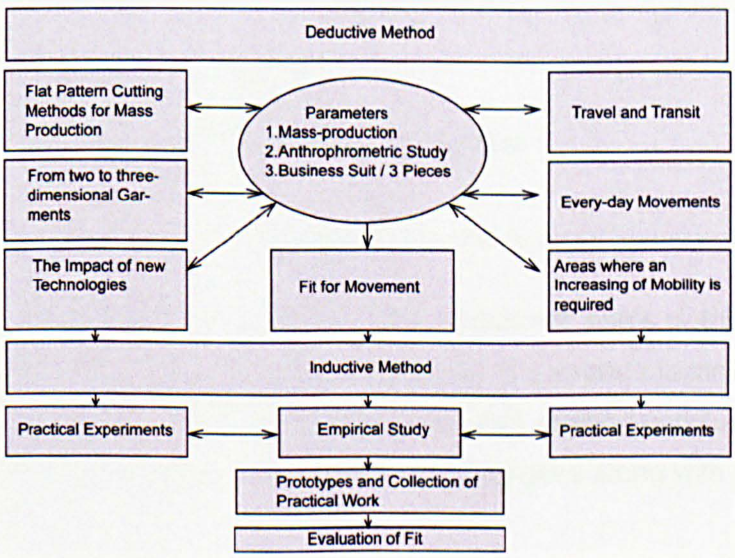


Figure 7, The Methodology of the Research Project

The developed methodology used for this research project is therefore specifically tailored to fulfil the aim of developing new principles within industrial block-pattern cutting on a practical basis. The data gained for the contribution of new knowledge is based on outcomes of practical experiments and so a methodology that combines theoretical underpinning to a practice lead research project is necessary. This combination is relatively new for research on a design-orientated topic or task – as a result existing work on research methodology fails to be sufficient for this particular project.

In the following the methods used to bring the segments of this project together and therefore form the methodology are given.

2.2 Methodology

The different strands of the combined methodology used, consists of the following:

2.2.1 The deductive/inductive method

The approach to this study is experimental. Therefore, the deductive/inductive method is suitable to gain qualitative research.

In order to see the logic behind this combined method, the terms deductive and reductive/inductive, are explained as follows.

According to Buhr (1972: 922), the following example given in Figure 8 explains the difference between a deductive and inductive method. :

Example for deduction: if p, then q

Therefore p is true = consequently q is also true

Example for induction: if q, then p

Therefore q is true = consequently p is also true

Figure 8, Source: Buhr, Philodophisches Wörterbuch Band 2 (Eng.: Philosophical Dictionary Volume 2), 1972, p. 922

P is the statement 'someone is moving', q is the statement 'one's clothing goes along with the movement'. In both cases the conclusion is, 'if someone is moving, someone's clothing goes along with the movement'. The deductive method concludes that, when it is known that someone is moving, someone's clothing goes along with the movement.

Whereas the inductive method concludes that it is also known that someone's clothing goes along with the movement, but this does not necessarily mean that someone is moving. The movement of the clothing can also be a result of something else.

Therefore, inductive conclusions are of a hypothetical character. Yet, both methods are based on the same logic. It is not therefore useful to see these methods as logical contrasts. Instead, the same logic is shown through a deductive and inductive method. Buhr (1972: 216) argues that because of the fact that the deductive method draws conclusions on former deductively proven statements, this method needs practical experiments in order to get a true result. The deduction is always based on other statements, which need to be proven as true as well, as they are in this research the outcomes of the questionnaires. The logical usage of these practical experiments as shown in the video documentation of the garments made-up following six different flat-pattern cutting systems, together with their results, feed into the inductive/reductive method.

The inductive method is used in the theoretical part of the project, which consists of an analysis of the use of historical and contemporary flat-pattern cutting and an investigation into aspects of mobility within urban life. As a starting point, the project considers the flat-pattern cutting systems which have been used in the production of clothing. Different systems have been analysed in order to find points, where the practical experiments logically have to take place.

The outcome of this inductive part of the research forms a basis for the practical side of the project which follows the deductive method. Experiments include an investigation into the general fit of contemporary mass-produced clothing and the addressing of areas within flat-pattern cutting where new ideas can be applied. The aim is to improve the fit and mobility by means of changes in commonly used flat-pattern principles for structured women's wear. All practical experiments, together with the creation of prototypes, are tested and discussed with consideration of the former inductive outcomes.

2.2.2 Qualitative research and the phenomenological influence

Techniques for investigating the phenomena of historical and contemporary pattern cutting that primarily reflects the upright standing body, are investigated through first hand information from observation of working women and the fit of their business-wear during travel and transit situations.

The theoretical underpinning of this project begins with an examination of the changed circumstances for professionally working females and consequently the new requirements of contemporary tailored business work-wear in Chapter 3.The preferred mode of documentation is the video documentation and extracted stills.

The observation leads to the development of a questionnaire to be handed out to working females with the aim to gain knowledge about their preferences in business-wear and the experience of performing every-day movements while wearing formal work-wear.

According to Mc Carthy and Wheeler:

> *By the term qualitative research we mean any type of research that produces findings not arrived at by statistical procedures or other means of quantification. It can refer to research about persons, lives, lived experiences, behaviours, emotions and feelings (...).Mc Carthy and Wheeler (1996: 10)*

The ontological examination goes on to investigate the wardrobe preferences of females who are not involved in clothing in a professional way. As well as monitoring members of the target group of professionally working women, a qualitative questionnaire is undertaken to gain first-hand information on every-day workwear.
In this case the qualitative method is suitable, because the subjects are not involved in the research question, which asks whether the fit for movement of mass-market soft-tailored womenswear is sufficiently addressed in its construction and appropriate for body movements. This part is crucial in order to maintain objectivity in the research process and to reduce a biased interpretation of the results. (Walter, Holling, Schulz-Gambard: 1996)
Interviews and recorded conversations with professionals working in the clothing industry and in the academic area, together with accounts of work experience in mass-market companies, are considered through qualitative content analysis.
Content analysis is a method of analysing written, verbal or visual communication messages (Cole: 1988).
In contrast to the standard interviews of members of the target group, the method of centred problem-led interviews, as being a type of qualitative interview, helps to avoid a preconception in regard to the subject. (Lamnek: 1995)

The form of the qualitative interviews is arranged around the research question and hypothesis, that flat-pattern cutting in general and specifically the construction of block-pattern follow the upright standing body without considering the moving form, given in Chapter 2.4. As the terminology centred problem lead interview presumes, these interviews are intended to encourage the interviewee to speak openly, subjectively and personally. (Witzel: 1985)

2.2.3 Comparative research influenced by a pragmatic and applied concept

In order to link the practice part of the research project to the theory of Chapters 3 to 7, a reflective practice carried out through a comparative study of six flat-pattern cutting systems from Great Britain and Germany is undertaken in order to evaluate contemporary pattern cutting for the mass-production of clothing in Europe, as found in Chapter 8.

Schön (1983: argued that reflective practice seems to be the most popular choice for research that involves a practice-based element, where the process of designing is an integral part of the research.

The actual block-pattern for women's fitted jacket, trousers and skirt are constructed with computer-aided design/computer-aided manufacturing (herein referred to as: CAD CAM) software and overlaid in order that a comparison can be made.

In a second step the flat-pattern constructed after following the instructions of the six flat-pattern cutting systems are made up and compared on a real model performing a course of every-day movements.

The visual survey is documented by video and by extracted stills.

The design of practical experiments which are able to examine and later analyse these issues needed to reflect real life situations. These situations were chosen after random observations of females and their movements in public. These everyday movements are condensed into the following main six movements: standing upright, stretching up the arm while standing, walking, sitting down, leaning forward while sitting and stepping up. These six movements are performed in different combinations and variations throughout travel and transit situations. The performing of a set course that integrates all of the above movements enabled the accumulation of data on the behaviour and fit of different garments. Anatomical phenomena are briefly stated and integrated in Chapter 8, in order to show which body movements cause ill fit.

It also allowed the most problematic areas within the different garment types to be highlighted while the movements were performed.
The empirical method of re-enactment of reality was first undertaken in a preparative video documenting daily travel and transit situations. It paid attention to the active movements that are performed, thereby giving first hand information. In order to avoid interference with personal rights, the situations were chosen from the outcomes of an earlier questionnaire of 36 females and then enacted by a model.

Earlier observations of working females and their professional clothing showed that they predominantly wear their soft-tailored jackets buttoned-up. Consequently the jackets are also fastened up to the neck during filming.
The video aids overall visualisation of the subject performing a pre-set course of every-day movements from different angles. This is extended by investigation to understand the anatomical phenomena of movement in relation to flat-pattern construction. Also investigated were existing patterns constructed to widen the range of movement for certain areas of the body used in other categories of garments.
Even though, this research project considered recent technological inventions, such as the 3D body scanner, the outcomes from measuring the model in different positions were weak and unusable. The outcomes are stated in the section on fit, in Chapter 7.
The theoretical underpinning of this project begins with an examination of the changed circumstances for professionally working females and consequently the new requirements of contemporary tailored business work-wear in Chapter 3.The preferred mode of documentation is the video documentation.

2.2.4 The experimental method

This same set of video analyses is then used for the second visual survey womenswear garments consisting of experimental flat-pattern amendments. The different existing pattern cutting solutions for gaining a wider range of movement in traditional sports- and dance-wear inspired the design of the flat-pattern experiments of block patterns for womenswear jacket, trousers and the skirt.
Gay justifies that,

> *The experimental method is the only method of research that can truly test hypotheses concerning cause-and-effect relationships. It represents the most valid approach to the solution of educational problems, both practical and theoretical, and to the advancement of education as a science.* Gay (1992: 298)

The experimental nature of integrating existing construction techniques for sports and dancewear to aid movement were insightful these were categorised into folds and gussets. For the prototyping variations of these folds and gussets are integrated into the block-pattern construction methodology for the different areas under consideration of the envisaged body movement. From there the suggested experimental prototypes were designed in an inductive method based on former work.

The data gained from the contribution of new knowledge is discussed in the rationale in Chapter 11. This is followed by a summary of key findings, limitations and conclusions, along with recommendations and suggested consequences for further research.

2.3 Rationale of the Methodology

Since the 1950s mass-produced women's wear in Western Europe grew in popularity, a considerable amount of literature has been published on the theoretical side of pattern cutting, in particular, efficient use of pattern-cutting for the mass market. A lot of these books have been written for an educational purpose; either for further training for professionals already working in the industry, or for students in further and higher education. Industrial processes for garment production, including the construction of flat-patterns, are the basis of practical training in the field of fashion design today. According to interviews with members of academic institutions and the clothing industry, this development is a result of the coherency between educational institutions and the industry, in which the industry is interested in supporting the adequate education of future employees by means of projects and competitions. The subject of flat-pattern cutting is generally understood as an important part of the production process in the mass-clothing market.

Moreover, instructions on how to construct flat-patterns have been regularly updated in order to follow changing fashions but academic literature that goes beyond the point of being purely descriptive and instructive is seldom found on this subject.

As previously reported in Chapter 2.1, the comparison between flat-pattern construction in Germany and Great Britain is of great interest.

The research starts with the beginning of mass-production for women's wear in the 1950s, but looks back further in order to unveil historic circumstances and influences that have had a direct impact on the chosen time frame, as introduced in Chapter 1.3.1. This rational is condensed in the following research question and hypotheses.

2.4 Research Question and Hypothesis

1. The problem identified is that contemporary, woven soft-tailored womenswear is made to suit the standing, non moving body, as it can be seen in general fitting situations and how clothing is presented in shops. Nevertheless, daily life consists of travel and transit situations that demand a high level of flexibility and movement, as shown in Chapter 3, which is not reflected by the clothing. Is it possible to extend the range of movement in wear for women's soft-tailored jackets, trousers and skirts by the addition of folds and gussets to existing flat-pattern cutting methods?

2. The proposed hypotheses are that today's mass-produced woven womenswear is not constructed to follow every-day movements, but, by contrast, to resemble the static, non-moving, body. This phenomenon is observed through empirical and visual evidence. The data gained from observation and experimentation allowed the researcher to address the areas within the clothing where a widening of the range of movement is most needed. The overall question then, is whether such problems can be solvable through the construction of clothing in order to give a better fit for the moving body, while at the same time follow general methods of industrial production.

2.5 The Scope of the Research

The contextual research of this project begins with an examination of the changed circumstances for professionally working females in regard to the increased amount of travel and transit situations and consequently the new requirements of contemporary soft-tailored business work-wear. This examination is undertaken by direct observation and the opinion of thirty-five working women gathered by a questionnaire.
After that the historic flat-pattern cutting is examined.
This is followed by an investigation on sizing as fundamental for the mass-production of clothing.
Then the technical and economical aspects of historic industrial flat-pattern cutting for mass-market women's wear starting with the 1950s are described. Information on the development of flat-pattern cutting since the 1950s is taken from written work on the subject. Therefore, this research involves investigations of various European archives, such as The Tailoring Archive located in the London College of Fashion, the Jaeger Archive as part of the art and Design collections of the Westminster City Council in London,

the Costume Archive of the Victoria and Albert Museum in London and the archive belonging to the MOMU Fashion Museum in Antwerp, Belgium. Besides these museums which are open to the public, this research includes visits to private archives, such as the Kunst- und Gewerbemuseum in Hamburg, Germany.
An early attempt to gain information through the investigation of historical paper pattern was not pursued, because the only available patterns were for home sewing.
From there, the contextual review concentrates on contemporary mass-production of clothing together with recent technical inventions in the area of sizing.
The knowledge gathered from the contextual review is the base for the development of the practical body of work in Part 2.
This design-led empirical approach sought to resolve the issue of restriction of movement observed in woven women's business-wear, as worn in daily travel and transit situations, by amending the block-pattern used in traditional flat-pattern cutting techniques. This approach of evaluating the way in which the range of natural body movement is restricted by woven mass-market womenswear from an observational perspective was found by the researcher to be informative to a further design process.
A number of stages were involved in the research. These are listed below together with the time of undertaking of questionnaires and video productions. In order to investigate the research question and the hypothesis the research project targets the following areas:

i. Identifying poor fit in woven mass-market women's business-wear through observation and condensing every-day movements involved in travel and transit into basic movements as a base for fit evaluation
ii. Developing first questionnaire to find out wardrobe preferences of 35 working females (undertaken in 2003)
iii. Backing up outcomes from the first questionnaire with the development of employment and commuting in Europe after World War 2 (2003)
iv. Reviewing the historic development of mass-market women's business-wear
v. Comparing the construction principles of selected pattern cutting systems
vi. Production of video analysis 1 for viewing the fit of the womenswear jacket, trousers and skirt made up following six flat-pattern cutting systems representing flat-pattern cutting in academics and the industry in England and Germany (undertaken in 2005)
vii. Gain information through interviewing professionals from the clothing industry and academic institutes. Each recorded interview was transcribed and analysed for relevant information.

viii. Considering folds and gussets inspired by sports- and dance-wear as design options for women's business-wear
ix. Production of video analysis 2 for testing the fit for every-day movements of the experimental flat-pattern prototypes (undertaken in 2011)
x. Developing second questionnaire to get feedback on proposed flat-pattern amendments (undertaken in 2011)

2.5.1 Identifying poor fit in woven mass-market women's business-wear through observation and condensing every-day movements involved in travel and transit into basic movements as a base for fit evaluation

Through first hand observation and the researcher's own personal experience poor fit in woven women's business-wear is identified. The outcomes are documented in a self made video, which later on laid the foundation for choosing this medium for documenting in further stages of the study. Furthermore, this first experience with video documenting helped to condense every-day movements down to six main flows of movement, which set parameters for further comparison.

2.5.2 Developing questionnaire to find out wardrobe preferences of working females

A supporting questionnaire with 35 working females is included in Chapter 3. This provided the first stage of the literature and contextual review with first-hand information about the daily-life of working women and their preferred workwear. It further on helps to define the garment types generally seen as appropriate business-wear, which later on informs the selection of garments for theoretical and practical comparison. Similar to the questionnaire with working females in Chapter 3,
The information gathered is found in Appendix 2.

2.5.3 Backing up outcomes from the first questionnaire with the developing of gainful employment and commuting in Europe after WW2

The necessity of adjusting the design of womenswear to modern living conditions has its reason in the steadily rising number of females following gainful employment in Europe since the end of World War 2 together with the amount of commuting involved. Through this the reason for redeveloping traditional flat-pattern cutting for women's business-wear is pronounced in living conditions which involve a high amount of daily travel and transit.

2.5.4 Reviewing the historic development of mass-market women's business-wear

This part of the research builds the bridge between the theoretical and practical parts. The acknowledgement of the historic development of flat-pattern in general and specifically in the context of mass-production leads the way to the following practical comparison of flat-pattern construction for soft-tailored womenswear.

2.5.5 Comparing the construction principles of pattern cutting systems

This practical comparison recorded the principles of traditional flat-pattern construction invented and used in England and Germany. Through this the reasons why this way of construction is suitable for mass-production are observed.

2.5.6 Production of video analysis 1 for viewing the fit of the womenswear jacket, trousers and skirt made up following six flat-pattern cutting systems representing flat-pattern cutting in academia and the industry in England and Germany

Having compared the block-pattern constructions methodologies from a theoretical base, they were then made up into garments. The observation of this practical part is imbedded in a photographic documentary, accompanied by a video production, referred to as video analysis 1. The video aids analysis and evaluation of the fit of three garment types, the jacket, the trousers and the skirt while being worn. These garments were made up following the instructions for construction of block patterns using the six different flat-pattern cutting systems. The six jackets are cut high up under the natural neckline to reflect the basic shape of a block-pattern that without the distraction of a collar. However the blocks could be manipulated into various different forms.

2.5.7 Considering folds and gussets inspired by sports- and dance-wear as design options for women's business-wear

Folds and gussets as used for widening the range of movement in traditional non-stretch sports- and dance-wear are applied as inspiration for the design process of woven women's business-wear.

2.5.8 Gain information through interviewing professionals from the clothing industry and academic institutes

Outcomes of fourteen interviews with professionally working pattern cutters and teachers are stated in Chapter 6.

These interviews provide an insight into flat-pattern cutting for mass-market production as well as personal experiences in the clothing industry and in academic institutes. Furthermore, through these conversations the difference between the way flat-pattern cutting and especially block-pattern cutting is used in England and Germany became apparent. As a consequence the theoretical and practical comparison of generally acknowledged flat-pattern cutting systems is examined to see whether the ones having their origin in a country where multiple systems are used, as it is the case in England, or the ones coming from Germany where a single system is predominantly used, vary in the way they consider the moving body in their construction of block-pattern for soft-tailored womenswear. Transcripts of the interviews are gathered in Appendix 3.

2.5.9 Production of video analysis 2 for testing the fit for every-day movements of the experimental flat-pattern prototypes

The experimental prototypes are outlined and documented in video analysis 2 (Chapter 10). The variables between video analysis 1 and 2, as there are two different models and the uncontrolled positions while performing the course of movements, are accepted in order to reflect mass-market clothing. This concept is due to the aspect of mass-produced womenswear which aims to fit a group of women conforming to the same designated size. The models performing the same set of movements are different in each video but of the same size. Because the research concentrates on widening the range of movement in certain areas, slight variations of movement of the individual model are not seen as being disturbing.

2.5.10 Developing second questionnaire to get feedback on proposed flat-pattern amendments

The analysis of these practical experiments is supported by a second questionnaire handed out to 35 persons between October and December 2011, academics in the area of fashion and professionals in the clothing industry. The questionnaire consisted of stills taken from video analysis 2 showing the different garment types during various movements. The questioned people were asked to give their opinion on the fit of the garment for the movement from viewing the images using a Likert Scale. The amended block-pattern prototype toiles are evaluated from an observational perspective, with consideration to allowing for a wider range of movement.

The outcomes of this second questionnaire are integrated in Chapter 10 and inform on how successful the different solutions are when judged visually. Consequently the interpretative observations lead the way to further work on the subject.

In the following Chapter 3 the changing lifestyle of employed women who are involved in transit situations as part of their daily routine is investigated. It also pays attention to working women and their preferred mode of dress.
Section 3.1 looks at contemporary soft-tailored womenswear.
Chapter 3.2 examines the development of female employment in Europe since the 1950s, in order to highlight the definition of a modern life-style that mainly takes place in public and involves travel and transit situations.
Section 3.3 looks at travel and transit situations through the help of a video documentation to define a range of every-day movements.
Paragraph 3.4 explores the different modes of travel, divided into to those for active and for passive transportation.
The outcomes of a questionnaire, undertaken to enlighten the preferences of working females in regard to their business wardrobe are stated in Chapter 3.5.

3 HISTORIC, SOCIOLOGICAL AND ECONOMICAL CONTEXT OF FEMALE WORK-WEAR

The twentieth century has seen many changes in the role of the women in society in most Western countries. Probably the trend which has had the greatest effect on women's lives in Great Britain over the past fifty years has been the increasing participation of married women in paid employment.

Hunt (1988: 9-22) confirms that there are more detailed statistics available regarding the role of women during the Second World War than regarding earlier years. In addition to statistics collected as part of the administrative process, sample surveys had become accepted as a means of obtaining reliable information about population groups.
However, Thiel (2004: 381-390) argues that during the First World War women's clothing changed significantly from being decorative towards a simple and practical style. The two-piece skirt costume became a necessity together with the invention of the knitted jumper, which did not require time consuming ironing. Thiel (2004: 389) also refers to women's magazines *Wiener Mode*, which gave instructions for altering uniforms into female garments in a publication from 1919.

As referred to by Laver (1982: 210, 211) the social and cultural developments of the early twentieth century, such as women's rights to vote and for further education, led the way to womenswear which reflected these new privileges. Garments which had originally only been used for working in were now worn in other situations to illustrate sympathy for the reforms. One of these garments was the shirt-dress, which became popular.

However Thiel (2004: 396) is of the opinion, that attention moved away from the waist - and therefore no need to wear a corset - and the shortening of the skirt to just below the knee, gave women the possibility to move more freely. Furthermore, Thiel (2004: 396-398) adds that this is why, despite all the technical inventions in the field of mass-clothing production, female garments went back to being based on simple forms of human clothing. Kiener (1956: 115-117) argues that as women sought to be accepted in the man's world of business as part of equalisation of men and women, they often adopted the general structure and elements of men's clothing, such as suits.

3.1 The Origin of Work-wear

Simmel (1904) quoted by Entwistle (2000: 114) says, that fashion is to some degree important in modern society, as to exhibit the contradictory desires for social imitation and individual differentiation. It can be concluded that fashion embraces not only the desire to imitate others but also to express individuality. However, Sommer and Wind (1988: 42, 43 and 44-47) argue, that it is not so much a question of professional qualifications and financial possibilities, but more of every-day-aesthetics, which are based on similar ways of life, which forms conformity in choices of clothing.

König (1971: 336, 337) stresses, that female work-wear needs to allow freedom of movement and should make the wearer feel comfortable.

According to Laver (1982: 250, 251) the morning or frock coat dominated men's wardrobes throughout the nineteenth century. The frock, as pictured in Figure 9, had a waist seam, was fitted at the waist, and frequently padded in the chest.

The morning coat came in many different cuts including the cutaway, tails, or the Prince Albert. The latter, a knee-length coat with a full skirt, was especially popular with professional men.

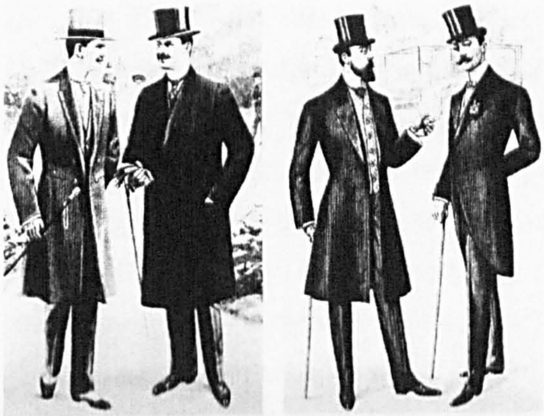


Figure 9, Men's Costumes, 1907, left and 1913, right, Source: Thiel (2004:337)

Payne (1965: 460) considers the waistcoat, evolved from the seventeenth century, with its long back panels in combination with short, down to the waist front, to be the last bit of splendor of past centuries to disappear in the nineteenth century.

The development of the more casual menswear sack shape can be seen from the 1920s onwards. Before that, sack-shaped jackets were worn by male factory workers only. Figure 10 shows male and female workers employed by the textile industry on strike in Augsburg, Germany in 1914. The sack-shape is present in jackets and coats. However, the casual sack-shaped jacket for menswear was not accepted as formal wear before the early twentieth century. It was seen as too casual to be worn by anyone other than laborers.

Figure 10, Workers of the textile industry on strike in Augsburg, Germany, 1914, Source: Borromäus and Loibl (2010:50)

Female business-wear, consisting of a jacket in combination with trousers or a skirt directly relates to the development towards looser shapes in menswear.
For menswear, the significant style change can be seen after the First World War. Again, until then the long morning coat was the formal business attire for men.

After the First World War, men's fashion began to change towards baggier and fuller looks. Clothing became more elaborate in the 1920s, since rationing of materials was no longer necessary. Men in the 1920s followed the fashion trend for casual clothing, due to the growing popularity of sports. Laver (1982: 274) agrees that spectator sports grew in popularity in the 1920s and, with this, casual sportswear became more fashionable with men. More importantly, the simpler silhouette of clothing was introduced, inspired by working class clothes but aimed at non working class males and for worn at formal occasions. Laver (1982: 250) confirms that the morning coat had become a rarity and was to be seen only at formal occasions, such as weddings and funerals after the First World War and that the sack, or lounge, suit had now become ordinary town wear, as pictured in Figure 11.

Both the waistcoat and the morning coat were replaced by the sack-suit or sack-coat. The sack-suit was the most common garment type for men in the 1920s. Unlike the former morning style, which had five vertical seams, the sack usually had three.

Figure 11, Sack Coat, 1859, Source: Payne (1965:462)

After the war the sack-shape was widely accepted as formal work-wear. The new informality was due to the influence of widely-known personalities such as
Edward the 8th was seen wearing casual menswear from as early as the end of the nineteenth century.
Figure 12, shows on the left side of the picture Edouard Herriot the socialist mayor of the city of Lyon in France. The Knickerbocker pants, worn by the British labor politician Ramsay MacDonald on the right are directly linked to sportswear. Furthermore, the sympathy of both men for the working classes links their wardrobe with their political opinions.

Figure 12, New informality in menswear, 1924, Source: Laver (1982:251)

Thiel named the irrational production procedures and the resulting fact that mass-produced clothing was not much less expensive then made-to-measure clothing as accounting for slow success. Payne (1965: 467) claims that in the last thirty years of the nineteenth century the increase in factory production of clothing corresponded with a decrease in quality.

So, the use of block-pattern for menswear had its starting point with the increase in factory production in the last thirty years of the nineteenth century and further on for the production of uniforms for the First World War. Despite this, industrial mass-production for womenswear did not begin until after the Second World War.

Aldrich (2007: 1- 3) argues that ready-to-wear clothing began to be available to the mass of the growing urban populations from the middle of the nineteenth century. For womenswear, it was the modification towards simpler clothing, similar to menswear after the First World War that made the mass-production of womenswear possible (Aldrich: 2007, Laver: 1982).

Aldrich (2007: 39) clarifies that the new silhouette for tailored womenswear jackets was very similar to the menswear sack-jacket and that the flat-pattern for this type of style could be developed from a rectangular, a sack-like shape. As the weaved fabric itself is plain and rectangular, this way of constructing allows for a minimum of wasted material, which elides with the aim for efficiency of mass-production where the amount of material used forms a part of the calculation of the price of the garment.

Furthermore, flat-pattern allows for laying-up and cutting multiple layers of fabric in one production step. Next to the saving in labour, a reduction of material was also aimed at during both war periods.

3.2 Female Work-wear

Contrary to the former historic fashions for women before the First World War which were based on the taste of ethnic, social or other defined minorities, fashions today are accepted by and made for an urban group of professional women all over the world.

Until some twenty years ago it had been a question of a certain group setting themselves apart from the masses. Entwistle (2000: 114) states that this was a pertinent way in which fashion could be deployed for particular groups, at particular times and used to differentiate groups from one another. She concludes that this effect can be seen in the sense of signaling one's allegiance to a group through what one wears.

3.2.1 Historic female work-wear

The working masses have always been the only ones who have worn garments that have allowed freedom of movement. Thiel (2004: 380) confirms this necessity for flexibility went hand in hand with a neglect of the latest fashion trends. Entwistle (2000: 105, 106), argues that there is a lack of evidence for female work-wear up to the late nineteenth century. This is because picture evidence mainly reflected only exclusive, elite fashions. In the nineteenth century this slowly changed. With the invention of photography, pictures also included representations of people in their work-wear. Furthermore, Entwistle (2000: 220) adds that female work, in the factories as well as in shops or offices, did not demand particular kinds of dress.

3.2.2 Women's work-wear during the First World War

However, Thiel (2004: 381-390) argues that during the First World War women's clothing changed significantly from being decorative towards a simple and practical style. According to Thiel (2004: 389), the two-piece skirt suit became a necessity.

She also referred to the Austrian women's magazine *Wiener Mode* from 1919, which gave instructions for altering uniforms into female garments.
For womenswear the First World War meant restrictions and limitations of material. The fabric production was almost entirely used for the production of heavy fabrics for uniforms. In womenswear a double skirt with the under layer being very long and tight at the ankle, with a tunic shaped upper skirt reaching below the knee, was popular. The limitations of available material as well as the impracticality of these skirts for the work involved in wartime work led to the abandonment of the underskirt. Furthermore, extravagant dressing, either in the use of decorated and fragile fabric or in the amount of fabric needed for a garment, was judged out of place in wartime. Thiel (2004: 396-398) adds that this is why, despite all the technical inventions in the field of mass-clothing production, female garments reverted to being based on simple forms.

Thiel (2004: 396) also concedes that a neglect of the waist - and therefore no need to wear a corset - and the shortening of the skirt to just below the knee, gave women the possibility to move more freely in their work.
As referred to by Laver (1982: 210, 211) the social and cultural developments of the early twentieth century, such as Women's Suffrage and for further education, led the way to womenswear which reflected these new privileges. Garments which had originally only been used for working were now worn in other situations to illustrate sympathy for the reforms. This development can be compared to the one in menswear, as stated in Chapter 3.1.
Figure 13 illustrates the new streamlined silhouette of a womenswear jacket.

Figure 13, The new fashion shape, 1926, Ladies' Garment Cutting and Making, John Williamson Company, London Source: Aldrich in Ashdown (Edt.) (2007:39)

Figure 14 shows the flat-pattern for a simple womenswear jacket from 1926, similar to the one shown in Figure 14.

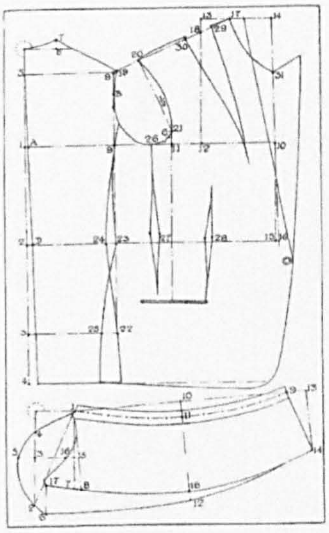


Figure 14, Williamson, John., 1926, Ladies' Garment Cutting and Making, John Williamson Company, London Source: Aldrich in Ashdown (ed.) (2007:40)

3.2.3 Women's work-wear during the Second World War

Sladen (1995: 43) pronounces that the combination of utility cloth and austerity restrictions resulted in (menswear) suits in familiar materials but with slightly shorter jackets, lacking waist pleats, breast pocket or buttons on the cuff.
Figure 15 shows a similar change of style for womenswear.

Figure 15, Standard Second World War womenswear, Source: Laver (1982: 252)

Furthermore Sladen (1995: 77) mentions, that in Britain Stafford Cripps and Harald Wilson, successively Presidents of the Board of Trade in 1947 denounced the waste of materials and labor on these 'imbecilities'.

3.2.4 Trousers as part of women's work-wear

As mentioned before the two-piece skirt suit, consisting of a structured jacket and a knee-length skirt and accompanied by a blouse in the style of a man's shirt, were already useful during the years of the Second World War. However, Laver (1982: 252, 253) argues that the shortage of material during and after the war years, had the consequence that the garments themselves became simpler. Whereas, Thiel (2004: 415) mentions that the only garment which was not directly adopted after the war were women's trousers. Seeling (1999: 62) explains that the only occasions trousers were acceptable for women, were for sport and leisure activities. It was not until the 1960s that trousers were worn by women for everyday situations and this became accepted within society. However, Seeling (1999: 62) acknowledges that women wearing trousers after the war was only a question of practicality, as they still had to work in professions which had formerly been carried out by men. Therefore women's trousers could not be regarded as a fashion, but as a necessity.

Recorded interviews with female contemporary witnesses as part of the exhibition *High Sixties Fashion* in the *Museum für Kunst und Kulturgeschichte* in Dortmund, Germany, reported that even though jeans became popular in the 1960s, it was not common to wear trousers for women at work and in general life until the 1970s.

3.2.5 Women's work-wear from the 1950s

Kiener (1956: 115-117) argues, that as women sought to be accepted in the male world of business, they often adopted elements of men's clothing, such as suits.

Beese and Schneider (2001: 63) observe that it was popular during the 1950s to wear aprons or similar garments over the clothing. This was not only to prevent the workers' cloths from getting dirty, but also, as a kind of uniform, to signal that they were working. After work the women usually changed their clothing, either in the companies' own changing rooms or at home.
After women got wider job opportunities at the beginning of the twentieth century, the idea of work changed, as women became more emancipated.
Beese and Schneider (2001: 65) found that in the post Second World War years women tended to see their job purely as a means of earning extra money for the family or if they were not married, of earning money to buy the basic household things to start a family.

The idea of women choosing a certain profession is an idea that belongs to the last couple of generations. Previously women went to work in the nearest factory or company. However, Entwistle (2000: 124) argues that women in the 1950's seldom identified with their work and did not seek employment in order to find occupational fulfillment.

3.2.6 Work-wear and leisure-wear

The general neglect of wearing the same clothing for work and free time can be seen in the 1950s and 1960s. As Thiel (2004: 341,342) assents, many women were acquainted with mass-produced clothing as the manufacture of simple garments or underwear. At that time it was believed that garments worn at work were not good enough to be seen in other social situations.
However, König (1971: 272) states that the mass-production of fashionable clothing did not necessarily lead to products of lower quality. Soon the standard of production increased in quality. Since the manufacturers were able to produce large quantities of not only practical garments, but also fashionable clothing, a large number of women could afford to buy more garments than before. From that point on it became possible to wear more fashionable clothing at work. Despite the clothing being fashionable, König (1971: 336, 337) implies that work-wear needs to allow freedom of movement and make the wearer feel comfortable first.

3.2.7 Work-wear and identity

Urban-living relies on a high demand for practicality, either in the sense of being protected against various weather conditions, or as a tool for recognizing individuals as members of particular groups. Hoffman (1985: 44, 45) wrote about the different ways of corresponding through clothing, as: corresponding to others, corresponding to oneself and corresponding to the inside and the outside at the same time. He argues that communicating with others through clothing means to deceive and to advertise in order to convey a desired image.

For this study the social and emotional side of wearing garments is not considered. The communicating through garments is done solemnly through an observing perspective. It is presumed by the researcher that a widening of the range of movement of soft-tailored womenswear will enhance a general positive experience of wearing clothing.

Entwistle (2000: 112) observes that the way we perform our identity has to do with our location in the social world as members of particular groups. The clothes we choose to wear represent a compromise between the demands of the social world, the surroundings in which we belong and personal desire and taste.
This directly relates to the general acceptance of a tailored skirt or trouser suit as appropriate female work-wear, as it is assumed for this study.
As quoted by Entwistle (2000: 123), Finkelstein (1991) argues that fashion is a bond that links individuals in a mutual act of conformity to social conventions.
Outcomes of a questionnaire with working women, given in 3.7, underline the above and show that a general acceptance has to be considered while investigating contemporary female work-wear.

3.3 Working as Part of Modern Society

Apel (1984: 210, 211) indicates that in modern-society it is the working person who influences fashion rather than an elitist group of people. In consequence, class differences are not easily recognised in public anymore. Furthermore, being public can be seen as a phenomenon of modern life. It is suggested by Entwistle (2000: 259) that during the nineteenth century individuals had to face an ever-increasing number of strangers. In this environment, appearance was the only means of interpreting others. She adds that recognition through clothing was an important tool for judging and identifying others and also draws attention to the importance in a nineteenth century city of protecting oneself from social encounters by identifying others by their appearance. Entwistle (2000: 118, 119) concludes that consequently fashion became central to the experience of the modern city.

3.3.1 The urban surrounding

König (1971: 199) argues that the city itself was of great significance for the adaptation and spread of fashion, adding that the people living in urban surroundings are the first to accept inventions in contrast to country-folk, which are generally least likely to do so.
Entwistle (2000: 106) suggested that modernity, beginning with the Industrial Revolution, invokes urbanisation as one of its main developments.
Simmel (1905: 15) finds that fashion is to some degree important in modern society, to exhibit the contradictory desires for social imitation and individual differentiation.

Therefore, fashion embraces not only the desire to imitate others but also to express individuality. However, Sommer (1988: 42, 43 and 44-47) argues that conformity in choices of clothing is not so much a question of professional qualifications and financial possibilities, but more of every-day aesthetics based on similar lifestyles.
Breward pronounced that,

> *Fashion now occupies the centre ground in popular understandings of modern culture. It enjoys unprecedented coverage in the western media and defines the tenor of urban life like no other visual media. Breward (2003: 9)*

3.3.2 Appropriate work-wear

Another important aspect of work-wear is the realisation of the appropriate appearance through clothing. Modern society is used to judging people not only on their income or education but also on their outward appearance.
To feel confident in one's clothing is therefore a necessity. Entwistle (2000: 116) argues that this is particularly the case in urban surroundings, where people have only fleeting moments to make an impression on each other. König, Hummel, König and König (1999: 264, 265) added that, in general, people living in cities have always been more curious about everything new and are therefore more likely to adopt new fashions.
Rocamora (2009: 186) stressed that a capital will always have a superior positioning because of its status as the place of ascent and prestige.

According to working women interviewed by the researcher, (given in Chapter 3.7), many females agreed that they feel confident wearing garments which give their body a certain silhouette, such as structured jackets or, generally speaking, garments which cover the arms, legs, hips and breasts. In other words, even though they would like to be covered up, they still prefer a garment which gives them a close fitting silhouette.
As stated by Thiel (2004: 362), many garments which are worn for work today developed from the need for women to fulfil men's work and therefore adopt clothing which was most practical.

It can be concluded that, historically, the working classes were the ones who wore clothing that allowed for movement. In contrast to female factory workers who wore resistant clothing for work only, members of the higher professions preferred sober, menswear orientated garments.

Entwistle (2000: 123) declares that fashion and dress articulate group identities in order to define the groups. However a questionnaire - of which the outcomes are given in detail in Chapter 3.7 - showed that working women today do not like to look as if they are working. This is based on the consideration that the working outfit in the past was not something to be seen in outside work. According to the interviewees, today work-wear needs to fulfill more conditions than a few decades ago. Today outfits need to 'stretch' from morning until evening and to be appropriate for many different situations which might occur in between.

3.4 Female Employment

In contrast to the situation during the First World War women, too, were conscripted during the Second World War. Hunt (1988: 12) mentiones that young single women could be directed into the armed forces or other essential work away from home, whereas married women without children could be directed into essential work within daily travelling distance from home. This can be seen as the first experience for many married couples of both partners going out to work.

3.4.1 Female employment after the Second World War

By 1955 the female labour force in the UK had risen to over seven and a half million (35 per cent of the total labour force). By 1980 the number of women had risen to more than 9 million (42 per cent of the total labour force). Martin and Wallice wrote an essay on women and unemployment (1985), in which they stated that the increase of working females was almost entirely due to the growth in part-time working of married women, whereas the number females employed on a full time basis had slumped since the end of the Second World War.
Elias and Main (1982) emphasized the development of the occupational structure of part-time employment essentially being the domain of women returning to the labour market after a period of withdrawal, usually for starting or managing a family.

The following Figure 16, taken from Hausen and Krell (1993: 209), illustrates the rates of female employment in the European Union between 1979 and 1995. Figures for the year 1995 do not differentiate between part- or full-time occupations.

Female employment within the European Union

1979, 1987 and 1995

	1979	1987	1995
Belgium	47.4%	52.0%	no fig. given
Denmark	69.9%	75.9%	82.6%
France	54.2%	55.7%	61.0%
(West) Germany	49.6%	51.9%	51.3%
Greece	32.8%	41.7%	no fig. given
Ireland	35.2%	38.5%	39.8%
Italy	38.7%	43.4%	47.7%
Luxembourg	39.8%	44.3%	no fig. given
Netherlands	33.4%	41.9%	52.3%
Portugal	57.3%	57.4%	58.5%
Spain	32.2%	37.5%	no fig. given
Great Britain	58.0%	62.6%	62.2%
Sweden	53.0% (1963)	85.0% (1989)	

Figure 16, Frauenerwerbsarbeit (Eng.: Gainful Employment), Source: Hausen and Krell, p. 209

Hausen and Krell (1993: 208) observe that the demographic development within the service sector has increased. Traditionally a sector occupied by female workers, this has led to an increased demand for women on the labour market. Figures 17 and 18 give the percentage and exact figures of women at work in 23 European countries together and separately for the United Kingdom, Germany, Norway and Sweden.

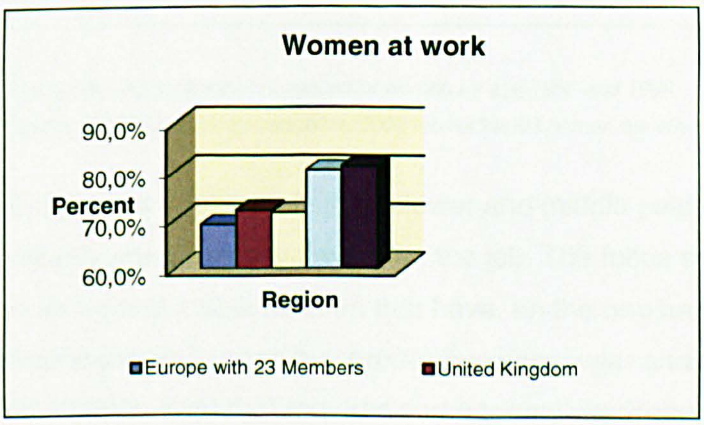


Figure 17, Women at Work for the female population between 1 and 65 years of age, Source: Brockhaus Lexikon 2002-2007

Europe with 23 Members	United Kingdom	Germany	Norway	Sweden
69,0%	72,0%	71,5%	80,3%	81,3%

Figure 18, Women at Work for the female population between 1 and 65 years, exact figures, Source: Brockhaus Lexikon 2002-2007

In their review from the 28th of August 2007 the Bureau of Labour Statistics (BLS) noted that the percentage of women employed for wages has risen from 1950 to 1990 from round 30% to over 60% and now, as shown above, to 72%. In the same time the percentage of men has declined from 87% down to 74%.
Figure 19 illustrates this development by showing different aged females grouped and their participation in employment in comparison of the year 1950 and 1998.

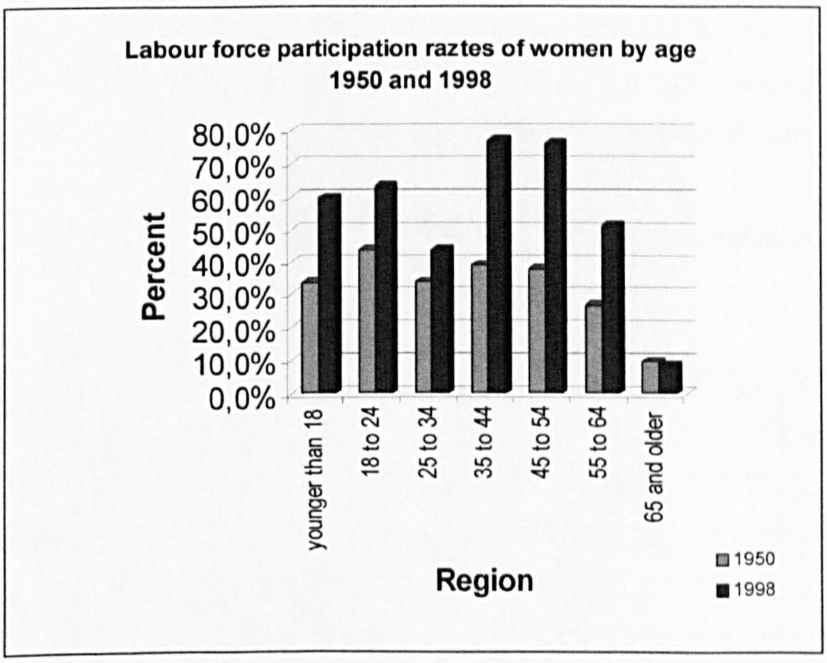


Figure 19, Labour force participation of women by age 1950 and 1998,
Source: http://www.bls.gov/opub/ted/2000/feb/wk3/art03.htm on the 4th September 2007

Employees – especially in the lower and middle paid jobs – approved *the development for* casual-wear on the job. The focus of this project is to look for those working and mobile women that have, on the one hand, an appreciable amount of disposable income to buy proper business-wear and, on the other hand, an occupation level that requires some formal wardrobe. Finally, the aspect of expressing some individuality through clothing normally relates to the state of education and social standing.

Since the late seventies well-educated women with career interest and a developed social competence and self-confidence have entered mid- and high-level occupations. These women build the market for women's formal business wear that is the focus of this work.

Even though the numbers of female workers during the Second World War declined immediately after, the war period provided a foundation for women to seek gainful employment. Since then the figures of working females have constantly grown.

3.5 Travel and Transit

The fact that today employment is strongly connected with travelling is observed by Simpson (1992: 15), who discussed the relationships between the work place and living place, the pattern of employment decentralization in cities has been identified in numerous empirical studies and has been the subject of considerable analysis and discussion. Employment decentralization is an important fact in urban studies.

Figure 20 shows commuting distances covered by household income for Greater London.

Household income (GBP)	< 1.000	1.000 - 1.750	1.750 - 3.000	>3.000
Inner (0 –10 km)	46.5 %	36.7 %	26.8 %	24.5 %
Middle(10–12 km)	39.6 %	46.0 %	50.6 %	51.8 %
Outer (>20 km)	13.9 %	17.3%	22.6 %	23.7 %
Average distance (km)	12.0	13.1	14.7	15.1

Figure 20, Commuting distances covered by household income for Great Britain, Source: Greater London Transportation Survey, 1971

Even though the table above presumes that the workplace is located in the city centre, the following figures give a more general view about commuting, based on the wider area of Greater London. Furthermore, it shows the development of commuting in London from 1991 to 2001. Gareth Piggott, who undertook a census for Greater London Authority in February 2007, stated that in this year there were 3.7 million people whose journey to work involved travelling to London.

The following Figure 21 is an extract taken from Piggott for the Greater London Authority:

	1991 (people 16 and over)	2001 (people from 16 to 74)	Change	Change In %
Population	6.679.699	7.172.091	492.392	7
A. lives in London and works outside London	149.820	236.018	86.198	58
B. lives and works in London	2.676.620	3.083.116	406.496	15
C. lives outside London but within England and Wales and works inside London	672.730	722.539	49.809	7

Figure 21, Extract from Piggott for Greater London Authority1991,
Source: Census Table LO6 and L82, 2001 Census Table TT10 and KS09

Sennett mentioned the experience of speed as being *of* great importance for an urban geography in his work on the relation between the human body and the city from 1994. The following quote explains the idea of a speed-conscious life style:

> *People travel today at speeds our forbears could not at all conceive. The technologies of motion (...) made it possible for human settlements to extend beyond tight-packed centers out into peripheral space. Space has thus become a means to the end of pure motion- we now measure urban spaces in terms of how easy it is to drive through them. Sennett (1994: 271)*

Sennett articulated that, in comparison to former times, daily life today consists of micro-motions, which can be understood as less movement, rather than the physical movements involved in driving a horse-drawn coach. Modern society requires very little physical effort in comparison to past times. We make micro motions in an ever less complex environment.

Even though a lot of the daily distances involve making use of various means of transportation, the 'micro-motions', as Sennett called them, involve body movement. Yet the urban circulatory methods which are used in daily life needs to be investigated.

3.6 Different Modes of Travel

New means of transportation are most often introduced because they reduced the time needed to bridge a distance. Schönhammer (1991: 1) believes that this does not necessarily widen the subjective experiences of the passenger. The impressions of the outside world are diminished when travelling at speed. Gentler pace allowed for a very different experience. Written work by Appleyard and Lynch (1976: 4) evaluated different subjective impressions of individuals using various modes of travel. They coined the phrase 'environmental psychology' which involves phenomena such as density and crowding in public transport.

Appleyard and Lynch argues, that:

> *Even among the users of the road, there are several different kinds of audience. The tourist sees the landscape with a fresh eye (...), but is urgently engaged in orienting himself within it. The commuter, or other habitual user of the road, is more likely to ignore larger landscape features in favour of activities, new objects, or the moving traffic of the road. Appleyard and Lynch (1976: 4)*

3.6.1 Passive transportation

Passive transportation - which involves all modes of public transport - leaves the individual as a passenger who cannot have an effect on the speed or other technical aspects of that travel. Yet, public transportation involves body movement even if it is holding onto a handlebar or sitting down and getting up.
Schönhammer (1992: 81 pp) who interviewed thirty-five adults about their preferred modes of travel, noted that journeying by bus and train allowed passengers to do other things. This can either be preparation of work, reading a book or newspaper or, more relevant on longer train journeys, simply enjoying the view.

The stated outcomes are based on a questionnaire completed by 29 adults aged between 20 – 39 years old (9 female; 11 male) and 15 people over the age of 40 (9 were female and 6 male.) The questionnaire was undertaken in Munich and Bonn, Germany, during the summer of 1988.

The online publication of the German newspaper *Die Welt* stated at the 1st July 2004, that underground trains alone are used by approximately 2.7 Million people in London every day. Special occasions, such as a strike of the underground's employees result in traffic chaos.

The basic movement of sitting in a seat is combined with standing and waiting and getting in and out of a train or bus. Next to this, the passenger has to hold himself and his belongings. Mental concentration, required for active transport, is not required.

3.6.2 Active transportation

Active transportation, such as walking, driving a car or riding a bike leaves the pace of movement up to the individual. By contrast to passive transport, active transportation involves physical cooperation, concentration and planning for eventualities from the individual.

Schönhammer (1992: 243) found that only 14% of the adults asked walk to work. 23% of the individuals generally prefer walking to other ways of travelling. Various reasons are offered - such as being independent from others, feeling more receptive of outer impressions and being able to concentrate on thinking. While walking, the legs are in a constant forward movement. Whereas the upper part of the body remains relatively steady, performing only secondarily movements. Figures 22 and 23 show two women walking, one captured from the side and the other from the front.

Even though modern life and its different ways of transportation do not require physical labour, the activity of walking plays an important role in the daily routine. Therefore the visual analysis, as it can be seen in Chapters 9 and 10, leaves the model to perform the basic every-day movements integrated in a walking course.

Figure 22 (left), Walking, Source: The Sartorialist, 17.09.2009, New York
Figure 23 (right), Walking, Source: The Sartorialist, 25.05.2009, Milan

Schönhammer (1992: 226 pp) recorded that two impressions about travelling by bike run in parallel. On the one hand, the direct feeling of pace, the body and the environment is seen as positive. On the other hand, the fact those bicyclists also have to take part in the traffic - which means they have to concentrate while riding - is seen as negative. Figure 24 shows a picture of a woman riding a bike.

Figure 24, Riding a bike, Source: The Sartorialist, 29.01.2007, New York

In Schönhauer's questionnaire, 37% of persons asked said that they used a bicycle (as opposed to a motor bike) as a way of getting to work and 34% said that going by bike was their favourite way of travelling.
Furthermore, Schönhammer (1992: 137 pp) found that 37% use the car for going to work. He also argues that the car can be seen as being part of the body of the person driving it (1992: 31).
Therefore it can give the driver a feeling of security and also of having power and control over the other traffic. The car can also function as a private place, because only a small part of the driver is visible to the outside. Even though the main movement of driving a car is sitting, the legs and arms are strongly involved. Getting in and out of a car also requires the exertion of the whole body.

3.7 Working Female Consumers and their Work-wear

For this research project female subjects were asked their opinion on business-wear. This was the starting point for a systematic exploration into female work-wear that would take into account personal experience as well as the subjective views of the target group.

In order to find out whether the initial research question could be backed-up by the consumer, the questionnaire consists of the following:

Target Group	Data Collection	Transliteration	Evaluation
Working females	Questionnaire	Sheet of Paper	Qualitative Content Analysis

The questionnaire was supposed to reach a broad spectrum of professionally working women from different age groups. A demographical representation was not initiated. The interviewees were needed to have a clerical occupation in order to leave out work-wear for physical labour jobs. All of the 35 adult women asked were working under similar conditions. They all had to do writing tasks sitting at a desk as well as having internal and external meeting with direct contacts with clients and customers.

Mayring (2002: 114) formulates that the qualitative content analysis allows summarising key findings, extract and structure the outcomes of a questionnaire in social studies. The outcomes of the exploration were significant for the ongoing research into travelling and what to wear, despite the marginal sample size and the subjective view, which is characteristic of these kinds of interviews. The findings contribute to the initial points of the project.
The initial aim for using the questionnaire was in order to underline the hypothesis that mass-market woven women's business wear is purely constructed for the static body and not for the performance of everyday movements.
The basic aim of the questionnaire was to find out whether women prefer certain garment types for going to work and what they are wearing when feeling comfortable. More specifically, the females were asked to state what they feel is unpractical and uncomfortable for their daily travel.
The recording instrument was an A4 size sheet of paper with boxes to tick and appropriate space for writing down answers. The answers are of a short and condensed telegraphic style.
Although this leaves room for subjective colourings of the answers, it simplifies the roundup of synonymic conclusions. In addition, the subjects tended to explain their answers and reasons for the given answers verbally.

The questionnaire was developed using open questions, in order to determine the interviewees to start thinking about their business or work-wear in general and specifically about unpractical or practical aspects of their garments.

Hereby, the concept of naming concrete examples of the customer's perception and appraisal was of great importance. After the researcher made clear that the questions concern the every-day work-wear only, the interviewees were handed out the questionnaire on a sheet of paper at their work places and on train stations. All outcomes of the questionnaire 1 can be found in Appendix 2.

The first four question aim to find out which garment types are seen as appropriate as formal work-wear. The terms confident and comfortable are used as synonyms for non-restrictive. Furthermore, they force the interviewee to give a personal opinion.

1. *Do you feel confident with what you are wearing today?*

2. *What garment types or aspects of garments are relevant for you feeling confident or unconfident?*

3. *Is the clothing you are wearing at work comfortable or do you change?*

4. *What garment types or aspects of garments are relevant for you feeling comfortable or uncomfortable?*

Questions 5 and 6 investigate certain aspects in garments or garment types which might cause problems during travelling in order to pin down areas of a restricted range of movement.

5. *In regard to clothing, is there anything practical/unpractical or comfortable/uncomfortable on your journey to and from work?*

6. *Can you think of anything what would improve/decline practicality and comfort while travelling?*

Questions 7 and 8 aim to select garment types which are judged appropriate as work-wear.

7. *Which garment types have you found out are suitable as business-wear?*

8. *Which garment types have you found out are unsuitable as business-wear?*

The outcomes from the questionnaire are as followed:

- From a pool of 35 females, 21 (N=21) said that they wear the same clothing throughout the day. The ones who said that they change their garments over the day (N=14), mentioned special occasions in the evening as a reason for doing so.

- Nearly all women (N=24) agreed that they feel most comfortable and confident wearing garments which are not too tight. A pair of long trousers (excluding jeans), was a favourite garment to wear at work for a lot of women (N=31). This is because it is easier to move wearing a pair of trousers and because the legs are covered, which also adds to a more comfortable feeling. Structured garments, such as a blazer were also favoured (N=21), as long as it is not too tight. A pair of jeans was only accepted by a few women (N=3) and this only in combination with a structured jacket or blazer.

- Next to the fact that most females liked to be appropriately covered by their business-wear (long trousers N=31, blazer/jacket N=21, not showing too much skin N= 29), they did not like to wear garments which are thick, stiff or padded (N=3).

- Wearing a skirt was seen as unpractical and inappropriate by most of the women (N=28). Next to this, bulky garments were seen as unpractical (N=16), the same for clothing which is too tight (N=15).

These outcomes are similar to a study undertaken by Yoo (2003: 49 pp) who developed a questionnaire to investigate consumer's personal, psycho-social, job-related and physical characteristics on business jacket design preferences of working females. Yoo (2003: 54) reported that 20.8% of all working females, aged between 22 and 65 years, wear a business jacket to work at least once a week.
Yoo (2003: 60) summed up the resulting style preferences of the preferred business jacket as being one with a fitted and semi-fitted silhouette. Customers between the ages of 25 and 35 years name these as the preferred tailored jacket and state that it gives them comfort because they are covered up and they like the shoulder pads and the overall formal appearance.

3.8 Summary of Chapter 3

Simpson (1992: 177) declares that the conventional theory of urban structure is formulated as a static model for analytical simplicity. Inevitably, urban models will be criticized for their static approach. Furthermore, Simpson (1992: 175pp) argues, that with decentralized employment, commuting patterns become more complex.

Each mode of travelling involves body movements. Even passive movement, such as breathing, has an effect on the torso. Wilhelm (1954: 34) argues that while breathing in and out the circumference of the bust girth can vary by up to ten centimeters.

Even though professionals prefer a work place nearby, this might not be the case for several reasons. The possibility of increased speed of both public and private transport also enables a widening of the radius for the job search, because the time spent on travelling is the same as with slower transportation modes and shorter distances. This being in constant transit consequently leads to one set of garments being worn over the whole day.
Working women strongly relate comfort to a confident feeling of being properly dressed. The asked women stated that they preferred jacket should not only cover the form of the female breast and hips, but also achieve a structured look with the help of shoulder pads. Therefore they preferred the jacket fitted but not too tight. This structured jacket is preferably combined with long trousers. In other words, a variation on the traditional menswear suit is obvious in contemporary female work-wear.

For this research project the outcomes of the questionnaire are considered without an evaluation of general ergonomics principles. The focus is on every-day movements as they are involved in daily travel and transit situations and not in body movements for certain operational procedures of the various occupations.

Having stated the development of the silhouette of accepted women's business-wear and the preferences for certain garment types, which are the fitting jacket, the long trousers and the skirt, the following Chapter 4 looks at the historic development which lead the way to constructing a three-dimensional garment from two-dimensional woven fabric in general and flat-pattern cutting as part of mass-production in particular.

The historic development of clothing and flat-pattern cutting is evaluated in the following Chapter 4. Section 4.1 looks at the historic development of clothing and flat-pattern cutting. Even though this research project is set between the 1950s up to 2012, going back to the beginning of man-made clothing and the use of paper pattern for repetition is necessary to understand the wider context of block-pattern for mass produced woven womenswear.
In 4.2 the development from two-dimensional to three-dimensional garments is stated. Section 4.3 looks at the possibilities of allowing for movement in three-dimensional garments made from non-stretch material.
Paragraph 4.4 examines historic flat-pattern cutting from its beginning in the sixteenth century. This paragraph includes sections on first publications on flat-pattern cutting, the use of matrices in flat-pattern cutting, proportional flat-pattern cutting, paper patterns and flat-pattern cutting for home dress-making.
The following clause 4.5 deals with the technical term flat-pattern, and divides it into pattern orientation, block-, derived- and fashion-pattern.

4 THE HISTORIC DEVELOPMENT OF CLOTHING AND FLAT-PATTERN CUTTING

Jenss, Kraft and Willingmann emphasise that in comparison to draping, the artificial, rationally technical principal of flat-pattern cutting is irrepealabel:

> *The way of dressing gives an import insight of the cultural history. As the cut of the garments can be seen as elementary part of the historical clothing, because none of the non-wrapping garments would have been made up without cutting the fabric in the first place. Furthermore, the way this process of cutting was made opens up an understanding of tools, machinery and later technology which reflects the level of development at the certain time and place.*
>
> *Jenss, Kraft and Willingmann (2001: 102)*

This process of cutting a flat rectangular piece of fabric to fit a three-dimensional body is what is of interest for this research project. Hereby the historical development of this technique gives reason for the principles of contemporary garment construction.

4.1 Evaluating Historic Flat-pattern Cutting

Sorber (2003: 23) articulates that flat-patterns were usually drawn on paper or cardboard until the mid 1990s, and the fragile material did not stand up to the test of time. In her search for historic patterns in order to formulate an exhibition on pattern cutting at the *MOMU Fashion Museum* in Antwerp in 2003, Sorber (2003: 23) finds that the limited amount of paper patterns to have survived to the present day show that they were esteemed to have very little value. However, Aldrich (2002: 10) states that many instruction pamphlets and books on pattern drafting have survived from as early as the 1830's.

Costume collections in Europe, such as the costume collection of the *Victoria and Albert Museum* in London and of the *Kunst- und Gewerbemuseum* in Hamburg, contain quantities of historic garments. Despite that, flat-patterns are seldom found.
According to the archive of the *Kunst- und Gewerbemuseum* in Hamburg, many of the garments are presents from private collections or are donated to them by companies or designers. Therefore the flat-patterns are missing and the archives often have limited information about a garment's age or where it was made, let alone its original pattern.

Investigating the garments closely and intensively helps in the discovery of how they were made. This does not necessarily provide information about how the patterns were constructed. Historic garments can be measured and translated back into a pattern, but it is still not possible to examine how the pattern was created. The reconstructed garment together with the body measurements of the specific size could show how the garment fitted on the body if one had precise details of the body size for which the garment was made.
What can be examined next to the visible style of the garment is, how it was generally put together. As a result, the examination of historic garments does not enable to say anything about how the flat-pattern was used or how it was constructed.
In order to evaluate the development of flat-pattern construction the general development of clothing from two- to three-dimensional garments is undertaken prior to an investigation into historic flat-pattern pamphlets and books, as suggested by Aldich above.

4.2 From Two- to Three-dimensional Clothing

The following extract is quoted from Taylor, who wrote on computers in the fashion industry.

> *At one time, all patterns were arrived at by modelling in cloth on a stand or a model form of the human shape, and the resulting shapes were the patterns from which further garments would be cut and made-up. Modelling is the only way to extract balanced 2D patterns from a 3D shape, and to arrive at a true understanding of a very complex shape: the human body. Somebody then hit on the idea of taking a basic pattern shape from a body and, by cleverly worked out system of manipulations, altering the basic pattern 'on the flat' to any desired style without having to use the model form or a live human body.*
> *Taylor (1990: 89)*

This needs to be kept in mind when exploring the beginnings of clothing construction. Taylor is of the opinion that a pattern which is constructed without using the human form as a model would not fit as well as a modelled one. Even though this might be true for individual made-to-measure clothing, it does not mention whether the garment based on a modelled pattern does ensure a better fit for every-day movements.

4.2.1 Two-dimensional garments

Rolf (1979: 75) states that two-dimensional costumes can be found in Europe between the Romanesque (ca.1100-1200) and the Gothic period (ca.1200–1525).
Two-dimensional garments followed wrapping-garments and were the first to make use of seams. This allowed for different parts to be attached to each other. The characteristic of such a garment is that can be laid out flat. Through the use of folds, slits, separate belts and adding or cutting out wedges it can thus be adjusted to the body.

Boucher (1965: 192) mentiones the development of short costumes replacing the long ones for men, in the fourteenth century in parts of Europe,
as a starting point for further development of garments as well as for introducing new decorative elements in a formerly purely functional way of clothing.

Further on, he relates this development to the influence of short plate armour from the last years of the thirteenth century.
Rolf (1979: 80), names the invention of the dart in Europe around 1250 as the beginning of the three-dimensional garment. The dart transforms the flat cloth into a three-dimensional form.

At that time the shape of European and Asian costumes started to diverge because Asian costume continued to be two-dimensional. Sorber (2003: 31) adds that flat-patterns are not necessary for cutting traditional Asian clothing, such as the Japanese kimono, because their shape directly derives from the rectangles of the width of the fabric used to make them.

4.2.2 Three-dimensional clothing

Three-dimensional clothing is achieved by attaching different pieces together. Such garments retain their three-dimensional form when not worn on the body. They cannot be laid out flat.

Rolf (1979: 85) records that the forming dart can first be found around 1300 in Europe. Loose shirt-like two-dimensional garments were replaced by a tight fitting bodice. She sees the establishment of the dart, as the starting point for a third major change of costume, following the two-dimensional segment costumes and wrapping costumes. Figure 25 illustrates the development of pattern for two- to three-dimensional garments. The pattern set on the left for a two-dimensional garment shows rectangular pieces only, whereas, the pattern set on the right, a three-dimensional one, shows straight and curved pattern pieces and forming darts.

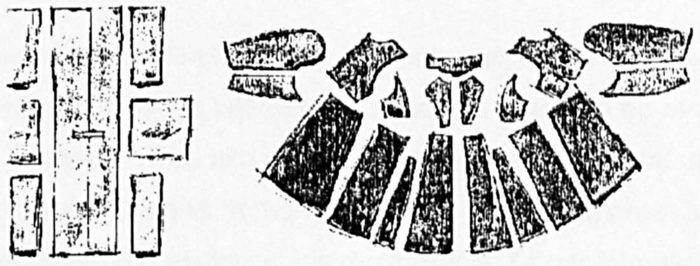


Figure 25, Development of pattern cutting from the two- to the three- dimensional costume. Source: Rolf (1979:74)

Technically, there are various solutions to give a two-dimensional piece of cloth a three-dimensional appearance.
Figure 26 illustrates, from left to right, the folded wedge, the vent, the inserted wedge and the attached bell-shape of two-dimensional garments followed by the dart and the curved dart of three-dimensional clothing.

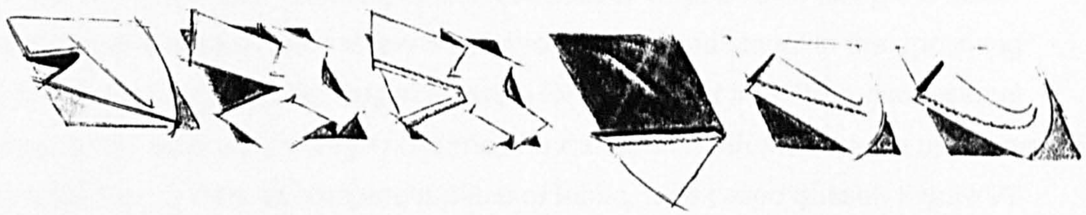


Figure 26, Illustration of wedges, vent and darts. Source: Rolf (1979: 97)

In the sixteenth century the three-dimensional costume replaced the two-dimensional one. Rolf (1979: 85-89) stresses that the main aspects of three-dimensional garments are the marked waistline and the curved sleeve, in contrast to the straight sleeve attachment of two-dimensional costume. Boucher (1965: 206) argues that the sleeve in the shape of a bouffant sack became fashionable in England and Germany in the fourteenth century. Such a sleeve can be seen as three-dimensional because the cut resembles the form of the arm.
Three-dimensional garments have been made by using well through segmentation. The plain fabric is formed through the different segments of the garment. The garment should mirror the shape of the human figure. When sewn together, two-dimensional flat segments result in a three-dimensional garment. Rolf (1979: 86) argues that general segmentation of garments took over all parts of the western world by the mid-nineteenth century. Rolf (1979: 87) adds that earlier forms of protecting garments used a similar system of loosely attaching different segments onto each other. Freedom of movement was achieved by these openings and flaps in the fabric.

As the three-dimensional garment is made to follow the prominences of the human body it cannot be laid out flat, instead it needs to be evaluated on the body or on a dress-stand. The aim of creating a three-dimensional garment from a flat piece of cloth is to resemble the human body without showing creases or up-folding fabric without restricting the wearer in his movements. Consequently, the garment is constructed after the individual measurements of the person for whom it is made. The individual difference between the waist and the upper and lower parts of the torso is now, for the first time, important in regard to the cutting of the pattern.

4.2.3 Allowing for movement in three-dimensional garments

Integrated folds have been a common way for allowing for a wider range of movement in traditional sportswear made of non-stretch fabric. Historic examples can be found in the private archive of the *Bogner* Company in Munich which is located on the premises of the company where sportswear for skiing from the 1950s can be seen. The Norfolk, a traditional menswear shooting jacket, consists of vertical folds along the back armhole, as well as contemporary motorcycle jackets, as stated in the upcoming Chapter 9. A more specific way of allowing for movement in a three-dimensional garment can be found in stage costumes for dancers. Costumes for the upper part of the body may consist of a separate piece of fabric, a so called gusset. Figure 27 illustrates, from left to right, a diamond-shaped and a circular-shaped version of a gusset, as examples for gussets on set-in-sleeves. Ingham and Covey (1980: 115,116) stress that gussets are often used in costumes to facilitate arm movement. The circular-shaped gusset allows for complete arm movement, even in fitted sleeves.

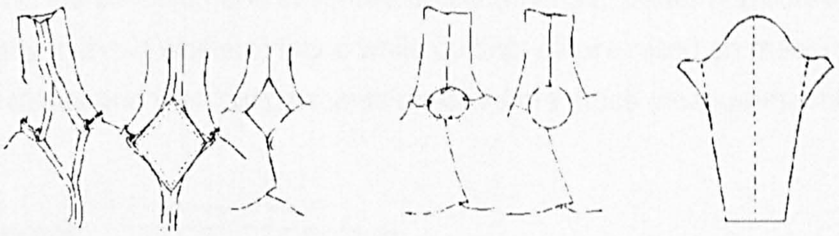


Figure 27, Dancer's Gusset,
Source: Rosemary Ingham and Liz Covey, The Costumer's Handbook, (1980:115, 116)

Even though the underarm gusset is an extra piece which need to sewn into the side and sleeve seam, it has a positive effect on allowing the arm to move upwards without interfering with the overall look appearance of the garment. Because of this and the fact that every-day movements during travel and transit consist of lifting up the arm to hold onto a rail, as visually observed in the comparison of the jacket prototypes made up following the instructions of existing flat-pattern cutting systems in Chapter 9, the underarm gusset is an existing way of constructing traditional dance-wear which inspired the practical experiments on allowing a greater range of movement of woven women's business-wear, as stated in Chapter 10. Rolf (1979:88) is of the opinion that the only possible further development of three-dimensional garment is the combination of traditional pattern-cutting together with the use of stretch fabrics. This can lead to skin-tight garments such as leotards or tights.
It can be assumed that Rolf sees three-dimensional garments as being the best possible solution of dressing the body when made from woven material.

4.3 Historic Publications on Flat-pattern Cutting

Niemann (1986: 42) mentions that the first publications on the required knowledge of a professional tailor date back to the early sixteenth century. A first hand-written example in which the necessary parts for a garment were drawn and arranged to fit onto the measurements of the fabric can be seen in the book of the tailor Jörg Praun, written after his training years in Innsbruck, Switzerland in 1501.

The invention of modern printing in the mid fifteenth century allowed for the first books on pattern cutting to be published. The first printed book for the tailoring guild dates back to 1589. It was written by the Spaniard Juan de Alcega and entitled in Spanish *Libro de geometrica pracia y traca el qual*, published in Madrid, Spain, - found today in the collection of the Victoria and Albert Museum in London.
Figure 28 shows a template from this book. Sorber (2003: 4), who also mentions the work by Juan de Alcega as the oldest work on pattern cutting, observed that the tailor during the sixteenth and seventeenth century used pattern layouts in tailor's books mainly to avoid waste of fabric while cutting; others relied on measurements taken from the clients and then cut garments directly from those measurements.

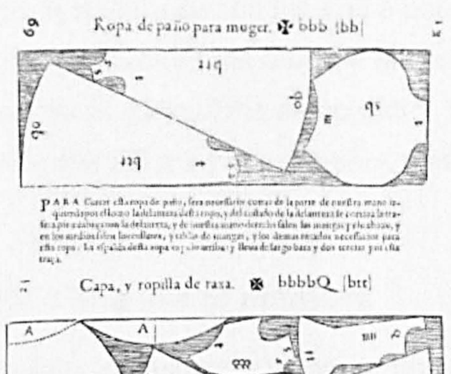


Figure 28, Juan de Alcega, Libro de geometricapractica y traca el qualtrata de lo tocante al officio de sastre (Eng.: Book of practical geometry and trace, regarded to official tailors), 1589, Source: Sorber (2002:25)

These early illustrations of the laid out pattern pieces are *already* recognisable as flat-pattern. The first instruction for making the pattern for women's wear clothing which directly takes the body measurements as a base for the pattern construction was written by J. S. Bernhardt, a tailor in Dresden, Germany in 1810.Niemann (1986: 43) states that Bernhardt's instructions were entitled *Instruction for clothing the human body, especially the female one, following the different body measurements*. The book was written for tailors who wanted to make women's wear corsets and underwear trousers according to the specific measurements of the individual body. Bernhardt used a matrix on the fabric to make his comparison between the differences in measurements easier for the reader of the book to understand.

In regard to the development of flat-pattern cutting the nineteenth century, this was the period in which many different ways of transferring the body measurements onto the plain fabric were developed. As the sixteenth century's systems either represented loose-fitting garments or patterns which were individually adjusted to the client's measurements, the idea of taking average measurements which fit a group of people with similar shape arose in the nineteenth century.
Niemann (1986) found an example for a scientific flat-pattern cutting system that was developed by J. H. Michel in 1818. Michel worked as a German tailor in London.
His system based on the entire body height together with calculated measurements which separated the bust measurement into two halves and then one of these halves into three parts of the same width. The first third marked the front, the second one the side and the third one the back part for a pattern for half of the body.

4.3.1 The use of matrices

Heyder, quoted by Niemann (1986), wrote in his book *The Whole of the Art of Making Clothing*, from 1824:

> *An accurate measurement taken for various types of garments which follows either the well- or the miss- proportioned body at every age, or to cut the fabric after a good pattern; and to sew the neatly cut out pieces of fabric together with a needle and thread; and to decorate the garment following the current fashion; that is the whole of the art of making clothing. The correctly drawn patterns, together with an accurate way of cutting out the pieces from the fabric are most important parts within the process. Heyder (1824)*

Niemann (1986: 13) argues that Heyder relied on a scientific method, using a square matrix on which the pattern pieces were constructed. This was helpful as the flat-pattern was published in a smaller scale. With the help of the net structure underneath the pattern, the tracing was made easier. The tailor had to draw the matrix in full scale onto the fabric before tracing the lines of the pattern.
Furthermore, it is stated by Niemann that in 1828, Compaigne and Fontaine invented the first cutting method based on centimetres, in which the half of the bust measurement was parted into forty-eight sections. In the following years Lavigne, who also worked as a professor for pattern cutting in Paris, developed a method which took the bust measurement as a starting point around which all other measurements were calculated.

4.3.2 Proportional flat-pattern cutting

Klemm, director of the *European Fashion Academy* in Dresden, Germany, developed Michel's proportional- or reduction- method by insisting on taking direct measurements of the front length, the shoulder height, the length from the neck to the waist and the measurements of three additional diagonal lines of the front and the back.

These measurements were adjusted to a basic pattern which followed the proportional method. This method of using direct body measurements was then called *Corporismetrie* (Lat. Corpus= body).
This proportional method of flat-pattern cutting has its origin in tailoring techniques. Hecklinger pointed out this development from dressmaking to tailoring in the preface of his written work on his system for cutting ladies' garments:

> *To the dressmaker it (the system) will present a way of producing a pattern of a dress or jacket which is far superior to any known method she may be acquainted with, as it is purely and simply a Tailor System, and the success which tailors have in making the modern tailor-made dresses, can just as well be acquainted by the dressmaker by conforming to its use. Hecklinger (1881)*

The difference between a female dressmaker and a tailor is clearly stated as the tailor being the one who drafts a pattern after tailor system using direct measurements and proportions in comparison to the dressmaker who only uses direct measurements.

Niemann (1986: 44) mentioned F. A. Barde, who developed a flat-pattern cutting system based on direct body measurements in 1850. It is described in Barde's book *Traite Encyclopedique de l'Art du Tailleur*, published in Paris in the same year. Niemann (1986: 45) also relates that in 1879 E. Kuhn developed a flat-pattern cutting system that took the length of the head as a basic measurement to construct the clothing on a scale which parted the whole body into horizontal sections, all the same length as the head. This was the first time that a certain proportion within the pattern, could be achieved. Niemann (1986: 46) *mentions* the Michael Müller system from 1890, the Gustav Hofer method from 1915, the Alfred Maurer way of flat-pattern cutting from 1918 and the Franz Herzberg system from 1927 which are based on seven and a half lengths of the head.

Clark (2008: 260) cites the professional pattern cutter and tutor at the London College of Fashion, Cannon Jones. Jones remembered that, in 1962, he learned to cut a pattern by creating a scale from a set of measurements based on half the chest measurement: all other body proportions were fractions of that scale.
Niemann (1986: 34) observes that these basics of the construction of flat-pattern have been further developed over the following decades. The method of using a matrix on which the pattern is constructed and the proportion- or reduction- method can, in its basics, can still be found in contemporary flat pattern cutting systems.
Some of the above methods, such as the M.Müller&Sohn system, which was originally developed for use by tailors, were later renewed for the different requirements for the use within mass-production. Other authors, such as Aldrich in her book on flat-pattern cutting from 1996, used small scale basic block-patterns, drawn on a matrix.

4.4 Paper Patterns

Paper patterns for clothing were introduced in the nineteenth century. Before that it was common to draw the pattern directly onto the fabric. *Quarks & Co.*, a program on German television about Din norms and body sizes, reported that the first paper pattern was developed by Ebanezer Butterick in 1863. The Butterick were the first patterns using tailoring techniques. Even though, Aldrich (2003: 151) names the American Madame Demorest and the British Mrs. Whiteley who sold their paper patterns as early as 1855 for Mrs. Whitleley and 1860 for Madame Demorest, following a flourishing import of full size patterns from Paris as early as the 1830s.

Aldrich (2003: 151) relates the upcoming success of the paper patterns in America to the wide spread of the domestic sewing machine market at the same time.
The American Butterick Company is also well known for its paper pattern for home sewing from the end of the nineteenth century onwards.
Sorber (2003: 27, 28) argues that the success of paper patterns was based on the proliferation of fashion magazines in the early part of the twentieth century. These magazines, which were mainly geared to seamstresses and housewives, led to the introduction of practical instructions on how to make garments. Small-scale patterns were regularly used as early as the 1830s. By the 1860s sheets with full-scale patterns were attached to journals.

4.5 Flat-pattern for Home Dressmaking

Sorber (2003: 28) supposes that the area where historic pattern construction can become more evident as that of home dressmaking because journals, such as the German *Burda Magazine* have archived many of their patterns, which still come as a package together with the magazine, and have done so since their first issue in 1950. A visit to the *Burda Magazine* headquarters in Offenburg, Germany, showed that many flat-patterns for home dressmaking are available.

A thorough investigation into this field is not considered necessary for this research because these patterns are aimed at the unprofessional dressmaker and do not reflect mass-production of women's wear. Nevertheless, the following section briefly considers this area.

4.5.1 Home dressmaking in the 1950s

Entwistle (2000: 229) states that up to this point the average middle- and working class woman either purchased their clothing second hand or made them at home, because sewing skills were widely spread. The fact that so many women were able to sew is underlined by the success of commercial patterns made by companies, such as *Buttericks* in Great Britain and *Burda* in Germany.
The first issue of the *Burda magazine* was published in Germany in 1950 and consisted of 100.000 copies.

Since then the number of sold copies has varied between 100.000 and 150.000. In 1990 the number of published copies dropped to 97.000. In the third quarter of the year 1969 Burda was published in runs of 47.000 copies.
The popularity of these journals between 1950 and 1990 also indicates the growing success of mass-market womenswear from the 1950s onwards.
Next to mass-produced work-wear, underwear and sometimes men's suits, a lot of womenswear had been home produced and therefore the resulting garment had been in detail up to the person who produced it.

Thiel (2004: 414, 415) adds that the fashion hierarchy in the 1950s was dictated mainly by Parisian couturiers, who introduced new silhouettes regularly. The women making their garments at home copied these silhouettes from sketches and pictures in fashion magazines. The personal taste and individual sewing skills of the dressmaker determined the method of constructing the actual garment as well as making individual alterations to the commercial paper pattern.

Popcorn (1996: 60) mentions the American Designer Isaac Mizrahi is producing flat-pattern for home-sewing in order to publicise his designs. Such flat-patterns for home-sewing are fashion-patterns. Their intention is to encourage a certain style of garments. Fashion-patterns are based on a first basic block-pattern which can be manipulated in various ways.

In the following the different variations of flat-pattern are described. In order to understand the relationship between flat-pattern and fabric, the section starts with a paragraph on pattern orientation.

4.6 Pattern Orientation

Pattern orientation describes the positioning of the pattern pieces on the fabric. This can be done in three main directions. Common wise the lengthwise grain (warp) of the woven fabric is parallel to the centre front of womenswear jacket and to the crease line of both parts of the trousers in industrial mass-production.

Laying out the pattern pieces on the fabric, manually or with the help of lay planning software, uses the direction of the fabric and, particularly, the grain line.

Yet, pattern can be cut in all directions of the fabric, as there are the above lengthwise grain, the crosswise grain and diagonal, the so-called bias grain which is at 45 degrees to the grain line. Figure 29 illustrates these.

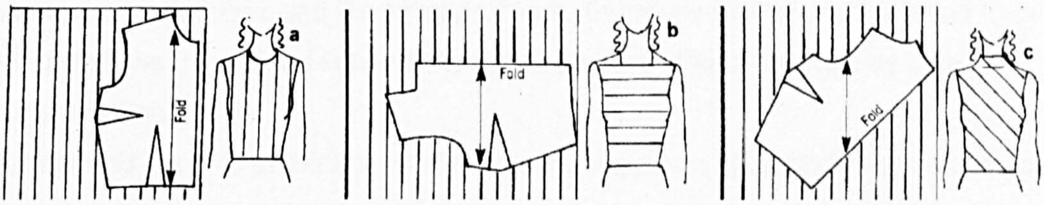


Figure 29, a) Lengthwise grain, b) crosswise grain, c) bias cutting. Source: Stanley (1991:82)

Cutting pattern pieces on the bias gives them a certain flexibility which they do not have when cut cutting length- or crosswise. Figure 30 illustrates the bias characteristic of allowing for flexibility in one area and consequently a shortened and narrowed area above and below.

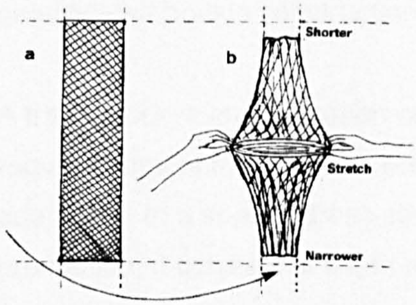


Figure.30, Bias Characteristics, Source: Stanley (1991:83)

Fischer (2009: 64) stresses that the cut of a garment in relation to the direction of the grain line will strongly affect how the fabric hangs on the body. She adds that garments cut on the bias have a positive effect on the fabric going around the body but that this way will take up a lot more fabric than cutting the pattern pieces on the lengthwise or crosswise grain.

4.7 Block-pattern

The main criteria for a pattern being a block-pattern are that it follows the individual body measurements or the average ones from a size chart and that it can be manipulated into various different flat-patterns. Block-patterns are also known as primary blocks.

The term block-pattern is sometimes divided into standard, trade and tailoring pattern blocks. Even though a standard block needs to be neutral regarding various fashion trends, it must never be old fashioned in line and fit

Bray (1961: 10, 11) divides the different blocks into the standard block, the simplified block, the trade block and the tailoring block. Standard blocks are the basic foundation which follows the natural lines of the figure and are little influenced by other considerations.

Its main object is to provide a reliable and lasting basis of correct proportions and fit. Bray mentions that a standard block-pattern has to be tested frequently for line and fit. Furthermore, Bray suggests that it is important that the basic structure of a block pattern should be such that any necessary adjustment can be introduced easily, without upsetting the balance of the whole pattern.

The simpler version of a standard block is the simplified block which is often used for learning to draft patterns. Bray (1961: 11) states that the simple block is to have reliable pattern for practical dressmaking and not for understanding the more complicated bodice construction.

A trade block is an adaptation of the standard block. It is made to suit various requirements of mass-production – for example the following of a size chart or the adaptation to a special dress-stand. As a trade block is made for using it industrial production, it consists of seam allowances. Trade blocks might vary from company to company.

Aldrich (1976: 17) adds the intermediate block as being additional to trade blocks. Intermediate blocks are of basic shapes, such as the kimono block or the 'A' line skirt block. In contrast to this Bray (1961: 12) called these secondary blocks. She is of the opinion that all standard blocks are primary blocks for either the bodice, the straight sleeve and the standard skirt.

Bray (1961: 11) names another variation of the standard block which is the tailoring block. It includes special points linked with the technique of tailoring. As already mentioned in Chapter 4.3.3 the tailoring system for drafting is a proportional one. Furthermore, tailoring involves the use of padding and interlining which also need to be reflected in the drafting of the pattern (a visual explanation of the term tailoring can be found in the glossary).The standard block is judged as being suitable for well fitting mass-production and high- class individual made-to-measure.

As every change in shape and posture of the average figure must be reflected in its construction, it is up to the individual pattern cutter to decide how far these are reflected within the block-pattern.

4.8 Derived-pattern

Derived-patterns are developed from a block-pattern. As said above in section 4.6, sometimes derived-pattern are referred to as secondary or intermediate blocks.
A derived-pattern is a development from a standard block-pattern. These are pattern for various sleeve shapes, such as a raglan or a kimono construction. An 'A' line skirt is a derived-pattern as well. Derived-pattern can be used for further construction without having to start with a primary standard block-pattern. Even though there are derived-patterns in many variations, they do not follow fashion trends. Some of the solutions offered are regarded as being more fashionable than others at a certain time but, despite this, they are all simply variations on a basic shape. The difference between a derived-pattern and a trade block might be minimal.

4.9 Fashion-pattern

In contrast to basic-block and derived-block pattern, the one which is constructed following a design of a garment is called the fashion-block. A fashion-block can be developed from a basic-block or from a derived-block. The reflection of the body measurements which is of great importance for the block-pattern may no longer be recognisable in a fashion-pattern.

4.10 The Dress-form or Workroom-stand

The various flat-patterns need to be tried out to see if they fit the body in case of a block-pattern or if they fulfil the requirements of a certain style for fashion-pattern. Preferably, this is done on a live model but it also be checked on a dress form which is also known as workroom-stand. The dress form has its origin in made-to-measure production where the dress stand was made up following the individual measurements of the client, in order to minimize the amount of personal fittings.
The dress stand is frequently used for seamstresses who used it as explained above or for home sewing personal clothing. The dress form is an example for the phenomenon of considering the upright standing figure in garment production. Figure 31 illustrates the three-dimensional form of the dress-stand, resembling the human body and the front and back of what appears like a block-pattern for a sleeveless dress.

Figure 31, The relationship of the body, or dummy, and the three dimensional costume. Source: Rolf (1979: 89).

The dress form based on measurements from size charts instead of individual measurements can be directly connected to the beginning of mass-production of clothing that was for the first time widely used for the production of uniforms in Europe at the time of the First World War. The dress form is further on evaluated as a way of fitting garments in Chapter 7.2

4.11 Summary of Chapter 4

The need for following body measurements became necessary through the general development from two-dimensional wrapping costume to three-dimensional body fitting garments. The size of the former two-dimensional wrapping costumes was based on the dimensions of the fabric as they were mostly worn with a belt around the waist to keep them in place.

The first three-dimensional garments appeared in the twelfth century. They consisted of vents, folds and darts employed in order to make plain fabric fit tightly over the forms of the body and - for the first time -showed a waistline smaller than the bust- or hipline in the pattern construction.

Within these, folds with their double amount of fabric and underarm gussets are suitable for allowing movement and are therefore of interest for the practical part of this research project.

Historically, tailors drew the patterns directly onto the fabric and early books on flat-pattern cutting for the craftsman were published in the mid sixteenth century. The tailor system of pattern cutting relies on direct and proportional measurements.

This way of constructing patterns finds its way into the dressmaker's system of using direct measurements only. An early book from 1881 on this subject advertises the tailor system as being far superior and better fitting than the dressmaker's one.

Full scale patterns were successfully sold in France from the 1830s onwards. By the 1860s commercial paper pattern were also sold in America and Europe.
Not many paper patterns are available for inspection today. Nor are flat-patterns commonly archived. Historic flat-patterns for home dressmaking which were supplements to fashion magazines, such as Burda, are archived and date back to the year 1950 for this publication. Nevertheless, the technical text books on flat-pattern cutting from the 1950s onwards are available and still in use for contemporary pattern cutting.
It can be concluded that before mass-production in the clothing industry was introduced, the flat pattern itself had been a helpful tool for dressmakers who were not able to make a garment without it.
Sorber (2003: 28) pronounced that without the pattern a reproduction of the same design would not have been possible. Next to the reproduction which is essential to mass-production, the dressmakers and tailors of former times needed the individual direct measurements of their clients. In order to use flat-pattern construction for mass-market production, it needed to follow the average measurements taken from size charts instead of individual measurements.
Because this research concentrates on flat-pattern cutting for mass-market womenswear, the later practical experiments in Part 2 of this research will make use of the average measurements of size charts. Individual made-to-measure pattern cutting and making-up has the aim to fit one single person. As this research project is interested in general body movements during and how far it is possible to carry them out while wearing accepted women's business-wear, the individual made-to-measure production of clothing is not considered.

In the following Chapter 5 the development of size charts and their importance for mass-produced soft-tailored womenswear is investigated.

Section 5.1 explores the historic development of sizing from the eighteenth century onwards. This paragraph involves sections on the use of direct measurements, ease of movement and the use of full-scale pattern.
Clause 5.2 concentrates on the historic development of size-charts, subdivided into the development of size-charts before the nineteenth century and into the development of size-charts for uniforms.
Paragraph 5.3 investigates historic instruments for measuring the human body.
In the following section 5.4 the development of size-charts after the Second World War is investigated.
Section 5.5 deals with recent sizing surveys, including a paragraph on the three-dimensional body scanner and the possibilities of it in regard to gaining body measurements for improving the fit of garments.

5 THE COEXISTENCE OF SIZING AND MASS-PRODUCTION

Mass-production of fashion and the standardisation of garment sizes have a complex relationship. This mutual relationship runs through much of the literature on mass production within the garment industry, described by Thiel (2004: 381), Sorber (2003: 27) and Hoffmann (1985: 17-19). These theorists examined the ways in which the standardisation of sizes became a necessity for modern garment production.
Sommer and Wind (1988: 34,35) found that the technical developments necessary for mass-production of clothing was invented between 1890 and 1910, largely due to the introduction of the sewing machine in the eighteenth century and its large scale use starting around 1850. The assumption that the invention of the sewing machine started clothing mass-production is shared by other authors (Entwistle: 2000, Sorber: 2003).
However, Sorber (2003: 28, 29) arguedsthat a significant innovation for achieving measurements of the human body was the introduction of the flexible tape measure replacing a static measuring stick. Sorber (2003: 28, 32) states that the tape measure was first mentioned in the written work by F. de Garsault, entitled *L' Art du tailleur* from 1769. In this text the tape measure is quoted as being used for the production of a garment, in the course of which adjusting the chosen pattern to the individual measurements was a key process.
Niemann (1986: 43) mentions the written work of F. A. Barde from 1815 in which the use of the tape measure was mentioned as a tool for gaining body measurements.
Sorber (2003: 28) stated that the tape measurement was called an innovation in a Dutch book about trades from 1849.

5.1 The Historic Development of Sizing from 1800

Mass-production of clothing is dependent on developing sizes that have to reflect the various measurements of the human figure. The only way of producing garments that fit masses of people is to have a system which translates the highest possible amount of individual measurements into different categories: the sizes.
According to Philip Kunick's written work *Sizing, Pattern Construction and Grading for Women's Wear*, published in 1967 many empirical methods of flat-pattern cutting were in use in the clothing industry.
This is based on the fact that the clothing industry is founded on past centuries of needlework practice and some methods are still used in the production of mass-market clothing today.

As said above, some flat-pattern cutting systems, such as the M.Müller&Sohn system, were initially developed for the craftsman and were later adjusted to meet the requirements of mass-production.

5.1.1 The use of direct-measurements

Direct-measurements are measured on the body of the individual subject. The tape measurement allowed for measuring around the human form. Through this, the girths, such as the bust- or waist- girth which are of great importance for the construction of patterns can be measured accurately. Sorber (2003: 5) highlighted that early flat-pattern used direct-measurements and then cut garments directly from those measurements.

5.1.2 Tolerance or ease allowance

The main criterion for block-pattern is that it follows the individual body measurements or the average ones from a size chart. Differences to these actual measurements can be seen in the various amounts of tolerances for ease allowance which are added to the above measurements in order to allow for movement.
Kunick (1967: 11) observed that close body measurements resemble the exact dimensions of the body over foundation garments. Tolerances are added for comfort and movement.

Furthermore, Kunick (1967: 11) declares that a garment needs at least one inch (2.5 centimetres) of ease added to the girths of the actual body measurements. He adds that through adding extra ease the general size of the garment is getting bigger.
But still, the general enlargement, through adding ease, results in a looser shape of the garments. A looser shape might allow for certain body movements taking place underneath but it is not a solution for widening the range of movement with the garment.
This enlargement is depending on the type of garment. An overcoat would have more tolerances because it is worn over a blouse and a jacket, whereas a jacket has less tolerance because it is traditionally only worn over thin layers of clothing.
Kunick (1967: 17) stated the various tolerances in specific areas of different garment types.

The average of five centimetres tolerance for half of the bust-girth measurement, which are found in various flat-pattern cutting systems, allow for passive movement, such as breathing. The tolerances do not reflect the ability of active movement.
Hirokawa and Miyoshi (1997: 218-226) revealed that a different ease was found for better wearing comfort at width across the body for the relation between ease quantity and wearing feeling of jacket both in stationary standing posture and in moving condition.
The various flat-pattern cutting systems as well as the clothing industry are able to choose the different amounts of tolerances individually. Wang, Newton, Ng and Zhang (2006: 247-256)) who worked on the topic of ease allowance for womenswear, criticise the general procedure of adding a certain amount of ease allowance onto the different horizontal construction lines, such as the bust-, waist- and hip-line, for being insufficient.
However, Lenkeit-Schnur (1991: 11-14) argues that the pattern tries to resemble anatomical facts of the human body within a specific design. It consists of a dismantling, from which all human movement is eradicated. The pattern projects the figure on a much larger scale. Therefore, it could be seen as a simple packaging which is also larger than the wrapped object. Furthermore, Lenkeit-Schnur (1991: 17, 18) adds that in order to develop garments which fit, a certain percentage is added to the body measurements. The extent of this depends on the garment type and its design. The resulting value of the body measurement plus the added additional width is then the construction measurement, which is used to develop the pattern.

5.1.3 Full-scale pattern

In her essay on the history of pattern cutting Sorber (2003: 24) mentions that it remains questionable whether full-scale patterns were used to cut clothing in the sixteenth- and seventeenth centuries. The author adds that occasionally tailors used old garments taken apart to cut out new ones, instead of using the direct measurements from the customer. The use of direct measurements transferred onto the fabric can only be used for made-to-measure clothing, because the garment is constructed for the specific body measurements. Historically, this was a privilege for the higher classes. Sorber (2003: 24) reports that the lower classes could not afford made-to-measure clothing and therefore had to make do with either second-hand or ready-made items.

In the sixteenth century tailors who belonged to the *Antwerp Tailors' Guild* made a series of garments using the same shapes and sizes. This could lead to the conclusion that these tailors used pattern or templates. This could be seen as an early stage of minor mass-production.

In the following eighteenth century with its interest in science and aiming to accurately describe and classify every part of the world, the manual system of both exactly measuring the human body and constructing clothing to fit these forms and shapes were explored. Groves (1966: 41-42) states tailors would use clipping strips of paper to obtain a pattern, since each strip could be placed directly on the fabric.

5.2 The Development of Size-charts

The following section starts before the nineteenth century and moves on to the production of uniforms for the First World War.

5.2.1 The Development of size-charts before the nineteenth century

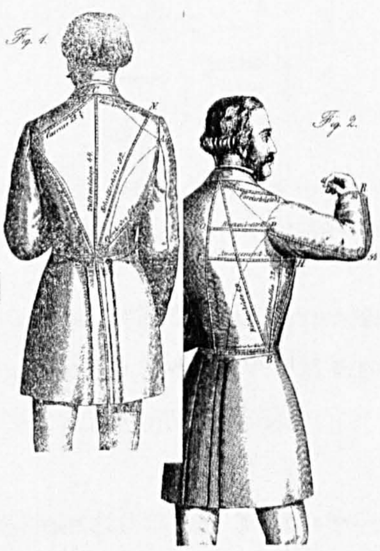
Aldrich (in Ashdown.Edt.2007: 2) articulates that only little evidence of early attempts to systemise measurements and to apply them to pattern drafts can be found before the nineteenth century. Aldrich (in Ashdown.Edt.2007: 7) names Benjamin Read whose size tables were one of the earliest. Figure 32 shows these size tables for men's clothing from the year 1815.

1	2	3	4	5
36	5	2	4	19
$36\frac{1}{2}$	00	00	00	00
37	$5\frac{5}{36}$	$2\frac{1}{18}$	$4\frac{1}{9}$	$19\frac{19}{36}$
$37\frac{1}{2}$	00	00	00	00
38	$5\frac{5}{18}$	$2\frac{1}{9}$	$4\frac{2}{9}$	$20\frac{1}{18}$
$38\frac{1}{2}$	00	00	00	00
39	$5\frac{5}{12}$	$2\frac{1}{6}$	$4\frac{1}{3}$	$20\frac{7}{12}$
$39\frac{1}{2}$	00	00	00	00
40	$5\frac{5}{9}$	$2\frac{2}{9}$	$4\frac{4}{9}$	$21\frac{1}{9}$
$40\frac{1}{2}$	00	00	00	00
41	$5\frac{25}{36}$	$2\frac{5}{18}$	$4\frac{5}{9}$	$21\frac{23}{36}$

6	7	8	9	10
$10\frac{1}{2}$	$4\frac{1}{2}$	17	4	16
$10\frac{31}{48}$	00	$17\frac{17}{72}$	00	00
$10\frac{19}{24}$	00	$17\frac{17}{36}$	$4\frac{1}{9}$	$16\frac{4}{9}$
$10\frac{15}{16}$	00	$17\frac{17}{24}$	00	00
$11\frac{1}{12}$	00	$17\frac{17}{18}$	$4\frac{2}{9}$	$16\frac{8}{9}$
$11\frac{11}{48}$	00	$18\frac{13}{72}$	00	00
$11\frac{3}{8}$	00	$18\frac{5}{12}$	$4\frac{1}{3}$	$17\frac{1}{3}$
$11\frac{25}{48}$	00	$18\frac{47}{72}$	00	00
$11\frac{2}{3}$	00	$18\frac{8}{9}$	$4\frac{4}{9}$	$17\frac{7}{9}$
$11\frac{13}{16}$	00	$19\frac{1}{8}$	00	00
$11\frac{23}{24}$	00	$19\frac{13}{36}$	$4\frac{5}{9}$	$18\frac{2}{9}$

Figure 32, Read, B., (1815), The Proportionate and Universal Table, The Author, London: 1, breast, waist, thigh; 2, half back; 3, back, neck; 4, side seam hollow; 5, armhole; 6, half front or top of the outside thigh; 7, fork width; 8, armhole for pelisses; 9, front edge of shoulder point; 10, diameter for a cloak. Taken from British Library, 712.g.12, Source: Ashdown (2007: 8, 9).

The following Figures 33 illustrates on how to measure the necessary measurements for the construction of a menswear morning coat from 1846. Figure 34 shows similar instructions for a womenswear jacket from 1884.



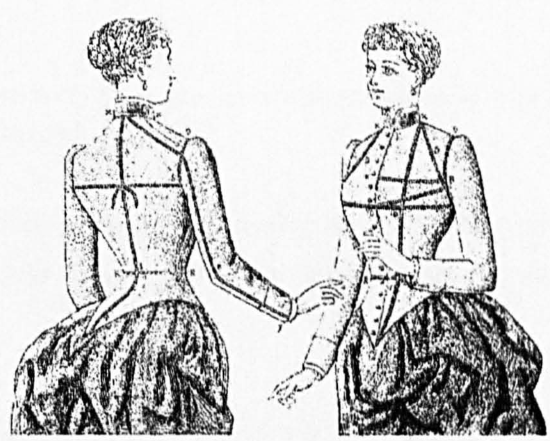


Figure 33 (left), Illustriertes Handbuch der höheren Bekleidungskunst für Civil, Militär und Livree (Eng.: Illustrated handbook for exceptional tailoring for civil, military and livery purpose) by Heinrich Klemm 1846, Source: Niemann (1986: cover)

Figure 34 (right), Tailors' measurements for a jacket, 1884, The Ladies' Tailor, 1, Plate 4, Source: Aldrich in Ashdown (Edt.) (2007: 30)

5.2.2 Size-charts for uniforms

Standardisation of sizes was crucial for the production of uniforms from the beginning of the seventeenth century onwards. Smith (1983: 159) declares that between 1769 and 1784 Richard Lowe, a sole supplier to the marines, delivered 127.245 garments. Therefore, the military garment production had an interest in the development of size-standardisation. As size-charts were first used for uniforms and they were restricted to men's and boy's clothing.

Figure 35 shows an illustration of a boy's uniform-style blouse with its pattern, as originally published in the book *Preparazione professionale della donna: cenni storici sulla moda femminile: metodo di taglio* by Margherita Corrias, published in Turin, Italy in 1939.

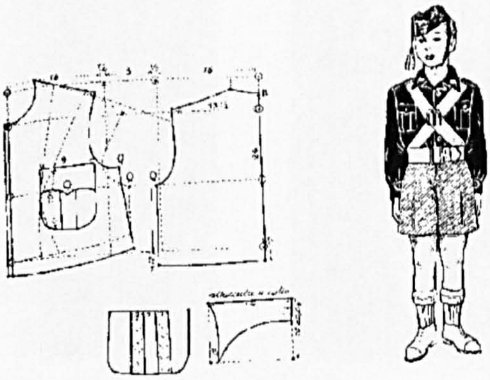


Figure 35, Model and pattern of black blouse with collar open at two points and accordion pocket, 1939, Source: Lupano and Vaccari (Ed) 2009: 201)

Holland's (2004) sizing guidelines for the US apparel industry, ASTM, date back to before the Second World War, while others even date back to before the American Civil War (1861-1865).

Sorber (2003: 29, 30) states that the results of a survey measuring 100.000 civilian men during demobilisation at the end of the First World War were published in 1921. Whereas, Thiel (2004: 340, 341) says that such a standardisation was used since the 1940s for underwear and menswear. Next to the production of uniforms, Sorber (2003: 28) argues that the purchase of clothing through mail order businesses had become well-established in the United States of America by the last quarter of the nineteenth century. Here again, the need for standardisation was a mutual one: the customer needed a system to judge the sizes of garments while the clothing industry needed sufficient measuring systems to determine the different sizes.

5.3 Historic Instruments for Measuring the Human Body

Next to the tape measurement, other instruments were developed to measure the human body. Figure 36 shows the so called *Plastes Apparatus* invented by the Italian Luigi Branchini in 1941. The flexible construction could be adjusted to individual shape. The resulting measurements draw a complex and detailed picture of the linear measurements of the body. Furthermore this instrument relates to the proportional method of flat-pattern construction, as stated in Chapter 4.4.3, as it shows the various measurements in proportion to each other.


Figure 36, The Plastes Apparatus, patented by Luigi Branchini, 1941, Source: Lupano and Vaccari (2009: 19)

Figure 37 illustrates another instrument for gaining data from 1957.

Figure 37, Measuring students for a Parisian modelling school in 1957, Source: Sorber (2003: 29)

5.4 Size-charts after the Second World War

Taylor and Shoben (1990: 11) suggest that with the help of sizing surveys, starting in the beginning of the twentieth century, it has been possible to categorise certain measurements into sizes. The authors refer to a survey set up in the United States of America in 1940, in which sixty measurements of 10.000 women were taken and a survey which was carried out in England in 1951 using a sample of 5000 adult females and thirty-seven measurements. Kunick (1967: 15) confirmes that he was one to carry out this survey on behalf of the Clothing Industry Development Council in Great Britain. The results were published in a report by the Joint Clothing Council who succeeded the Development Council in 1953. This was later published under the title *Women's Measurements and Sizes* by the Board of Trade in 1957. One main result of these surveys was that it produced a set of measurements for the average woman.
Taylor and Shoben (1990: 11) observe that the average figure represents the highest percentage of the population. Furthermore, several size-charts were made from the survey sizing data. These charts were arrived at by taking three height and six bust categories with eight hip sizes all of them including a five centimetre increment in each measurement. Kunick (1967: 1, 2) argues that these intervals between the sizes are the most convenient, if they are consistent. Because of consistent intervals, the gradations of one size are known. If required, it can be extended by consistent increase to cover an indefinite number of large sizes.

A lecture given by Ashdown, Professor of the Cornell University in New York, at the London College of Fashion on the 22nd of July 2004, revealed that the first recorded measurements of the female body in the United States of America were taken in 1942. The resulting anthropometric data consisted of measurements taken from 4400 subjects in the United States of America and in Europe. With the help of the tape measure 72 landmark measurements were taken.

According to the international textile research centre of the *Hohenstein Institut* in Bönnigheim, Germany, which is working on body sizing, grading, pattern cutting and also in the field of textile research since 1946, the first sizing surveys and resulting size-charts for Germany date back to 1952. Since the first collection of anthropometric data from Germany in 1952, sizing surveys have been undertaken every ten years to renew the data through the *Hohenstein Institute*. The latest publicly available size chart was published in 1994.
In other countries these surveys have not taken place on a regular basis.

Kunick (1967: 15, 23) named the manual study *Size Codes for Women's Outer Wear as the latest which* was published in Great Britain in 1963. This survey was undertaken by the *British Standards Institution* a national organisation for the issue of British standards. The survey was set up to find a solution to the problem of the lack of sizing consistency in Great Britain. Furthermore the aim was to make recommendations which would lead to general agreement in the industry.

The International Organisation for Standardisation (ISO) attempted to establish international standards for the sizing of clothing in 1968. This standardisation of sizes is still different for most European countries.

In order to see whether recent sizing surveys consider the moving body instead of concentrating on the non-moving static position, they are investigated in the following.

5.5 Recent Sizing Surveys

The most recent sizing survey in Great Britain is the *Size UK* survey. According to the internet publication of *Size UK*, the preparation for the survey started in 1999. The, carrying out and analysis of the survey and the outcomes took place in September 2006. The data collection took place in the years 2001/2. From the approximately 11.500 men and women, ages 16+.the eldest lady was 95 years old.
The data was available for industrial partners to access almost right away, due to the development of many tools that the retailers could use for data mining which they could undertake from their own offices.
This development shows that fit improvement is important to the fashion industry. At the same time it shows that fit improvement concentrates on gaining updated measurements for the size charts of the non-moving customer only. Comfort to perform every-day movement is not improved.

Other companies in England use a size chart by the British Standard Institution. According to Standards Direct the latest available being the BS-EN 13402-3:2004, published in 2005.
Furthermore a full data analysis of which key outcomes (changes in height/weight/bust /waist /hips and average measurements for men) were released to the public at a press launch in September 2004.

For *Size UK* every person was scanned standing and seated but there was no software developed for measurement extraction at this time for the sitting position. Consequently the *Size UK* study did not give any information about that.

An experiment carried out by the researcher in 2010, showed, that accurate data extraction for the sitting position and other positions different to the standard standing one, was not possible, as stated in Chapter 7.5.

Figure 38 shows one of the scans of a subject, standing and sitting, as published by the *Size Uk* survey.

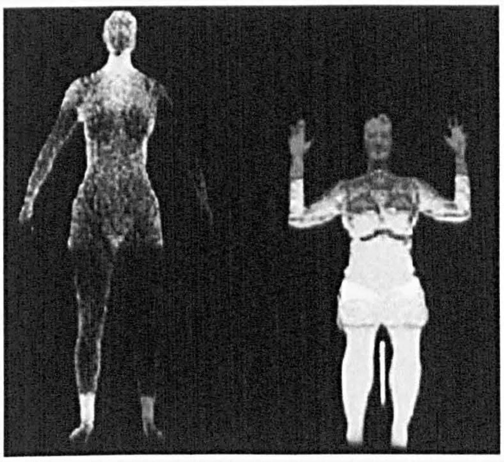


Figure 38, Standing and seated stance, Source: www.fashion.arts.ac/uk/sizeuk.htm

Next to the average of 140 accurate measurements a questionnaire asking for the subject's health, fitness, shopping habits and socio-economic grouping was undertaken. These answers together with the measurements enabled to identify various profiles. The British clothing industry which supported the survey was hoping for the ability to target products more accurately.The interest in sociological fact of the persons scanned influenced the questionnaire undertaken by the researcher as stated in Chapter 3.7. It is important to know the habits of the But still *Size UK* does not consider movement while travelling or commuting.

The last manual sizing survey in the USA using tape measurements was undertaken in 1942. This was followed by *Size USA*, using the three-dimensional body scanner as a tool for measuring, which finished in 2004.

For a similar survey in Germany, *Size Germany*, 13.362 subjects were measured between July 2007 and October 2008. The *Hohenstein Institut* undertaking the survey, indicated that each subject was scanned three times, in two standing and one sitting position. The project was sponsored by over 80 German companies.

The outcomes were available from August 2011. The outcomes of *Size Germany* are restricted to the over 100 business establishments in the areas of clothing and automobile production, who sponsored the study.
For the upcoming practical part of this study the latest publicly available size chart by the *Hohensteiner Institute* from 1994 is used. It is chosen because it is used for the flat-pattern cutting text books by M.Müller&Sohn, the German pattern cutting system which is selected for the prototype construction in Chapter 11.

5.5.1 The three-dimensional body-scanner

Simmons (2001: 11) stated that it was Magnant who produced a system which used a horizontal sheet of light to completely surround the body in 1985. Framework for the system carried the projectors and cameras needed that would scan the body from head to toe. This scanning technology used light to reflect the form or silhouette.
Simmons (2001: 12) mentioned that systems utilizing lasers were also being developed during this same period of the late 1970s and early 1980s, such as the system by Clerget, Germain, and Kryze who illuminated their measured object with a scanning laser beam in 1977.

Since the mid 1990s the three-dimensional body-scanner is used for achieving anthropometric data through laser technology. Body-scanners had already been used for medical examinations. The three-dimensional body scanner had been used commercially in various industries before, such as the car industry.

The *TC2* company announced that their first 3D scanner model, the 3T6, was made available to the public in 1998. The first four systems to be delivered were to the Levi Strauss&Company in San Francisco, to the U.S. Navy, to the North Carolina State University College of Textiles, and to the *Clarity Fit Technology of Minneapolis*.
The (TC2) scanner was the first scanner to be developed with the initial focus on the clothing industry.

In the mid 1990s the first scanners for scanning flexible forms in particular, such as the human body, were introduced on the *CEBIT* fair trade in Hannover, Germany. The *CEBIT* is an international fair which shows inventions in the area of office- and information technology and telecommunication since March 1986.
Ashdown explains that a typical three-dimensional scanner consists of four columns, located in each corner of a cube.

Depending on the technology used, either a red or a white light camera glides over the object. The data points are connected by a wire frame, which can later be added to a surface layer to reveal the three-dimensional shape of the object.
A three-dimensional scan of the human body allows to measure up to 300.000 data points. These measurements can be combined with, or added to manual measurements. There are special types of software, such as *Polyworks* which are used to work with the measured data from the anatomically extractions in diagrams or on the computer screen.
Figure 39 shows how the subject is scanned in a three-dimensional body-scanner.

Figure 39, Scanning the human body and resulting basic measurements, Source: www.humansolutions.com

5.5.2 Possibilities of the three-dimensional body-scanner

An advantage of the three-dimensional body-scanner is the automatic extraction of the measurements right after scanning. Figure 40 shows an example.

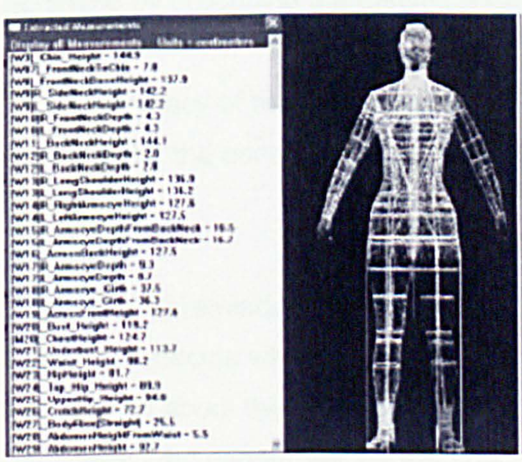


Figure 40, Automatic measurement extraction, Source : www.fashion.arts.ac/uk/sizeuk.htm

In contrast to manually gained measurements a three-dimensional scan allows to show the shape and the silhouette of the figure.
Measurements gained by using the conventional manual method provide linear data without showing the distribution of the measurement on the body. Therefore, a three-dimensional body-scan explains where the measurement is actually located on the body.

Bougourd, Dekker, Grant-Ross and Ward (2000: 163-173) were of the opinion that it is generally recognised that scanners give much higher levels of repeatability than manual measurers; both are completely different processes, one being contact the other non contact. Furthermore the body surface can be captured by a three-dimensional scanner.

When interviewed on the 13th of May 2004, Markus Schotte of the made-to-measure department of the *Windsor* Company in Bielefeld, Germany (since 2009 *Windsor* is part of the *Holy Group* based in Kreuzlingen, Switzerland) stated that the companies who use a three-dimensional scanner in their factories mainly use this technology for made-to-measure clothing production.

5.6 Summary of Chapter 5

It can be concluded that the use of size charts based on sizing surveys for developing flat-pattern is connected to the mass-market of womenswear in the middle of the twentieth century. Kunick (1967: 1) compares these size charts with geographical charts that provide information on little known territory, because the sizing economy is achieved by producing the minimum number of sizes to cover the maximum number of women.
This inaccuracy of mass-manufactured clothing is, according to Kunick (1967: 1), accepted by the consumer, who is willing to put up with some variation in the size of garments.

Faust (2009) reminds that size standards are voluntary and those who initiate garment orders can decide whether or not to adhere to national standards. Faust gives cause for concern about the size label system creating an ambiguous situation for the consumer who cannot rely on the size label to identify a good fitting garment.

Taylor and Shoben (1990: 12) indicated that it is impossible to cover the whole population by a basic size-chart. Therefore, each manufacturer should decide the increments between the sizes of the major girth widths, which are selected by the authors, to be the size indicators.

Classical anthropometric data provides information on static dimensions of the body in standard postures (Kroemer, Kroemer, & Kroemer-Elbert, 1986). Body-scanning is now allowing data to be captured in three-dimensions
The garment producing industry benefits from the use of the three-dimensional body-scanning technology. The three-dimensional scanner allows an insight into the relationship of the human shape and its size with a degree of exactness that is not possible with manual measuring. Ashdown, who is working with body-scans at the *Cornell University* in the USA, mentioned that surveys in co-operation with the clothing industry have already started in order to improve the fit of garments. She explains that the scanner helps to get a better understanding of the human shape and silhouette, because the measurements can be located within the figure. Therefore, the flat-pattern constructed after these measurements, could be adjusted with the result that particular fit problems could be solved. Ashdown currently uses this technology to improve the fit of women's trousers.

However, Simmons (2001: 55) states that even though body scanning technology is capable of extracting an infinite number of data types, a problem exists in the consistency of measuring techniques between scanners. Simmons worked with four different types of body scanners and concluded that the several scanners that are currently available show significant variance in how each captures specific body measurements. Furthermore, she predicts that the data capture process of specific body measurements need to be standardised or communicated among scanning systems otherwise this technology could not be utilized for its maximum benefit within the apparel industry.
This again shows that the 3D scanning technology is based on the non-moving body. Minor body movements in the standing position cause distortions, whereas data from any other position cannot be accurately extracted, as shown in an experiment undertaken by the researcher with a TC2 body scanner, outlined in Chapter 7.5.

At the moment there is no 3-dimensional body scanner which is able to gain useful data from scans of any other position than the non-moving upright standing one.

A breakthrough of the technology would be achieved if the scanning data could extract accurate measurements from various positions. This would allow for gaining information in what way and to what extend body movements result in different body measurements.

Currently the various sizing surveys using the three-dimensional body scanning technology, aim to update the size charts.
Size-charts, as being a fundamental tool for mass-produced clothing are set into the context of mass-production of clothing in the following Chapter 6.

After having observed the development of sizing surveys and size charts, the following Chapter 6 considers the findings in the context of mass-production of clothing.
Section 6.2 states the technique of grading.
Paragraph 6.3 describes the technique of lay-planning.
Clause 6.3 deals with the historic beginning of industrially produced womenswear, with separate sections on flat-pattern in mass-production, the Utility Scheme and civilian mass-production of clothing after the Second World War, home dress-making and the beginning acceptance of mass-produced clothing.
Section 6.4 examines the industrial mass-production of clothing with sections on the general organisation of mass-production of clothing and the different ways of production.
Phase 6.5 states contemporary industrial flat-pattern cutting for womenswear with subsections on styles in mass produced womenswear and flat-pattern as a tool for creating styles.
Section 6.6 investigates the use of new technologies within the clothing industry, divided into historic technical inventions in mass-production before the computerisation and contemporary technical inventions.
Paragraph 6.7 deals with computer-aided-design, divided into two-dimensional computer-aided flat-pattern cutting and three-dimensional computer-aided-design.
Clause 6.8 sums up experiences of professional pattern cutters and teachers in this area.

6 MASS-PRODUCTION OF CLOTHING

Sorber pronounces that:

> *(...) the fundamental and practical tool of the pattern is known by its reproduction. The pattern clarifies an aspect about clothing and fashion, something which one can easily fail to see. The ordinary customer is not interested in the pattern, even if the result of a design depends entirely on its pattern. Sorber (2003: 23)*

Besides looking at historical flat-pattern cutting, this investigation also observes how flat-pattern is utilised in common practice today.

6.1 General Organisation of Clothing Mass-production

The clothing producing industry is divided in two general groups of production. One is the mass-production and the other one the individual-production. Mass-production is also known as flow-production and the individual-production as workshop-production. Peters (1975: 21) observed that a mixture between both can often be found.

Mass-production can furthermore be divided into the parallel mass-production, consisting of the production of various types of garments in separated production units, or in a single production line. Parallel mass-production is suitable for highly automotive equipped factories. A factory with less atomisation is likely to produce series of similar garment types.

Figure 41 illustrates the general organisation of clothing mass-production. The way of organisation shown is called 'flow-production', which is explained in Chapter 6.1.1.

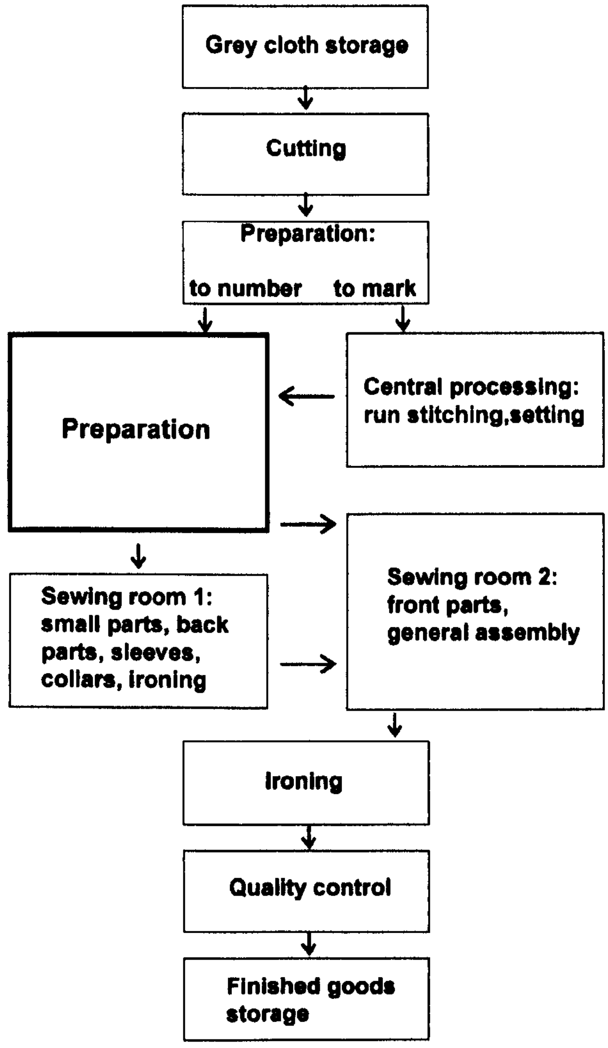


Figure 41, Organisation of mass production of clothing, Source: Peters (1978:29)

6.1.1 Flow-production

The flow-organisation is the way of production with the highest amount of organisation. It consists of work stations being arranged following the different steps of the production. Each work place is used for the production of one and the same step.

As said above, a mixture between the various types of mass-production is often found today. A purely flowing-production as described above is not found very often in the production of contemporary clothing. Especially within womenswear which consists of seasonal style changes, a flowing-production is too static in its organisation. Typical advantages of flow-production, such as relatively low space for the production, short ways of transportation between the various stages and highly controllable production, come to account for the production of series of the same or similar garments.

6.1.2 Workshop-production

Workshop-production consists of variable work places which can be rearranged depending on the individual circumstances of production. This organisation allows for high flexibility regarding various seasonal changes or styles.
Whereas the structure of organisation is a fundamental and static part of the mass-production of clothing the order of events can be seen as dynamic, flexible and communicative tools between the various stages.

Each type of organisation influences the whole course of production. A combination of flow- and workshop- processes insures the advantages of both ways of production come into account, whereas the disadvantages can nearly be locked out.

The technical management together with the department of work preparation overviews the various departments from which the creation of prototype garments are the first within the process. The development of these prototypes is under control of the technical management which gives instructions and limitations for the design of the different prototypes. All flat-patterns for the prototype garments are constructed following the average measurements of a size which is chosen individually by the company.

The 'preparation' section is the part of the organisation of mass-production on which this research concentrates.

Figure 42 gives an insight of this section showing different flat-pattern pieces laid out on a long table. Cardboard flat-patterns are hung up on rails in the background.

Figure 42, The clothing industry, 1970s, Source: Loppa in Heavens (Edt.) (2003: 7)

Flat-pattern cutting for mass-production of clothing consists of various areas. In the following the technical processes of grading and lay-planning are described. Both are important for the production process because they are aiming to reflect and serve a wide range of customers and be efficient at the same time.

6.2 Grading

Peters (1975: 80) states that the term 'grading' means the up- and down-scaling of the size of the pattern. Figure 43 shows the different outlines for the various sizes of a historical grading method from 1916.

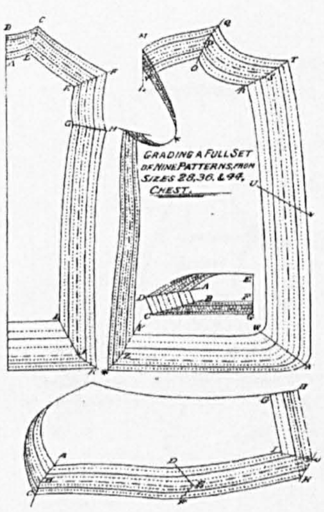


Figure 43, A method of grading a full set of patterns for a jacket , The Cutter's Practical Guide to Cutting by Model Patterns, John Williamson, 1916, Source: Aldrich in Ashdown (Edt.) 2007: 37)

Mass-production of clothing is based on the production of one design in various sizes. Therefore all other sizes then the sample size need to be graded.
Aldrich remarks that:

> *The grading of patterns by computer is based on the identifying where specific points on the pattern have to be extended or reduced to create a new size. These points are extended or reduced by means of X and Y co-ordinates. The X and Y co-ordinates tell the computer the direction in which a point has to move; measurements have also to be given to identify the position of the new point. Aldrich (1997: 182)*

The following Figure 44 illustrates the basic grading method and the co-ordinate directions of grades on the example of the back panel of a bodice block.

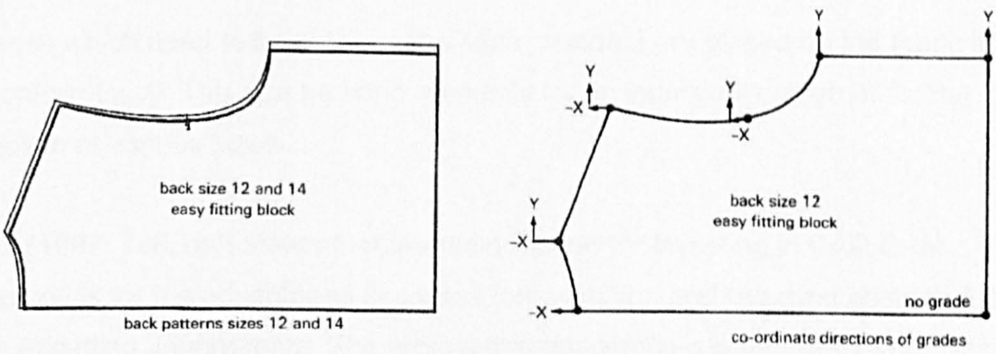


Figure 44, Basic grading method left and co-ordinate directions, right, Source: Aldrich (1994:182)

Figure 45 illustrates the principle of grading on the example of the shoulder point.

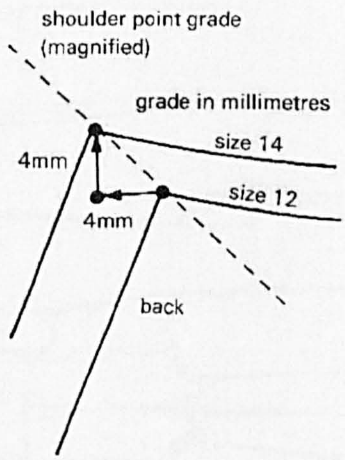


Figure 45, Grade rule for the shoulder point, Source: Aldrich (1994:182)

Aldrich (1997:178) mentions that the different sizes are grouped in size groups which all have different grades. The grading system is based on the idea that small sizes have a minor grade, whereas the bigger ones do have a higher grade. These so called grade rules are instructions on how much a pattern increases across a range of sizes in X and Y co-ordinates at given control points. Manual grading uses the horizontal and vertical orientation instead of the X and Y co-ordinates.
The pattern pieces, graded in the requested sizes, will in the following laid-out in order to be arranged efficiently. Next to CAD CAM other digital solutions for highly efficient pattern grading are Product Lifestyle Management (PLM) and Product Data Management (PDM).

6.3 Lay-planning

All pieces which need to be cut from the same material are placed on the fabric in the most efficient way. This can be done manually for an individual design or for the production of various sizes.

Aldrich (1997: 186,187) states that the main reason for investing in CAD CAM technology is for the advantages in control, organisation and reducing costs that it brings to cutting departments. She argues that lay-planning is important in the initial costing of a garment.

Lay-planning is used for complex lay-planning of garments in various sizes. The following two illustrations, Figures 46 and 47 show examples of a manual and a computer aided lay-plan.

Figure 46, Full lay plan, Source: Peters (1978:88)

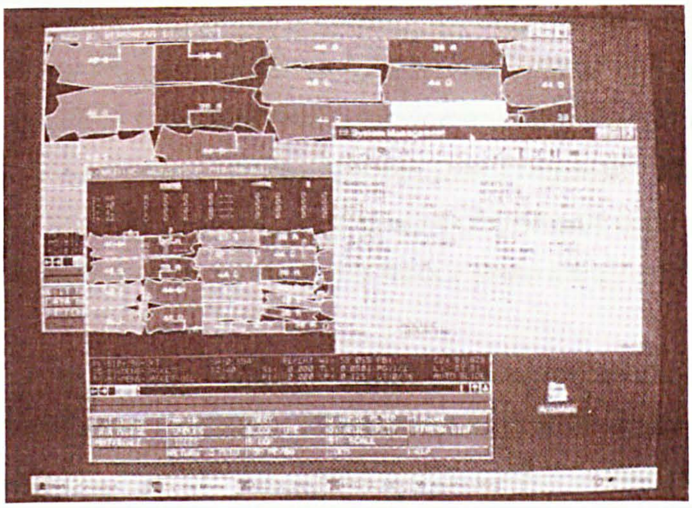


Figure 47, CAD CAM lay plan, Gerber Garment Technology, Source: Aldrich (1994:189)

Down (1999: 89) states that the lay-plan is calculated to make the greatest use of the fabric area, produce the shortest cutting time and keep waste of fabric to less than five percent. Peters (1975: 86, 87) suggests that a lay-plan is further on needed for calculating a certain style. The calculation of the needed fabric is of vital importance for mass-production. The amount of fabric needed for a certain style influences the price of the finished garment.

6.4 The Beginning of Industrially Produced Womenswear

This research begins in the post Second World War years. These years were of importance for the subsequent development of womenswear mass-market clothing, as already stated in Chapter 1.3.1.

Sorber (2003: 24) argues that even the very early paper patterns from the sixteenth century were primarily meant to indicate how fabric could most economically be cut. She shows that pattern layouts in early tailors' books from 1589 show that the pattern was used to guide the tailor to avoid waste while cutting.

6.4.1 The *Utility Scheme* during the Second World War

As argued by Entwistle (2000: 208) the Industrial Revolution in Britain had in fact been set in motion by the textile industry. Beese and Schneider (2001: 201-206) agree that the clothing industry together with other mass-productions industrialised a whole region in central Germany, the *Ruhrgebiet*, in the post Second World War years.

Even though the use of block-pattern had its starting point at the time of the Industrial Revolution and further on for the production of uniforms, during the First World War, industrial mass-production for womenswear started after the Second World War. Rouse (1989: 177,178) declares that a regulation was introduced by the government In Great Britain in 1940. This *Utility Scheme* banned the production of inessential goods so that all raw materials and labour could be concentrated in the war industries.

Sladen (1995: 43) is of the opinion that the combination of utility cloth and austerity restrictions resulted in (menswear) suits in familiar materials but with slightly shorter jackets, lacking waist pleats, breast pocket or buttons on the cuff. Laver (1982: 230) confirms that a national standard dress for civilians was proposed and at least one utility garment was said to have been produced in early 1918.

Sladen (1995: 25-39) affirms that utility clothing in Britain during the Second World War was extremely unpopular, because the population strongly connected standardisation with general constriction. Sladen (1995: 31) presumes that therefore it took until after the Second World War, for mass-produced civilian clothing, which is based on standardisations in various areas, to gain in popularity. Furthermore, he mentions that the Board of Trade, which was partly responsible for the utility scheme for clothing, employed the designer Reginald Shipp to design a trade mark for utility clothing. He developed *CC41*, of which the number indicates the date and the double letter C stood for civilian clothing.

6.4.2 Civilian mass-production of clothing after the Second World War

Naturally, after the Second World War the demand for uniforms declined. Together with the people's longing for decorative things the production of mass-manufactured clothing started off again after the war, which had predominantly produced goods relevant for combat during wartime.

Beese and Schneider (2001: 16, 17) argue that people all over Europe urgently needed clothing, particularly in November 1948 the main need was for warm winter clothing. The clothing industry had to produce huge amounts of garments in the shortest amount of time. One company in Germany had to produce 1.5 Million shirts, 300.000 suits and 150.000 winter coats for girls and women in this very year.

Furthermore, Beese and Schneider (2001: 15-17) give a German example, similar to the British *Utility Scheme*, the *Jedermann Programm* (Engl. Everybody's Program), which started under government jurisdiction in November 1948. This program was also aiming to introduce the new idea of mass-manufactured outer-wear garments.

Sladen (1995: 77) reported that in Britain Stafford Cripps and Harald Wilson, successively Presidents of the Board of Trade in 1947 denounced the waste of materials and labour on these 'imbecilities'.

In the post war period the shortage of material could not only reasoned by the familiar reduction of fabrics. In regard to womenswear, the newspaper Picture Post commented Dior's New Look on the 27th of September 1947 as follows:

> *Dior alters your shape to fit his clothes (...) even if the many thousands of yards of material were available and every women had enough coupons for an entire new wardrobe can anyone seriously contemplate hopping on a bus in a hobble skirt? Our mothers reed us from these in their struggle for emancipation (...) in our own active workday lives there can be no place for them.*

It might be presumed that such ideas of waste are still present in the way flat-pattern cutting is used today. As seen in the comparative part of this study, the general way of construction womenswear jackets, trousers and skirts is similar to what it has been right at the start of mass-production after the Second World War.

6.4.3 The acceptance of mass-produced clothing

Breward (1995: 183,184) remarks that mass-market clothing offered cheap and attractive clothing products to a larger proportion of the population and this, together with the media by which fashion changes were communicated has allowed for a wide distribution of fashion information.

König (1971: 272) indicates that the 1950s marked the progress and growing acceptance of mass-produced womenswear. König compared the standardization of mass-production of clothing to other mass-producing industries.
He suggests that mass-productions on the one hand opened the products to the masses, but on the other hand resulted in social consequences. He states that it was not until the population got used to the positive sides of mass-produced garments,

such as new fashions becoming widespread and thus obtainable and affordable for all, that patterns became an acceptable item for manufacturing garments.

Entwistle (2000: 208) argues that by the mid twentieth century the developments within the mass-production of fashion had led to fashion being extended to a greater number of people than ever before. Mass-marked womenswear is chosen for this project because it is an available source for soft-tailored business-wear.

The common outsourcing of the actual clothing production to non-European countries since the 1980s (Beese and Schneider: 2001) and the global spread of chains and brands also underline the approach for this project to select mass-produced womenswear. Breward supposes that:

> *The twentieth century is characterised by historians from various fields as the age of mass-production and also of mass-consumption. These characteristics of the Western society are imprinted upon clothing and the formers attitudes to dress and identity. Breward (1995: 182, 183)*

Entwistle (2000: 211) concludes that mass-production was already successfully established for menswear in the early twentieth century in Europe's centres of industrialisation, such as in Birmingham and in Berlin.

Thiel (2004: 341) wrote that besides menswear, mass-produced clothing was nearly only present in the fields of work-wear and underwear. Thiel (2004: 340) adds that the unpredictable fashionable changes of womenswear being restrictive for mass-production. Entwistle (2000: 212) states that by the 1920s the women's clothing industry was still less developed than the menswear production, where the latter was already working with staple production.

Apel (1984: 83-91) asks whether or not the women's clothing industry has ever achieved a status which could be called mass-production. He is of the opinion that due to the rapidly changing styles in womenswear a mass-production per definition is nearly impossible, as long as mass-production is only defined as a repetition of static designs as in men's-, work- and underwear.

Thiel (2004: 341) agrees that the changing fashion in womenswear prevented an early start of mass-production in clothing. However she argues that the mass-manufacturing of womenswear was able to follow menswear production in the late 1920s because of the introduction of loose fitted,

simply cut female clothing together with the emergence of less structured forming foundation garments such as the corset. Still, Thiel (2004: 381) observed that the mass-production of menswear was a step ahead with womenswear slowly following.

6.5 Industrial Mass-production of Clothing

Beese and Schneider (2001: 199-206) define mass-production as the production of the highest possible amounts of goods, organised in economically efficient steps in the shortest possible amount of time together with getting the most out of man power. Successful mass-production was important to the general industrial development in many countries after the Second World War.
(Beese and Schneider: 2001, Fischersworring: 2007).

Mass-production made the spreading of fashion possible. Therefore, fashion became an important part of popular culture from the 1950s onwards. König (1971: 263) argues that womenswear mass-production in the 1950's can be regarded as the last major change in the socialisation of fashion. Until then all fashions had been dictated by minorities, mainly to distance themselves from the ordinary masses. Mass-produced fashion is no longer exclusive but freely available to everyone. But as mass-produced garments are available to everyone, it is also necessary that they fit everyone.

In contrast to made-to-measure production, in which the various stages within the production process could be carried out by an individual, mass-production deals with a group of employees, each working on individual steps within the production process. Every individual has his own defined task to work on and to finish, handing over to the following stage of manufacture fulfilled by another worker. This production process can be more efficient, if the design of the garment is not varied, because then the working individual gets accustomed to his task and remembers the best and fastest way of working. If the designs are based on rapid and complex changes, the production process is slowly and therefore less efficient.

Breitenbacher (1975: 24) indicates that the production of clothing is divided in outer-fabric, lining and inter-lining collections. The highest number is found in outer-fabric collections. Figure 48, gives the numbers of outer-fabric collections for mens- and womenswear in Germany in 1970. The high number for menswear outer-fabric collections is based on the various fabrics each single style is made of.

Product Group	Average Number	Highest Number	Lowest Number
Men's Wear	405	912	161
Women's Wear	194	616	-

Figure 48, Number of Outer Fabric Collections, Source: Breitenbacher (1975:24)

The following paragraph concentrates on flat-pattern cutting, as part of the production.

6.6 Contemporary Industrial Flat-pattern Cutting

The pattern is a fundamental and practical tool in the process of producing garments. Especially within the countless reproduction of mass-market clothing the pattern is the core of the design. With the help of the pattern each design is clarified.
Lauwaert (2001: 42, 43) argues that the two-dimensional pattern rather resembles an architectural drawing or a mathematical graph.
Nevertheless, the approaches on industrial flat-pattern cutting vary.
Bray differentiated between,

> *(...) standard block-pattern which main object is to provide a reliable and lasting basis of correct proportions and fit, from which modifications can be undertaken and trade block-pattern which purely rely on measurements from size charts and may include details and proportions based on commercial considerations to help in the sale of the garment to a bigger range of figures. Bray (1961: 10, 11)*

For the practical part of this research project the block-patterns from six different flat-pattern cutting systems, which relate to their pattern as block-pattern constructed using the body measurements plus ease, were chosen, because the correct proportion and fit of the patterns is of importance for examining the fit during movement.

6.6.1 Styles in mass-produced womenswear

Taylor (1990: 89,90) says that the manipulations which are necessary for altering a basic block-pattern into any desired style have proved useful in speeding up the process of pattern construction and helping to standardise fit and sizing. Other construction methods, such as draping, are not satisfactory for mass-production because the draped garment can either only be made once or its parts need first to be translated into a flat-pattern.
Seeling (1999: 71) mentions that a garment created by Madeleine Vionnet in 1935 was seen as unfinished because only a few people were able to find out how the garment had been draped into shape.
Nevertheless, each garment type would normally have a different block-pattern. The differences are based on the various shapes or silhouettes of the garment type.

The variations within the different styles of a garment are achieved by shortening and lengthening the construction lines which are marked on the block. Sommer and Wind (1988: 79) argue that these shapes are based on basic graphic shapes, such as a line, a circle, a square or a triangle. These shapes are connected to corresponding proportions and symmetrical relations. Asymmetry in the basic pattern has been avoided in the past.

Mass-produced styles are often developed by attaching various shaped pattern pieces, such as collar, cuffs and pockets, which are not dependent on the size of the human body in the same way as the block-pattern does. Besides these seasonal changes the fashionable appearance is achieved at by the chosen fabric, the used colour and items such as buttons and zippers.

6.6.2 Flat-pattern as a tool for creating styles

Beese and Schneider (2001: 29) remark that the garment industry is, like every other mass-producing industry, to a great extent subject to economical and functional work processes.

Flat-pattern cutting is economical with the result that most of the fabric can be used. Besides, the sack-shape style with its mainly straight or slightly curved lines, underlines the efficient mass-production because it limits the waste of fabric. The garments are easy to iron and can be stored efficiently when put on a hanger. This also saves space at the company or during transportation.

When interviewed on the 22nd of March 2005 Andreas Jaenicke, head of design and Julia Stuckberger, head of pattern department at the *Strenesse Company* in Nördlingen, Germany claimed that they still try out new or complicated patterns on paper. For some, using an original size paper pattern helps to understand the proportions, which would not be possible for them on a screen on a much smaller scale.

In personal or telephone conversations other professionals confirm that they construct the block-patterns manually and that they use the computer for developing the fashion-pattern. Many professional pattern cutters develop a pattern in the traditional way with a full size paper pattern. This is especially the case for professionals aged 50 and above. Most of the professionals under 50 years of age are using CAD CAM software and manual pattern cutting. Transcripts of the conversations and interviews can be found in Appendix 3.

According to personal experience of the researcher, the pattern cutting department of a garment producing manufacturer is of major importance for the general success of the company. Today, when every company tries to sell to the highest possible amount of customers, the fit in every size is extremely important.
Even if a piece of clothing appears to be fashionable and has an affordable price, the garment will not be sold very often if it is not well fitted. If the garment not only fits badly but also restricts the customer in his movement, the whole design has failed. To prevent such failures most of the European mass-producing companies still have their new designs produced on their premises in order to check the fit of the garments before they go into production in low-cost labour countries,
In most cases the area, provided for fitting is directly situated next to the pattern department. Like this, even smaller patterns, such as ones for collars or pockets, can be evaluated on the workroom stand or the live model at once.

6.7 New Technologies within the Clothing Industry

Bye, LaBat and DeLong (2006: 76) affirmed that computer-aided-design was adopted to conserve economic resources and help make the clothing industry more competitive. The researcher's own experience in pattern drafting with CAD CAM systems, is that the technology is time sufficient when it comes to attaching seam allowance or to grade a pattern up and down into the different sizes,
and that artistic and unusual approaches to the pattern can be performed as well as manually, but that a manual experimental phase is needed before working digitally.

Before the mid 1990s, when the computer generated work place took over the constructional process, the companies had their flat-patterns constructed manually. Still today, manually constructed flat-pattern can be found especially in small workshops. With the help of the computer it is possible to digitise a sample garment and lay it over the company's original block-pattern. Therefore just the design of the piece is copied, without changing the basic measurements of the block-pattern. Following this the problems regarding a constant fit for all sizes nearly disappeared in many companies.

One early written work, which is dedicated to the use of computers in the fashion industry, is by Taylor (1990: 88-89) who describes the pattern design systems as the latest in computer-aided-manufacture (CAD CAM) systems.

Taylor argued that at the time of writing in 1990, the pattern design systems were not all that popular with the designers and pattern cutters. Taylor concluded that this was because the process of designing patterns was difficult enough without the added burden of a complex program to learn and manipulate.

6.7.1 Technical inventions in mass-production before computerisation

In order to understand the development of computer-aided workstations in different parts of mass-production of fashion, it is necessary to step back and see what the clothing industry was initially built on at the time of early mass-production.
Sorber (2003: 28) argues that the most obvious change in garment production in the nineteenth century was the introduction of the sewing machine. Although the earliest patents date from the end of the eighteenth century, large scale use of the sewing machine was introduced in the 1850s. Furthermore, Sorber (2003: 28) supposed that the invention of the sewing machine played an important role in mass-production of clothing.
The sewing machine necessitated a range of inventions in the fields of cutting, preparing and sewing fabrics. Entwistle (2000: 213) agrees that the sewing machine was the primary piece of technology in the production of clothing.

However the clothing industry was not as far developed as other industries. Whereas industries, such as the car industry, used machinery to replace individual workers, the sewing machine required the individual operator for every machine.
Entwistle (2000: 208,209) found that the clothing industry is much less mechanised, and technological developments have not replaced this basic unit of production. Beese and Schneider (2001: 171) argues that a significant change within the clothing industry cannot be seen in the development of machinery, but in the shift of the production towards countries outside Europe. This transfer has been taken place since the mid 1980s and is widely accustomed today.

6.7.2 Recent technical inventions

International fair trades such as the *Techtextil* take place every three years and display an enormous amount of specialised machinery for sewing in zippers, flap or welt pockets. The fair trade aims for all technologies and services for the processing of flexible materials. The first *Techtextil* took place in May 2011 in Frankfurt, Germany, replacing the former *IMB World of Textile Processing* in Cologne, Germany, of which the last took place in May 2009.

In 1987 the *International Fair for Textile Machinery* in Paris and in 1988 the *International Fair for Machinery for the Production of Clothing* in Cologne, started a discussion about computer-generated possibilities within the production of clothing. The outlook for the future then was to generate the whole production process. The subsequent research on automation within the garment industry intensified.
However an automotive control system failed due to the lack of interaction between the various steps of the production and the many minor processes, which are not able to be realised on an automatic basis.

Prototypes had to be send back and forth, because this was the only way of solving the problems. To prevent such problems, European companies keep the sample, or prototype, production at the premises of the company.
As argued by Entwistle (2000: 212) the main part of clothing production, the actual sewing on the machine cannot be replaced by machines.
Further inventions include the software for an automatic lay-planning which saves 2.3 percent of fabric, as shown in Figure 49.

Time of manual marker nesting	25 min.
Marker length	5,519 m
Material consume/size	1,38 m
Efficiency	87,00%

Time of Master Marker nesting	4 min.
Marker length	5,378 m
Material consume/size	1,34 m
Efficiency	89,30%

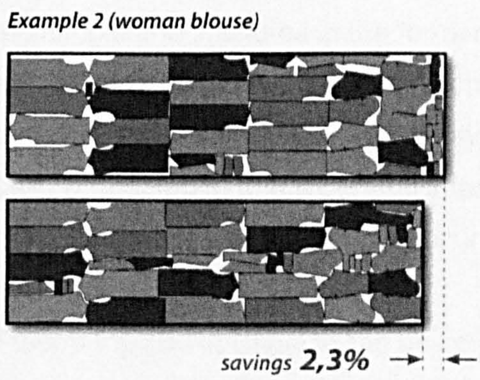


Figure 49, Automatic module for material savings through corrected lay planning, Source: www.inventex.eu

Beese and Schneider (2001: 172) stated that the general impact of new technologies, such as email, has been of great importance for international communication and for sending and receiving data but it did not directly enhance mass-production of clothing.

6.8 Computer-aided-design

It was not before the early 1990s that the computer screen replaced the table as the main work place for the development of flat patterns. Since the mid 1990s many companies use computers together with specific programs for some procedures; one being the construction of flat-patterns.
The software for constructing a two-dimensional form or pattern is not something which has been invented by the garment producing industry. Before computer-aided-design (CAD) was used in the clothing industry, they had been used in the car industry and for architectural and purposes. According to personal experience with CAD CAM Software for architecture, apart from the above aspect of working with non solid materials, all basic steps within the CAD systems are the same as for the development of flat patterns for clothing. Prof Dr Rödel from the *Technische Universität Dresden* agrees that all CAD programs are similar and even if they are not intended for clothing it is still possible to construct flat-pattern for garments.

The *Technische Universität Dresden* has been working with CAD software as early as 1982. In a personal interview with Prof. Dr. Hartmud Rödel on the 17th of March 2005, the work group at the *Technische Universität Dresden*, Germany, started with flat-pattern for tents. Rödel used a prototype version of the Grafis CAD software system which officially launched at schools and institutes in the former German Democratic Republic in 1991. Rödel himself established the first CAD technology for an underwear company in 1984. Rödel believed that the early use of CAD systems in the former German Democratic Republic is connected to the general interest in new technologies in the nineteen-eighties and because the clothing production in the country was solemnly mass-production.
In the Federal Republic of Germany and in England the use of CAD CAM software is present in mass-production of clothing from the early 1990's onwards.

6.8.1 Two-dimensional computer-aided-design for flat-pattern cutting

The construction of flat-pattern on a computer screen is similar to the traditional manual method of drawing the patterns on paper using a pen. The main difference is the reduction of the full size paper pattern to one that fits the size of the computer screen. The necessary tools to develop a traditional paper pattern, such as a pencil to draw the lines, various types of straight and rounded rulers to ensure accurate lines and curves and also a pair of scissors to cut out the drawn pattern pieces, have been adapted by the different software. Additional tools for indicating a button or a zipper onto the pattern construction can also be found in the computer-aided-design programs.

Pattern cutters today have learned both to develop a pattern on the computer and to construct it manually, even though there are some amongst them whose education was before the use of digital pattern cutting in the 1990s, who are purely familiar with manual flat-pattern cutting, see interviews with professionals in Appendix 3.

Rödel said that his students learn manual pattern cutting in the first six months, but tend to prefer computer-aided-design for flat-pattern cutting as soon as mastering the technique.

Next to the positive aspect of saving time which is spent on constructing the pattern by adding and leaving out certain steps without having to start from the beginning again, as it would be necessary while constructing manually, the resulting pattern is more accurate. The exact lengths are measured by the computer and the thickness of the construction lines can be chosen.
Connected to a pattern printer, which prints out a full-scale size pattern, the CAD CAM program allows printing flat-pattern as often as necessary in a constant quality.
When interviewed in October 2003, Barbara Wentzel, Technician at the London College of Fashion, stated that CAD CAM is especially helpful for an overseas production, as the patterns themselves or complete lay plans can be communicated via the internet and this as often as necessary.

Even though the clothing industry has been working with two-dimensional computer-aided-design programs since the mid 90s, the first programs for three-dimensional constructions were introduced at the *IMB* fair-trade in Cologne, Germany, in 1997

6.8.2 Three-dimensional computer-aided-design for fitting

The industries working with static materials have a design tool for creating three-dimensional models, such as cars. Creating a three-dimensional construction tool for flexible materials or for different types of fabric with different draping properties depending on their weight and texture is more difficult to develop.

As early as 1990 Taylor wrote about the computer-aided-design programs which are involved in the production process of clothing. Taylor (1990: 89) stated computer-aided-manufacture programs, which involve the grading of the flat-pattern into different sizes, as a follow up from the first CAD CAM systems. This tool was judged as very useful in speeding up the process for mass-market production and for standardising a company's fit and sizing. Still, in the following he objects the pattern design systems being a dangerous tool, because it is purely a flat medium and resists the use of modelling, plus there is the difficulty of mastering the program and the illusion the computer gives of infallibility. Taylor (1990: 90) mentions the fact that the pattern technician is working at a reduced scale. This argument against developing a flat-pattern with the help of CAD CAM systems can often be heard by pattern technicians and teachers.

The critique on two-dimensional construction programs being resistant to the use of modelling garments was a starting point for the software companies to develop three-dimensional construction programs.

Three-dimensional programs have been in use in industries working with solid materials since the late 1990s. The main difference to moving materials, such as fabrics, is the need to reflect the weight of the fabric together with the gravity.

The combination of both factors reflects a specific fall of the cloth that needs to be visible on the computer screen.

At the time when the first software developers explored the field of three-dimensional designing, the aim was for a programme with which a three-dimensional model could be created first, paired with a garment design, following a direct translation into a flat-pattern without the necessity of developing the pattern separately. International software companies started to present their three-dimensional pattern cutting systems at the *IMB* in May 2006, the aim of automatically generating a two-dimensional pattern from a three-dimensionally designed garment has not been fulfilled yet.

6.9 Experiences of Pattern Cutters and Academics

Mass-production of woven womenswear supports the use of flat-pattern cutting as being efficient and therefore appropriate for mass-production. Because of that, flat-pattern cutting is a major part in academic and vocational training.

As colleges in England and polytechnics in Germany educate their students for a future in the industry, the industrial method of mass-production is taught.
Even though vocational training is intended to prepare for working in the industry and the curricula are developed according to industrial requirements, the approach to pattern cutting can be different. Flat-pattern cutting taught often concentrates on individual made-to-measure production, because through this the student might understand the relation of the body and the pattern. Fittings for individual measurements are not part in industrial production which relies on average measurements from size charts.

The following outcomes of interviews, undertaken in Germany and Great Britain between 2003 and 2010, with teachers at fashion schools and pattern cutters in the clothing industry reveals, that nearly all German subjects, except of the ones who lived in the former Federal Republic of Germany, were trained on the M.Müller&Sohn flat-pattern cutting system.
This is up to the fact that this system offers courses for achieving the status of a pattern cutter in three different cities in Germany. The first institute was established in Munich in 1890. Furthermore, it was the primarily used system in Germany since the Second World War.
Consequently, all German subjects use this system in their job and in the academic case, teach this system. In contrast to this, subjects working in the UK are familiar with various flat-pattern cutting systems.
German interviewees stated that they are satisfied with the M.Müller&Sohn system and that they have never seen the necessity of trying out a different system. Even though some admitted that they made personal minor changes regarding the use of the measurements given by the M.MüllerSohn system.

Others do appreciate the fact that the M.Müller&Sohn system works with direct body measurements and not only with calculated ones, as for example the Hohenstein system does. One subject added that body measurements are practical for fitting and tight-fitting garments but not for looser shapes. It was mentioned that taking body measurements manually is in itself not easy and often results in badly fitting garments. The group of subjects is parted between those who think flat-pattern cutting can be done either with the help of the computer or manually and others who strongly prefer manual flat-pattern cutting for the more important stages within the production, as for developing block-pattern or fashion-pattern prototypes. When interviewed Annegret Friehe, pattern technician at the University of Applied Sciences in Bielefeld, Gernany, said that she refuses to cut pattern with CAD CAM, because of the changed proportions from a full-size paper pattern and a small scale pattern on a computer screen. Whereas Christel Weber, another pattern technician at the same institute, interviewed in December 2004, strongly believes in the practicality of CAD CAM pattern cutting in regard to the clothing industry. Furthermore Weber stressed the time sufficiency of digital lay-planning and grading in comparison to do it manually.

Even though, Weber added that she knows about many clothing companies in Germany who have problems getting good pattern technicians lately. Weber is of the opinion that this is up to students who are getting more and more trained on the computer without being able to do so manually. This implies that the subject is of the opinion that it is necessary to learn manual flat-pattern cutting before constructing the pattern on the computer.

Andreas Jaenicke, designer and Julia Stuckberger, head of pattern department at the Strenesse company in Nördlingen, Germany, said when interviewed in March 2005 that their company can afford to employ two groups of technicians, one works manually and the other one develops the pattern on the computer.
From both of these groups, the ones who work manually are treated with more respect because they are working on the more exclusive designs and they are a 'dying species'.
When interviewed in October 2003, Barbara Wentzel, pattern technician at the London College of Fashion, said that three-dimensional CAD CAM programmes are used since the year 2000.
The researcher initiated a course on the test version of *3D-Fit* by Lectra at the University of Applied Sciences in Bielefeld in October 2005. At that time the University of Applied Sciences in Bielefeld and the Technische Hochschule Dresden were the only educational institutions teaching three-dimensional visualisation software in Germany.
Transcripts of the recorded interviews can be found in Appendix 3.

6.10 Summary of Chapter 6

The technical developments of the mass-production of clothing have made great improvements since the 1990s. All inventions aim for a higher efficiency which runs parallel to lowering the costs of labour.
But still, it is possible to produce mass market clothing on simple sewing machines. All tasks performed by specialised machinery can also be done with the sewing machine. The main difference is the variation in time consumption.

Entwistle (2000: 212) argues that the garment producing industry followed other industries historically in their adoption of new technologies and developments. Considering outcomes from interviews a certain resistance against the exclusive use of pattern design systems can still be seen today.
Even though three-dimensional CAD programs are already fully used in the car industry where the software is used for constructing the flat-pattern for car seat covers, the available programs designed for the clothing industry are not working up to their full potential. The *Technische Universität Dresden* has been researching on the use of CAD programs for developing car seat covers for the *Audi* company in Ingolstadt, Germany.
The tool which let a virtual mannequin wear garments is more likely to be used for a first general fitting of lengths or different pattern. Even though there are programs which provide an ever growing number of different fabrics in a library,
the fall of the fabric on the virtual mannequin stays artificial and is not helpful for evaluating the fabric. The visualisation software *3D-Fit* by Lectra, formerly called *Virtual Garment*,
which was tested by the researcher between 2005 and 2007 at the *University of Applied Sciences, Bielefeld*, Germany, was presented at the *IMB* in Cologne in May 2006.
Before and after the virtual trial of the garments the user works with a two-dimensional pattern design system to create the flat-patterns first and to modify them afterwards. The construction technique for flat-pattern cutting is two-dimensional, as opposed to modelling, by which the material is directly applied to the form of the model in order to arrive at the desired style.
At the moment the method of construction can therefore not be called three-dimensional, as it would be with direct modelling.

Three-dimensional CAD CAM programs are based on a standardisation of sizes, to make them applicable to mass-production. The following chapter investigates sizing and size charts and their relation to the mass-production of clothing.
Flat-patterns for mass-production need to fulfil certain requirements. They need to be constructed manually or by the help of the computer. Additional folds on the pattern directly result in a higher amount of fabric or lay plans with more than five percent of wasted material.

Despite new technologies, such as constructing a flat-pattern with the help of the computer and then have it virtually made up for a fitting on the computer mannequin, the constructional method of womenswear flat-pattern has not yet been of great interest for further inventions or research.

In the following Chapter 7 the term 'fit' is investigated in regard to soft-tailored womenswear.

In the following Chapter 7 the fit of garments is investigated.
Phase 7.1 states general fitting criteria.
Section 7.2 describes the workroom-stand as a tool for checking the fit in mass-production.
Paragraph 7.2 states the static nature of basic body measurements with a subsection on static body measurements and body movement.
Section 7.3 examines fashion-pattern and fit, the preferred styles in mass-produced women's wear and the subjective side of styles fit.
Paragraph 7.4 describes lack of fit with a subsection on individual dress-fitting.
In Chapter 7.5 the possibilities for fit advancement in mass-produced clothing through three-dimensional body scanners are investigated.

7 FIT

Workman and Lentz (2000: 252) suggest that fit refers to the way a garment conforms to or differs from the body. According to Ashdown and O'Connell (2006: 111) there currently is no industry standard or accepted research protocol to assess the quality of fit for apparel in general. Furthermore Ashdown and O'Connell (2006: 112) quote Leibowitz and Post (1982) who are of the opinion that experts analyse fit by visually assessing a garment on a body. Even though this seems to be a subjective process they ensure that the human senses used as a testing instrument are able to identify and process complex stimuli more efficiently than any machine.

Nevertheless, a garment's fit is judged mainly on how it looks on the person while he/she is standing in an upright position. This is done either on a living subject or on the workroom-stand. This directly relates to the hypothesis of this research project, that garment construction considers the upright standing, non-moving body.
Croney (1980: 11) describes the general anatomical position as:

> *The anatomical term of position assume that the body is standing upright and at 'attention' with the arms hanging by the sides with the palms of the hands facing to the front with forearms fully supinated.*

This implies that a good fit in garments can only be achieved in an upright standing non-moving position. Consequently, the garments will most definitely show ill fit when the person wearing them is moving or changing the position.

7.1 Fitting Criteria

Wang, Newton, Ng and Zhang (2006: 250) affirmed that seams should follow the natural silhouette of the body. According to the authors the following general fitting standards apply while the model is standing upright:

-all vertical seams are perpendicular to the floor
-all horizontal seams are parallel to the floor
-the shoulder seams rest smoothly on top of the shoulder and end at joint
-the armholes create a curve around the arm with sleeve caps free of puckers
-the necklines fall close to the body without pulling or gaping
-the bust darts point to the fullest part of the bust
-all other darts point to the fullest part of the body contour
-the hems are even and parallel to the floor

Furthermore, the editors of Creative Publishing international (2005: 15) name the neckline and the shoulders as important fitting checkpoints on which the garment should rest smoothly against the figure without showing any wrinkles.
All of these fitting standards are identified for the upright position, as shown in the historical development of sizing the human body, as stated in Chapter 4.6.2.1.
Most of the above fitting criteria no longer have any effect in case the subject is not standing upright or performs movements. Fitting criteria for the moving body cannot be found for soft-tailored womenswear made of non-stretch fabric. What can be found is written work on altering womenswear for the un-proportional figure or for certain physical characteristics as a hump back and for different postural deformities (Bray, M. Müller&Sohn). Again, these alterations are there to enhance the fit on the upright standing, non moving body. A consideration of every-day-movements is missing.

7.2 The Workroom-stand

According to Kunick (1967: 73):

> (…) *workroom-stands were in common use amongst tailors long before the clothing industry was formed. In 1865 the first workroom stand made from papier mache was made by the Stockman brothers in France. This was the first time that bust measurements of the clients were reproduced as a dummy, as before, the workroom stands were little more than props on which the tailor observed the hang of the garment and checked the set of collars and sleeves. The Stockman brothers also defined a bust measurement of 88 centimetres was at the greates demand and called it size 44, which became accepted as the size of the average French woman. As the demand for workroom stands increased, they produced several sizes, with size intervals of 4centimetres.*

The following Figure 50 shows a toile, a trial out garment usually made of calico, on the dress-stand.

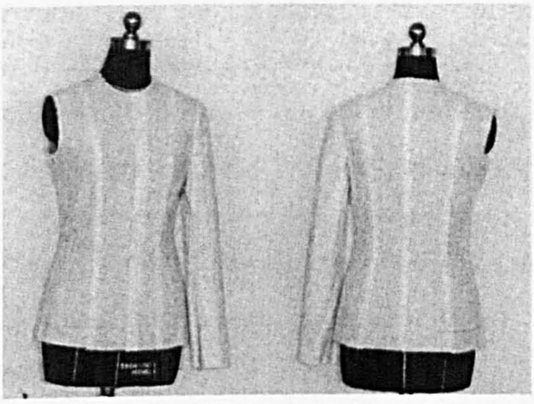


Figure 50, Toile on a dress-stand, Source: Wang, Newton, Ng and Zhang (2006: 250)

Workroom-stands, or 'dummies', resemble the upright standing body of an average size. Kunick (1967: 74) directly relates the development of the workroom-stand to the formation of trade associations within in the clothing industry which tried to standardise sizing and published brief size charts.

Today workroom-stands are part of industrial mass-production which produces garments according to size charts. It is important that workroom-stands are changed according to the updated information coming from every new sizing survey.

Gray, who investigated the historical development of the used measurements from different flat-pattern cutting systems for womenswear at the University of Ulster in Belfast, compared the measurements of the block-pattern to the ones of the workroom-stand. Parts of her work were published in the Point Journal (2000: 43-49).
Figure 51 lists the measurements of this dress stand and the bodice block-pattern in millimetres. The table is taken from Gray's (2002) thesis for the University of Ulster. Gray asserts different block-pattern cutting systems in regard to sizing.

Measurement	Dress/Workroom Stand	1951 Bodice Block
Bust girth at scye	910.0	954.0
Waist girth	670.0	704.0
Scye girth	365.0	409.0
Neck girth	360.0	372.0
Nape to waist	390.0	400.0
Front waist length	340.0	360.0
Shoulder length	130.0	126.0

Figure 51, Comparison of dress-stand and bodice measurements, Source: Gray (2002: 268).

Even though Kunick stated in his second book (1984: vii), that his pattern methodology had been developed for the modern apparel industry the comparison above shows differences between the workroom-stand and the bodice. Added ease of movement can be seen in the hip-, waist- and neck-girth.

Kunick (1967: 7) argues that some of the shapes in use for workroom-stands are far removed from human form and renders the task of garment sizing difficult in the extreme.

According to the researcher's personal experience in mass-producing companies and academic institutions, workroom-stands are replaced when being worn out. To purchase new workroom-stands based on updated size measurements is not common practise. Furthermore, upper extremities for fitting garments with sleeves are seldom found in both environments. These arm extensions are mostly made by the people using the stands, as the dummies come without. Even though women's trousers have gained popularity since the nineteen seventies, dummies for the lower extremities which reach from the waist down to the ankle are also rare do be found.

When interviewed on the 22nd of March 2005, Andreas Jaenicke, Head Designer and Julia Stuckberger, Head of Pattern Department at the *Strenesse AG* in Nördlingen, Germany, articulated that every new pattern is tried on the workroom-stand for approximately five times. This includes the first fitting of the paper pattern pinned onto the workroom-stand and fittings of the actual made up prototype garment. (Appendix 3)

The workroom-stand is a non-moving resemblance of the human figure in a certain proportional size. The following paragraphs investigate the static nature of the basic body measurements in other areas of clothing production.

7.3 The Static Nature of the Basic Body Measurements

The modelling person, similar to the workroom-stand, appears as a three-dimensional hanger immobile and static. Therefore it is rather the appearance which is judged than the actual fit on the human body.
Lauwaert (2001: 41) suggests that apparel on the one hand has a fundamental element of movement, but on the other it can be compared with architecture and sculpture.
Wilhelm (1954: 33) argues that the tailor is in charge of correcting the posture of a client towards a correct upright standing one in case the natural posture varies too much from it. This neglects the essential unity between the movable body and clothing. Being in motion is the fundamental factor for determining the fit of clothing. But still, the moving body is not considered in detail while fitting mass-produced clothing.
According to Bye, LaBat and DeLong (2006: 67) in mass-production of clothing it is expected that the human body matches the clothing standards of size-charts rather than to develop clothing to fit.

7.3.1 Static body measurements and body movement

Croney (1980: 93) states that the neck spine allows up to 90 degrees of movement in bending and 55 degrees of rotation from the middle position and the chest spine up to 30degrees of movement in bending.
Wilhelm (1954: 35) states that through the daily course of movements the surface of the human body shows many different forms which have impact on the fit of the garments up to being restrictive. Consequently Wilhelm (1954: 40) suggests extra amounts of fabric in various parts of the garments to prevent restrictions.

Figure 52 shows the uplifting of the arm on an anatomical illustration and two illustrations of arm movement and the result on the example of a tailored menswear jacket, similar to the type of womenswear jacket chosen for this project.

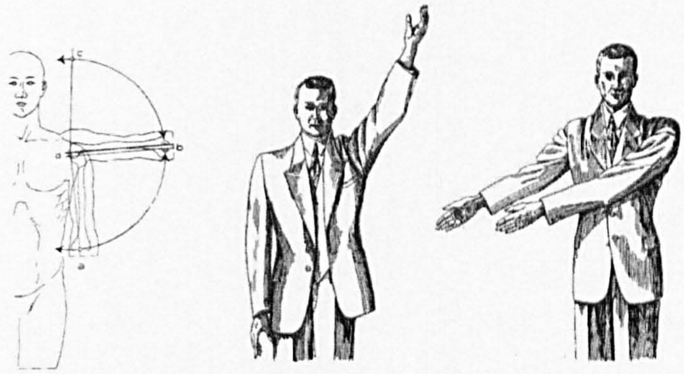


Figure 52, The uplifting of the arm and the consequences on the tailored jacket, Source: Wilhelm (1954: 36)

Figure 53 shows in how far the movement of the shoulder is connected to the arm and to the torso.

Figure 53, The Shoulder, Source: Wilhelm (1954:37)

Wilhelm (1954: 40) is of the opinion that the way in which extra fabric for comfort is arranged on the garments is an aspect of fashion.

7.3.2 Fashion-pattern and fit

According to Sommer and Wind (1988: 79, 80) the different shapes or silhouettes of the human body change according to different fashions. Farmer and Gotwals (1982: 6) remark that well-fitting garments do not necessarily imply a close fit, but that it rather refers to the fit being fashionable at a given time.

The editors of *Creative Publishing international* (2005: 12) suggest that it is the traditional tailored garment of which the fit is the most demanding. The authors reason that it is the tight fitting quality of tailored garments that complicates a good fit.

Despite block-patterns are constructed after direct body measurements plus additional ease to comfort basic movement, as explained in 4.6, there have been ways of inserting mobility in fashion-pattern. The extended shoulder length combined with a deeper and wider armhole in women's jackets enables to move the arm inside the garment. Whereas up-lifting of the arm to 45 or 90 degrees causes even more restriction because of the excess fabric on the shoulder and because of pulling up of the whole jacket. The extended shoulder length leads to an extended back and bust width of the back and front part of the jacket. The commercial success of such jackets from the early 1980s onwards is based on the fact that the enlargement fits more variations of a body size into the actual garment. As argued above the flat-pattern construction for a loose-fit garment requires less precision than for tight-fitting ones, such as the block-pattern from which other styles can be developed.

Even though broad shoulder jackets do not follow the actual body measurements they are constructed by manipulating block-patterns. When interviewed in 2005 Annegret Friehe, pattern cutting technician at the University of Applied Sciences Bielefed, Germany, said, that within every block construction for a women's jacket with a set in sleeve she would directly lengthen the shoulder and deepen the armhole, no matter what style she is aiming for. As an explanation for doing so, the improvement of fit was given. (Appendix 3)

7.3.3 Preferred styles in mass-production

Comparative studies in menswear showed that men who are not used to wear a custom-made jacket which tends to be tighter to the body than the mass-produced one, do experience it as being too tight. An internal study on this matter was undertaken by the menswear department of a clothing store after they decided for a co-operation with a leading menswear manufacturer in Gütersloh, Germany in 2005. For that reason a three-dimensional body-scanner was installed in the menswear department, offering the customers made-to-measure suits.

The owner of the department store declared, that they keep the scanner for promotional reasons but tend to rely on jacket prototypes in various sizes for the customer to try on after having been scanned and leave it to him in which he feels most comfortable. In this case the fitting criteria are determined by a subjective view.
As this research investigates fit seen from an observing perspective, this experience is not further investigated.

7.3.4 The subjective side of preferred styles and fit

LeBat and DeLong (1990: 43) state that a factor that may contribute to women's dissatisfaction with the body is that fashionable clothing reflects a standard they do not fit. When clothing does not fit, the consumer may perceive the cause as related to the body and not the clothing with resulting negative feelings about the own body.
As the aspect of well-fitted garments can on one hand objectively judged when comparing the actual body measurements with the measurements of the garment, the individual impression on the other hand shows that fit strongly relies on a personal, subjective view.
Apeagyei, Otieno and Tyler (2007: 340) found that deciding on procedures regarding collating data on psychological issues related to garment fit is an obscure process that is not clearly documented in literature.

As mentioned before, the fundamental posture of the human body which is taken for trying on prototypes or collection pieces is the upright standing position with both arms hanging down. But garments cannot be seen as covers for a static form, ignoring the constant movements of the human body.

Because individuals vary in size and shape, average figure types of varying proportions are the basis for the sizing of patterns. Standard body measurements have in the first place been established by the clothing industry to uniform sizing. The standardisation allows having a range of figure types and pattern sizes from which to choose. It is not only when making up made-to-measure garments that the part of choosing a basic size is crucial for the fit of the garment.

The main positive aspect of having standardisation of body sizes may that they try summarising a wider range of shapes in one size. If an individual's proportion is not the same as the one of the size the result is a garment which does not fit well.
The figure type is a matter of proportion. The overall proportion of the body, as there are the length of the torso, the location of the bust and hips in relation to the waist and the difference between bust, waist and hip measurements, are important factors in determining the figure type. Whereas the made-to-measure garment allows to ignore proportional size-charts, ready-made clothing does not.
Yoo (2003: 57) examined the preferred style of jacket for working women. The outcomes of her study revealed that a short- or hip-length jacket with notched or shawl collar were the most preferred styles.

7.4 Lack of Fit

To value badly fitted garments is not, as some might think, purely subjective. According to Lenker (1984: 187) the following aspects should be taken into consideration for judging the fit of garments:

- -all vertical seams should be perpendicular to the floor
- -horizontal seams should be parallel to the floor
- -the shoulder seams should rest smoothly on the top of the shoulder and end at the shoulder joint
- -armhole seams should create a smooth curve around the arm with sleeve caps free of puckers
- -the front and the back neckline should fall close to the body without pulling or gaping and they should be free of strain
- -the bust darts point to the fullest part of the bust, whereas all other darts point to the fullest part of the body contour over which they are shaped
- -the waistline seams should fall at his natural waist and they are supposed to be snug but comfortable
- -the cuffs should end at the wrist bone
- -the hems are even and parallel to the floor

The whole garment should smoothly fit around the body, with no pulls or wrinkles.

7.4.1 Individual dress-fitting

The subject of fitting for non-proportional figures is present in many books which are on individual dress-fitting. All of these books mention the above as criteria for good fitted garments. Authors include Bray (1970) who describes the basic principles of individual dress-fitting and Lenker (1984) who concentrates on fitting a proportional mass-produced garment to a non-proportional figure. Both of the above named books start with a detailed description of how to measure the various parts of the body.
A general introduction of dress-fitting is followed by sections on the various fitting problems of specific parts of the garment. Whereas Bray (1970) separates her sections according to the different garment types, Lenker (1984) mentions individual body shapes, the possible problem while wearing a specific garment and the alterations for correcting the fit.

Alterations can only be undertaken after they have been defined through fitting the garment. Even so, these alterations are made following an individual body shape. It might be that the same adjustments do not result in a better fit for all individuals whose body sizes are the same, but their shape or silhouette might be different.
Lenker (1984: 30) judges the choosing of the most suitable size as being the most important decision for achieving good fit.
According to Winks (1997: 4-6), the consumer is dissatisfied when a garment is ill-fitting, irrespective of the quality of the material or the workmanship, or the garment being fashionable.

7.5 The Three- dimensional Body-scanner for enhancing Fit

Simmons (2001: 11) stated that it was Magnant who produced a system which used a horizontal sheet of light to completely surround the body in 1985. Framework for the system carried the projectors and cameras needed that would scan the body from head to toe. Furthermore, Simmons and Istook (2003: 306-332) added that the development of new technology such as three dimensional body scanners make accurate measurements a very real and achievable goal. It allows for the extraction of body measurements within seconds.
The following Figure 54 shows the static upright standing position of the subject as it is necessary for scanning on the left and on the right the resolving scan together with an extraction of some of the possible measurements.

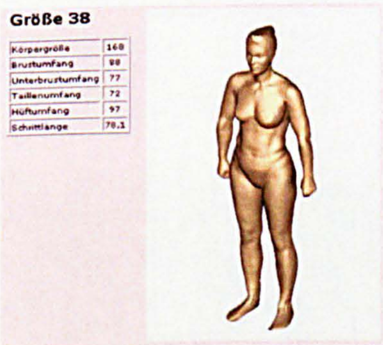
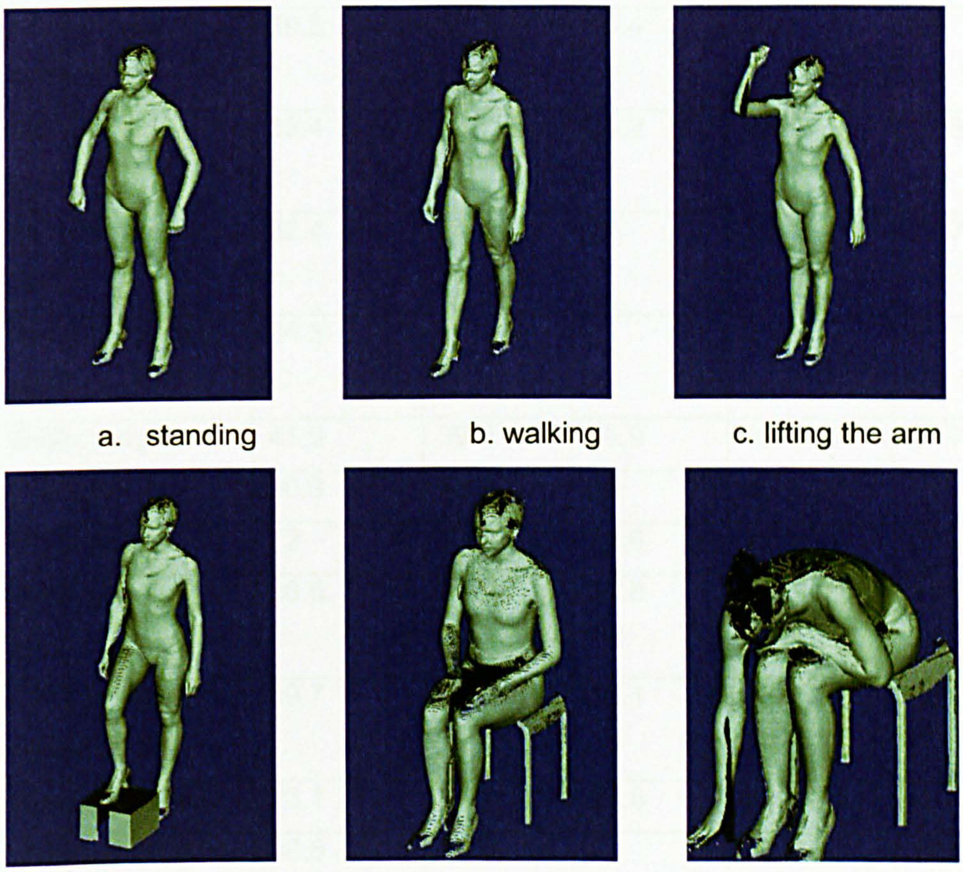


Figure 54, 3D Scan of the human body and the resulting basic measurements,
Source: Human Solutions

For this research the three-dimensional body scanner could not gain detailed measurements of the different 'frozen' every-day movements.

The following set of scans in Figure 55 shows six different positions taken by a three-dimensional body-scanner. The model used for the three-dimensional scan will appear again in the first video analysis as stated in Chapter 9.



a. standing b. walking c. lifting the arm

d. stepping e.sitting f.leaning forward

Figure 55, Basic every-day movements captured by a 3D Body-scanner

Figure 56 shows the positions 'sitting' and 'leaning forward' from all four sides. The three-dimensional body-scanner marks bench points for gaining measurements, indicated by the brackets.

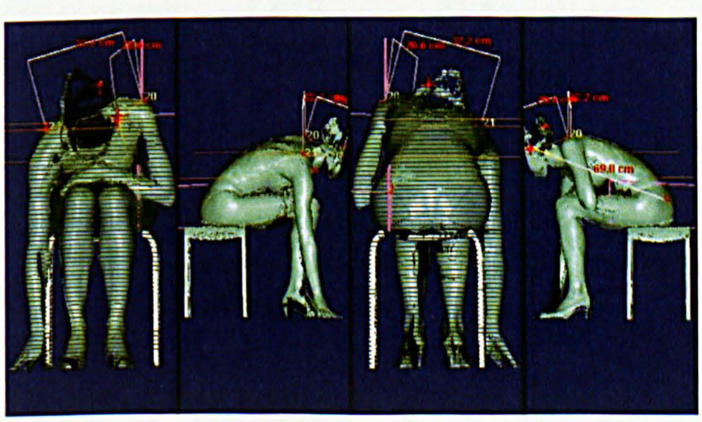


Figure 56, Sitting, seen from four sides

Figure 57 gives the measurements of all of the six images of Figure 55.

Measurements given in cm	**Standing arms down**	**Walking**	**Standing right arm up**	**Stepping**	**Sitting**	**Leaning forward**
Across front width	39.3	36.1	46.4	38.4	83	43.9
Across back width	33.4	34.7	25.2	33.6	32.8	42.8
Across back width	32.4	34.5	29	32.4	27.7	32.5
Distance back to waist	24.3	25	-	21.9	-	35.5
Width armpits	41.9	39.8	19.9	42.2	37.7	
Bust girth	90.3	90.8	86	88.2	-	-
Waist girth	72	73.9	72.6	71.1	-	-
Neck to waist front	36.5	37.5	34.8	34.5	31.8	-
Neck to waist centre back	39.7	42.1	46.1	38.9	40.2	51.5
Waist to buttock	23.1	22.2	21.8	24.8	-	-
Distance waist to buttock	18.5	18.6	-	18.7	16.1	-
Hip Girth	95.1	92	-	117.6	158.1	-
Arm length*	61.7	65	60.6	70.8	61.4	-
Elbow girth*	23.3	22.9	-	22.4	-	-
Upper arm diameter*	8.9	9.9	7.5	9.3	31.6	-
Mid neck girth	30.8	31.4	-	31.4	-	-
Side upper torso length*	24.8	24.8	-	22.5	-	-
Shoulder width*	14.9	13.7	13.6	14	-	-

1. a dash (-) indicates no information given
2. * an average is calculated, adding the left and the right side together and divided by two

Figure 57, Extracted data from 3D scans

The extraction of the data as shown in Figure 57 was undertaken at the *University of Applied Sciences Niederrhein*.

The three dimensional body scanner measures each side of the body separately. As this is inconvenient for mass production, the average is automatically calculated. Even though the three-dimensional body-scanner allows for gaining accurate body measurements when the subject is standing upright, some areas, such as the arm pit, cannot be measured. Furthermore, the scanner does not give valuable information of the different measurements taken in different situations. The scanner's software is developed for gaining measurements from an upright standing posture. It fails to calculate measurements from other positions.

The *University of Applied Sciences Niederrhein* in Mönchen Gladbach, Germany, undertook a comprehensive study in which manual measurement taking was compared to gaining body measurements from a three-dimensional body-scanner in 2009. This study was undertaken by a student of the university, the same one who extracted the data from the scans for this research project. Unfortunately the outcomes of this study are not publicly available. Nevertheless, the former student, who prefers not to be named, mentions problems with scanning the upright standing body (underarm area and top of shoulder cannot be scanned) and major difficulties with scanning a subject in any other position as being outcomes of the above study.

The full extraction of measurements can be seen in Appendix 4.

7.6 Summary of Chapter 7

The fitting of garments does follow general rules. These consider the upright standing body. This stands in line with the fact that historic sizing surveys and resulting size-charts are based on the upright standing, non-moving body, as shown in Chapter 4. Anatomical phenomena, such as the complex shoulder movement has been targeted in the fashion for broad shoulders in the 1980s. This style enables the wearer to move the arms underneath the jacket, but restricts the up-lifting of the arm. Furthermore, the broad shoulder together with the deeper armhole allows for greater variety of body silhouettes to fit into a size category. Consequently, the male mass-marked consumer feels comfortable in a wider, loose fitting jacket, as stated in 7.3.3. But still, outcomes of the questionnaire, given in 3.7, reveal that the female mass-marked consumer prefers fitting jacket styles.

Aldrich, Smith and Dong (1997) undertook a study of natural extended upper body positions and its use in comparisons of functional comfort of garments. The authors found out that buyers and designers have two major concerns;

the aesthetic appeal of the garment and its 'fitness for purpose'. This anthropometric and ergonomic study on women's tailored work-wear for the upper body was aiming at to place the subject in different recordable and repeatable natural body positions as they occur during working. Aldrich, Smith and Dong (1997: 345) concluded that: the study showed that the postures the human body performs in a working context are much more complex than ergonomic positions.

Even though, the three-dimensional body scanner is a tool for measuring the body and extracting data on the measurements as well as on the silhouette of the subject, it cannot provide accurate data on the different body positions. The one position which can be measured is the upright standing one, but still for this position the scanner works with minor difficulties of measuring the underarm area and the top of the shoulder. Simmons (2001: 56) found that for this technology to serve the industry best, it needs to be able to clearly and precisely indicate how and where measurements were taken and that these measures must also be accurate to ensure fit of the garments.

Nevertheless, Gray (2002) defined body scanning as the best strategy to implement, strengthen and enhance the appeal of made to measure clothing.

For gaining qualitative data for every-day frozen movements, the three-dimensional body-scanner is not appropriate. The extracted measurements are unreliable because the software only recognises landmarks of the body for the standing position.

The anthropometric and ergonomic study concentrating on different body positions as being condensed every-day movements and the 3D body scanner for capturing data on changed body measurements in these positions, fail to give accurate information. A positive outcome of this test would have allowed for accurate data on body measurements in the different positions. As a consequence, the question, whether basic body movements are restricted by wearing soft-tailored womenswear, need to be tested differently. The fit for movement which cannot be captured by the 3D scanner needs to be observed on the life model performing movements.

At this point of the research the hypothesis and research question cannot be investigated further by a purely contextual review. In the following Part 2, Chapter 8 practically compares six different flat-pattern cutting systems which are used in the mass-producing industry as well as in academic and vocational training in Great Britain and in Germany, through overlaying their block-pattern constructions for the jacket, trousers and skirt.

The following Chapter 8 is a comparative study on six flat-pattern cutting systems, representing flat-pattern cutting systems in Great Britain and Germany. This involves the constructions of block-patterns for a womenswear jacket, trousers and skirt constructed following the instructions of each of the six systems with the help of computer-aided-design software for two-dimensional pattern cutting.
These representative six flat-pattern cutting systems are examined by their author's professional background and approach to pattern cutting, as stated in Chapter 8.1.
In section 8.2 the research hypothesis, whether the block-patterns for mass-market women's business-wear reflect the moving or the non-moving body, is investigated through a comparative practical study, on the example of six flat-pattern cutting systems.
This comparison of the block-pattern constructions is the first practical contribution to new knowledge. The outcomes had an effect on the following practical work. Therefore, the emerging issues from the first practical comparison are stated in Chapter 8.4.

8 COMPARATIVE STUDY OF BLOCK-PATTERN CONSTRUCTED ACCORDING TO SIX FLAT-PATTERN CUTTING SYSTEMS

Even though fashion has mainly been connected to the female wardrobe, the mass-production of womenswear follows developments of the simple sack shape of the menswear jacket. The need for uniforms in the First World War pushed the mass-production of clothing and the popular sack-shape with its roots being in outdoor sports in the 1920s. This influenced the highly-decorated and tight-fitting womenswear towards a simpler style. This simplicity not only fulfilled the restrictions on fabric but also allowed for a wider range of movement. Because womenswear mass-production started after the Second World War, the following comparative study of six flat-pattern cutting systems covering the period from before the Second World War until the 2000s. The systems for investigating were chosen because they are generally accepted as fundamental work in the field of pattern cutting and are frequently used in Great Britain and in Germany in academic institutions as well as in the clothing industry. Another aspect for selection was that these systems have been updated.

The huge amount of publications of flat-pattern cutting systems in Great Britain reasons the number of four chosen systems for this study, in contrast to two German systems. Next to the fact that each system needs to be publicly available, the date of invention of each was inclusion, in order that they should cover the time from the Second World War onwards.

In contrast to the many different flat-pattern-cutting systems published in Great Britain, the situation is different in other European countries. In Italy, Austria and Germany a single flat-pattern cutting system achieved general acceptance, both in the academic and in the professional field. In the following this is explained in detail. In order to find out whether a single flat pattern cutting system is in any way different to the various publications available in Great Britain, the German systems are added to the comparison. This system dates back to before the Second World War (approximately 1920 for womenswear). This research references a publication from around 1960. Another more recent system from 1990 is also used to represent German flat-pattern cutting systems, even though it is not as widely spread as the older one.

The aim of this comparative study is to show that commonly used flat-pattern cutting for the construction of womenswear is developed with measurements which were taken of the static, upright standing human body. Furthermore, the comparison aims to find out whether the six different ways of construction show similarities or where they are significantly different. This is especially important as the flat-patterns are made-up and the fit of the garments during movement is tested on life model in Chapter 9. Here again, the fit is evaluated from an observing perspective as it is done in traditional anthropometric studies as stated in Chapter 7. The upcoming theoretical comparison looks at the block pattern of the modern women's soft-tailoring business suit, consisting of the fitted jacket, together with the two-seam sleeve for jackets, trousers and skirts of each of the six flat-pattern cutting systems.

8.1. Published Mass-market Flat-pattern Cutting Systems in Great Britain and Germany

In order to investigate contemporary flat-pattern cutting as used in mass-market clothing production in Great Britain and Germany, the following flat-pattern cutting systems were selected to represent commonly used systems. Relative to the number of published systems in both countries, four different systems have been chosen from Great Britain and two from Germany.

The systems published in Great Britain are: Aldrich, Bray, Kunick and Shoben and Ward. The ones published in Germany are: M.Müller&Sohn and Jansen and Rüdiger.

8.1.1 Time of first and following publications of the chosen flat-pattern cutting systems

All of these systems were published after 1950, with the exception of the M.Müller&Sohn system which date of publication cannot be traced back.
Figure 58 shows the time of the first publication of the different systems and the release of further editions.

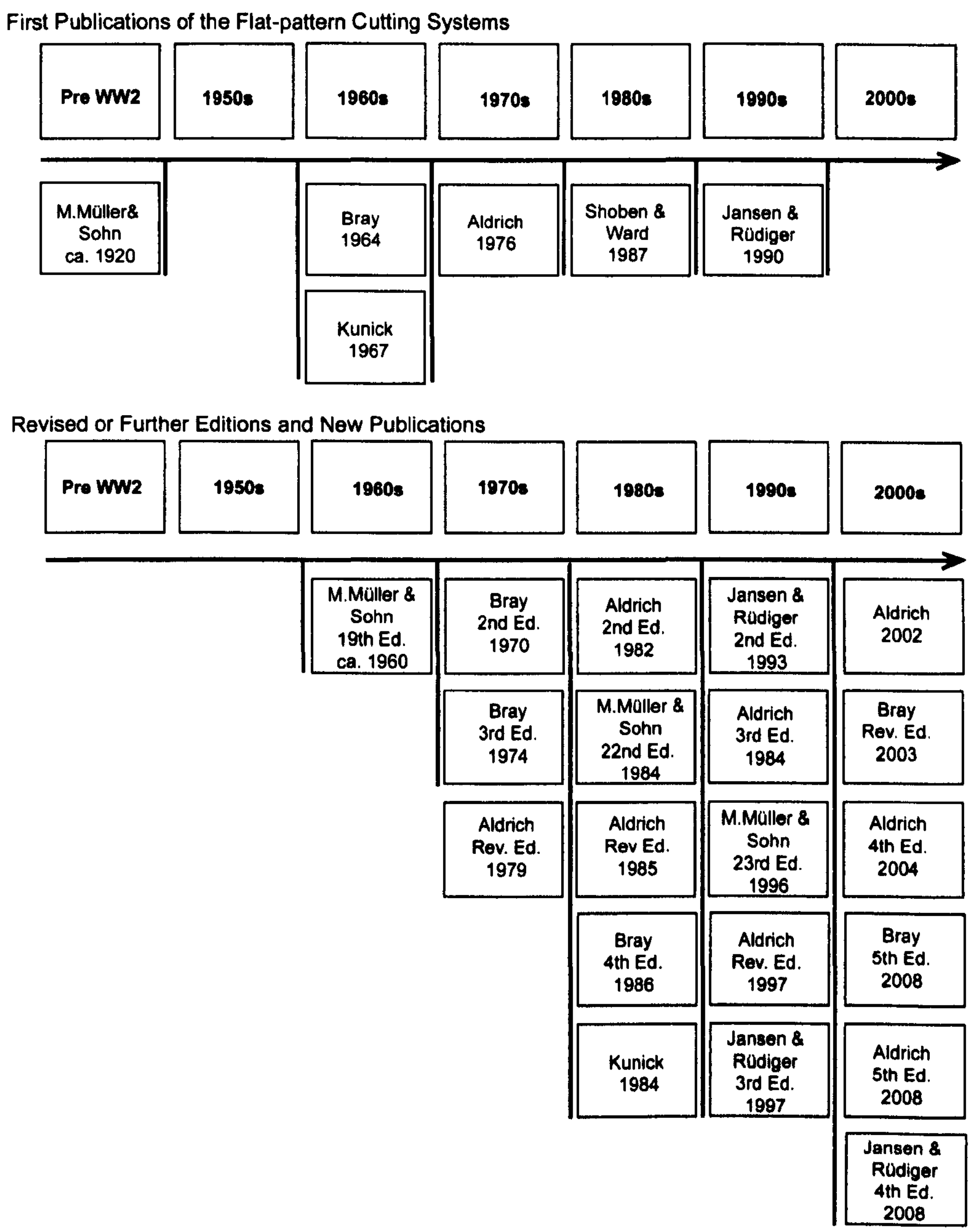


Figure 58, Time of first, revised and further publications of the chosen six flat pattern cutting systems

The exact dates of the revised editions could be found for five of the relevant six systems. For the M.Müller&Sohn system no clear statement regarding the time of publication can be made. All text books have been printed without a date. Neither the publisher, nor the M.Müller&Sohn institute have archives and neither are able to trace back the earliest publication of womenswear pattern cutting books. When interviewed on the 21st of April 2010 Niemann who investigated the historical development of flat-pattern cutting in Europe estimated the year 1891 for the first M.Müller&Sohn publication on womenswear.
Nevertheless, Berlin's *Lipperheidische Bibliothek* (a library specialising in costume, being part of the *Art Library*), keeps the earliest available (nineteenth) edition of the M.Müller&Sohn system, entitled *Der Zuschnitt für den Damenschneider, Blusen und Kleider* (Eng.: Flat pattern cutting for the women's wear tailor, blouses and dresses), dating back around 1960. A manually note on the date of publication can be found in library copies. In case the date is not noted down, it is impossible for the user to know which edition he is holding.

The following paragraphs investigate the professional background of the authors and the time of the first publications.

8.1.2 The authors and their professional background

As stated above the six flat-pattern-cutting systems differ in the time of publication. With the help of the following background information, each of them is set into the historical and sociological context.
Each system will be taken in order from the date of its first publication, starting with the M.Müller&Sohn system.

8.1.2.1 M.Müller&Sohn

Niemeyer (1986:37-39) wrote that the German M.Müller&Sohn flat-pattern cutting system was invented by the Munich based tailor Michael Müller (1852–1914) who also founded the *Deutsche Bekleidungsakademie* (Eng. German Academy for Clothing) in Munich in 1891. The first written work on flat-pattern cutting for menswear was published in 1890.
Since then all textbooks have been published through the Rundschau Verlag which belongs to the M.Müller&Sohn institute. A yearly magazine on flat-pattern cutting for mens- and womenswear is published since 1931.

This system was initially developed to suit the craftsman. Müller was of the opinion that his system could help the pattern cutter as well as the person sewing the garments who could fulfil his tasks much better by having background knowledge of the construction of garments. The major aims were to reflect non-proportional body shapes, ease of use and time-sufficiency. The system directly evolved from the bespoke tailoring craft.
The fact that it has based on three or four direct body measurements together with an additional three or four variable proportional measurements made it applicable for both individual made-to-measure and mass-market clothing production.

The proportional measurements have to be calculated from the main body measurements. On the M.Müller&Sohn website it is said, that this enables the cutter to determine deviations in the human figure and to be able to apply on them when constructing the flat-pattern. The M.Müller&Sohn system compares the front and back length of a pattern and uses this information to judge the body posture. This aspect only applies to individual made-to-measure flat-pattern cutting and is reflected in the edition from around the 1960s which pays much attention to non-proportional figures, such as a humpback or a sloping shoulder. Today the company sees their flat-pattern cutting system as being suitable for both individual and mass-market production.

The M.Müller&Sohn system was adopted quickly in German speaking countries, following three further flat-pattern cutting schools in Germany opened in 1931 in Düsseldorf, Hamburg and Berlin after the first pattern cutting school had opened in 1900 in Munich, Germany by Franz Xaver Müller, the son of Michael Müller. When interviewed on the 29th of May 2009 Niemann affirmed that there were around many different flat-pattern-cutting systems in use before Hitler's coming to power of which many are archived as originals or copies by himself at the *University of Paderborn*, Germany. It is said that Franz Xaver Müller, the son of Michael Müller, was successful with his system not because it was the best but because he was very fond of the political regime. Consequently the Müller system was the only one taught at schools during the Third Reich in Germany. Even after the end of the Second World War one criterion for the examination of the Master Craftsman Diploma was to be able to use the M.Müller&Sohn system.
When interviewed professionals in the clothing industry and pattern cutting technicians in the academic field confirmed that the M.Müller&Sohn flat-pattern cutting system is used predominantly in academic institutes and in the industry all over Germany (recorded interviews can be found in Appendix 3).

In 1955 Franz Xaver Müller left the company, including the various schools and the publishing house. Since then the chairmanship has been in the hand of Franz Josef Köhler, a long time manager who bought the company in 1982. His son, Michael Köhler took over in 1995.
Following the information published by the M.Müller&Sohn Company, their system shares 100% in the customised market and it is also leading (no given figures) in all other areas of garment production and in the area of education in German-speaking countries. Furthermore, it is claimed on the companies' internet representation that the M.Müller&Sohn system is the basis for 70% of all CAD CAM systems worldwide.
An attempt to reach new customers outside German-speaking countries can be seen in the first English translation of a M.Müller & Sohn textbook, entitled *Metric Pattern making for Jackets and Coats with sleeve/bodice combinations,* published in 2009.

8.1.2.2 Bray

Gray (2002:194) formulated that Bray's *Dress Pattern Designing*, published in 1961, was an account of pattern construction methods practised at the *Katinka School of Dress Designing* in London, of which Bray was the Principle. Furthermore, Gray identified the philosophy behind the system as a mixture between French Modelling (French: Moulage) and flat-pattern cutting because the shape of the figure and its circumferential size is the basis for constructing a block-pattern. Gray discovered that Bray did not have access to body measurement data. Her system was based on combining practical experience and distinct methods for drafting a bodice block.
Gray indicated that:

> *Bray's sizing data was based on direct figure measurements taken close to the body. Size referred to the figure to be fitted; the size for each block pattern was based on either the bust or hip measurement. Gray (2002: 194)*

Bray uses eight body measurements plus six proportional measurements. She does not categorize these measurements into the general British size range, but prefers to give them Roman numbers. Even though the book has been reprinted and revised since, it does not contain flat-pattern instructions for womenswear trousers or for a two seam sleeve, which is the traditional sleeve for jackets. Therefore, this work references *More Dress Pattern Designing*, written by Natalie Bray in co-operation with Ann Haggar in 1964. This textbook does include a section on women's wear trousers and on the two-seam sleeve as a part of a tailored jacket.

Dress Fitting – Basic Principles and Practice, was published in 1970. At that time Natalie Bray was still Principle of the *Katinka School for Dress Designing* in London. In the preface to the book, she wrote that the work was on fitting notes she made while giving lessons at this institute. All textbooks rather concentrate on particular cases rather than on general advice and elementary rules.

8.1.2.3 Kunick

Philip Kunick's publication *Sizing, Pattern Construction and Grading for Women's and Children's Wear*, from 1967 is directly based on the outcomes of a sizing survey. Kunick used data from a study, published by the Board of Trade in 1954. W.F.F. Kemsley, who prepared the report and summed up the outcomes. This report was prepared for on behalf of the Joint Clothing Council Ltd. The council went into liquidation in December 1954. At that time the report was not ready for publication. Therefore, the Board of Trade arranged the publication in 1955.
Philip Kunick, at that time technical member of the *Clothing Industry Development Council*, was in charge of the measurements which were taken from employees of business firms and members of woman's organizations.
Gray (2002: 252) also mentioned this sizing survey in her thesis. She added that, in 1951, five thousand women aged between 18 and 65 years were measured in their underwear. Thirty- seven measurements were taken from each individual. All of these body measurements were taken while the subject stood on both feet (Kemsley: 99). Kemsley undertook the statistical analysis of the measurements and had them transferred to punched cards. In the preface of the study the close collaboration between Kemsley and Kunick is stated. This gathering of direct body measurements has aimed at producing detailed size-charts. Size-charts are of great importance for the mass-market production because they enable to group the different measurements into sizes. They are not substitute for direct body measurements because the idea of mass production is in direct contrast to individual body measurements. With regard to the thorough research that went into these charts, it can be said that Kunick dedicated his flat-pattern cutting system entirely to mass-production of clothing.
This can also be seen in Kunick's work on developing a functional grading system - a process used to accomplish the sizing of manufactured clothing.
LaBat (1953: 13- 27) questions the belief that the foundation for grading is size measurements that are based on anthropometrical data.

In her research from 2005 she found out that only 17% of the body measurements were useful for grade rule formations. Faust (2009) argues that in 1967 Kunick proposed the establishing of a new size label to assist consumers in finding the right garments.

Kunick was also on board of the *London College of Fashion* in the 1970s. Besides his engagement in sizing, Kunick had his own womenswear company (Philip Kunick Ltd. London) from 1949 until 1987. *Modern Sizing and Pattern Making for Women's and children's Garments* was published in 1984. Kunick says in the subtitle that this written work is 'a scientific study in pattern construction and a standard textbook for the clothing industry'.

Similar to Kunick's system, the systems by Aldrich from 1976, and Shoben&Ward, from 1987, are both based on anthropometrical data. Indeed Gray (2002: 101) has judged Aldrich and Shoben&Ward have been directly influenced by the work of Kunick.

8.1.2.4 Aldrich

Winifred Aldrich published her first textbook *Metric Pattern Cutting* in 1976. The reference for this work is the third edition or the second major revision from 1994. Aldrich is coming from an industrial background, which is reflected in her flat-pattern cutting system. In the preface Aldrich states that she views her book as a basis for teaching flat-pattern cutting. Furthermore she explains successful trade designs, stressing the idea of mass-market production being the basis for her flat-pattern cutting system. Besides, this 3rd revision contains a chapter on computer-aided-design, including pattern grading, digitising of paper pattern and lay-planning (1994:177- 189). These sections underline the industrial approach of the author on pattern cutting as being understood as a tool for mass-production.

In 1980 a textbook on flat-pattern cutting for menswear was published which was followed by one on childrenswear in 1985. In 2002 Aldrich's book on tailoring cutting for womenswear was published. Since then Aldrich has been constantly revising her textbooks. The latest edition was published in 2009. Aldrich was Professor of Clothing Technology at the *Nottingham Trent University*. Furthermore, she taught an e-learning flat-pattern cutting course in September 2009 (www.onlinefashioncourses.com).

She frequently publishes articles. One of the latest with relevance for this research is *History of Sizing Systems and Ready-to-wear Garments*, published in 2007.

8.1.2.5 Shoben and Ward

Martin Shoben has been working in the fashion industry for all his life, following his father who was a tailor. In July 1970 Shoben started working at the *London College of Fashion* as a flat-pattern cutting teacher, a time when Philip Kunick still was on the board of the institute. At that time the college employed around fifty pattern cutters as teachers. He started to work on publications a couple of years after he came to the college. Since 1980, when he published his first book together with his colleague Janet Ward, he has written more than twenty different books.

When interviewed Shoben mentioned that he avoided the common scale systems and also those unsupportable theoretically – in order to concentrate on direct measurements for almost all block construction areas when developing his written work. Yet, Shoben suggests that a scale for the inside seam length of trousers can be helpful.
The Shoben&Ward title from which the references for this work are taken was published in 1987. Janet Ward also participated in the first electronically anthropometrical data gathering, called *Size UK* in 2000.
Shoben left the London College of Fashion in 1997 Shoben for establishing his own school, *The London Center for Fashion Studies*, in Islington, London. He recently sold his *London Centre for Fashion Studies* to the *Northumbria University* with its headquarters in Newcastle.

Shoben's written work is aimed at the clothing industry and at industry training. Despite this Shoben assumes that none of the published flat-pattern cutting systems is directly used in the process of clothing production. He is of the opinion that a textbook for cutting patterns can only be a guideline for explaining the overall construction. According to him, there is likely to be a personal adaptation of aspects taken from one or more flat-pattern cutting systems together with further individual developments of the construction depending on the personal experiences of the pattern cutter.

Today, Shoben publishes ready-to-use block-pattern charts for womens-, mens- and childrenswear. All of these multi size pattern charts include the British sizes 10 to 22 for womenswear and 92 to 108 cm chest girth for menswear at shobenfashionmedia.com. For the menswear charts he has worked together with Alan Cannon Jones, who is currently Principle Lecturer at the *London College of Fashion*.

8.1.2.6 Jansen and Rüdiger

The second German flat-pattern cutting system was developed by Jutta Jansen and Claire Rüdiger at a time when both were teaching pattern cutting at the *Lette Verein*, a vocational school for fashion, graphics and photography, in Berlin. The *Lette Verein* is a public trust was established as the 'Verein zur Förderung der Erwerbstätigkeit des weiblichen Geschlechts' (Eng. Society for supporting gainful employment for females) by Wilhelm Adolf Lette in Berlin in 1866. After his death in 1868, the institute was renamed as *Lette Verein*.

When interviewed on the 31st of March 2010, Rüdiger said that the idea of developing a flat-pattern cutting system grew out of the huge amount of collected materials for teaching. She and her colleague Jansen had always developed their own materials both in order to avoid payments when teaching the popular M.Müller&Sohn system and because neither Rüdiger nor Jansen believed the Müller system to be able to fulfil all their needs at their institute. Rüdiger criticised the M.Müller&Sohn teaching recommendations of working in a 1:25 scale. When Rüdiger came to the *Lette Verein* in 1979 – Jansen joined in 1981, she introduced flat-pattern construction on a full scale with which she got better results because she thinks that beginners are not able to spot mistakes on a small scale. Rüdiger herself worked as a pattern cutter in the clothing industry for over twenty years before she started teaching. She learned to cut flat-pattern only by her own experience, she was never trained in one particular system. The first book of a series of two was published in 1990. In the preface of the publication both authors stress the fact that modern times require an easy to understand flat-pattern cutting system. The instructions given are therefore less scientific in describing each step, compared to the M.Müller&Sohn system. Both authors stress the easy to understand graphics in combination with a clear structure and only the most necessary instructions. The aim of the written work is to ease the way from the block-pattern to fashion-pattern.

Rüdiger retired from her teaching position in 2004. Jansen is also retired but still works as a senior expert. Lill (2008) a journalist and author wrote an article about the Senior Expert Service in Bonn, Germany, which arranges exchange-service for professionals. The article about Jansen was published in the magazine *Brigitte Woman* in 2008. She supported fashion schools in Bulgaria and Uzbekistan as an expert. On this occasion Jansen introduced her textbooks of flat-pattern cutting which are also available as a Russian and English translation.

8.1.3 The systems and their measurements

The following Figure 59 illustrates where on the body the different measurements are taken. The way of illustrating the subject and the actual amount of measurements shown varies in each of the six systems.

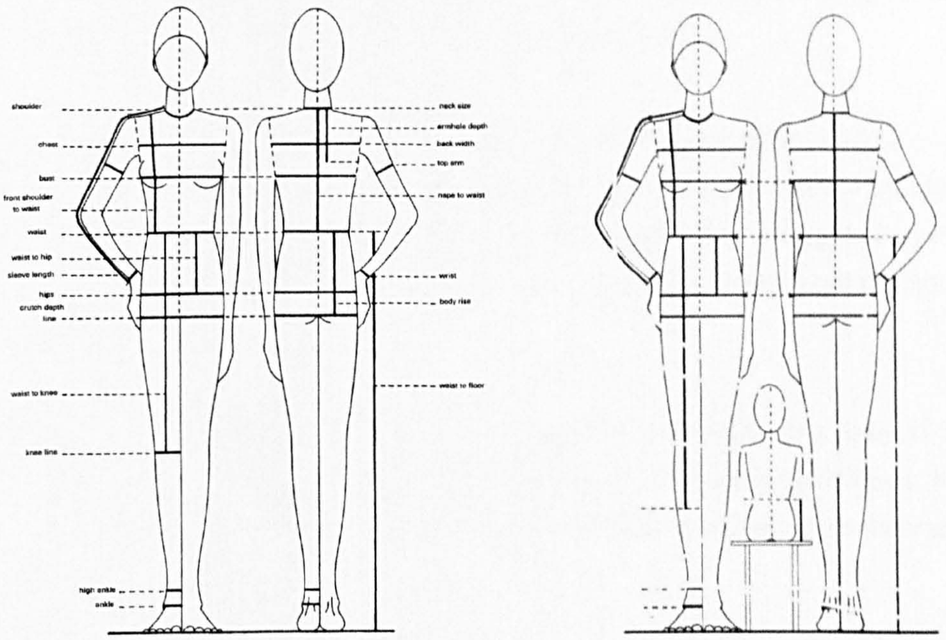


Figure 59, Body measurements, Source: Aldrich (1997:14 left and 37 right)

The following Figure 60 gives an overview over the general number of measurements of the six different systems.

Country of Origin	Great Britain	Great Britain	Germany	Great Britain	Germany	Great Britain
System	Aldrich	Bray	Jansen& Rüdiger	Kunick	M.Müller& Sohn	Shoben& Ward
Size-chart	Given	Given	Given	Given	Given	Given
Number of standard body measurements	21	12	given for particular garment types	42	given for particular garment types	18
for constructing a jacket pattern	14	14	16	31	17	20
for constructing trousers pattern	8	9	6	15	10	7

Figure 60, Comparative Number of Measurements Chart

As seen in Figure 60, the general number of measurements required for the different garment types vary. Kunick's system is the most accurate in reflecting direct measurements in the flat-pattern. Such a large amount of measurements is not used in mass-production of clothing as it reflects too much the individual body instead of an average size. It can be concluded that Kunick's accuracy is connected to his involvement in sizing studies, as stated in Chapter 8.1.2.3.

All systems require the subject to stand upright in order for direct body measurements to be taken. Except for gaining measurements for the construction of trousers Jansen and Rüdiger, M.Müller&Sohn, Shoben and Ward and Aldrich suggest that the model sits down to measure from the waist down to the seat in order to get the body rise measurement.

Kunick took nearly all body measurements on the upright standing subject, even though his written work consists of one chapter on measuring techniques. Kunick (1967) stated that the model stood erect with feet together and arms relaxed at the sides.

The difference in the number of measurements required for constructing block-pattern for different garment types shows the different approaches on proportions calculated from basic body measurements of the systems. Bray's system only requires few body measurements in combination with further six proportional measurements. Others, especially Kunick's system, do not make use of calculated proportional measurements. Of the 17 measurements needed for constructing a jacket block-pattern following the M.Müller&Sohn system, five figures are calculated which also indicates the idea of proportions next to direct measurements. A similar approach can be seen by Jansen&Rüdiger who needs 16 measurements for constructing a jacket block-pattern of which ten are direct and six calculated measurements. In contrast to this, Kunick refers to 42 direct body measurements that need to be taken.

As said before, Kunick (1984) was involved in sizing surveys. In his written work *Modern Sizing and Pattern Making for Women's and Children's Wear* 1984 the body measurements for the sizing of women's pattern and apparel by the *United States Department of Commerce and National Bureau of Standards* from September 1971 are given.

Furthermore, Kunick gives precise information on the distribution of bust sizes and compares two sizing surveys in order to show that the height of the women has been changing (in 1981 the average height for females increased by 1.3cm since 1951).

The German systems do provide women's size-charts in their publications. Whereas M.Müller&Sohn mention that their charts are updated every ten years by the latest Hohensteiner surveys, Jansen and Rüdiger fail to note where their given measurements come from. On enquiry, Rüdiger said that she, together with Jansen, used the size-charts from a company that produced dress stands in Berlin. Bray talks in her preface of the constant use of a modified English size 10, but does not give any information on the used sizes (Bray: 1961).
A similar situation can be seen in Aldrich's work. The reader is provided with a basic size chart of standard body measurements for women but does not get any information on the origin of these measurements. Shoben and Ward identify their given size-chart as being based on outcomes of sizing surveys. They recommend considering the work of Kunick for getting more information on size-charts and measurement taking (Shoben and Ward: 1980).

The original illustrations of all six systems for showing the positions of the specific body measurements and instructions on how to measure them correctly can be seen in Appendix 1.

8.1.4 The systems and their given ease of movement

Next to the measurements, either taken directly or from a size-chart, each of the six systems adds different amounts in order to allow ease of movement which is also referred to as tolerances.
Kunick (1967: 11) posited that the correct allowances to be incorporated in patterns are as important as sizing itself. Furthermore, he says that the ease allowance he is working with in his instructions on constructing block-pattern is intended to be seen as such and not for different garment types. He adds that these allowances for block-patterns are a guide and cannot be uniformly applied in extreme style variations. However, Gray (2002: 345) argues that to fit a body any block-pattern must include ease or allowance which is added to the body measurements to allow for body expansion, movement and comfort. Ease is not only important in active movements, such as walking or sitting down, but also during passive movements, such as breathing, during which different stages result in a different bust-girth measurements.

The following Figure 61 shows the tolerances in centimetres as suggested by each system for constructing a block-pattern for a women's wear jacket. These allowances are in the following taken to construct the block-pattern for the further comparison.

System + Cm	Aldrich	Bray	Jansen& Rüdiger	Kunick*	M.Müller & Sohn	Shoben & Ward
Back Height	0	0	1	1.5	2	0
½ Back Width	1	5.5	8.5	0.9	1	0.6
Armhole Girth	3.0	0	1	3.7	2	2.5
½ Bust girth	8	5	0 - 9	4.3	4.5 - 6	5
½ Waist Girth	0	0	0	2.5	0	0
½ High Hip Girth	0	0	0	2.5	0	0
½ Hip Girth	0	3	0		0	1.6
Shoulder back/front	1.5/0.5	0/0	1/0	1.2/0.6	1/0	1.5/0.6
Depth of Armhole	3		1	1.8	2	4

* All figures were calculated from inches to centimetres.

Figure 61. Comparative Tolerance/Ease Allowance Chart

The different way of adding ease for movement does vary, as seen in Figure 61. Bray generally adds ten centimetres to the bust- and six centimetres to the hip-girth. The Kunick system is the only one which uses specific ease at the waist line.
Figure 61 gives the different figures for ease of movement as they are used to construct the block-pattern in the following.

Gray (2002: 348) suggests that on the example of the Kunick system, the added ease of movement onto the body measurements of one size sum up to the body measurements of the following size without added ease of movement. Ease of movement is a subjective and diverse matter. Even though block-pattern are not intended to be fashionable, through the amount of added tolerances they can appear as manipulated fashion-pattern. A high number of added ease may result in a loose shape or it might be chosen by a person with a bigger body size than the measurements on which the flat-pattern construction is based on.

8.2 The Block-pattern Construction of the Chosen Systems

In order to have a basis on which the block-pattern can be compared all of these patterns are constructed using the average measurements for an English size 12/German size 38, taken from the Hohenstein size chart from 1994, which is the latest size chart available to the public. This size chart, published in 1994, is widely used in the clothing industry in Germany. Its measurements are based on a survey, undertaken in 1993, in which ten thousand women and girls in Germany were measured manually by qualified technicians who mostly visited the subjects at home.
The block-pattern of all six flat-pattern cutting systems was constructed with the help of CAD software (Assyst). A previous set of drafts made manually failed to match the necessary accuracy for comparing the block-pattern. Especially within the areas of the construction that are drawn by eye, such as the armhole, a repetition of the same curve in the entire six block-patterns is uncertain. Through constructing the pattern using CAD software these curves can be drafted for the construction of one flat-pattern cutting system and repeated to use for the remaining constructions.

8.2.1 Block-pattern for fitted jackets

Block-patterns for jackets are divided into three general shapes. The tolerances added to the body measurements increase from the close fitting, over the easy fitting, to the loose fitting block. The three block shapes, as illustrated in Figure 55, differ in the depth of the back and front neck, the shoulder length, the depth and width of the armhole and the bust, waist and hip line. Generally the differences between the body and the garment increases in all areas, with the close-fitting block having the least differences and the loose-fitting block showing the most. The following Figure 62 shows the different shapes of the block-pattern for a jacket.

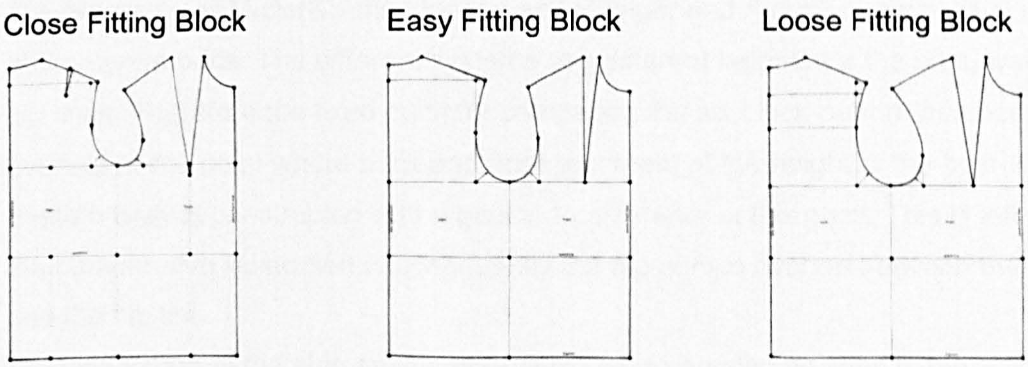


Figure 62, The different shapes of garments, Source: Aldrich (1997:19- 25)

All of the six flat-pattern cutting systems use the horizontal girth and vertical length measurements together with detailed instructions by which they are applied. In contrast to the above, the armhole or scye, the back and the front neckline and the shaping of the waistline are, with exception of some subsidiary points or lines, drawn individually by the person constructing the pattern. As mentioned previously, the use of CAD CAM software enables the extracting and repeating of curved lines which can then be used on all constructions.

The six systems differ in regard to what is the base for constructing a block-pattern for a fitted womenswear jacket. Aldrich, Bray, M.Müller&Sohn and Jansen and Rüdiger offer a special block-pattern for jackets. However, Bray (1986: 106) adds that for some soft (often unlined) dressmaker jackets which do not require any real tailoring, can be constructed from the ordinary bodice block. Following the original interpretation, a bodice block is drafted using body measurements plus a minimum of tolerances. The bodice block covers the upper part of the body down to the waist.

Kunick's system uses a bodice block plus extra added ease and Shoben and Ward uses the bodice block as a base for the jacket, but also for blouses and dresses. With both systems the elongation from waist down to the hipline is done with the help of a separate section, which is then added to the bodice block.

All blocks are created within a rectangle. The width of the rectangle is determined by the half bust or hip measurement, depending on the system. Bray, Kunick, M.Müller&Sohn and Shoben and Ward consider the hip measurement next to the bust measurement. Kunick and Shoben and Ward construct their block-pattern down to the waist line first, adding waist to hip as a separate part and then connect the two, whereas all other systems directly construct down to the hip line or further, depending on the required length of the jacket.
The blocks by M.Müller&Sohn, Jansen and Rüdiger and Aldrich show a waist shaping at the centre back. The different systems use different heights for the bust, waist and hip lines. Therefore the fixed point for comparing the six block-pattern has been overlaid at the point where back and front part meet at the height of the bust- line. System Bray is constructed with a gap of 1 centimetre at this point. This is left out in the comparative illustration. Consequently the hip curves overlap between the waist- and the hip line.
An overlapping of the side seams at both hip lines can also be seen in the constructions following the system developed by Aldrich.

The front part of the block drafted following the instructions by Aldrich, Bray, M.Müller&Sohn and Kunick is wider than the back. However, the constructions by Shoben and Ward and Jansen and Rüdiger suggest the side seam being half way between the centre back and the centre front. Systems Bray and M.Müller&Sohn suggest the shoulder line should be moved 1 cm to the front. The same amount is cut off from the back shoulder to ensure the proportion of both parts.

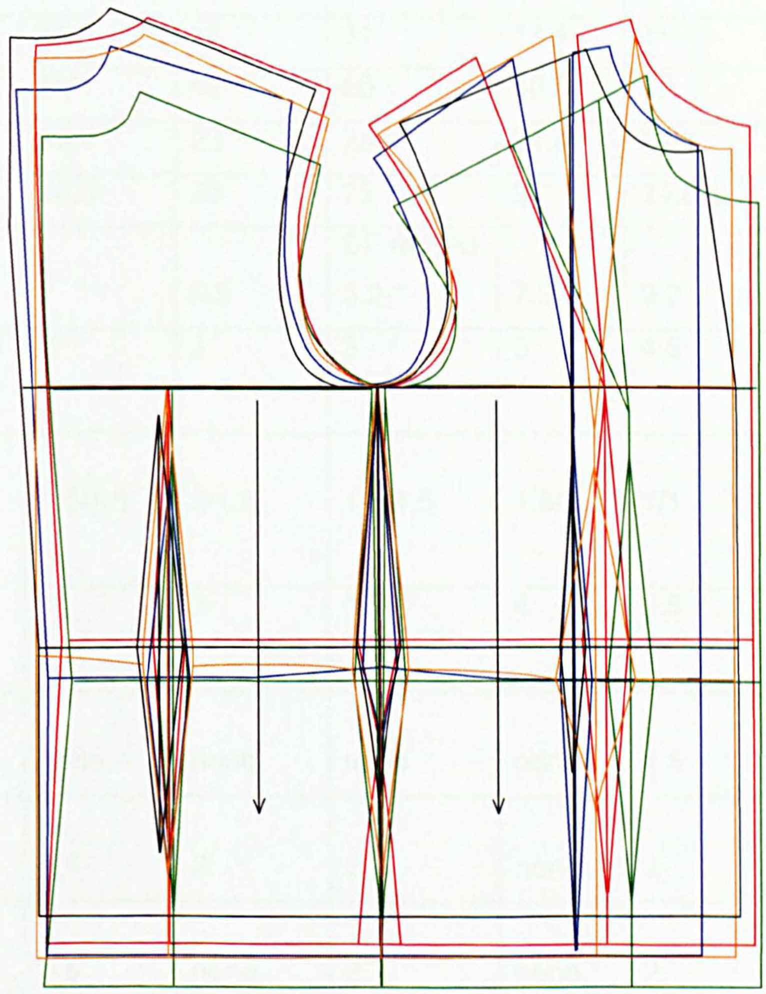
All block-patterns are shown having the back part on the left and the front part on the right side. Even though the two German systems, M.Müller&Sohn and Jansen and Rüdiger both have the front part on the left, they were constructed following the original instructions first and were then mirrored to match the remaining four other systems.

The following Figure 63 shows an extract of the Hohensteiner size-chart for the German size 38 together with half scale measurements (horizontal measurements only). A German size 38 resembles a British size 12.

Given in cm	Full Measurement	Half Measurement
Bust	88	44
Under bust	77	38.5
Waist	72	36
Hip	97	48.5
High hip	88	44
Height	168	-
Upper tight	55.6	27.8
Across back	35.5	17.5
Nape to waist	41.6	-
Nape to bust point	27.5	-
Hip to foot	146.9	-
Waist to hip	21	-
Waist to foot	106	-
Inner leg length	78.1	-
Shoulder length	12.2	6.1
Neck base girth	36	18
Outer arm length	60	-
Bicep width	28	-
Elbow girth	3.2	-
Wrist girth	15.9	-

Figure 63, Measurements for German size 38, Source: Extract from Hohensteiner Size Chart, 1994

The following Figure 64 shows all six jacket block-pattern placed over each other. They are compared on the side seam, where the armhole meets the bust line, indicated by an accentuated vertical line.
The centre front is cut high up to the neck. As for this comparison fashionable attributes such as collars are not useful, this neckline allows for the use of various collar solutions in a following pattern manipulation. Furthermore, the buttoned up centre front allows for a more precise way of judging the fit of the garments in the following practical comparison in Chapter 9, whereas an open neckline for the construction of a collar and lapels would interfere with the concept of concentrating on block-pattern.



Aldrich
Bray
Jansen&Rüdiger
Kunick
M:Müller&Sohn
Shoben&Ward

Figure 64, Comparison of Jacket Block-patterns

The measurements of the six flat-pattern cutting systems are given in Figure 65.

Given in cm	Aldrich	Bray	Jansen& Rüdiger	Kunick	M.Müller& Sohn	Shoben& Ward
Nape back/front	1.5/6.8	3/7.5	2/8	2/6.3	2/7.7	1.5/7.7
Nape length back/front	7.7/8.4	6.5/7.5	7/7	7/6.3	6.2/6.2	7.5/6.5
Nape to waist	40	40	41.4	40.3	41.4	40
Shoulder length b./f.	13.7/12.2	13.6/13.6	13.1/12.1	13.6/13	14.8/14.8	13.6/13.6
Armhole width	11.1	11	11	11.4	11	10.4
½ Bust girth	50	49	50	50.8	47	47
½ Back	23.7	23	25	24.8	22.5	23.5
½ Chest	26.3	26	25	26	24.5	23.5
Depth of bust dart	7	6.5	CF moved 3.2-*	7.2	9.2	5.5
Depth of back dart	2	2	3	5	4.5	3.5
Shaping of side seam at waist b/f	1.5/1.5	2/1.5	1.5/1.5	1.8/2.2	1/1	2/2
Depth of front dart	3	3	1.5	4	3.5	5
Depth of back shoulder dart	none	none	none	none	1.5	none
Centre back waist shaping	1.5	2	2	none	2	none
Centre back shaping at hip	0.5	none	2	none	2	none

* centre front moved inwards from neck to bust, instead of having a bust dart.

Figure 65, Comparative Size Chart for Jacket Block-patterns

8.2.1.1 Results and findings

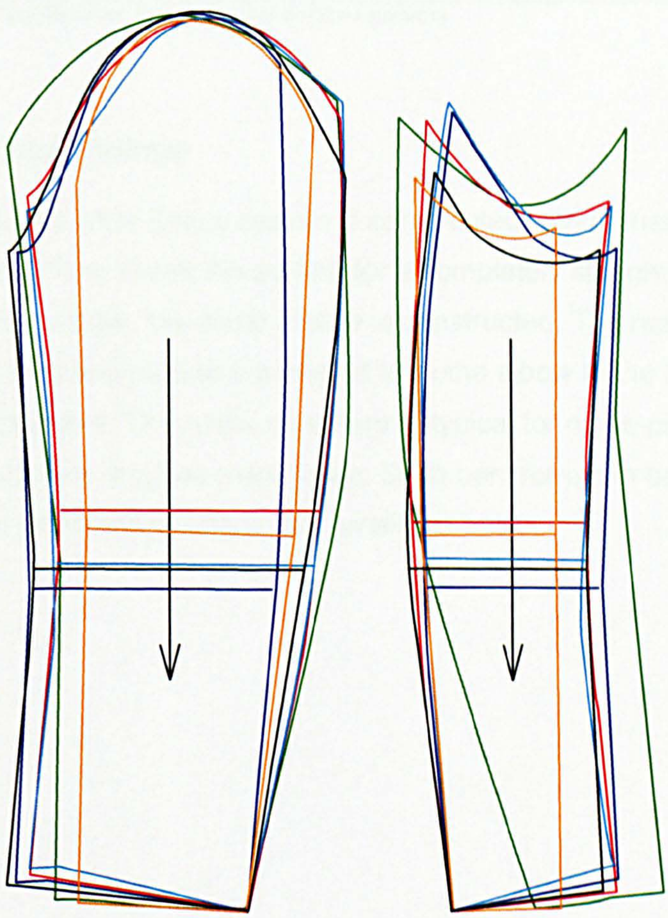
When placed on top of each other (Figure 43), the six block-patterns for a women's wear jacket show remarkable differences. The point from which they are compared is the under- arm meeting the side seam.

A similar method of comparing six different flat-pattern cutting systems could not be found by the researcher. A likewise method of comparison but with a different approach to pattern cutting can be found in the thesis by Gray (2002), who investigated the bodice construction without sleeves of the systems by Aldrich, Bray and Kunick. Hereby Gray placed two patterns of the same system onto each other in order to compare the measurements used in the different editions of the publications.

The depth of the back nape point varies between 6.3 cm in Kunick's system and 8 cm in Jansen and Rüdiger. The depth of the front nape point is between 1.5 cm in the systems by Aldrich and Shoben and Ward and 3 cm in Bray's system. The height of the nape point has consequences on the height of the waist- and hipline, which are measured down from the nape. The result for the systems using a lower nape, such as Bray, M.Müller&Sohn and Shoben and Ward, is a dropping of the waist and hip line. The tolerance for a half bust girth varies between 5 cm for systems Müller&Sohn and Shoben and Ward and 8.8 cm for system Kunick uses 5 cm tolerance for the bodice block plus extra tolerance for a fitting jacket block.
Bray's system shows the lowest and smallest armhole with a back height of 15.6 cm and a front height of 13.3 cm. The scye girth measures 36 cm. The two systems with highest armholes and the biggest scye girths are Aldrich and Jansen and Rüdiger with 20.9 cm for both as the back scye height and 19.2 cm and 18.7 cm for the front scye height. Aldrich's scye girth is with 46.5 cm 10.5 cm bigger than the smallest one constructed after Bray. The bigger armhole girths can be seen as results from using special jacket blocks instead of working with block-pattern. To use a jacket block might indicate that the garment is suppose to be worn over other clothing such as a shirt. Therefore the armhole is cut bigger to insure space for other sleeves. But, this, in the cases for Bray and Jansen and Rüdiger does not go hand in hand with a wider shoulder, as it might be concluded, because of a general rule which suggests that the armhole should be proportional to the shoulder length. The shoulder length of the above systems is comparable to the remaining systems, except of the M.Müller&Sohn shoulder which is 1.2 cm longer than the average shoulder length of all systems, even though, the others use a smaller and higher armhole.
Jansen and Rüdiger use a moved in front line instead of a bust dart. With exception of this, all other systems include a front neck dart. However, the position of this dart and the back and front darts at the waistline, varies in all of the systems.

8.2.2 Block-pattern for two-piece sleeves

All sleeves consist of two pattern pieces, a top- and an under sleeve. In regard to drafting the pattern, the under sleeve is constructed after the top sleeve. Additionally the drafting of the former takes place inside of the top sleeve construction.
All six two piece sleeves overlaying each other can be seen in Figure 66 below. All patterns can be compared at the outer seam at the height of the hem at the wrist, indicated by the emphasized horizontal line.



Aldrich
Bray
Jansen&Rüdiger
Kunick
M:Müller&Sohn
Shoben&Ward

Figure 66, Comparison of Two-Seam Sleve Block-pattern

Given in cm	Aldrich	Bray	Jansen& Rüdiger	Kunick	M.Müller& Sohn	Shoben& Ward
Height of sleeve head	13.5	13	17.8	12.5	15.5	15
Back scye	20.9	18.6	20.9	18	20.1	18.1
Front scye	19.2	18.3	18.7	17.5	16.5	17.5
Scye girth	46.5	43	47.2	42	41.5	41.6
Scye width	11.1	11	11	11.4	11	10.4
Wrist	25	26	24	26	23	22

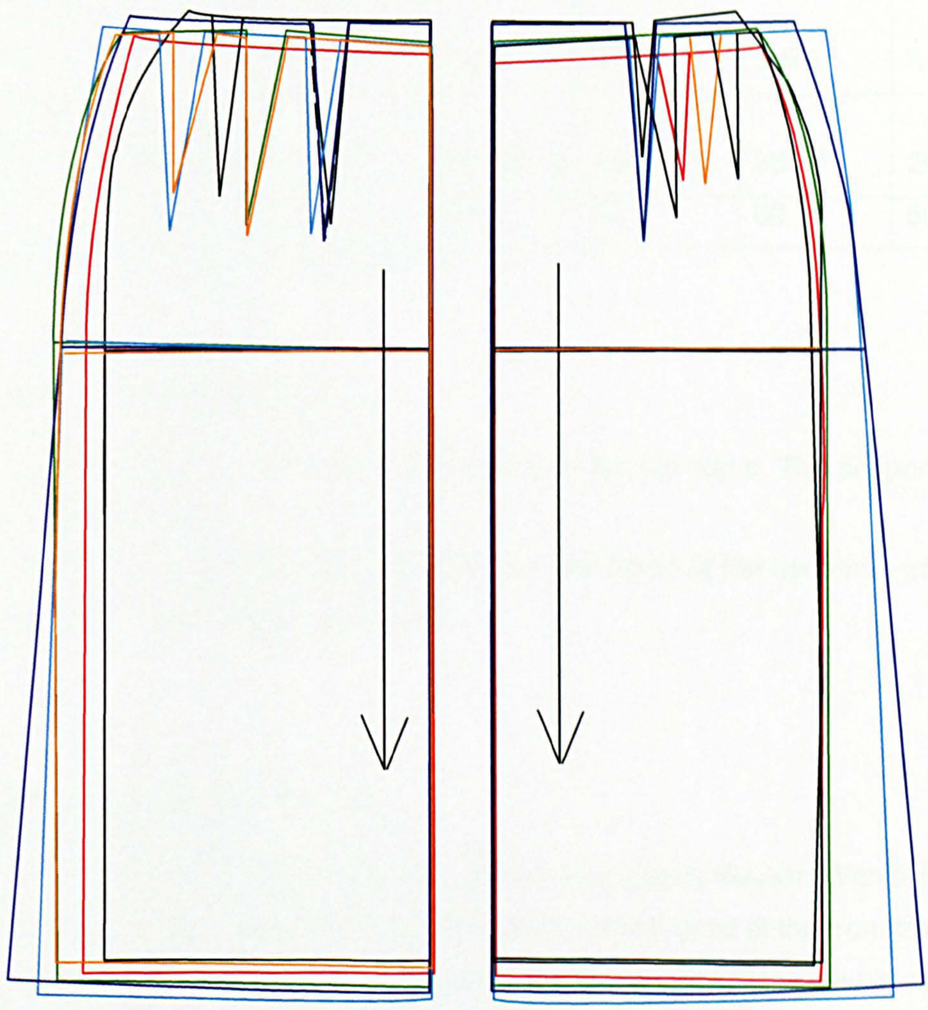
Figure 67, Comparative Size Chart for Two-seam Sleeve Block-patterns

8.2.2.1 Results and findings

The sleeve constructed after Bray's system is constructed without using the armhole from the jacket block. Bray drafts the pattern for a completely straight one-piece sleeve first. By folding it into a tube, the under sleeve is constructed. The resulting two-seam sleeve has very curved seams and it is angled from the elbow to the hem, echoing the natural position of the arm. This sleeve appears untypical for mass-production, because the curved form requires more fabric. Such bent form can be found in haute couture tailoring in combination with a very small armhole.

8.2.3 Block-pattern for skirts

Figure 68 shows all six block-pattern of the skirts on top of each other.



Aldrich

Bray

Jansen&Rüdiger

Kunick

M:Müller&Sohn

Shoben&Ward

Figure 68, Comparison of Skirt Block-pattern

Given in cm for half leg	Aldrich	Bray	Jansen& Rüdiger	Kunick	Shoben & Ward	M.Müller & Sohn
Width of waist back/front	18.7/18.7	25.5/21.5	20/19	19.5/18.5	19/19	20.5/19
½ Hip	50	50	49	49	50.1	50
Depth of darts back/front	4/2	4/4	3/2	5/3	3.5/4.1	3/1.5
Width of hip back/front	25.7/24.2	25/25	25.5/23.5	26/23	26/24	26/24
Length	60	60	60	60	60	60

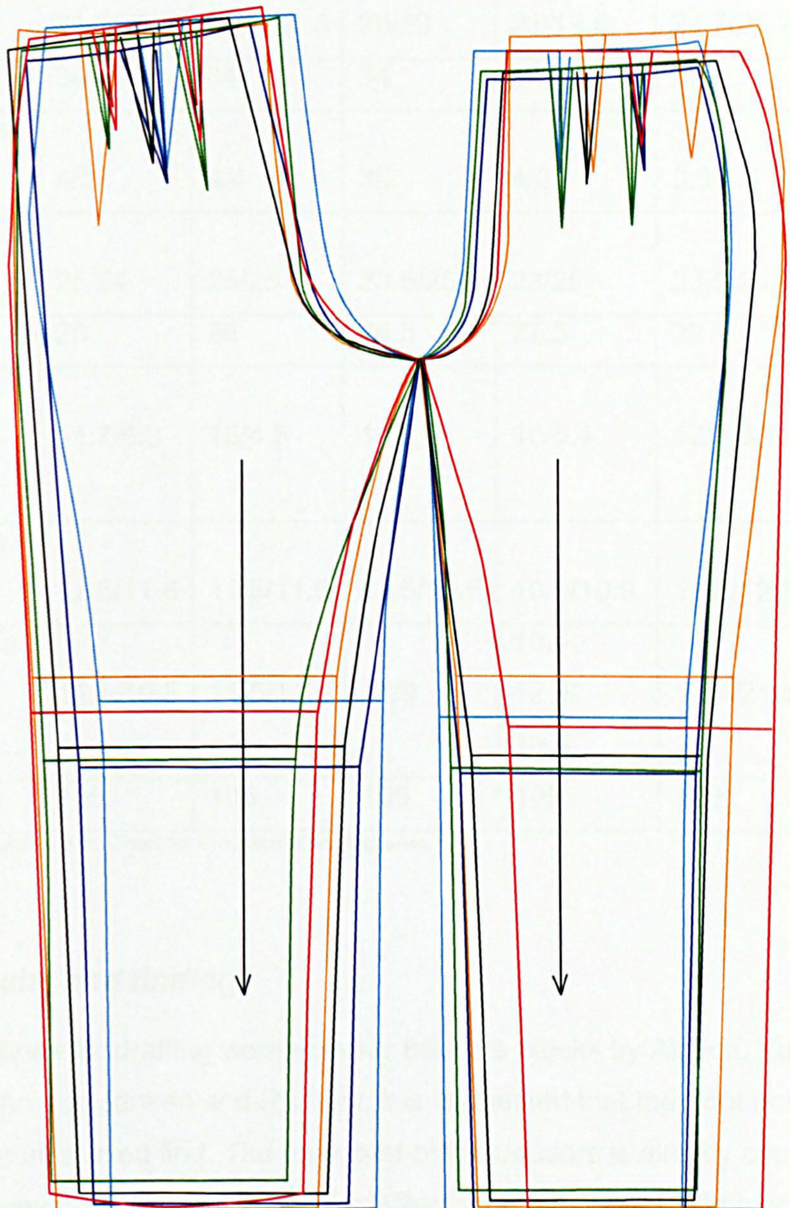
Figure 69, Comparative Size-Chart for Skirt Block-patterns

8.2.3.1 Results and findings

The darts vary in depth. This has consequences on the hip curve. The deeper dart results in a curvier hip.
The block-pattern by M.Müller&Sohn and Kunick are flared at the hem-line, whereas the others consist of a straight side seam.

8.2.4 Block-pattern for trousers

All trousers consist of two pattern pieces, a front- and a back trouser. With regard to drafting the pattern the back trouser is constructed on the base of the front trouser in the systems M.Müller&Sohn and Jansen and Rüdiger. Similar to the way in which the two-piece sleeve is constructed, the drafting of the back trouser takes place onto the finished draft of the front trouser.
The Hohensteiner size-chart suggests that the average outer length of the trousers for a German size 38 is 106 cm. For the pattern draft this is reduced by 1 cm, so that the trousers do not touch ground.
Figure 70 shows all six back and front trousers on top of each other. The pattern can be compared at the back and front fork point, indicated by two emphasised vertical lines, at right angles to the knee- and hem lines.



Aldrich
Bray
Jansen&Rüdiger
Kunick
M:Müller&Sohn
Shoben&Ward

Figure 70, Comparison of Trousers Block-pattern

Given in cm for half leg	Aldrich	Bray	Jansen& Rüdiger	Kunick	Shoben & Ward	M.Müller & Sohn
Width of waist back/front	21.2/19.2	25.5/21.5	20/19	21/19.5	24.7/21.2	20.5/19
½ Waist	34.4	34	34	34.5	37	34.5
Depth of darts back/front	4/2	4/4	3/2	4/2	3.5/4.1	3/1.5
Width of hip back/front	25/24	25/25	23.5/25	23/26	23.5/24.5	24/26
Body rise	28	28	26.5	27.5	29	26.5
Width of crotch/fork back/front	11.7/6.3	15/4.5	11/6.2	10/6.4	12.3/8.2	12/5.5
Width of knee back/front	12.8/11.8	11.5/11.5	12.5/10.5	10.9/10.9	13.8/12.3	12.5/10.5
Width of ankle back/front	11.5/10.5	11.5/11.5	11/9	10.4 - 12.9/ 10.4	12.4/21.4	11.5/9.5
Side length	105	105	105	105	105	105

Figure 71, Comparative Size Chart for Trousers Block-patterns

8.2.4.1 Results and findings

In the instructions for drafting womenswear trousers blocks by Aldrich, Kunick, M.Müller&Sohn and Jansen and Rüdiger, it is suggested that the front part of the trousers are constructed first. The back part of the trousers is directly constructed onto the front. However, Bray and Shoben and Ward use the straight skirt block from the waist- to the hipline as a base for constructing the trousers. Following the skirt block in which back and front part are drafted together, similar to drafting a jacket block where the back and front parts touch at the side seam, the two parts of the trousers are also constructed side, by, side. Furthermore, the instructions given by Bray involve straightening and folding of the skirt block to receive a seat angle at the back trousers.

8.3 Summary of Findings from the Contextual and Literature Review

Through this literature and contextual review it can be seen that simplified tailored womenswear which is called formal or business-wear was developed in the 1920s. The rectangular shape followed the development of menswear towards the sack-shape jacket at the end of the nineteenth century first seen as leisure or sports jackets. Parallel to this development the uniforms for the First World War also adapted this short rectangular shape.

Mass-production of clothing is able to cover the need for clothing in a short amount of time and was used for the production of uniforms for the First and Second World Wars. Furthermore, the need for civil clothing following the Second World War pushed not only the mass-production of clothing, but also the general acceptance of it. For womenswear it remained usual to have garments made by a seamstress or to practise individual home dressmaking.

It is agreed by authorities that the simplified womenswear made a mass-production possible because the form of the garments enabled the use of size-charts consisting of average measurements for the different sizes instead of individual body measurements.

As shown above, size-charts consists of measurements taken from the upright standing, non-moving body. Even though different technical inventions for measuring the human body can be seen next to the more usual tape measure, all of these reflect the non-moving body.

The body itself is best reflected at the first stage of pattern construction, within the block-pattern. These do not consist of any fashionable attributes, such as collars, pockets or fastening, because they are used as a base susceptible to manipulation, but only reflect the body measurements plus added ease of movement. Even though the systems by Aldrich, M.Müller&Sohn and Jansen and Rüdiger use a separate block for the tailored womenswear jacket, whereas the remaining systems construct the jacket from a bodice block elongated from the waist down to the hip line.

The six chosen flat-pattern cutting systems cover the time from before the Second World War to 2012. Because of that, it can be said, that one main outcome of the practical research on changes within the block-pattern revealed that block-patterns have hardly ever been subject of modernization. Even though Aldrich established her block construction for the womenswear jacket in 2002, it is similar to the first soft-tailoring blocks as shown in Chapter 4.3.3.
All six flat-pattern cutting systems do show similar principles in the construction of the womenswear jacket, trousers and skirt and therefore, they are comparable. All of these block-patterns for formal womenswear were of a rectangular shape similar to the one which was invented in the 1920s. The differences between the block-patterns are the results of the different measurements applied to location points, such as the back neck, depth of scye, nape to waist and added ease of movement at the bust and waist girth, for the example of the jacket block.
Because of the fact that these construction principles are still based on linear measurements of the standing, non-moving body, shows that the changes of body measurements while moving have not been considered.

The two German systems and the system by Aldrich do not use a bodice block but a jacket block. Furthermore there is no differentiation in the general shape of the jacket. This way the jacket blocks might already be an adaptation of the specific fashion at the time of invention. It might also be a concession to the mass-market industry, because the later tolerances allow the pattern to be useful for various shapes of figures of the customer, or even for more than the initial size.
These differences between the flat-patterns of the different systems allows for a general comparison because it shows that the principle construction is similar. Furthermore it enables to draw conclusions in regard to the ability of being able to make use of the full range of body movements while the garments are made up and worn, because this research wants to target the broad spectrum of various ways of constructing patterns for industrial tailored womenswear.

From the researcher's personal experience as a fashion design student and as teacher for pattern cutting, both at the University of Applied Sciences in Bielefeld, Germany and from working in the clothing industry, it is current practise when developing formal womenswear fashion-pattern to use the basic jacket block and add fashion attributes such as a collar, pockets and the fastening.

A successful prototype is used for many designs of the same garment type and shape. In this case the block-pattern also functions as a derived- or fashion-pattern. It can be concluded that the boundaries between block-pattern and fashion-pattern are obliterated.

Even though the construction of the six flat-pattern cutting systems could be analysed in the comparative study, it fails to give information on the fit of the resulting garments when they are worn.

When interviewed on the 17th of February 2010, Shoben states that block-pattern as such, generally only fit when the subject wearing them is standing steadily upright. He assumes that the fit of a garment can only be seen in derived- or fashion-pattern, of which both are manipulated block-patterns. This would lead to the consequence that well-fitting garments solely depend on the current fashion.

An example for this could be the enlarged womenswear jackets of the 1980s. Broad shoulders and deepened armholes enabled to move underneath the garment up to certain extend, but not with the garment. But such tent-like shapes still restrict the up-lifting of the arm and restrict certain movements.

The theoretical literature and contextual review does indeed give the necessary background information on formal womenswear in general and specifically on the block-pattern construction for the three piece wardrobe, but a further practical study needs to be undertaken in order to test the pattern's allowing for movement.

8.4 Emerging Issues

The flat-pattern constructions from six different flat-pattern cutting systems do not reflect the moving body. Even though block-patterns are used for testing the fit, this is not done while performing every-day movements.

It is common to present fashion on the static rather than on the moving body. The photographic image of worn garments is the generally accepted form of presentation, even though its static nature does not represent reality. Even though garments are shown on the walking model on a catwalk, the natural range of every day movements, especially in the upper part of the body and the shoulders, are hardly ever reflected.

Aldrich, Smith and Dong (1997: 345) refer to the unpublished MPhil thesis by Dong (1996) in saying, that a study on the performance of tailored womenswear jackets in a working environment found out that garment restrictions on the body affects the functional comfort significantly and serious garment distortions occur when extended body postures are performed.
When considering the opinion of working females (Appendix 2) the conclusion can be drawn that the customer is used to the fact that soft-tailored womenswear does restrict the range of movements in many ways. This might be a reason why it has not occurred to reconsider its basic construction. The outcomes reveal that they experienced restrictions in their daily travel, transit and other routines.
In order to compare the flat-patterns of the six flat-pattern cutting systems they need to be made up and the fit of these be evaluated on the actual moving model in order to be clearly analysed.

8.4.1 Definition of areas in which a wider range of movement is appropriate for every-day travel and transit

The research aim is to widen the range of movement of block-pattern construction for formal womenswear. In order to define areas where a widening of the range of movement would be suitable to enable for every-day travel and transit situations, the block-patterns evaluated in this chapter needed to be made up and worn.
From an early attempt to document every-day travel and transit situations, as shown in the introduction, every-day movements can be condensed into six basic movements: standing, walking, lifting the arm, stepping, sitting and leaning forward. Travel and transit situations consist of different combinations and variations of these movements.

8.4.2 The making up of the garments

The garments made-up following the patterns of all six flat-pattern cutting systems need to fulfil the criteria of contemporary mass-production of clothing, as far as it is possible. All six jackets, trousers and skirts may be different, because they are based on flat-pattern from different systems. Therefore, an industrial staple production would possibly wipe out the differences. As an actual industry production is not possible, the garments need to be made up from an expert seamstress with experiences in mass-production. As contemporary mass-production does not necessarily involve any more technical machinery than an industrial sewing machine, an over-lock machine and a steam iron,

the production process can be carried out by simulating the industrial surrounding. Furthermore the outer material, lining, interlining and further haberdashery, such as buttons and zippers need to be the same for each six of the three garment types.
As industrial mass-production of clothing is based on average sizes from a size-chart, the flat-patterns for the garments need to be constructed using measurements for one size from a size-chart.

8.4.3 Simulating reality

As already mentioned in the introduction, documenting working women on their daily travel and transit situations, does not give valuable information. The differences of the factors, such as the surrounding, weather, weight of the fabric the clothing is made of and the different figures with their individual gestures would aggravate a comparison. In order to evaluate the fit of the block pattern of the six flat pattern cutting systems the concomitant factors need to be as similar as possible. Consequently the comparison needs to simulate reality.

8.4.4 The video documentation

The decision to observe the way garments made up from block-patterns restricted while performing every-day movements through a video analysis was logical consequence, following the theoretical comparison of the six flat-pattern cutting systems. The eighteen garments need to be worn by the same model performing a pre-defined course of movements involving the basic every-day movements.
In order to integrate outcomes of the video analysis in the text, stills can be taken to visualize any findings. The use of stills does not contradict to the initial aim of investigating the fit of formal womenswear made up from block-patterns, tested on a live model while performing every-day movements. The stills taken from the original video are therefore seen as 'frozen' movements, which allow for a closer look. The video material is intended to be seen parallel to this. The film sequence of this video analysis 1 can be found on CD in Appendix 5.

The following chapter 9 states the practical comparison of the jackets, trousers and skirts all made-up following the instructions for flat-pattern construction of each system with the help of stills taken from a video. The aim of this is to define the areas in the garments and in the flat-pattern construction where body movement is restricted.

The following Chapter 9 consists of practical prototypes imbedded in a photographic documentary, accompanied by video productions. The video analysis reflects the idea of evaluating the fit of the garments while being worn. This is rounded up by an investigation into anatomical phenomena, their relation to flat-pattern construction and possible solutions for widening the range of movement.
Section 9.1 states the principle design of video analysis 1.
Paragraph 9.2 describes the process of making up the prototypes together with a section on specifications.
Clause 9.3 explores the human anatomy and the application on clothing as emerged from video analysis 1. This includes subsections on the defined areas of restricted movement, the torso, the shoulders and arms and on the pelvis and legs. In here examples of flat-pattern principles for allowing for movement for traditional sports- and dance-wear, as introduced in Chapter 4.2.3 and 4.2.4, are added.
Section 9.5 states the emerging issues from video analysis 1.

9. PRACTICAL EXPERIMENT – A VIDEO-ANALYSIS OF FLAT-PATTERN CUTTING SYSTEMS

The following practical experiment and analysis shows eighteen garments, six jackets, six trousers and six skirts, made up following the six different flat-pattern cutting systems, as introduced in Chapter 8. The component of fit for movement is now added to the theoretical comparison which has shown that despite the basic construction principles of the different systems are similar, but despite that could not give information about the fit of womenswear made up after the six different flat-pattern cutting systems. Because of that the following practical experiment is needed for evaluating the initial research question about the ability to make full potential of body movements while wearing mass-market tailored womenswear.

9.1 Principle Design of the Video Analysis I

The following practical experiment directly follows the analysis of the two-dimensional patterns constructed following the chosen six flat-pattern cutting systems. The different flat-pattern cutting systems are based on similar principles, as found in Chapter 8.

All of the block-pattern constructed after the instructions of the six different flat-pattern cutting systems started with one vertical line, on which the body measurements are measured from the top downwards, the highest point for jackets being the neckline and for skirts and trousers being the waistline. The points include one for the bust/hips and the general length of the garment. Each of these points is positioned at right angles to horizontal lines. The half of the body measurements corresponding to this point is measured along these lines. All resulting points are connected by curving out the angles in order to silhouette the human body.

The production of actual garments, constructed following each system enables a comparison of fit while moving. The outcomes of this comparison are documented by the video analysis 1 (Appendix 6). This fit is not only analysed on the static body, but concentrates on the moving subject. At this point the important aspect of performing movements while wearing garments is added to the analysis.

Fitting jackets, trousers and skirts are made-up following the instructions of the six different flat-pattern cutting systems, but using a high cut neckline in order not to limit the jackets to a collar and lapel style. They are made-up from the same fabric and under the same production conditions, are then worn by a model in front of a video camera. The model courses in a defined way so all different pattern systems undergo the most same movements. It is expected to find out in how far the pattern systems produce similar or different pleats, kinks or movements. From the expected results hints are extracted where an improvement of the flat-pattern would be useful. These do also function as starting points from which the experimental prototype development is undertaken.

9.2 The Process of Making up

In order to have a comparable foundation on which the different systems can be examined the aspects listed below have been respected in making-up the flat-pattern and tailoring the resulting garments.
All flat-patterns are constructed using the body measurements for the German size 38, which resembles a British size 12. As done before, the measurements for this size are taken from the newest publicly available sizing survey in Germany, from 1994, as shown in Chapter 8.2.1, Figure 63.

All flat-patterns are constructed by the researcher. All flat-patterns and the garments are produced under the same specifications, which are given in the following.
The garments are fully made up by the same professionally trained tailor working in mass-manufacturing. All aspects which are involved in making-up the garments, such as the seam allowances, over-locking, lining and inter-lining, are following instructions for the industrialised production.

9.2.1 Specifications

The fabric for realising the garments is a middle-weight, non-stretch wool-polyester mix fabric for jackets, trousers and skirts. All jackets are lined and inter-lined based on mass-market standards. Figure 72 shows the flat-pattern to be cut from the lining fabric for a jacket, using a side panel instead of having one side seam, as it is in the following experiment.

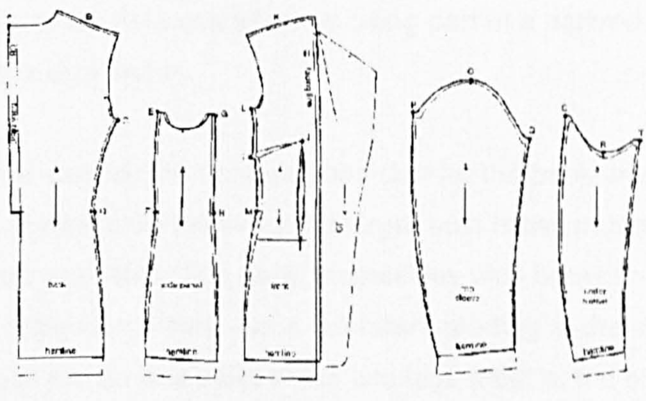


Figure 72, Lining, Source: Aldrich (2002: 44)

Figure 73 shows the mass-market standard for inter-lining for a tailored womenswear jacket. A woven, middle- weight inter-lining is used in all six jackets to ensure the soft-tailored impression.

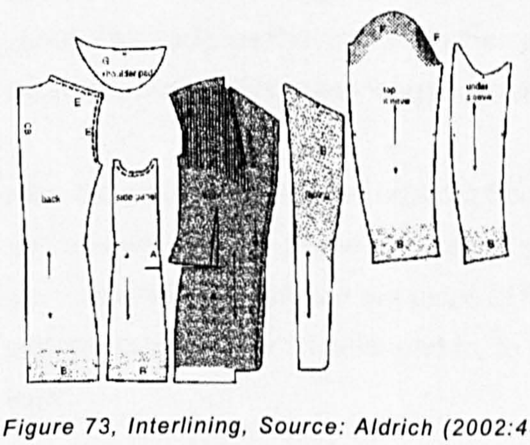


Figure 73, Interlining, Source: Aldrich (2002:43)

Shoben and Ward use a basic bodice block from which the jacket, a blouse and in combination with a skirt, a basic dress pattern can be developed. The pattern construction starts a point from which a horizontal line is squared out to the right and a vertical line is squared down.
From this point along the vertical line, the depth of the neck, the measurement from nape to waist and the depth of the armhole are measured and marked. This line is then the centre back of the pattern. All of these points are horizontally squared out. On these lines the measurements from half of the bust measurement is marked in order to be squared out vertically. This line is then the centre front. The whole bodice block pattern needs thirty eight different steps to be constructed. All tolerances are calculated onto the body measurements. As this pattern does consist of a front and a back panel only, the bust measurement is exactly divided into two halves to mark the side seam.

It is suggested in some systems which use a tailored-block, Aldrich, M.Müller&Sohn and Jansen and Rüdiger that the jacket block should consist of a side panel. Because a side panel is classified as being part of a derived-pattern for this study it is replaced by a side seam.

One dart for the front and one dart for the back are used to reduce the waistline, which is constructed following the larger bust measurement, down to the actual body measurement. The darts themselves vary between the different systems.
Shoben and Ward use a front dart, starting at the shoulder line beginning next to the neckline on one side, which two legs meet at the bust point. This bust point also is the starting point for the waist dart.
Whereas Jansen and Rüdiger have the same dart at the waistline which two legs again meet and end in the bust point. They do not use a dart from the shoulder line down to the bust point. Jansen and Rüdiger reduce the resulting measurement at the upper part of the front bodice through shifting the originally rectangular centre front into the front panel. This reduces the amount in the same way as a shoulder dart does. The form of the darts, their position and length generally varies slightly within the different systems.

After the pattern pieces were cut out from the fabric, all girths, such as the bust-, waist- and hip-girth and the elbow-girth of the sleeve, are marked by stitching before making-up. Furthermore, every cut out piece of fabric was marked with the name of the flat-pattern cutting system it belonged to, to prevent a mix up of the similar pieces by the tailor.

The process of making-up the eighteen garments simulating mass-production of clothing in the way that all cut out fabric pieces were made-up by a professional tailor working in the clothing industry. Due to the fact that all patterns have slight differences, such as the length and the position of darts, arranging the work in staples, as it is done in the industry to be more time efficient, was not possible.
All garments, except the jackets which are lined with acetate lining, were secured by over-locking before sewing. As mentioned by Shoben and Ward (1987: 37) the over-locking of most fabrics is extensively used in the clothing industry.
All seams are sewn using an open-stitch to the wrong side of the fabric. The seam allowance is four centimetres for the hems and one centimetre for all other seams. The trousers and skirts are closed by a concealed zipper. All of the pattern pieces were measured separately.

9.2.2 The structure of video analysis 1

In order to follow the idea of the human body being in motion most of the times, the evaluation of six flat-pattern cutting methods is, as well demonstrated in motion. Aldrich, Smith and Dong (1997) developed their 'body posture measurement equipment' which enabled to repeat different postures of the upper part body and take measurements.
As this research investigates the fluently moving human body and does not concentrate on the different static postures, the above approach is acknowledged but not used for this project.

The following Figure 74 shows the course of action which is undertaken by the subject.

Figure 74, Course Instructions for Video

The black circles show the different positions of the camera. Every single course is filmed from each of the four perspectives, by lacking this number of cameras; each course was repeated and filmed four times. Extracted stills are used for the comparison.
The arrows symbolise the directions the model walked. The course as a whole reflects the basic everyday movements as being addressed in photographic research at an earlier stage of the project. Furthermore it reflects on the planes of motion of the body, as shown in Chapter 9.3, Figure 75.
In order to get the best possible result for analysing, all of the movements, such as holding, climbing and leaning, are performed concentrating on this specific movement.

But still, as it is already mentioned in the section on the human anatomy, many minor movements are involved all the time.
Further combinations of the chosen movements among each other is of course possible, but would only complicate to analyse each sequence.
This course is paced four times wearing one garment. This allows to film from four different positions of the camera. In order to minimise the varieties of body movement, footprints with a natural distance between each other, reminded the model to walk with the same number of steps and to prevent to go off course.
It is necessary to mention that the model was wearing the same leotard at all times of filming. Furthermore she wore the same shoes, which she also wore while being scanned with the help of the three-dimensional body-scanner, as shown in Chapter 7.5.1.
Croney (1980: 87) pointed out, that there is a difference in body movement depending on the social circumstances. A leisure situation does not have the same requirements on the comfort or fit of a garment as a formal one has.
As this research analyses the fit of block-pattern for tailored women's business-wear, the model was told about this before, in order to simulate the required actions in a way that could be taking place in a natural formal working situation. Further to instructing her, the fact that her actions were video recorded and the camera operator and the researcher were present, justified the presumption that she herself did behave as required in a public surrounding.
To discuss the results of the video shooting, stills of typical phenomena are given to present an easier approach to some details. Furthermore these stills are accompanied by the flat-pattern with indication of the area in focus.

At this point examples of flat-pattern cutting are shown which target the restrictiveness of woven informal clothing garments in these areas.
Most of the examples are coming from traditional and modern sportswear. Their construction is used as inspiration for the design of the flat-pattern experiments in order to widen the range of movement in formal soft-tailored womenswear, as shown in the upcoming Chapter 10.

9.3 The Human Anatomy and the Application on Clothing

In order to understand the problems which occur when constructing clothing for the human body, it is necessary to briefly state the involved parts of the body. Such examination helps to locate problematic areas in which the clothing needs to allow body movements. Figure 75 shows the different areas of the human body and their range of movement.

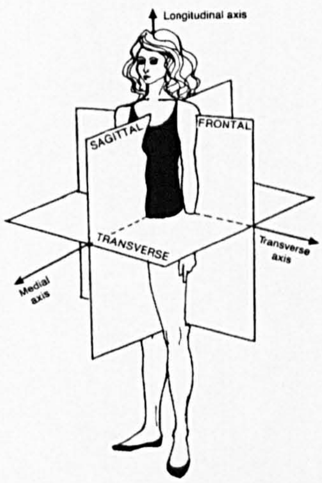


Figure 75, Planes of Motion of the Body, Source: Watkins (1995:220)

9.3.1 The joints

The main structure of the human body is given by the bones. All bones together build the skeleton. The skeleton insures a stable base on which the muscles perform the movements. Most of the analyses of the human body are based on an upright static position. But it is the constant changing of the body within the individual's personal constitution which makes it difficult to be reflected wearing clothing.
According to Wilhelm (1954: 28) who was trained as a tailor himself, it is the fact of not taking this into consideration, that the customer argues about the fit of the garment, not being aware that a certain volume of fabric enables him to sit down comfortably.

Body movements which complicate the process of fitting a garment can be found where two bones within the skeleton are connected with a joint. The following only considers the joints which enable a greater mobility whereas the whole skeleton has many more joints which are not directly relevant for this research because they are not involved in wider movements. For example, every single rib is at the back attached to the spine through a joint. But these joints are not able to perform wider movements.

The whole construction is in itself a chain of joints. Every vertebra is connected through a joint. Figure 76 shows all bone and joint connections which are important for the outer appearance of the body, because they build the static foundation for all movements. It illustrates the position of the joints at the collarbones (entitled Sg), the upper arm (G1), the elbows (Eg), the wrist (Ha), the hip (Hu), the knee (Kn) and the ankle (Fu).

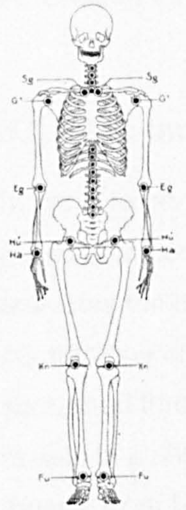


Figure 76, The skeleton, Source: Wilhelm (1954: 29)

Without these joints a fluent movement would not be possible. While analysing these joints, it occurs that not all of them have the same construction. If bending the elbow, it becomes obvious that it is only possible to follow a circular shape, whereas the straight arm, moved from the shoulder is able to perform a wider range of movements. It is possible to turn the arm in every direction. Therefore, it is important to differentiate between the socket- and the ball-joints.
Figure 77 illustrates that the socket joint (left) consists of a pen (Pf), a roll (R) with its shaft (Sch) and the side ligament (B). The movement can only be made in one direction, from a to b. Socket joints can be found at the neck, at the elbow, at the wrist, at the knee, at the ankle and as joints of the spine.

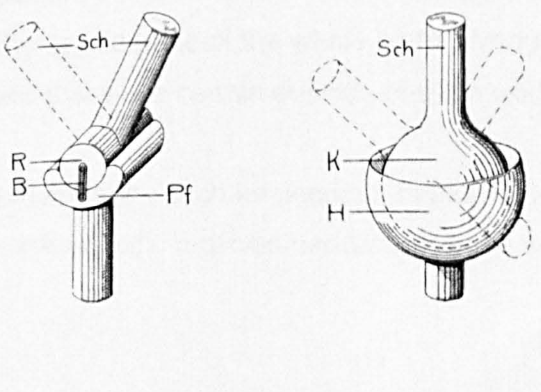


Figure 77, Socket- and ball- joint, Source: Wilhelm (1954: 29)

In contrast to this, the ball joint 8right) consists of a hollow ball (H) with a free ball-shaped joint (K) within it, as in the graphic on the right. Therefore the shaft offers a much wider range of movements than the socket joint. Ball joints can be found at the hip and at the upper arm.
These joints enable to perform movements on an x y coordinate system, as illustrated in Chapter 9.3, Figure 75.

9.3.2 The muscles

In order to perform a movement, the static skeleton and its joints need the ability of the muscles to contract through getting this impulse from the nerves. It is this tension which activates the levers of the bone structure. Figure 78 below, illustrates the ability to contract the arm. A muscle which ordinary length reaches from U to O is going to be shortened through a minor tension up to line 1, whereas the maximum contradiction results in a shortening up to point 2. Natural stretching can cause a lengthening of the muscle from U down to point 3, and forced stretching can cause a lengthening down to point 4.

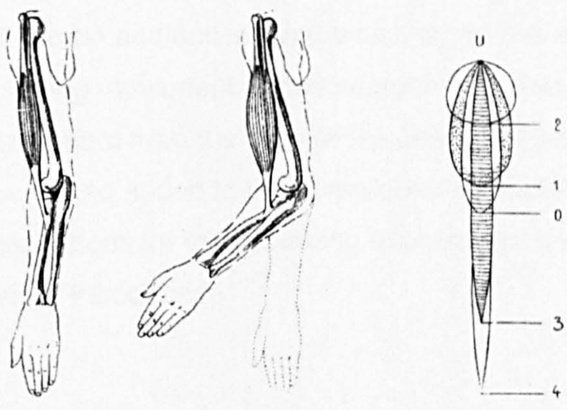


Figure 78, The arm muscles, Source: Wilhelm (1954: 30)

Because of this function of the muscles, not only the form of them is changed, but also the appearance of the whole body. Even if not all muscles are active at the same time, still there is a certain quantity of them working all the time.

Movements, such as bending, stretching and for inward- and outward rotation, all do have specific muscles performing these tensions. When taking a look at the arm and

the leg, one finds not only similar bones and joints, but also similar muscles. Obviously the movements performed by the legs are different to the ones performed by the arms. Therefore, it is necessary to take a closer look at the different positions of the body and the muscles which are involved in these positions. Even when standing upright a lot of muscles are working, especially the stretching ones of the legs and the spine.
Next to the muscles, different ways of breathing can also result in various deformations of the upper part of the body. Breathing in and out produces a movement of the ribcage and of the breastbone through the mentioned joints. To breathe in deeply may result in a difference of width of up to ten centimetres. Whereas ordinary breathing enlarges the thoracic cavity in a minor way and because of that it is without dramatic impact on the measurement of the bust girth. Wilhelm (1954:34) mentioned that the increasing popularity of practising sports resulted in wider breast, shoulder and back parts of the clothing.

The results are grouped into three areas of the human body. The first area is the torso. This is shown for jackets, trousers and skirts. The second area is the shoulder/arm section followed by the bottom/legs. The third area is the leg and knee area while walking and stepping.
These areas are visually explained by anatomical illustrations, stills taken from video analysis 1, a flat-pattern construction with the area in question indicated and examples of sports- and dance-wear which target this area in their way of construction for allowing movement. While searching for these, further examples for allowing for movement from the area of flat-pattern alteration and economical pattern cutting were found and added to the corresponding section in the text. These examples are seen as inspirations for the upcoming experimental prototypes in chapter 10 and are therefore briefly introduced.

9.3.3 The torso

Even if the torso itself does not change its position, its structure is changeable enough to have unfavourable results on the worn garments. The mobility of the torso is directly dependent on the spine, which allows the greatest extend of movement in the lumbar vertebrae. These are ball-and-socket joints, which most mobility is the forward bending, as shown in the left graphic below. The remaining part of the spine stays nearly constant, except of the cervical vertebrae, which is also a ball-and-socket joint. Its mobility is analogues to the one of the lumbar, bending forward. Figure 79 shows forward bending and the sideways mobility of the torso, which is much more restricted than the latter.

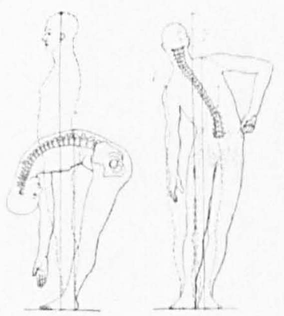


Figure 79, The movement of the torso, Source: Wilhelm (1954:44)

Leaning forward results in an up-lifting of the back part of the jacket. Figure 80 illustrates this at different stages of the very movement.

Croney (1980: 93) stated that the rib cage can move to the front, the side and the back and can therefore reach distances by up to 460mm.

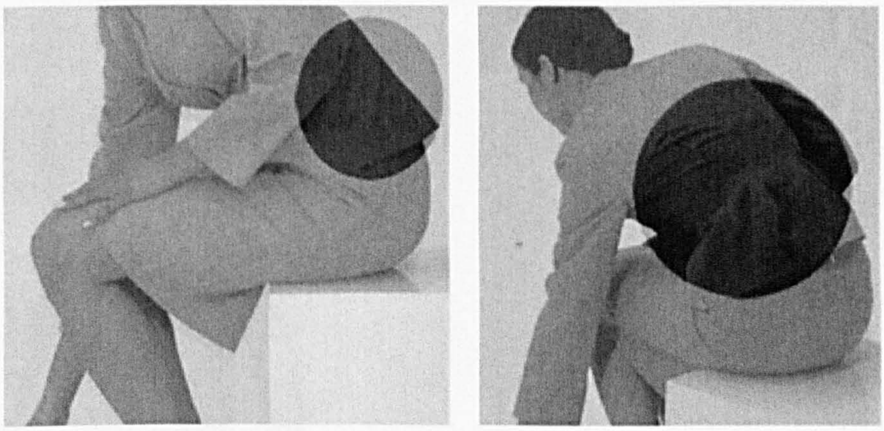


Figure 80, Shoben&Ward Jacket (left and right)

Figure 81 shows the flat-pattern with the problematic area indicated by a circle.

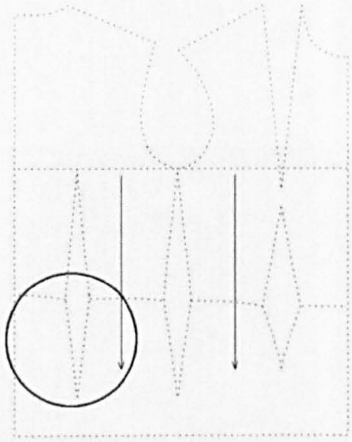


Figure 81, Shoben&Ward Jacket Block

While leaning forward the torso elongates. While a leak of fit occur at the lower part of the back, the upper part does show minor irritations. The back length of the jacket cannot follow the stretching of the torso.
However, there are designs for traditional and modern sports- and dance-wear that address the stretching of the torso. Figure 82 shows a parka with elongated front and back.

Figure 82, Vexed Parka by Vexed Generation, 1995,
Source: www.channel4.com/learning/microsites/R/realdesign/products/vexed

A similar phenomenon can be seen within the trousers in Figure 83. The lower part of the back and pelvis elongates, but naturally, the length of the waist to hip and crotch, of the trousers remain the same as they are while the subject is standing upright. This area is indicated in the flat-pattern in Figure 84.

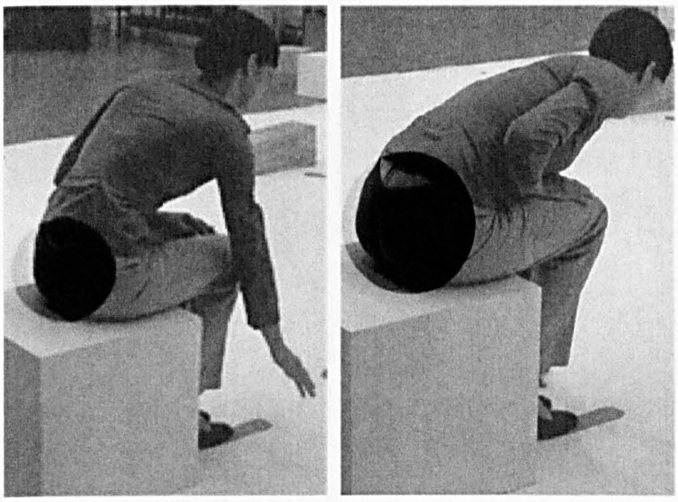


Figure 83, Bray Trousers (left and right)

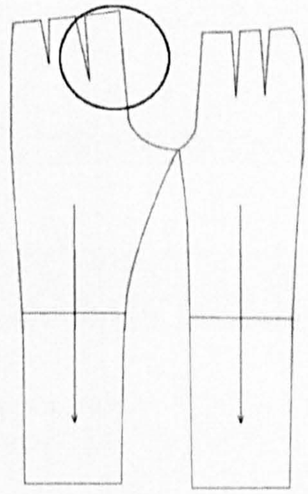


Figure 84, Bray Trousers, Block-pattern

Aldrich (1997. 78, 79) suggested a horizontal cut on the hipline of the back pattern and open it in order to elongate the back crutch and therefore achieve a better fit, pictured in Figure 85.

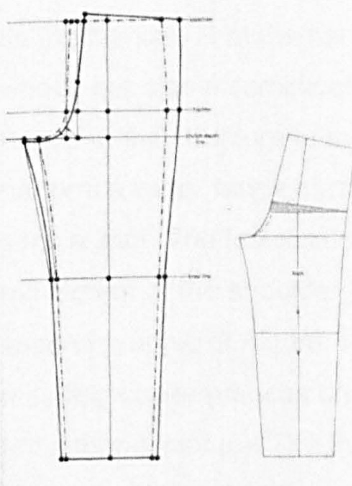


Figure 85, Ease in the back crutch, Source: Aldrich (1997: 79)

This way of adding extra length to the lower back area can also be found in sports-wear trousers. Freedom of movement in this area has always been necessary in all activities that involve upper torso movement out from a sitting position.
Figure 86 shows an illustration together with a pattern for a motorcycle one-piece suit from the beginning of the twentieth century.
These historic motorcycle trousers show an elongated back length at the centre back waist for ease of movement while sitting on the motorbike.

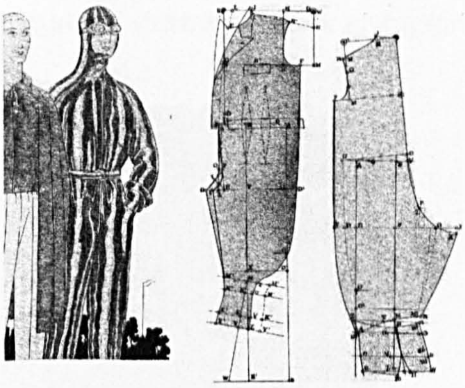


Figure 86, Motorcyclist's outfit, 1924, Pattern for motorcycle trousers, 1931, Source: Lupano and Vaccari (2009:167)

9.3.4 Shoulder and arm

Increasing change of the body's surface and resulting folds within garments does occur when movements are performed. Now, it is useful to examine up to what extend the human body allows such movements. An important role of the different movable areas is the shoulder area.

Its mechanism is at the same time one of the main important ones for the body as a whole, but also a complicated part for being resembled through clothing.

Because the structure of the bones consists of a ball- and- socket joint, it is possible to perform a wider range of movements with the arm, which is attached to the shoulder by such a joint. The first illustration of Figure 87 shows the forward (f, g) and backward (e) movement of the shoulder joint, which go further than the 90 degree angle (b, F). The second graphic of Figure 88 shows the forward movement of the arms and the resulting consequences on the form of the shoulder. The arc of the circles starts at the breastbone joint (c). The third illustration of Figure 88 shows the change within the form of the shoulder while the arms are bent backwards. As before, the arc of the circles starts at the breastbone joint (c).

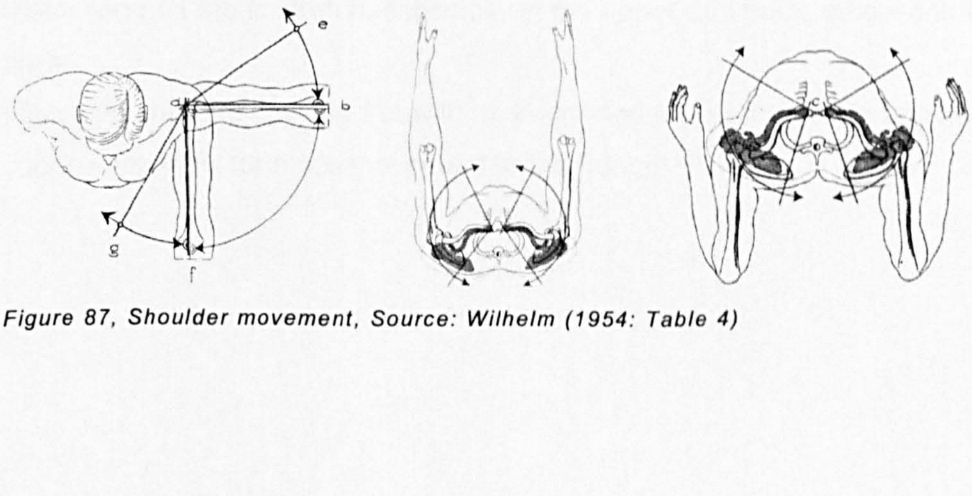


Figure 87, Shoulder movement, Source: Wilhelm (1954: Table 4)

Figure 88 illustrates that leaning forward concerns the shoulder, arm and back area,

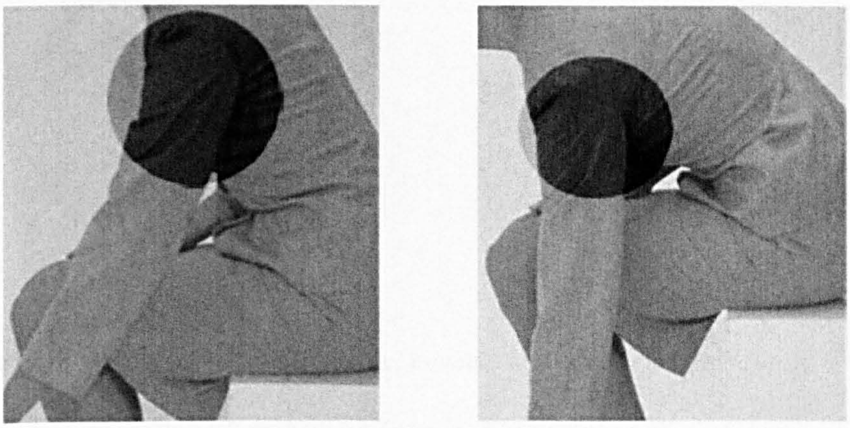


Figure 88, M.Müller&Sohn Jacket (left and right)

Figure 89 illustrates these areas in the patterns for the jacket and the two-seam sleeve.

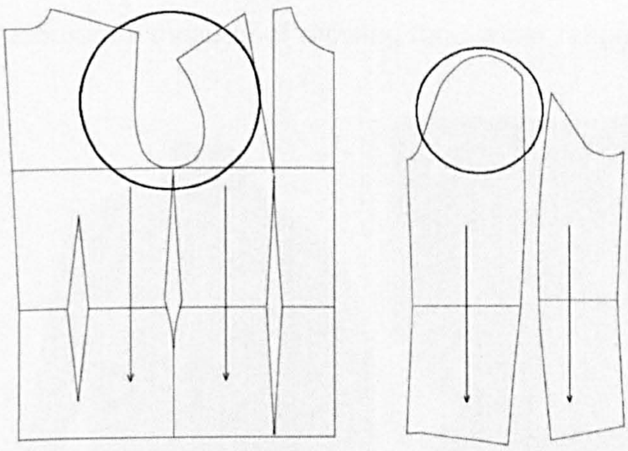


Figure 89, M.Müller&Sohn Jacket and Sleeve Block-patterns

Creases and excess fabric can be seen at the front of the sleeve. Tense and restriction of movement can be seen at the back of the sleeve.

Dong (1996) found out that the tailored womenswear jacket shows significant garment restriction and fabric stretch, especially in the upper arm back, elbow and armhole areas.

Figure 90 shows a sport jacket with an integrated fold at the centre back which is suppose to allow for more movement to the front of the arms.

Figure 90, Ski outfit, 1940, Source: Lupano and Vaccari (2009: 170)

Figure 91 shows a picture set of ski-wear as found in the Bogner archive in Munich, Germany. Both sweaters are made of thick woven wool. The example above is from 1960. It consists of a triangle shaped gusset, cut on the sleeve. The example below is from 1961 and it shows a one piece side and under arm panel. Both examples incorporate the idea of allowing for a wider range of movement for shoulder and arm

.

Figure 91, Two ski-wear sweaters from the Bogner archive in Munich, Germany, above from 1960, below from 1961

A further examination in improving the fit of the armhole can be seen in Figure 92. The measuring tool invented by Caraceni illustrates that the armhole area has been a complex one in regard to flat pattern cutting.

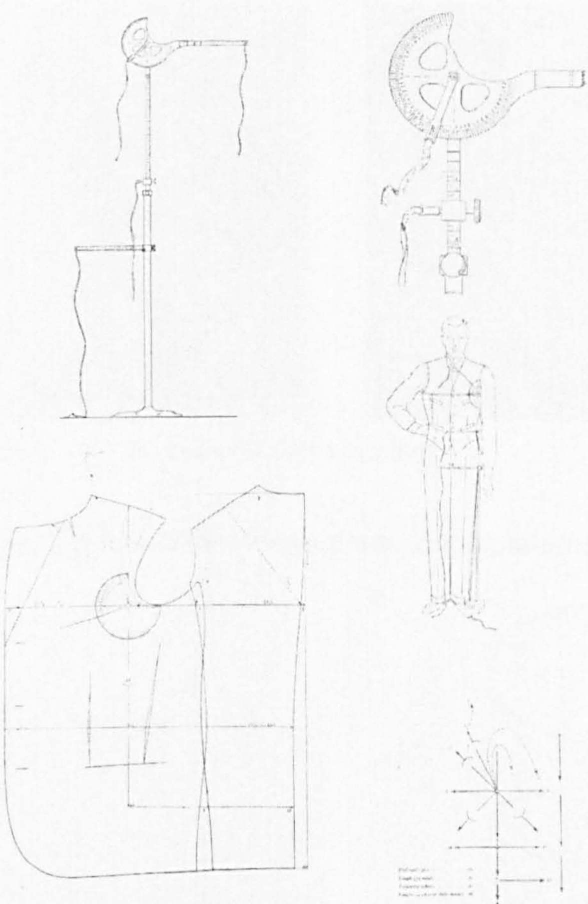


Figure 92, Measuring instrument devised and patented by Domenico Caraceni, Rome, 1933, Source: Lupano and Vaccari (2009:17)

Figure 93 shows two solutions for integrating extra fabric into the shoulder, armhole and back area of a tailored jacket through having folds on the back of the sleeve in the small drawing and through widening the back area in the bigger sketch.

Figure 93, Integration extra fabric for comfort, Source: Wilhem (1954: 41)

The following Figure 94 illustrates the tense at the back and the excess fabric at the front of the sleeve, Moreover, the bended elbow in the figure on the right shows excess fabric at the front side of the sleeve.

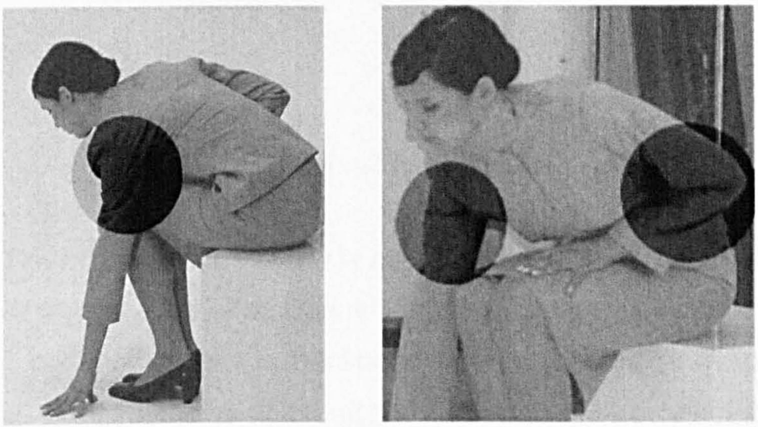


Figure 94, Kunick Jacket (left and right)

Figure 95 illustrates these areas in the patterns for the jacket and the two-seam sleeve.

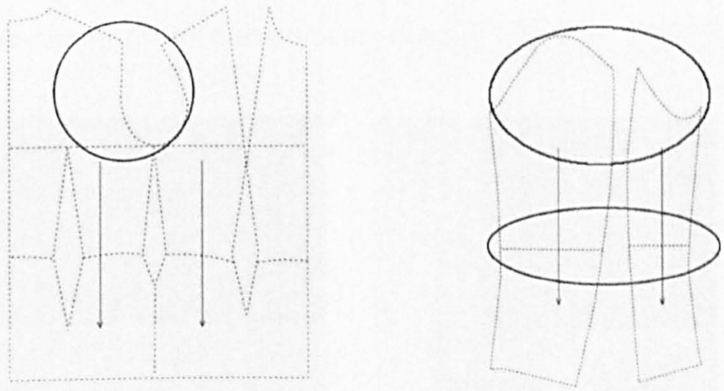


Figure 95, Kunick Jacket and Sleeve Block-patterns

The above problem concerns the armhole of the front and back panel, as well as both parts of the sleeve, as indicated in Figure 95.

The upward movement of the under-arm is illustrated in Figure 96.

The contours of the outer body change in the same way as the shoulder and the arm is moved. This gets exceptionally obvious in the changed armhole, when the arm is uplifted. This mechanism is pictured in the following graphic.

Figure 105 illustrates that as soon as the arm is lifted higher than horizontally (d), the collarbone-breastbone joint (c) does take over from the shoulder joint. The worn clothing cannot follow up with the huge expansion of the contour from point e to point g.

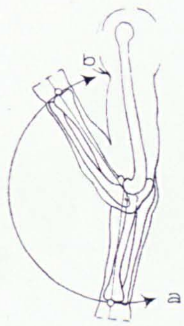


Figure 96, Under-arm movement, Source: Wilhelm (1954:39)

The bending of the elbow is addressed in historic clothing by an extended curve. Figure 97 shows a jacket by Chanel from the autumn winter collection 1968/9. Even though it is not sportswear it is mentioned here because of its unusual cut of the sleeve. Next to its extended curve at the elbow, it consists of three pieces with the parting running down from the shoulder point into the cuff vent.

This three-part sleeve was presumably used to make more sufficient use of the fabric when the pattern pieces were laid out but has no influence on ease of movement in the same way as the curved seam does

Figure 97, Chanel jacket, 1968/9, Source: Archive of the Kunst und Gewerbemuseum, Hamburg

Next to the elbow area the shoulder and arm area is complex in its variety of movements. Figure 98 illustrates the upward movement of the shoulder and arm.

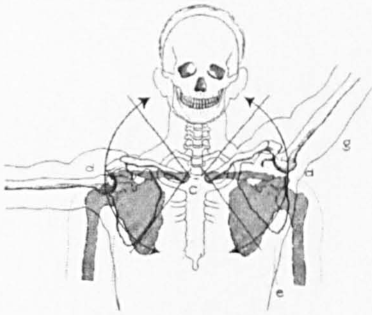


Figure 98, Shoulder movement, Source: Wilheml (1954: Table 4)

Figure 99 illustrates this upward movement of the shoulder and arm on the example of the jacket made-up following the instructions by Jansen and Rüdiger.

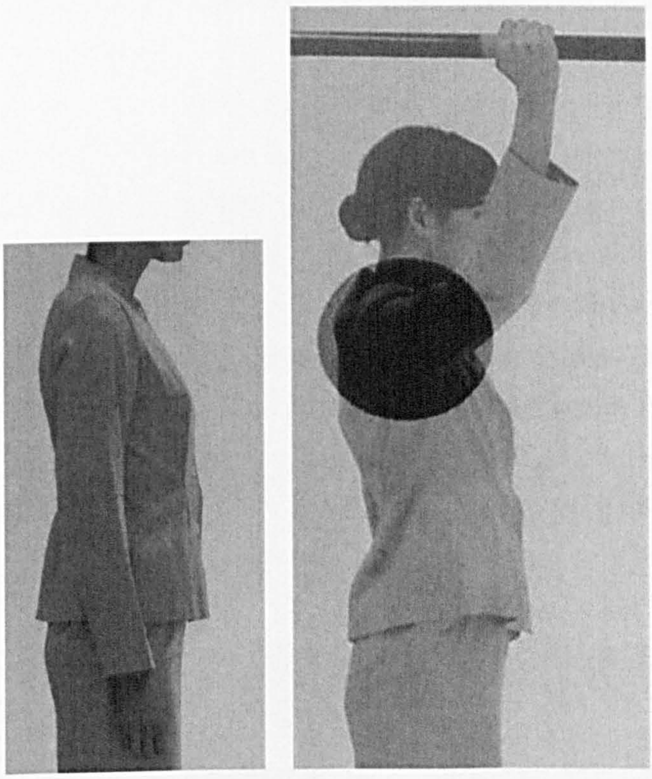


Figure 99, Jansen&Rüdiger Jacket

The above mentioned movement results in major restrictions, as the tense of the underarm area shows in Figure 99. In contrast to the upright position in the left, in the right picture holding up the arm consequently lifts up the whole jacket at the side where the arm is lifted up.

Up-folding fabric can be seen at the shoulder and the neck of the same side. Figure 100 indicates these areas in the patterns for the jacket and the two-seam sleeve.

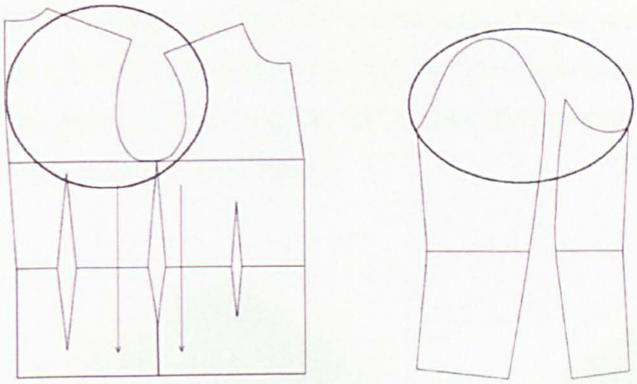


Figure 100, Jansen and Rüdiger Jacket and Sleeve Block-patterns

Wilhelm (1954: 34) suggests that increased physical action do need to be addressed in the clothing through having loose shapes in the area of the breast, shoulders and back of the body.

Figure 101 shows a so called *Norfolk* menswear *jacket,* originally developed for shooting. It consists of a cut on gusset for the under arm panel of a two-piece jacket sleeve. The additional fabric allows for a wider range of this sportswear jacket without being especially obvious when the arm is loosely hanging down.

Even though the shape of this gusset and the way it is cut onto the under arm panel is different to the traditional cut of a set in sleeve, its function for allowing the arm to lift up is comparable to the dancer's gusset, shown in Chapter 4.2.4 and the gussets used for ski-wear illustrated in Figure 91. The effect on the increased range of shoulder and arm movement by an under arm gusset is used as an inspiration for the experimental prototypes in Chapter 10.

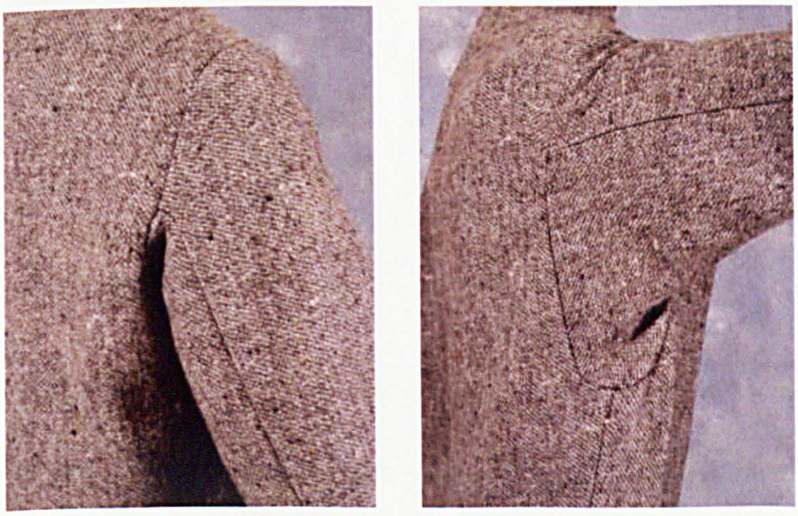


Figure 101, The under arm gusset of the two piece-sleeve of the Norfolk jacket in a natural arm position and with the arm lifted up, Source: www.cutterandtailor.com/forum

Another example of creating additional allowance for this particular movement can be seen in the flight jacket created by the American company *Bogen & Tenenbaum* for the U.S. navy in 1943. Figure 102 shows the front and back view of such a flight jacket as it is still in production today.

Figure 102, Flight jacket made up after the original version from Bogen & Tenenbaum from 1943, Source: www.goodwearleather.com

Despite for sports- or work-wear such flat-pattern cutting solutions are not present in women's tailored business-wear. Typical jacket designs of the 1980s, a decade in which the trouser or skirt suit became synonymous with female business-wear, as in Figure 103, show a wide shoulder in combination with thick shoulder padding and an enlarged armhole.

Figure 103, Giorgio Armani womenswear advertisement, 1980, Source: www.fashionindie.com

Even though, the enlargement means that the space between body and garment gets bigger, the advantage in regard to freedom of movement takes place underneath the garment and not together with it.

This enlarged armhole even stresses the effect that the subject wearing such a jacket cannot lift up the arm without pulling the remaining jacket right after, as seen in Figure 104 showing Margaret Thatcher on her first day as Prime Minister in front of Downing Street in 1979.

Figure 104, Margaret Thatcher, 1979, Source: www.theguardian.com

9.3.5 Pelvis and leg

As the arms are connected to the shoulders which are then connected to the torso, the legs are connected to the pelvis. The joints of the upper leg lay even deeper and are, therefore, more protected as the joints of the upper arm.

The movements which are performed by the thigh, having their starting point at the hip joint, resemble the range of a ball-and-socket joint. That means that the movements can be made in every direction. The highest degree in performance can be achieved to the front, only stopped by the torso. In contrast the same movement backwards is only minimal. Figure 105 shows the swing out mobility to the front and back, captured from the side of the body.

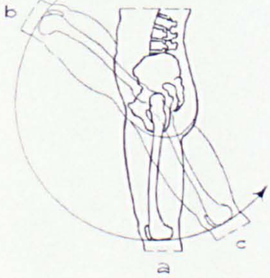


Figure 105, Upper-leg movement, Source: Wilhelm (1954:41)

The turning of the thigh around the above axis is one which is used frequently in every-day life. These distinct and frequent movements need to have room to move reflected in the garments. Without the contrary movement of the knee, which is talked about in more detail in the following, this could be achieved through enlarging the area around the hip and through cutting the parts for the legs wider. Figure 106 shows the mobility of the leg at the knee joint and the same for the similar arm mobility at the elbow joint. Knee and elbow joint both consist of a hinge joint. Therefore, the movement is a simple bending which is only possible backwards at the leg and forward at the arm. The leg can be bent up to 130 degrees. This movement is active while walking, running and especially while climbing stairs.

Figure 106, Knee movement, Source: Wilhelm (1954: 42)

An inevitable result of the above interplay is a richness of various folds of the worn clothing, as it can be seen in Figure 107 and the matching flat-patterns in Figure 108. The fact that the legs perform to carry the body and to move at the same time, explains the continuous changing of the folds. Even while sitting the legs can take every position, the clothing is in a contrasting creasing at all times.

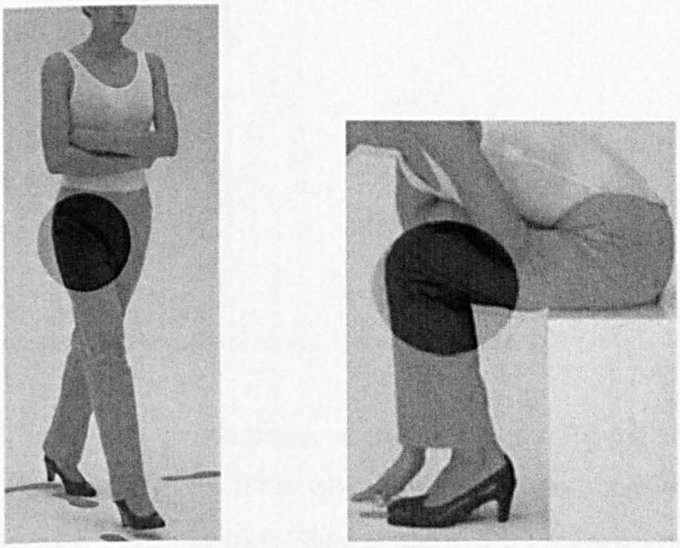


Figure 107, Aldrich Trousers (left and right)

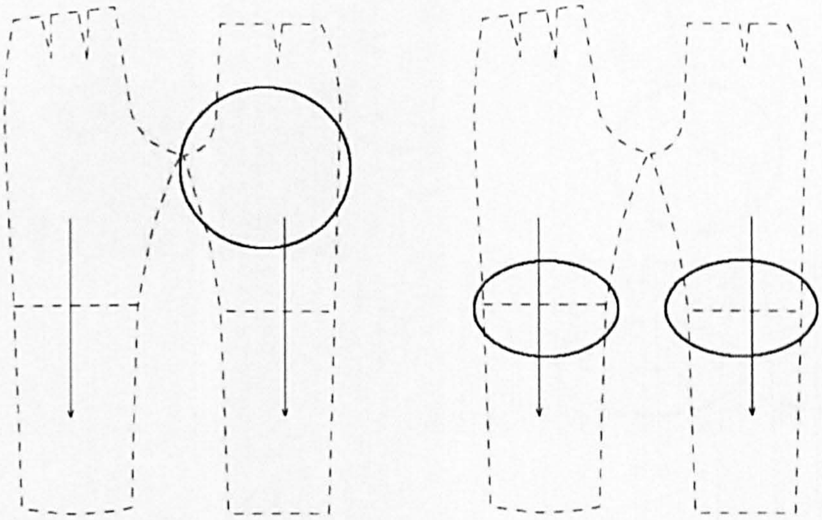


Figure 108, Aldrich Trousers Block-patterns (left and right)

Figure 109 shows the big gluteus muscle (1). The knee is stretched with the help of the femur muscle (2), whereas the calf muscle (3) is needed for stretching the foot. The bending of these parts is performed by the lumbar ileum muscle (4) at the hips and by the femoral bender (5) and the arteries muscle (6) at the knee. For bending the foot, the shinbone muscle (7), the toe stretcher (8) and the long toe stretcher (9) is needed. Further muscles are involved in the inward- and outward rotation. These are not needed for understanding the posture of the body. But, it is necessary to mention the spine stretcher muscles which perform the stretching of the spine and therefore, the upright posture. Because of the fact that the posture is of great impact to the outward appearance, even the static upright standing is the direct result of a permanent battle between gravitation and the muscles which are responsible for the upright stretching.

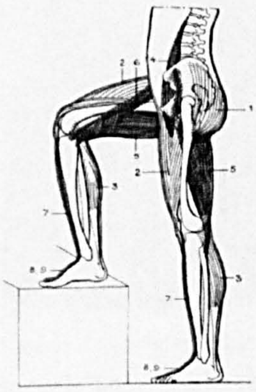


Figure 109, Stepping, Source: Wilhelm (1954:31)

The results on the trousers can be seen in Figure 110. Even the beginning of the movement in the left in which the right knee is only slightly bended causes folding. Figure 111 illustrates these areas in the patterns for trousers made-up following the instructions for the M.Müller&Sohn system.

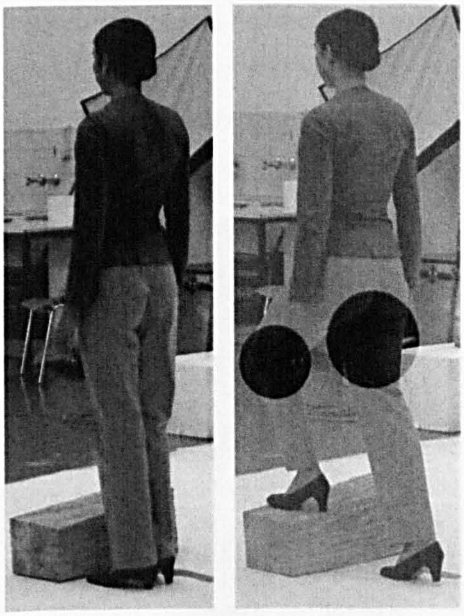


Figure 110, M.Müller&Sohn Trousers

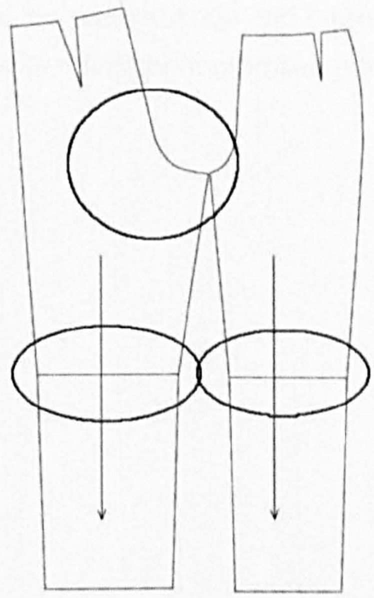


Figure 111, M.Müller&Sohn Block-pattern

A solution for the above lack of fit can be seen in the wide knickerbockers pants and the flat pattern for those, Figures 112 and 113. Through generally widening the leg in combination with holding it tight under the knee, which resolves in extra length of the legs, the mobility of the legs inside the trousers is expended.

Figure 112, Knickerbockers, 1933, Source: Lupano and Vaccari (2009: 159)

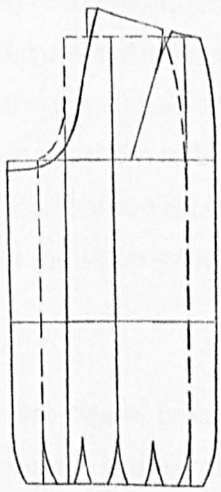


Figure 113, Flat-pattern for Knickerbockers, 1935, Source: Lupano and Vaccari (2009: 158)

Another starting point for allowing more movement can be seen in the motorcycle pants in Figure 114. When interviewed in September 2004, Ludwig, who worked as a pattern cutter at a company for motorcycling clothing, reported that the form of the trousers follow the bended knee and therefore they are comfortable when the knees are bended while riding the motorbike, but restricts the upright position of the legs.

Figure 114, Motorcycle Pants by Alpinstars, Source: www.alpinstars.com

9.4 Summary of Chapter 9

Every time the body performs a movement at one of the joints, the garment is under strain. For the trousers the most obvious strain occurs at the level of the body where the legs are connected to the torso. Because of the greater ability in which the legs can be moved to the front in comparison to ability to move them to the back, the fabric is pulled up at the front and stretched at the back. This can be recognised by creases in the front part and tensed fabric in the back part of the trousers after they have been worn.

A similar effect can be seen around the knees. Here again, because of the ability to bend the knee to the back and not to the front, creases appear at the back of the knees, whereas bending results in stretched out fabric at the front.
The garments that cover the upper part of the body show a similar result around the elbows, where the forearm can be bend towards the front but not to the back. The same result of a bending of part of the body can be seen when the torso bends forwards. The shortening of the measurement of the centre front measured in an upright position, leads to an access of fabric, whereas the opposite happens at the back, where the fabric is pulled.

Another area where a moving of the belonging body parts has an effect on the garment is the armhole. As mentioned above, the wide range of movements which can be performed by the arm at the shoulder joint, easily result in bad fit around this area. Again, most of the movements are performed towards the front, which conduct in an access amount of fabric, which then leads to creases, at the front armhole and strain put on the back armhole.
Aldrich, Smith and Dong (1997: 344) agreed that the maximum arm reach with free movement of the shoulder is much greater than with the shoulder restrained by clothing.

All eighteen garments show similar lack of fit in the assorted areas. These areas can be characterised by a lack of length and width at the area from which the movement starts, such as the armhole or the pelvis. Furthermore, sitting down results in tense and strains of the fabric because the general enlargement of the waist and hip girth measurements.

Even though it is up to a certain point subjective if one is feeling free to perform movements in one's garments, it can be said that lack of fit starts with leaving the upright static position.
When interviewed Shoben argued that block-patterns naturally do not fit during movements. According to him, the ability to move comes with fashion-pattern only. Furthermore, he suggests, that a jacket block which does consist of one single part reaching from the neck to the hip will always restrict movement, because the curved waistline, which is suppose to follow the human anatomy, is missing.
But still, block-patterns, as investigated in this chapter, are used as derived- or fashion-pattern in the mass-market industry. The pure attachment of pockets and collars do not change the fit of the basic block-pattern.

A general enlargement of patterns, as it can be seen in the boxy shapes of 1980s womenswear jackets, might allow for the impression of being able to move underneath the garment, but certainly not with the garment, as shown in 9.3.4, Figure 104.
Bray (1961: 11) suggested that these armholes larger than necessary are a commercial consideration to help in the sale of the garment.

9.5 Emerging Issues

The comparative practical experiment of block-pattern for womenswear jackets, trousers and skirts has shown that:

A general widening of the main body girths, whereas the bust-girth shows lower impact than the waist- and hip- girth, while sitting down. The expansion of the torso is bigger while sitting. As the body measurements for the torso are taken on the upright standing body, the enlarged expansion while sitting are not considerer and therefore the jackets, trousers and skirts show strains in the addressed areas.

The shoulder and arm area is very complex because of the different abilities of movement of these in comparison to the rather static torso. The ball joint of the shoulder enables a great range of movement of the shoulder and the arm. A widening and lowering of the armhole is a popular solution. Even though it guarantees enough space for further garments worn underneath cut in a similar way,
it restricts an up lifting of the arm in the way that the side of the jacket is pulled up, again as seen in 9.3.4, Figure 104. Attempts in sportswear were undertaken to integrate a gusset onto the lower part of the sleeve or folds between sleeve and the side of the back panel in order to allow for a wider range of movement. Both examples result in allowing for movement. In the case of the fold between the sleeve and the side of the back the arm can stretch out wider to the front, whereas the integrated underarm gusset allows lifting up the arm without pulling up the remaining jacket.

The elbow is restricted in bending. Up-folding fabric at the inner side of the elbow shows that there is too much material for undertaking the movement.
The seating area of trousers and skirts is too short for leaning forward while sitting. The height of the seating area is measured on the upright torso. Any forward movement of the torso elongates the lower back area. Consequently the waist line is dropping down.

The former investigation into how mass-produced womenswear jacket, trousers and skirt, made up following contemporary block-pattern, react to human body movements, has revealed tension in specific areas of the clothing.

The following experimental study in block-pattern innovations targets each of the above fitting problems through amended construction principles.

The following Chapter 10 forms the analysis of the practical experiments in which the contribution to new knowledge is shown. The renewed block-patterns are evaluated from an observing perspective under the consideration of allowing for a wider range of movement.
This section consists of a second video analysis.
Section 10.1 describes the changes within the block-pattern.
Paragraph 10.2 shows the prototypes in stills taken from the video documentation for each of the examined area where a wider range of movement would be suitable.
Section 10.3 compares the garments from Chapter 9 to the new prototypes. The prototypes are accompanied by a Likert scale stating a questionnaire's outcome.

10 INNOVATIVE EXPERIMENTS IN BLOCK-PATTERN

This experiment contains six proposals for the construction of the flat-patterns for the jackets, four for skirts and two for trousers.
In order to evaluate the changes in regard to fit the prototype garments were made up, filmed and photographed following the guidelines of the first video analysis 1, as stated in Chapter 9.
As shown in Chapter 8, the construction principles of the six different flat-pattern cutting systems are similar. Even though the different constructions consist of variables, such as the amount of ease or various dimensions of the darts, the areas which show weak fit during movement are the same, as found in Chapter 9. Therefore, the pattern construction by the M.Müller&Sohn system was chosen as a base on which the experiments were undertaken.
The aim of these experiments is to develop block-pattern amendments which can generally be used in flat-pattern construction. They are not dependent on a specific flat-pattern cutting system. The aim is to inform about the possibilities of the pattern construction in regard to incorporate every-day movements.

10.1 Framework of the Experiment

The comparative study in Chapter 9 showed that the areas where strains in the garments restrict the full range of movement while the subject performs every-day movements are:

- the shoulder and upper arm
- the elbow
- the upper and lower back of the torso
- and the knee.

Therefore, amendments to the pattern construction of the jacket, skirt and trousers need to be undertaken in these areas.
An inspiration to the design process of the amendments is taken from traditional and modern sports-, or active-wear as shown in Chapter 9. These examples make use of the extra fabric integrated in folds, a curving of formerly straight lines and an integrated gusset, all of which are intended for allowing body movement with less restriction.

The subject wearing the prototype garments is different from the one in video analysis 1 but she with the same size. As this project investigates mass-produced soft-tailored womenswear and not individual made-to-measure garments, the different model enables for a realistic view on mass-manufactured clothing because it is not made for a single person but for a range of people of the same size.
As a result from of undertaking video analysis 1, the fabric of the experimental prototypes is of various colour in order to prevent a mixing up of the prototypes. The video and the extracted stills are in black and white for the later comparison.

The visual analysis starts with an introduction of the amendments. This is followed by a table for jackets, one for trousers and one for skirts in which the amendments to the block-pattern constructions are stated accompanied by illustrations. Six prototype jackets, four prototype skirts and two prototype trousers are proposed.
All flat-patterns were constructed using the Assyst software at the CAD CAM facilities at the University of Applied Sciences in Bielefeld, Germany.
The resulting images were in the following dealt with a picture editing software (Adobe Illustrator), because CAD CAM software programs are not intended for creating images which could be filled into a text document without showing the software's disturbing construction background.

The amendments were undertaken on the block-patterns of the M. Müller&Sohn system, as shown in Figures 64 for the jacket block, 66 for the two-seam sleeve block, 68 for the skirt block and 70 for the trousers block. The use of this construction system is due to the personal education of the researcher and not
After each prototype is addressed, images of all prototypes showing the garment worn in the same movement are compared. These images of the actual garment worn by the subject in six defined movements represent the formerly evaluated problematic areas within the garment in terms of strain in the garment when the subject is in motion. In order to gain a clearer visual outcome, the pictures were taken at the same time while the video was shot. This is followed by a comparison between garments made up following the six flat-pattern cutting systems introduced in Chapter 8 and the prototypes. The visual analysis of the jackets is followed by the one for skirts and one for trousers.

10.2 Innovations within the Block-pattern Construction

As shown in Chapter 9.5, the areas where strain in the garments is visible are the upper arm and shoulder, the elbow, the upper and lower back and the knee. The aim of the practical experiments is to reduce strain in garments but integrate flat-pattern amendments into the traditional way of construction, as shown in the flat-patterns in Chapter 8.Thererfore renewed ways of constructed are undertaken at already existing seams of the original construction method. The amended pattern constructions for the soft-tailored womenswear jacket, skirt and trousers can be divided into five fields:

i. extended curve at the elbow
ii. diagonal folds
iii. vertical folds
iv. horizontal folds
v. integrated pleated gusset/grown-on-gusset

All of the changes undertaken on the block-pattern constructions with the aim to widen the range of movement in these specific areas are explained in the following. Illustrations of the proposed solutions are classified for the three different garment types, as shown in Chapter 10.3.

10.2.1 Extended curve at the elbow

The bending of the elbow is restricted because of the sleeve being too straight. A widen out of the curve at the elbow line by four centimeters should support the slightly curved position of the natural arm and its ability to bend.

10.2.2 Diagonal folds

As stated in section 9.4.1 the ball joint of the shoulder connects the highly moveable arm to the rather static torso. Because of the wide range of movement the shoulder is a complicated area in pattern cutting. The problem needed to be targeted in two directions. One is the shoulder moving to the front resulting in restriction across the back because the body enlarges. At the same time but to a lower extend the shoulder can be moved backwards. For performing the movement in both directions without being restricted, extra fabric is needed.Because the folds are of diagonal shape they are cut on the bias grain. Through this the woven fabric gets moreflexible than the rest of the front and back pieces, which are cut on the straight grain, as stated in Chapter 4.6.

The integrated folds run from the armhole to the neckline, one variation meeting in a pointed angle which can be sewn onto the point where the shoulder line meets the neck.

A variation of this fold consists of a flattened angle. The last enables to integrate the flattened fold into the neck line, which is in this case five centimeters long.The diagonal folds are tested in both, front and back part of the bodice as well as only in the back. They are integrated into the front and/or back part of the bodice. The folds need to be sown together. The connected folds rest on top of the original shoulder seam when worn in an upright standing position with the arms hanging down naturally.

10.2.3 Vertical folds

The general increase of the circumference of the bust-, waist- and hip-girth while sitting, results in tightness across the back of the jacket and at the waist of the trousers and skirt. Consequently the inserted inverted-pleat at the centre back adds an extra amount of eight centimeters to the across-back measurement. The same pleat is integrated into the centre back of the skirt.

10.2.4 Horizontal folds

Horizontal folds are added to the waist of the jacket, trousers and skirt. These folds address the lack of material at the lower back while bending over from a sitting position.

These folds are put into practice in two versions, one with a narrow pleat width of three centimeters for trousers and skirt and eight for the jacket and a second wider version of eight centimeters for trousers and skirt and 20 centimeters for the jacket.

10.2.5 Integrated pleated gusset/grown-on-gusset

The problematic aspect of pulling half of the jacket behind while lifting up the arm is a consequence of fabric missing at the underarm area. A first trial of a separate folded panel added twelve centimeters to the underarm.

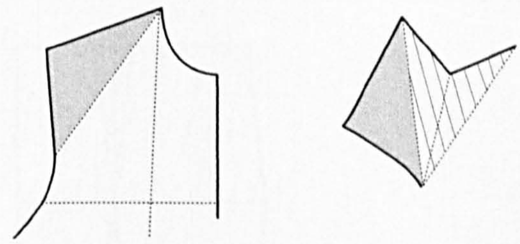
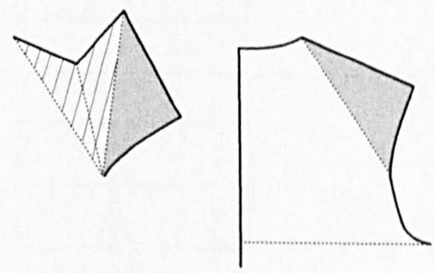
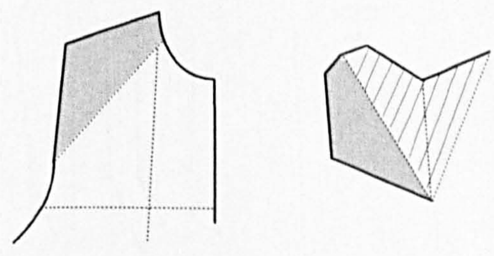
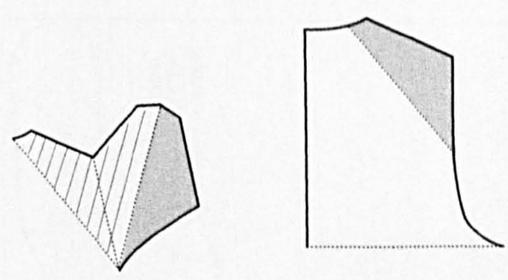
The grown-on-gusset of the underarm sleeve consists of extra six centimeters. The armhole of the front and back bodice was engrossed by two centimeters to allow for a longer gusset. This is inspired by the Norfolk jacket, shown in Chapter 9.4.4, but with a less deep gusset part.

In the following section all of the above changes of construction are sorted by garment type. Furthermore, the target area of the renewed construction principle is stated as well as brief descriptions of the problems in this area together with the proposed amendment to the pattern, accompanied by illustrations of the constructions.

The grey parts of the illustrations indicate the renewed aspects of construction whereas the hatched areas show the pleat under lap.

Figure 115 gives illustrations and explanations for the amendments used for the experimental prototype jackets and sleeves, Figure 116 for the trousers and Figure 117 for the skirts.

10.3 Targeted Areas

Amendments for experimental prototype JACKETS / SLEEVES			
Target Area	Problem	Flat-pattern	Illustration of Flat-pattern
Shoulder1. Front	The fort movement of the shoulder is not addressed	Inserted pointed pleat at the shoulder line and at the upper part of the front armhole	
Back	The back movement of the shoulder is not addressed	Inserted pointed pleat at the shoulder line and at the upper part of the back armhole	
Shoulder 2. Front	The fort movement of the shoulder is not addressed	Inserted flat pleat at the shoulder line and at the upper part of the front armhole	
Back	The back movement of the shoulder is not addressed	Inserted flat pleat at the shoulder line and at the upper part of the back armhole	

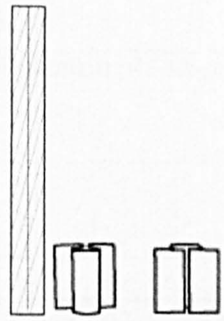
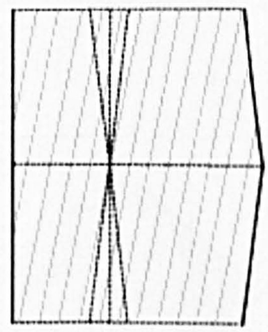
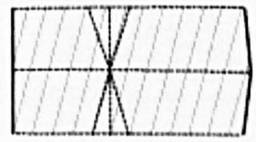
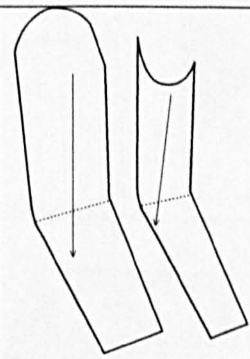
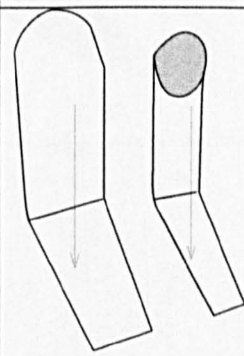
Across Back	The widening of the across back when the arms are turning forwards	Inserted vertical pleat at the centre back	
Lower Back 1.	Bending over the torso elongates the area	Inserted horizontal box pleat at the back waist (20cm)	
Lower Back 2.	Bending over the torso elongates the area	Inserted horizontal box pleat at the back waist (8cm)	
Elbow	The natural position of the elbow is slightly bended	Curving the outer and inner line of both parts of the two piece sleeve at the elbow line	
Armscye/ Underarm Sleeve	The elongation of the lower sleeve when the arm is uplifted is not considered	Inserted grown-on-gusset at the lower part of the two-piece sleeve in combination with a lowered armhole	

Figure 115, Amendments for Jackets

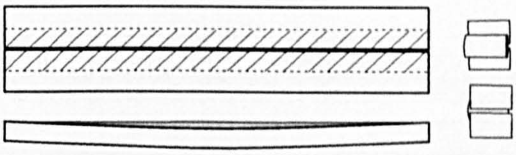
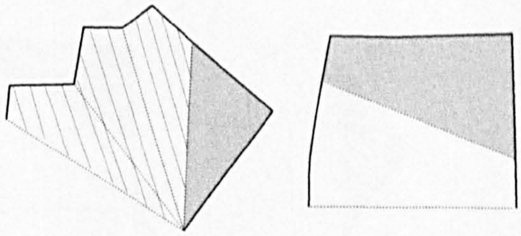
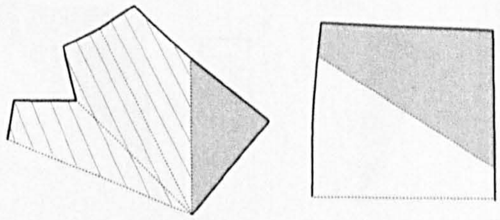
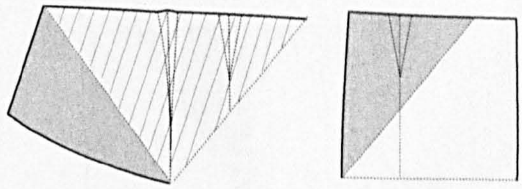
Amendments for experimental prototype SKIRTS			
Target Area	Problem	Flat-pattern	Illustration of Flat-pattern
Waistline	Elongation of area between waistline and bottom while sitting and bending forwards	Inserted pleat at the back waist	
Bottom 1.	Widening of the back hip area while sitting down	1. Inserted flat pleat at the back waist and the centre back	
Bottom 2.	Widening of the back hip area while sitting down	Inserted flat pleat at the back waist line and the side seam	
Bottom 3.	Widening of the back hip area while sitting down	Inserted pleat at the centre back and the side seam	

Figure 116, Amendments for Skirts

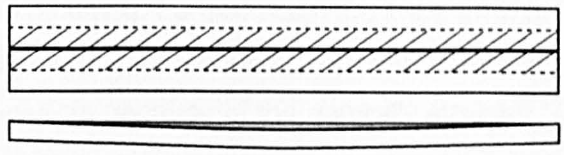
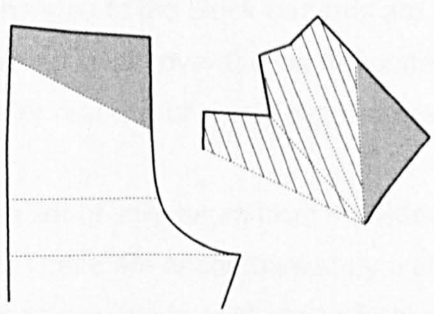
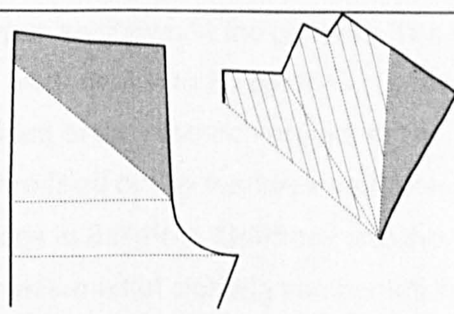
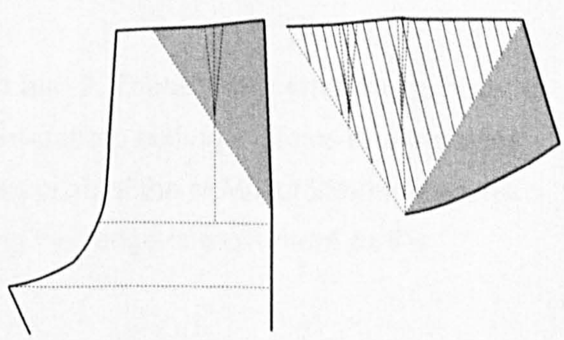
Amendments for experimental prototype TROUSERS			
Target Area	Problem	Flat-pattern	Illustration of Flat-pattern
Waist	Elongation of area between waist and bottom while sitting and bending forwards	Inserted pleat at the back waist band	
Bottom 1.	Widening of the back hip area while sitting down	Inserted flat pleat at the back waist and side seam	
Bottom 2.	Widening of the back hip area while sitting down	Inserted pointed pleat at the back waist and side seam	
Bottom 3.	Widening of the back hip area while sitting down	Inserted pleat at waist and the side seam line	

Figure 117, Amendments for Trousers

10.4 The Prototypes

The trousers and skirts both show up-folding excess fabric in positions, such as walking and sitting. But still, this excess fabric is needed for performing other movements or, while standing upright, to obtain a wrinkle-free appearance following the general guidelines for fit. Therefore, these areas are not considered for possible solutions through the construction of flat-pattern cutting. Furthermore, the knee area of the trousers is also not taken into consideration, because a curving, as it is possible to construct for the elbow of the sleeve, is not possible because of the naturally straight posture of the legs while standing upright.

In the following Chapters 10.5, 10.6 and 10.7 all prototype jackets, skirts and trousers are shown in detail. The descriptions of the changes to the block-patterns are followed by the construction. Furthermore, the construction is laid over the six flat-patterns of the specific garment type, as seen in Chapter 8. For reasons of clarity this is done on A3 size sheets.
Each diagram of the prototype is followed by a set of stills taken from the video analysis 2, which can be found in Appendix 5. These are accompanied by a Likert Scale indicating the opinion of thirty-two persons working in or studying fashion, asked to give their appraisal on the fit of the prototypes as shown in the pictures. The sheets showing stills of the experimental prototypes were shown to 30 persons. 19 filled out sheets were gathered at an internal presentation of the research project at the London College of Fashion. Seven questionnaires were filled out by teachers and professors for fashion at the University of Applied Sciences in Bielefeld, Germany and the remaining 6 were looked at by designers at mass-market clothing companies in Germany. The complete questionnaire was gathered in June 2011.

This is followed by stills from video analysis 1 and 2. These stills demonstrate how the prototypes made up after the six traditional flat-pattern cutting systems and the ones using renewed cutting principles on the construction of the M.Müller&Sohn flat-pattern cutting system allow the model to move during the range of movement as it is introduced in Chapter 9.2.2.

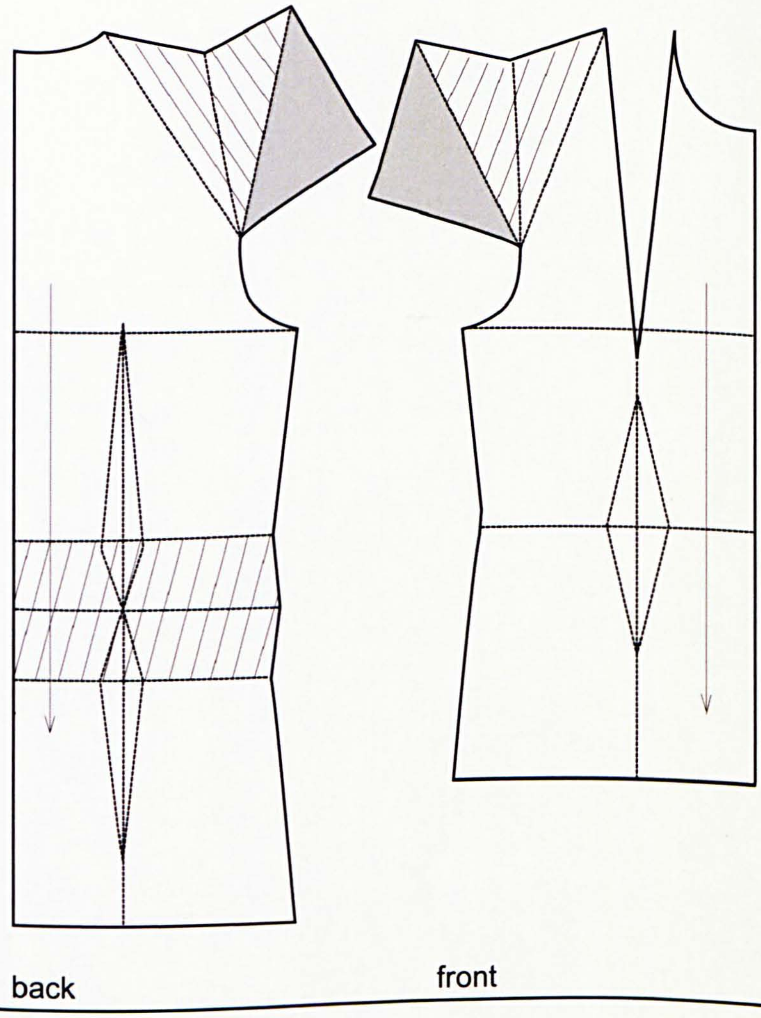
10.5 Prototype Jackets

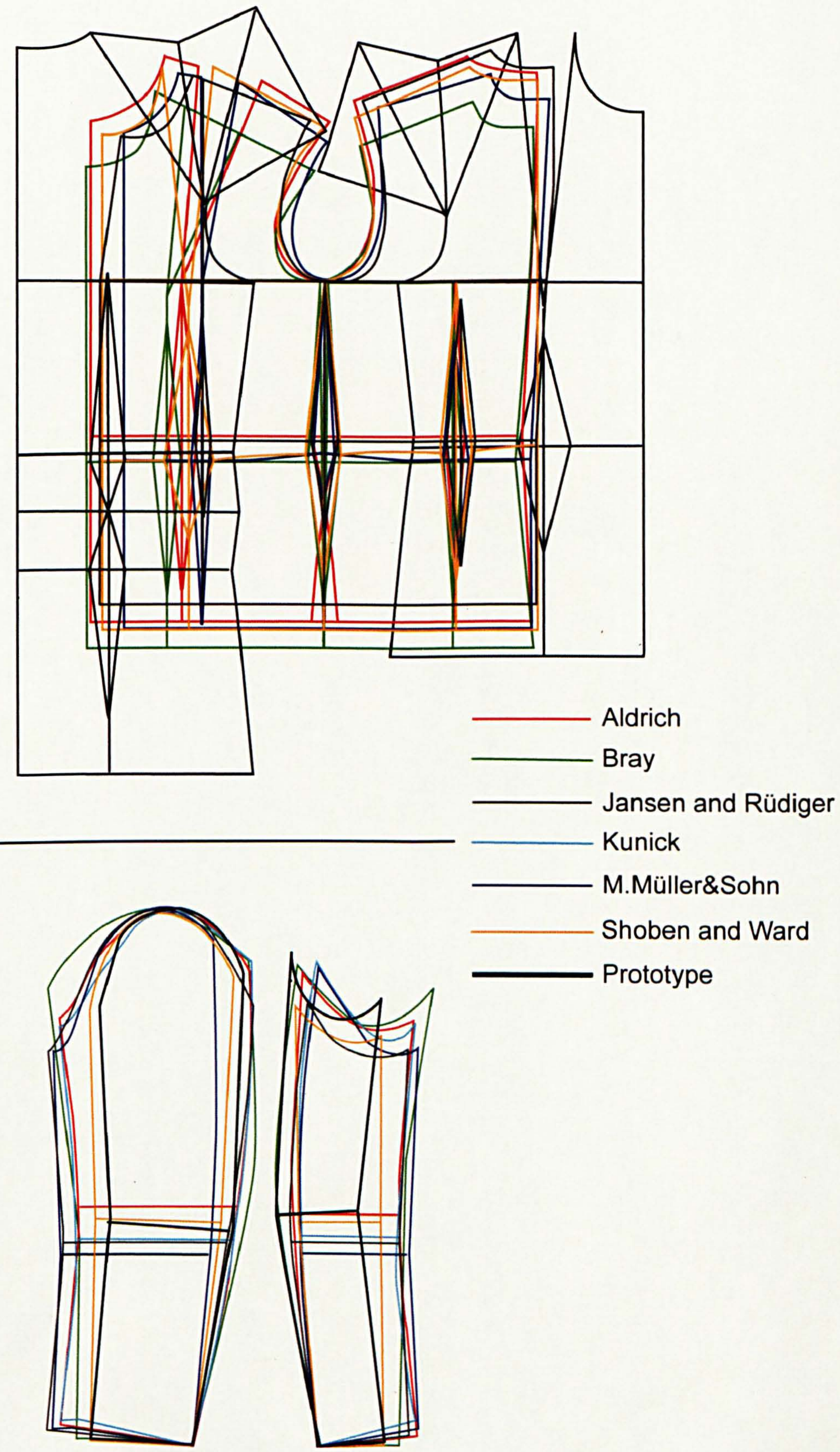
10.5.1 Visual analysis chart: Jacket / Sleeve Prototype 1

1. Front and back fold at the shoulder running from armhole to the neckline in a pointed angle (hatched).

2. Seperat fold panel at the armpit, attached to bodice and sleeve.

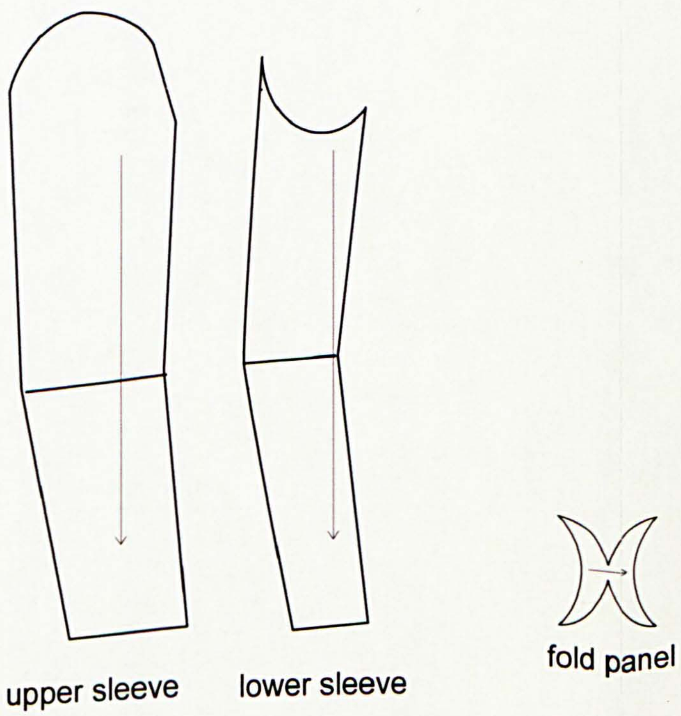
3. Horizontal box-pleat at back waist line (hatched)





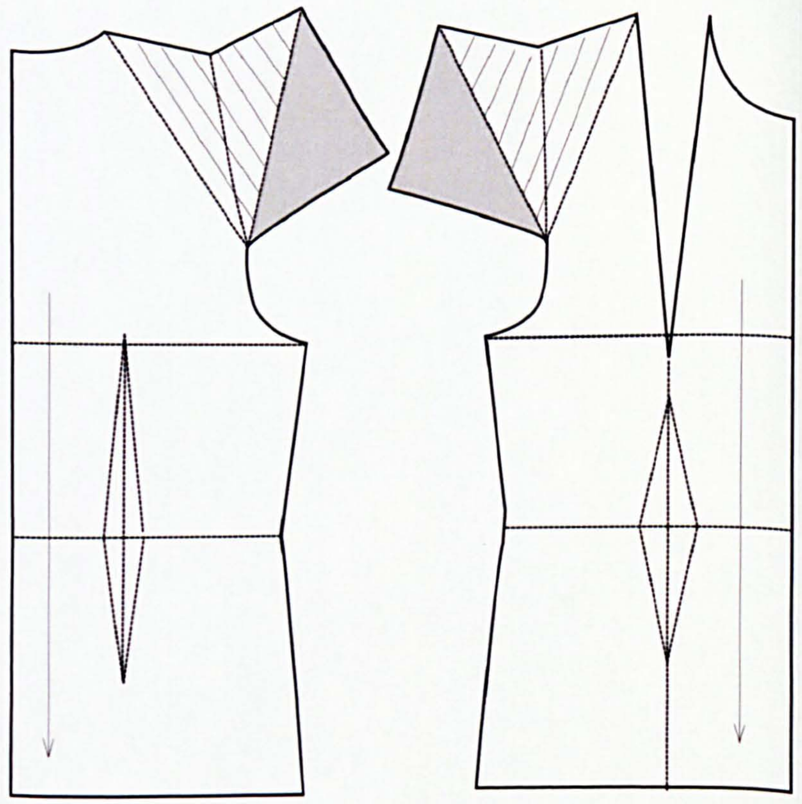
1. Slightly curved two-piece sleeve.

2. Separat fold panel at the armpit attached to bodice and sleeve.

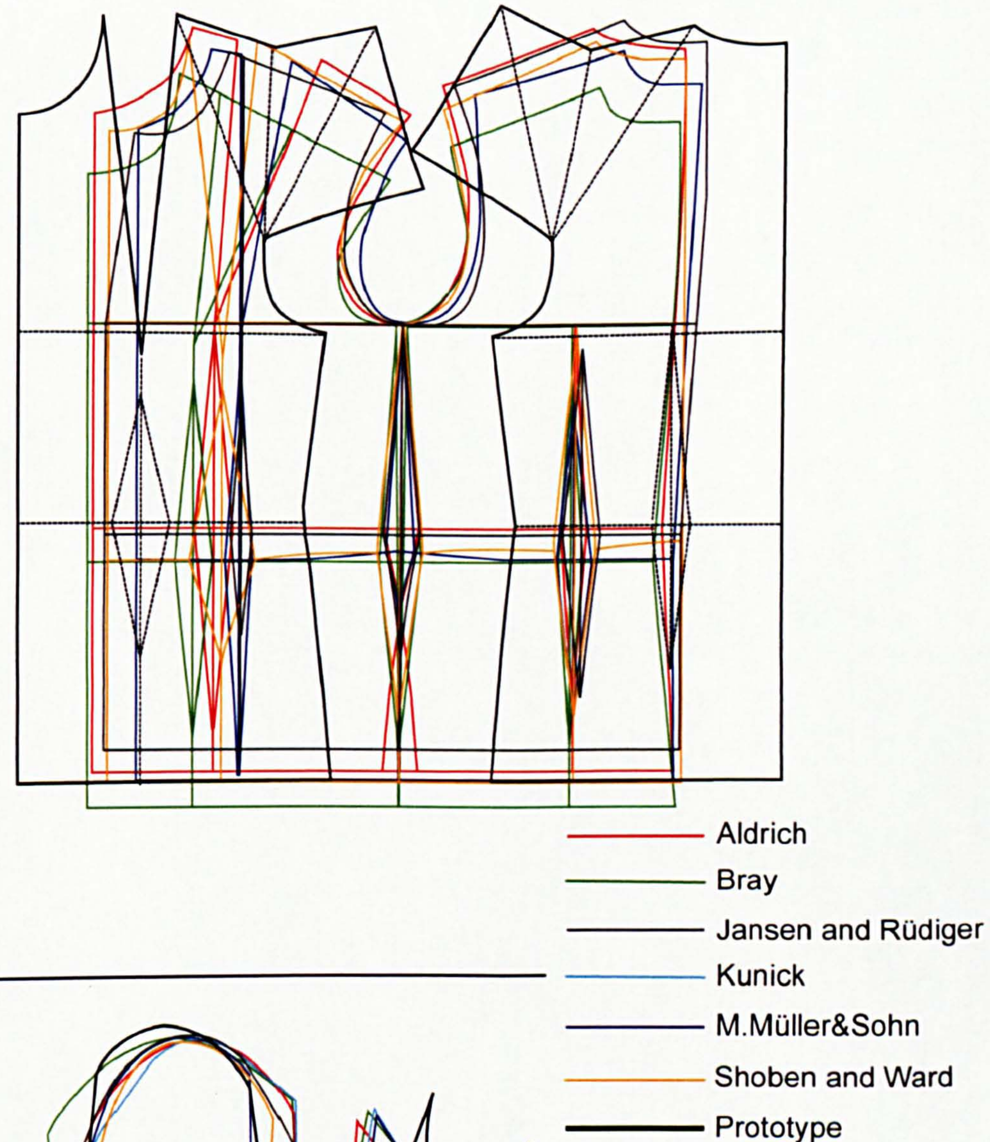


10.5.2 Visual analysis chart: Jacket / Sleeve Prototype 2

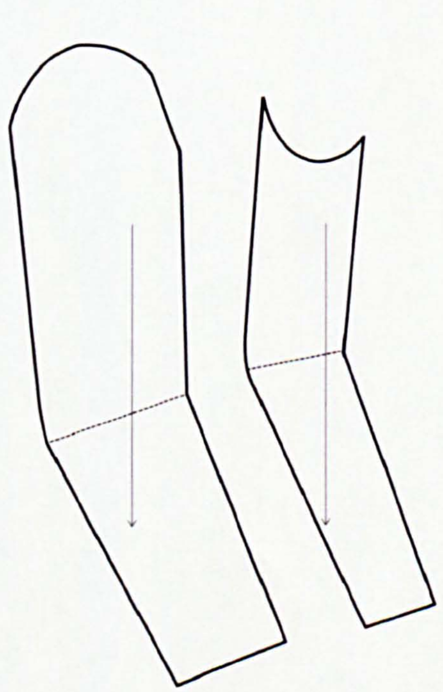
1. Front and back fold at the shoulder running from armhole to the neckline in a pointed angle (hatched area indicates the depth of the fold).



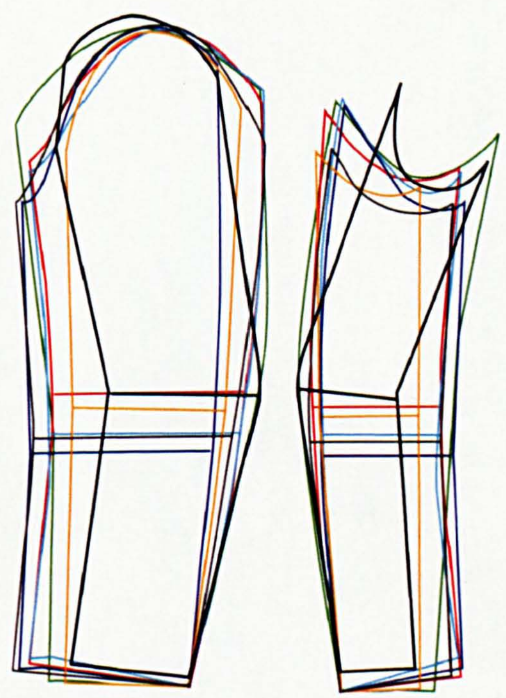
back front



1. The curves at the elbow line of the upper and lower sleeve are expanded by 4cm.



upper sleeve lower sleeve

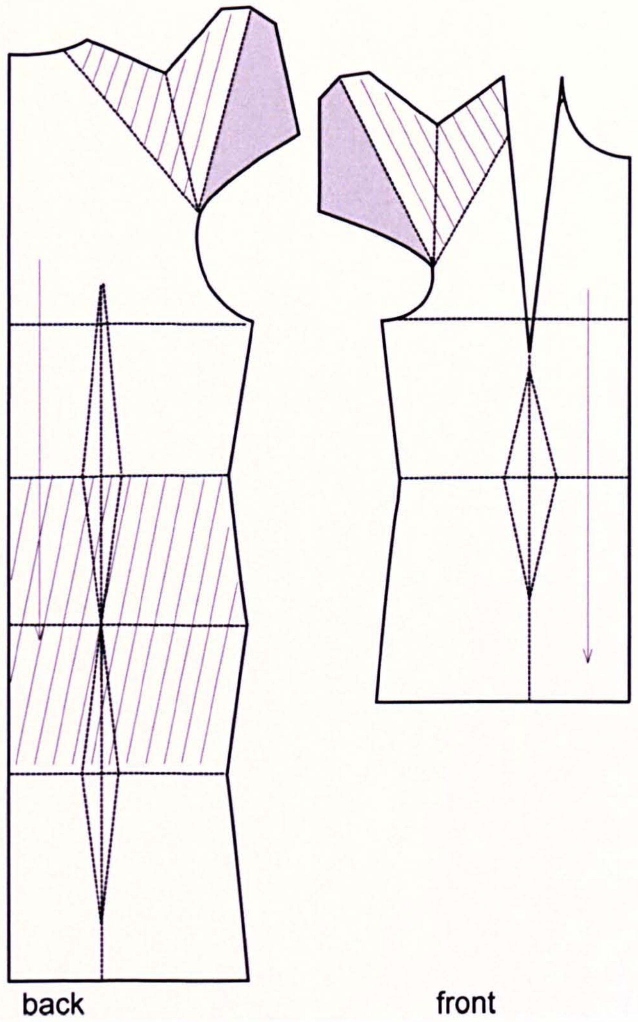


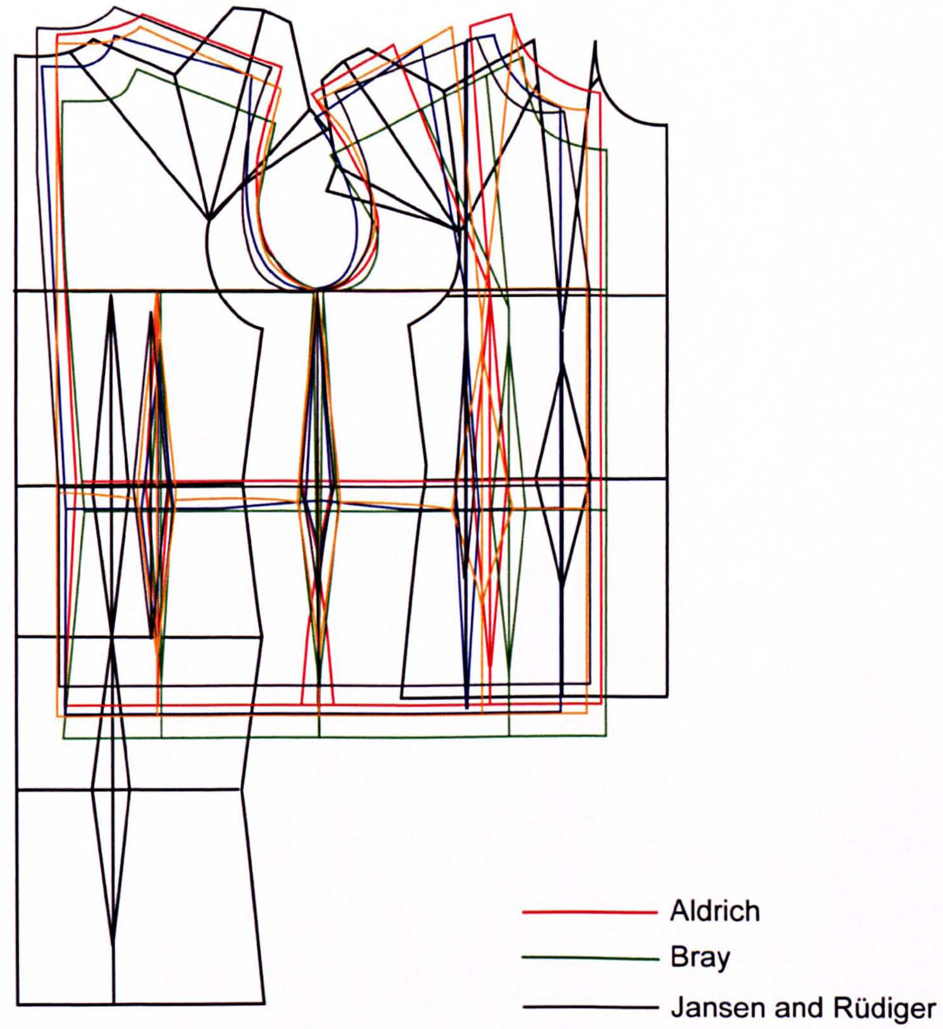
10.5.3 Visual analysis chart: Jacket / Sleeve Prototype 3

1. Front and back fold at the shoulder running from armhole to the neckline in an oblate angle (hatched area indicates the depth of the fold).

2. Armhole lowered by 2cm.

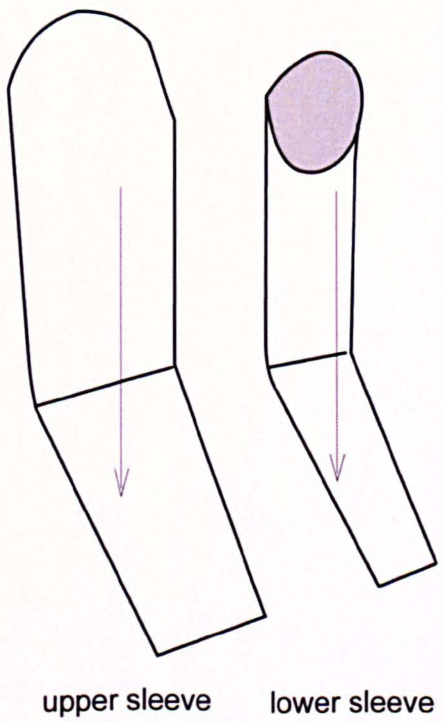
3. Horizontal box-pleat at back waist line (hatched area indicates the depth of the fold).

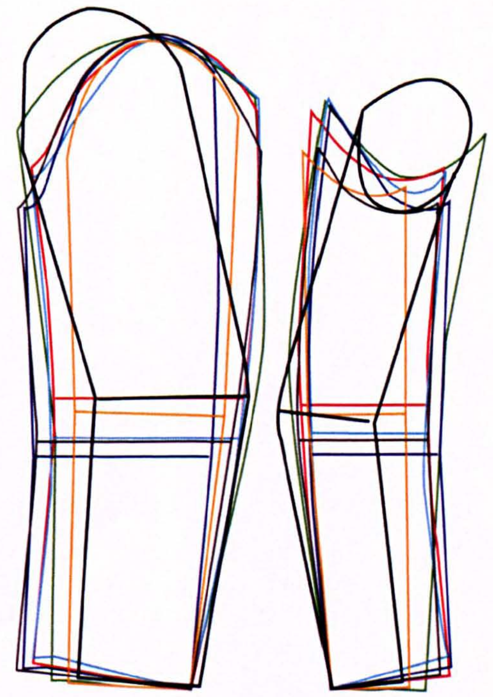




1. The curves at the elbow line of the upper and lower sleeve are expanded by 4cm.

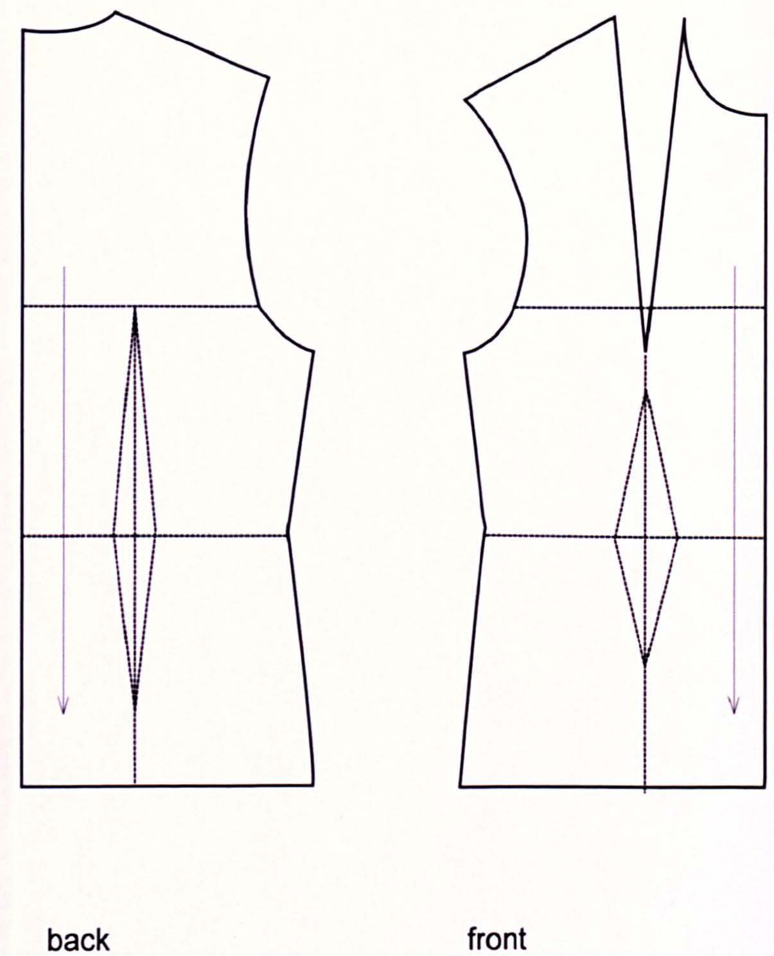
2. Integrated underarm gusset at the lower sleeve.

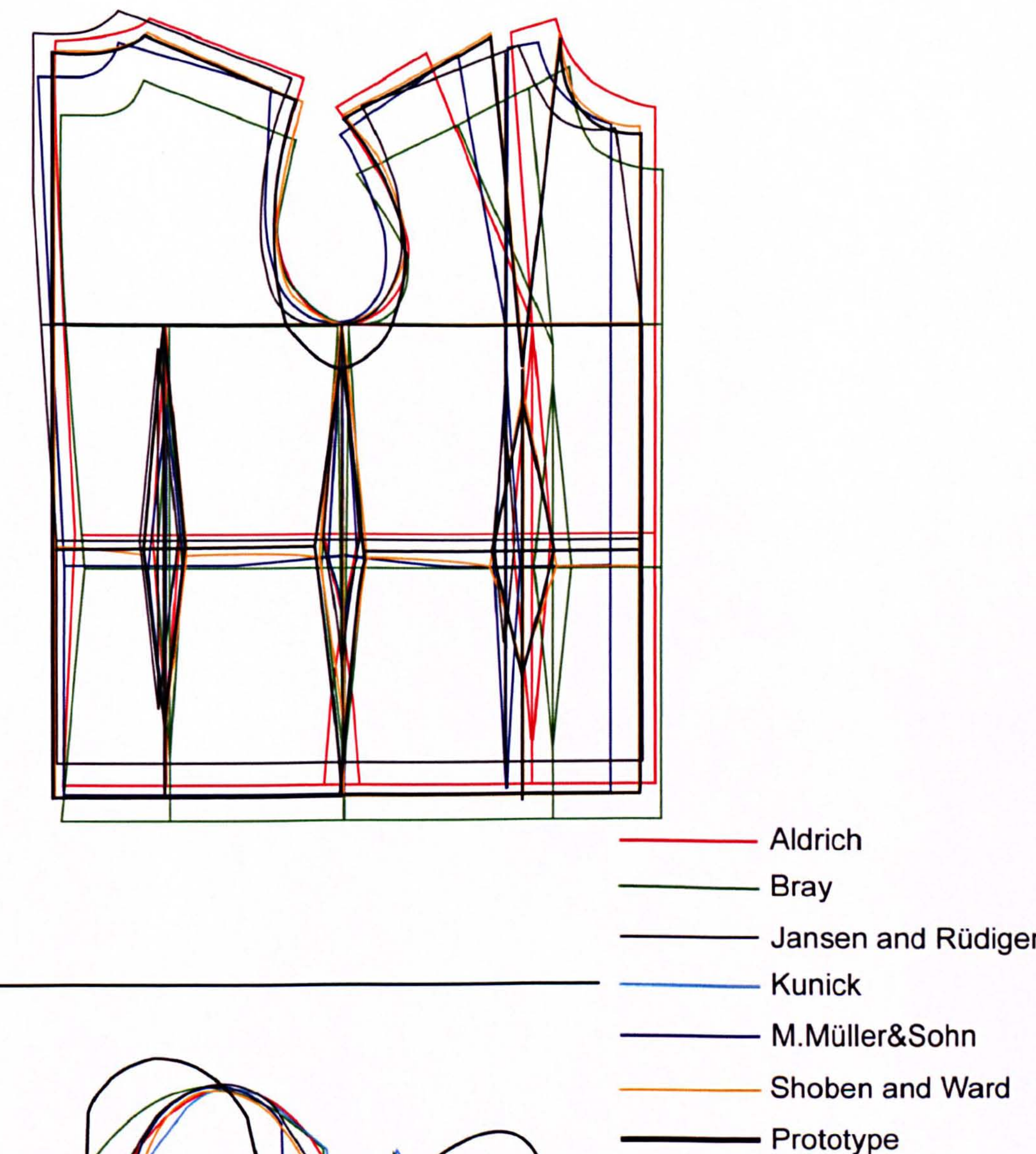




10.5.4 Visual analysis chart: Jacket / Sleeve Prototype 4

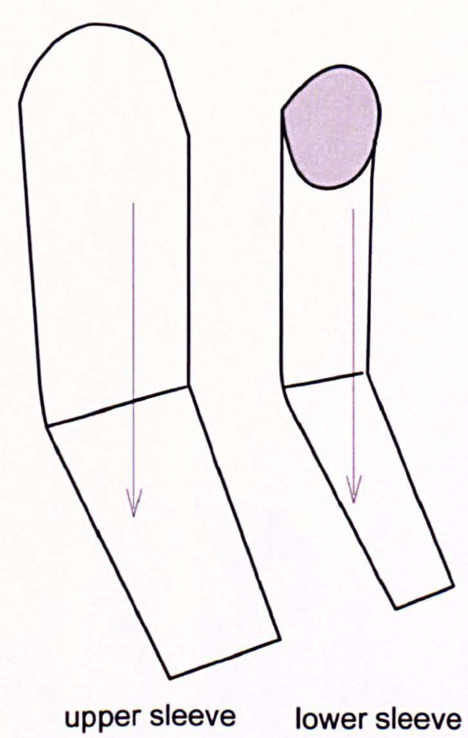
1. Armhole lowered by 2cm.

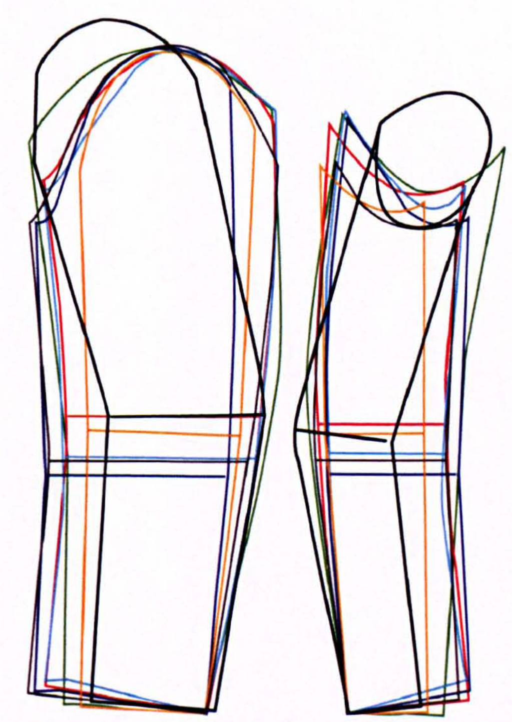




1. The curves at the elbow line of the upper and lower sleeve are expanded by 4cm.

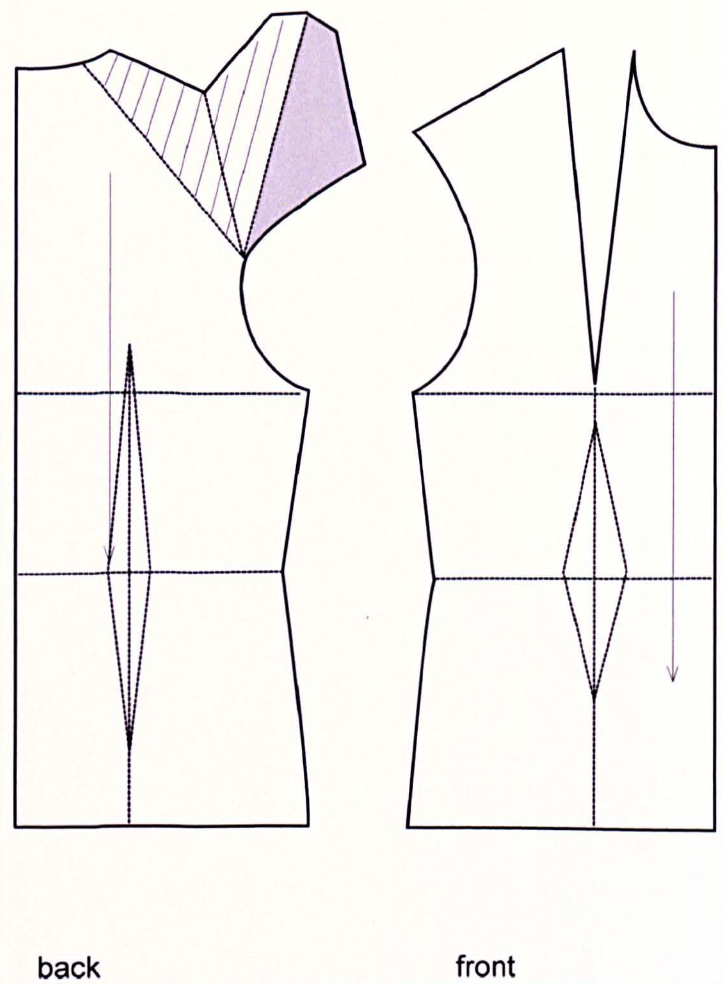
2. Integrated underarm gusset at the lower sleeve.





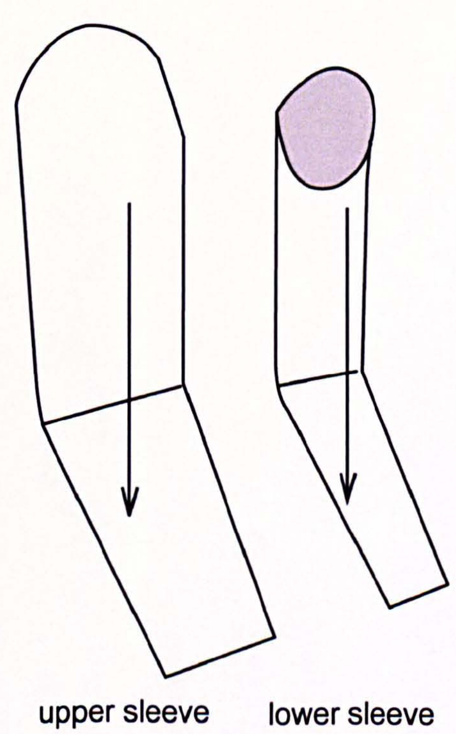
10.5.5 Visual analysis chart: Jacket / Sleeve Prototype 5

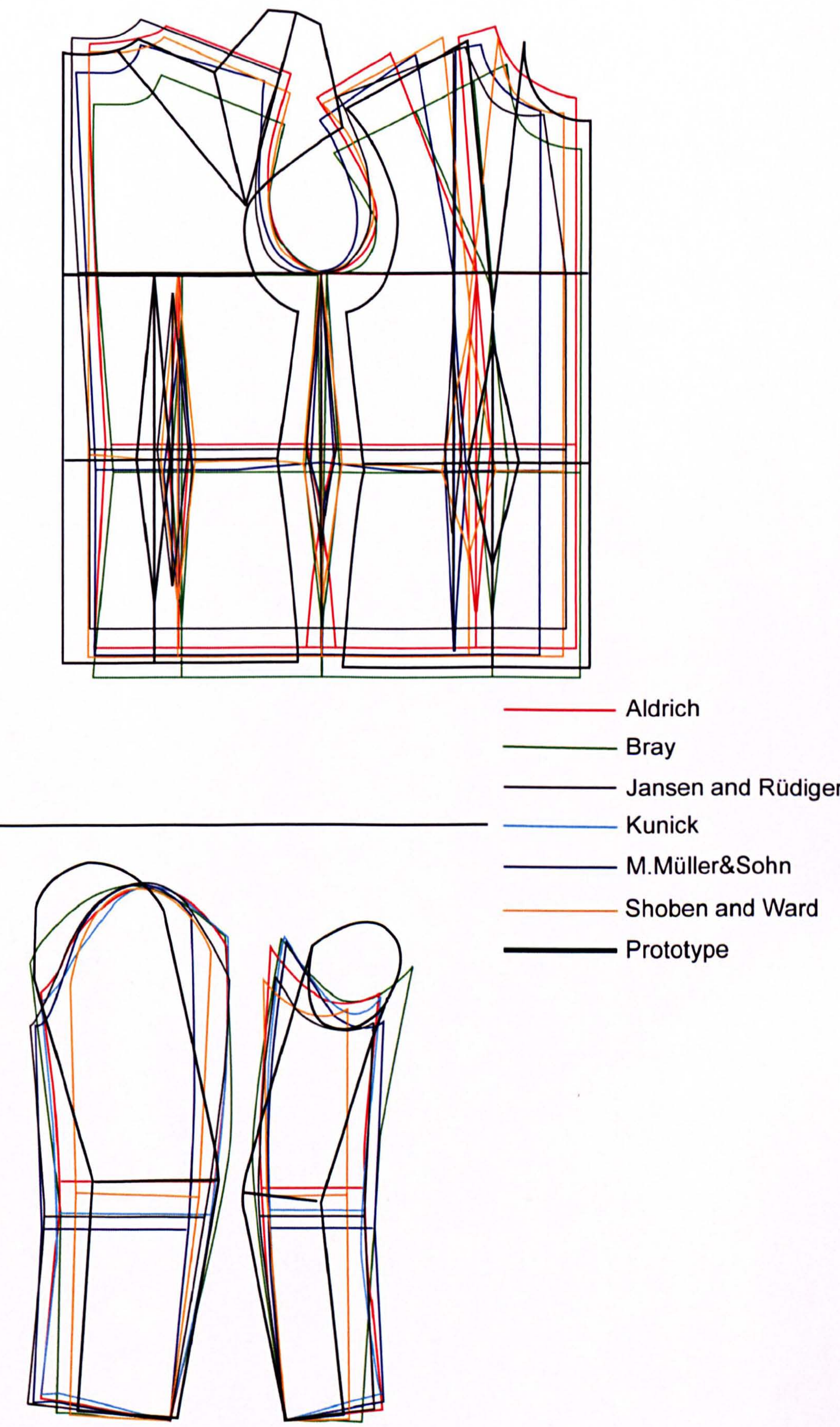
1. Back fold at the shoulder running from armhole to the neckline in an oblate angle (hatched area indicates the depth of the fold).



1. The curves at the elbow line of the upper and lower sleeve are expanded by 4cm.

2. Integrated underarm gusset at the lower sleeve.



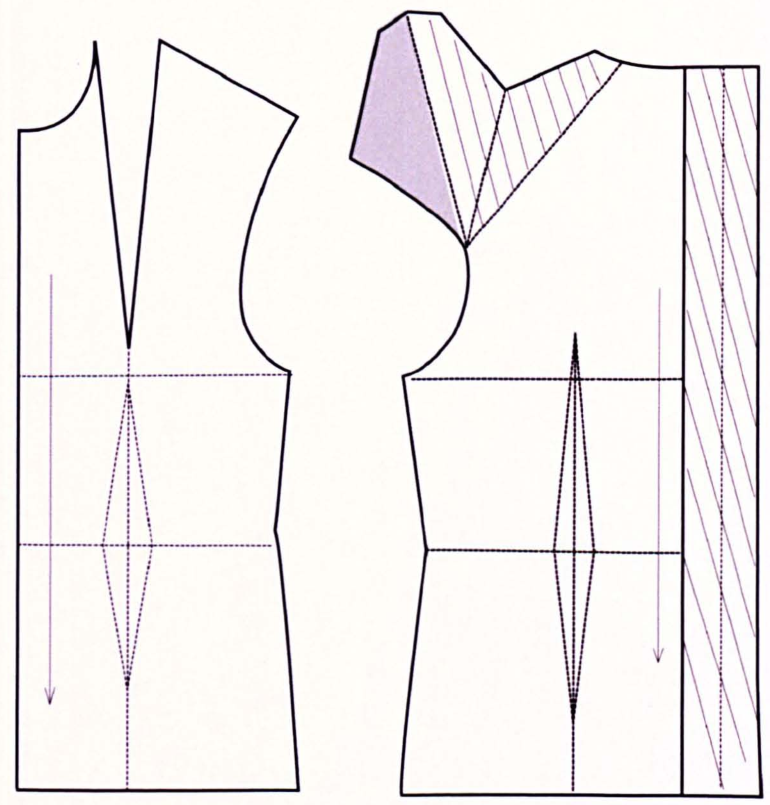


10.5.6 Visual analysis chart: Jacket / Sleeve Prototype 6

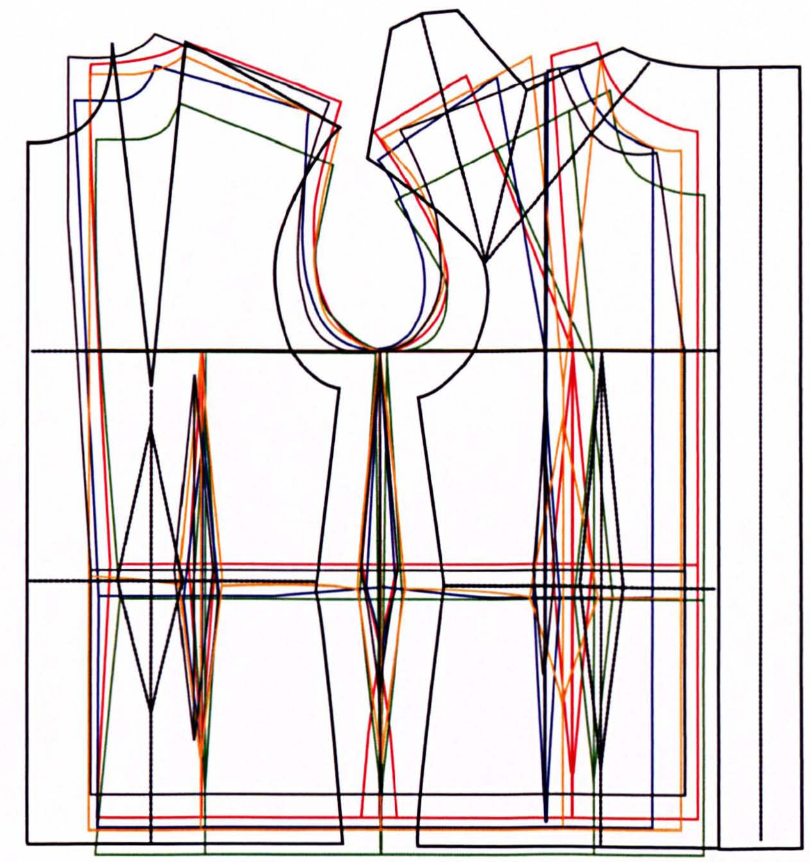
1. Back fold at the shoulder running from armhole to the neckline in an oblate angle (hatched area indicates the depth of the fold).

2. Armhole lowered by 2cm.

3. Vertical box-pleat at centre back (hatched area indicates the depth of the fold).



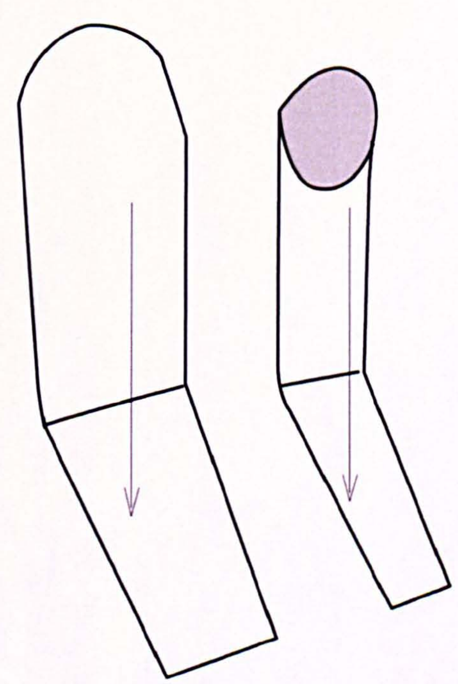
back front



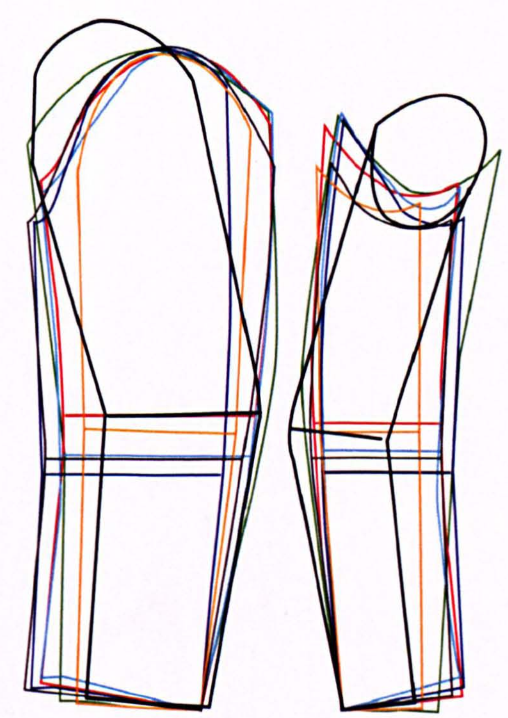
Aldrich
Bray
Jansen and Rüdiger
Kunick
M.Müller&Sohn
Shoben and Ward
Prototype

1. The curves at the elbow line of the upper and lower sleeve are expanded by 4cm.

2. Integrated underarm gusset at the lower sleeve.



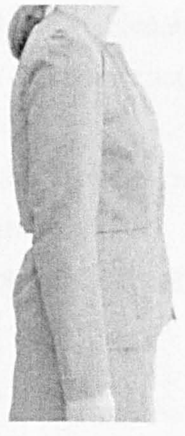
upper sleeve lower sleeve



10.5.7 Visual analysis prototype jackets – shoulder a.

For the purpose of clarity all of the following images were edited. They are shown in black and white and highlighted in order to gain similarity. In some images distortive background features were erased in order to keep the focus on the subject.


Prototype Jacket 1


Prototype Jacket 2


Prototype Jacket 3


Prototype Jacket 4


Prototype Jacket 5


Prototype Jacket 6

The interviewees were asked to judge the fit of the garment by allocating the prototype number to the small boxes. After evaluating the single sheets the number of persons who named a certain prototype is indicated by N.

	Strongly Disagree	Disagree	Agree	Strongly Agree
Bodice fit			P4 (N4)	
Shoulder fit				
Sleeve fit	Prototype 1 (N1)	P3 (N1) P5 (N1)	P4 (N4) P6 (N5)	

Figure 118, Prototype Comparison, Jackets/Shoulder

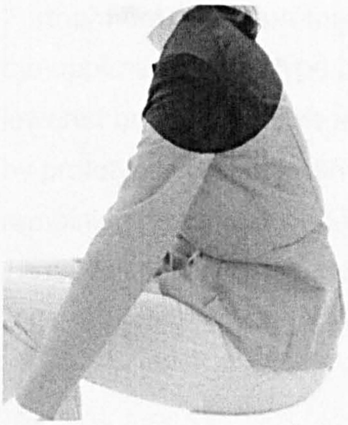
All shoulders of the above prototypes lay flat over the body. Prototypes 1, 2, 3, 5 and 6 are constructed with inserted pleats at the shoulder line. The inserted pleats at the front and back shoulder line (prototypes 1, 2 and 3), and at the back shoulder line only (prototypes 5 and 6), do not show from this perspective. Furthermore, the folds do not cause any folds or wrinkles.

The sleeves of prototypes 2, 4, 5 and 6 do all follow the naturally bended position of the arm. All of the above, together with prototype 3, are constructed with a curved elbow line. Even though prototype 3 is constructed the same way, the sleeve turns towards the front.

Prototypes 2, 4 and 6 show no wrinkles or tension along the sleeve, whereas such can be seen in prototypes 1, 3 and 5.

All six prototypes show unfolding fabric at the crown of the shoulder.

10.5.8 Visual analysis prototype jackets - shoulder b.



Prototype Jacket 1

Prototype Jacket 2

Prototype Jacket 3

Prototype Jacket 4

Prototype Jacket 5

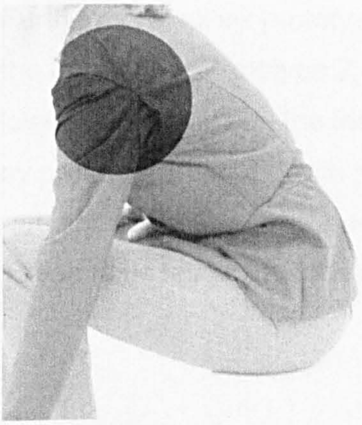
Prototype Jacket 6

	Strongly Disagree	Disagree	Agree	Strongly Agree
Bodice fit	P5 (N2)			P2 (N9)
Shoulder fit				P6 (N8)
Sleeve fit				

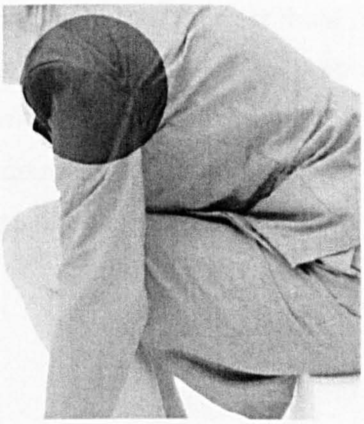
Figure 120, Prototype Comparison, Jackets/Shoulder 2

All six prototypes show various stages of up-folding fabric at the upper arm. Prototypes 1, 2, 3 and 4 show more up-folding, whereas prototypes 5 and 6 show less. Furthermore, all six prototypes show a tension reaching from the back armhole over the upper arm. Prototype 2, constructed with an underarm gusset in combination with a lowered armhole has the least amount of such tension shown. This example is followed by prototypes 5 and 6 with minor upfolding fabric because of tension to the fabric. The remaining prototypes 1, 3 and four show the most tension.
These folds follow the forward direction of the arm.

10.5.9 Visual analysis prototype jackets - shoulder c.

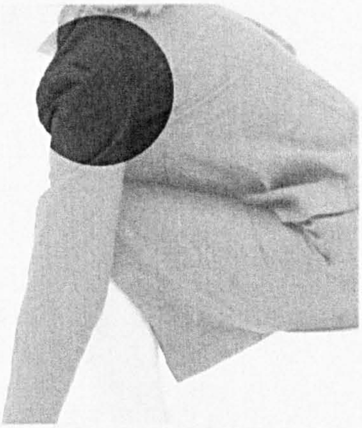


Prototype Jacket 1

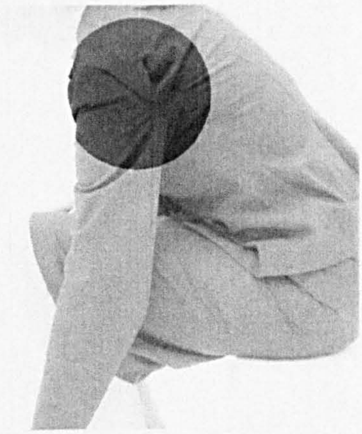


Prototype Jacket 2

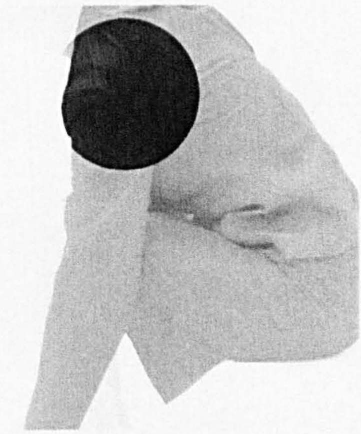
Prototype Jacket 3



Prototype Jacket 4



Prototype Jacket 5



Prototype Jacket 6

	Strongly Disagree	Disagree	Agree	Strongly Agree
Bodice fit				
Shoulder fit		P1 (N2)		P6 (N3)
Sleeve fit				P6 (N3)

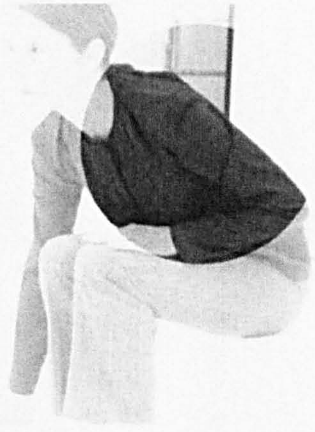
Figure 121, Prototype Comparison, Jackets/Shoulder 3

All six prototypes show various stages of up-folding fabric at the upper arm.
Prototypes 1, 2, 3 and 4 show more up-folding, whereas prototypes 5 and 6 show less.
Furthermore, all six prototypes show a tension reaching from the back armhole over the upper arm. Prototype 2, constructed with an underarm gusset in combination with a lowered armhole has the least amount of such tension shown. This example is followed by prototypes 5 and 6 with minor up-folding fabric because of tension to the fabric. The remaining prototypes 1, 3 and four show the most tension.
These folds follow the forward direction of the arm.

10.5.10 Visual analysis prototype jackets - shoulder d.

Prototype Jacket 1

Prototype Jacket 2



Prototype Jacket 3

Prototype Jacket 4

Prototype Jacket 5

Prototype Jacket 6

	Strongly Disagree	Disagree	Agree	Strongly Agree
Bodice fit		P1 (N5)		P2 (N5)
Shoulder fit	P4 (N2)			P2 (N3)
Sleeve fit	P4 (N2)			P2 (N5)

Figure 120, Prototype comparison, leaning forward, front view

All prototypes, except prototypes 2 and 6, show various stages of up-folding fabric at the upper arm.

Prototypes 1, 3 and 4 show more up-folding, whereas prototypes 5 and 6 show less. Prototypes 2 and 6, constructed with an underarm gusset in combination with a lowered armhole, have the least amount of such tension shown. This example is followed by prototypes 4 and 5 with minor up-folding fabric because of tension to the fabric. The remaining prototypes 1, 3 and four show the most tension.

10.5.11 Visual analysis prototype jackets - arm

Prototype Jacket 1

Prototype Jacket 2

Prototype Jacket 3

Prototype Jacket 4

Prototype Jacket 5

Prototype Jacket 6

	Strongly Disagree	Disagree	Agree	Strongly Agree
Bodice fit	P5 (N3)		P2 (N6)	
Shoulder fit	P4 (N3)			
Sleeve fit				

Figure 119, Prototype Comparison,Jackets/Arm

The uplifting of the arm causes major distortion of the jacket. As seen in the comparative study in chapter six, the movement causes and uplifting of the whole jacket as a consequence of the arm and shoulder movement.

Prototypes 1, 2 and 6 show the least effect on the bodice part of the jacket as the arm is lifted up. The first two of the above are constructed with a horizontal pleat, similar to a box pleat as described in the previous description of the flat pattern. Prototype 6 consists of a vertical box pleat along the centre back line.

Prototypes 3, 4 and 5 do all show an uplifting of the bodice part of the jacket, of which prototypes 4 and 5,

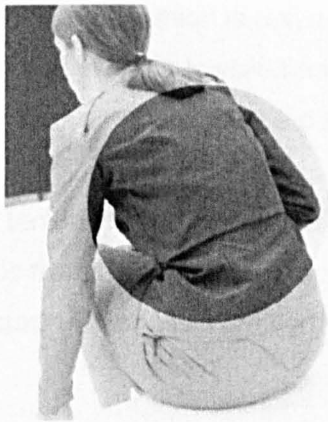
both constructed with an underarm gusset, show minor negative consequences to the bodice part in comparison to prototype 3, which consists of an ordinary armhole and sleeve.
All six prototypes show unfolding fabric at the crown of the shoulder.

All six prototypes show various stages of tension underneath the arm and at the conducting upper-arm part of the jacket.
Prototype 1, constructed with a box-pleat at the back waist, shows the most tension. Horizontal folds appear at the additional panel underneath the armpit. These follow the direction of the movement of the upper arm, being nearly parallel to it. Even though twelve centimeters are added, this prototype shows the most tension on the lower part of the two piece sleeve.
Prototype 3, constructed with an ordinary armhole and sleeve, also show a tension on the upper arm.
Prototypes 2, 4, 5 and six, all constructed with an inserted underarm gusset in combination with a lowered armhole, show no tension at the targeted area.

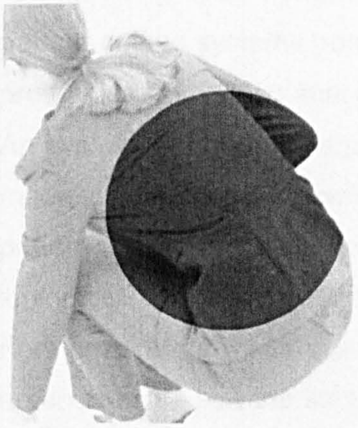
The contours of the outer body change in the same way as the shoulder and the arm is moved. This gets exceptionally obvious in the changed armhole, when the arm is uplifted. This mechanism is pictured in the following graphic.
The above mentioned movement results in major restrictions, as the tense of the underarm area. In contrast to the upright standing, lifting up the arm consequently pulls up the whole jacket at the side where the arm is lifted up. Up-folding fabric can be seen at the shoulder.

10.5.12 Visual analysis prototype jackets - back

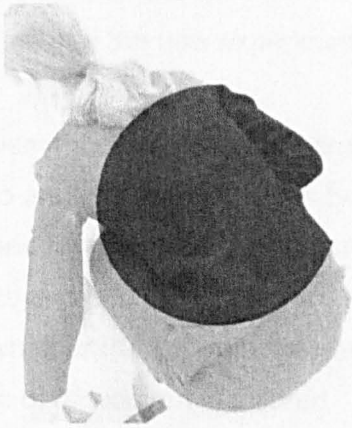
Prototype Jacket 1



Prototype Jacket 2



Prototype Jacket 3



Prototype Jacket 4

Prototype Jacket 5

Prototype Jacket 6

	Strongly Disagree	Disagree	Agree	Strongly Agree
Bodice fit	P5 (N3)		P1 (N3) P2 (N4)	
Shoulder fit				
Sleeve fit				

Figure 121, Prototype comparison, leaning forward, back view

While the subject bending forward out of a sitting position, prototype 1, constructed with an inserted horizontal fold at back wais line, lays smoothly over the body with only minor up-folding fabric. Nearly as smooth appears prototype 4, which is constructed with an underarm gusset at the lower sleeve in combination with a lowered armhole. The remaining four prototypes show similar vertical folds from the waistline down to the hemline.
Furthermore, prototype 4 shows no folds because of tension at the back. Again, the remaining five prototypes show similar horizontal folds from the armhole/armpit towards the centre back. Even though prototype 6 is constructed with an inserted vertical pleat at the centre back line, these folds appear.

The following double pages show the prototypes made up after the six different flat-pattern cutting systems from video analysis 1 on the left and the new experimental prototypes from video analysis 2 on the right.
An evaluation of the general fit and the fit during movement of the different garments is made visible. As the experimental prototypes of video analysis 2 are seen as basic flat-patterns which should be manipulated into derived- and fashion-pattern, the general look of a traditional garment is also a point to evaluate and to discuss later on. Furthermore, the visual comparison enables to see whether the different flat-pattern amendments allow the subject for widening the range of movement in tailored womenswear.

The prototype jackets are followed by the skirts and the trousers.

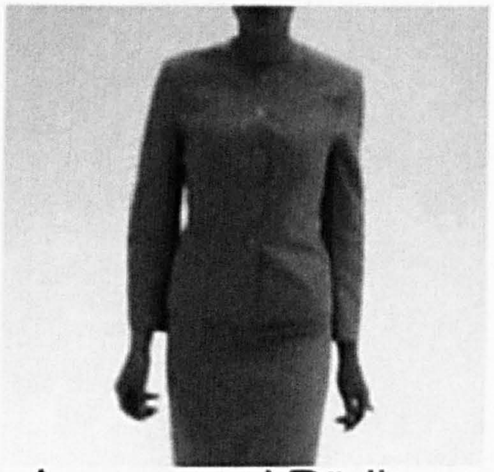
10.5.13 Visual Comparison 1 - Six Flat-pattern Cutting Systems and Prototype Jackets


Aldrich


Bray


Prototype 1

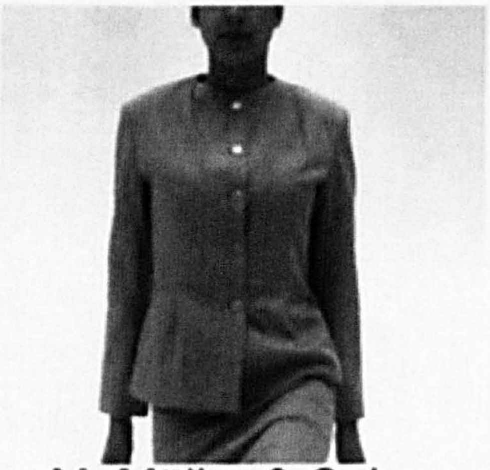

Prototype 2


Jansen and Rüdiger


Kunick


Prototype 3


Prototype 4


M. Müller & Sohn


Shoben and Ward


Prototype 5


Prototype 6

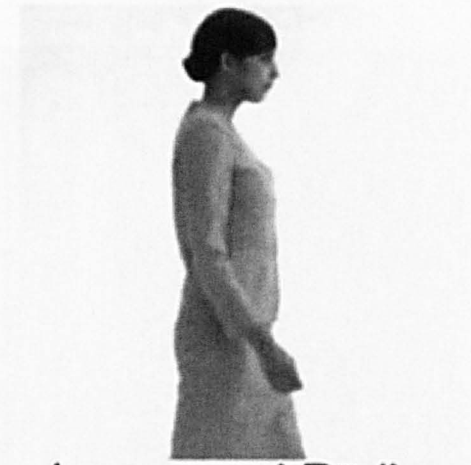
10.5.14 Visual Comparison 2 - Six Flat-pattern Cutting Systems and Prototype Jackets


Aldrich


Bray

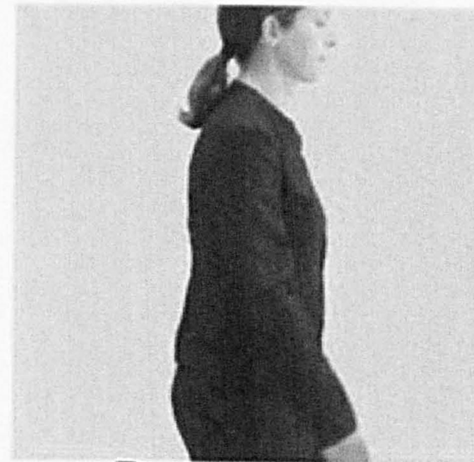

Prototype 1


Prototype 2


Jansen and Rüdiger

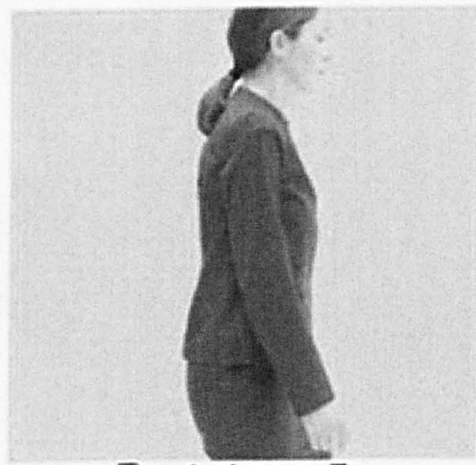

Kunick

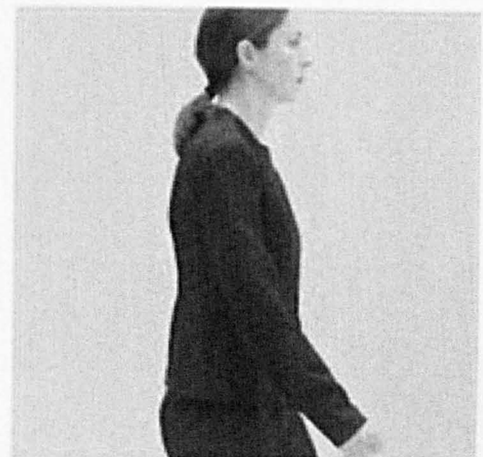

Prototype 3


Prototype 4

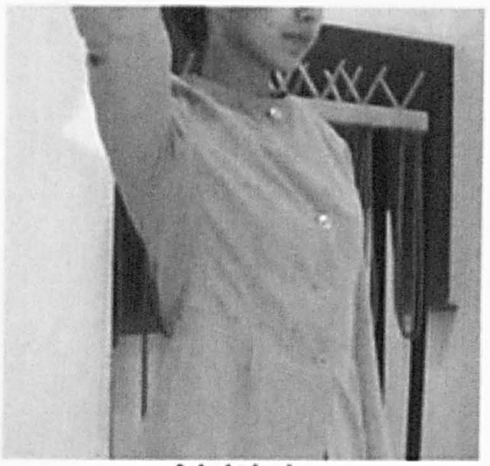

M. Müller & Sohn


Shoben and Ward


Prototype 5


Prototype 6

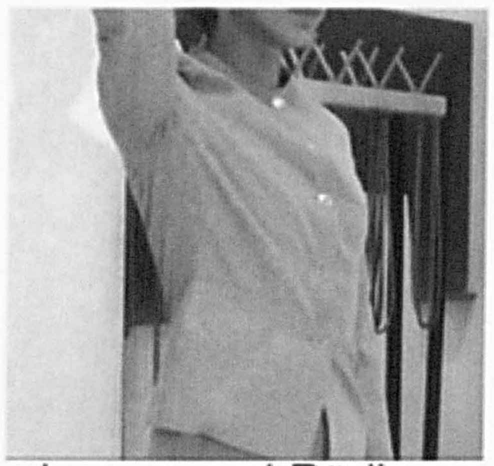
10.5.15 Visual Comparison 3 - Six Flat-pattern Cutting Systems and Prototype Jackets


Aldrich


Bray

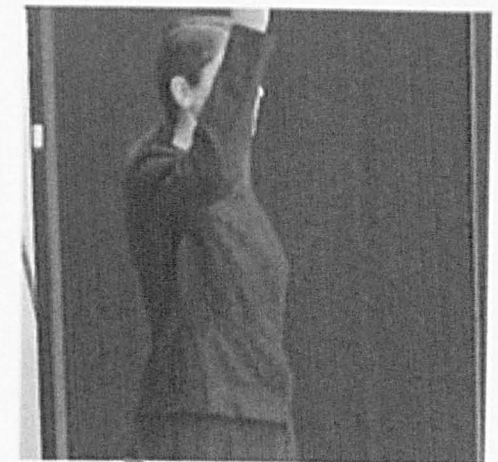

Prototype 1


Prototype 2

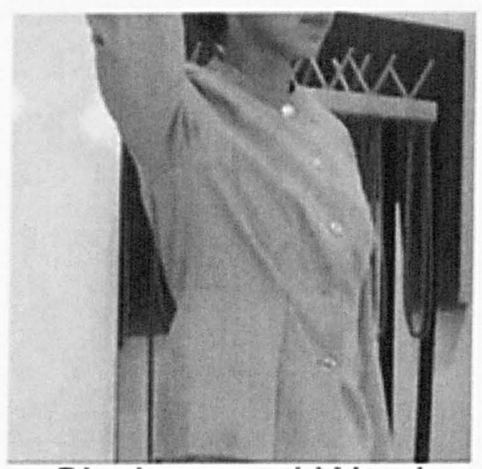

Jansen and Rüdiger


Kunick


Prototype 3


Prototype 4


M. Müller & Sohn

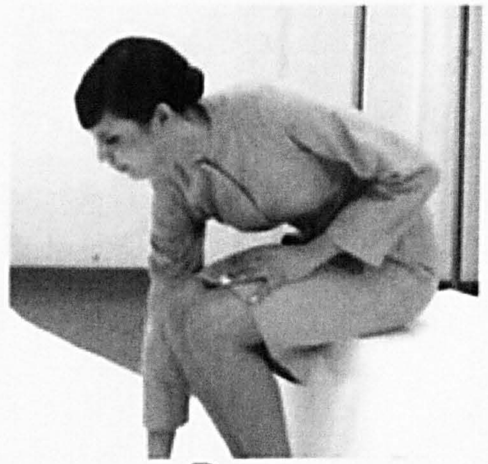

Shoben and Ward


Prototype 5

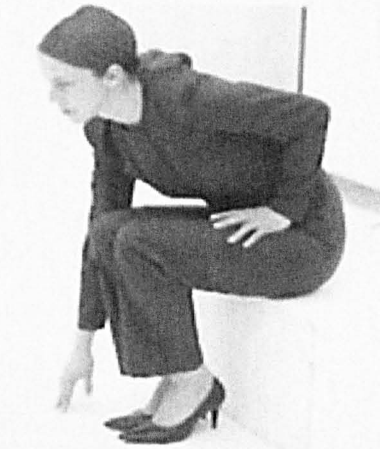

Prototype 6

10.5.16 Visual Comparison 4 - Six Flat-pattern Cutting Systems and Prototype Jackets

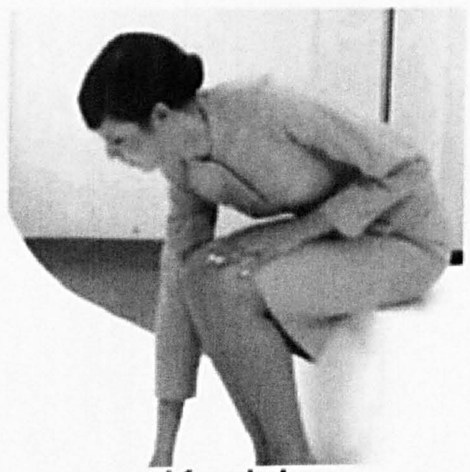

Aldrich


Bray


Prototype 1

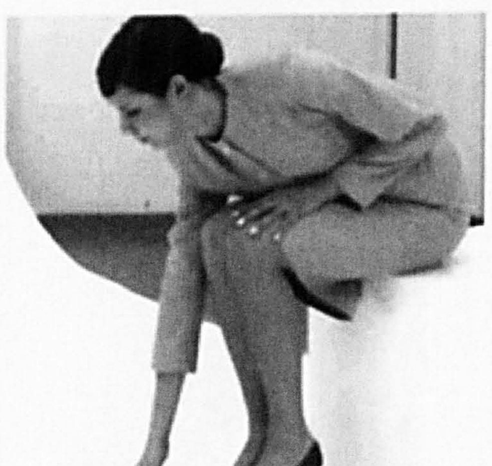

Prototype 2

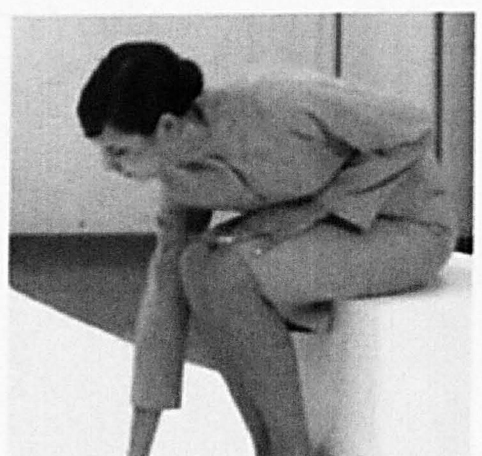

Jansen and Rüdiger


Kunick


Prototype 3


Prototype 4

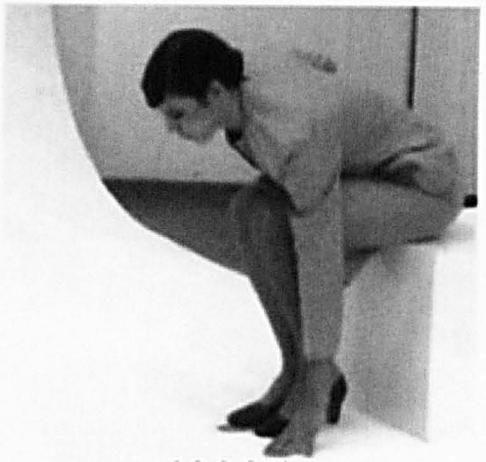

M. Müller & Sohn

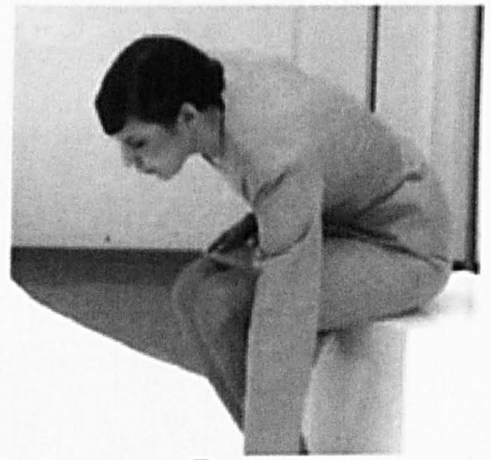

Shoben and Ward


Prototype 5


Prototype 6

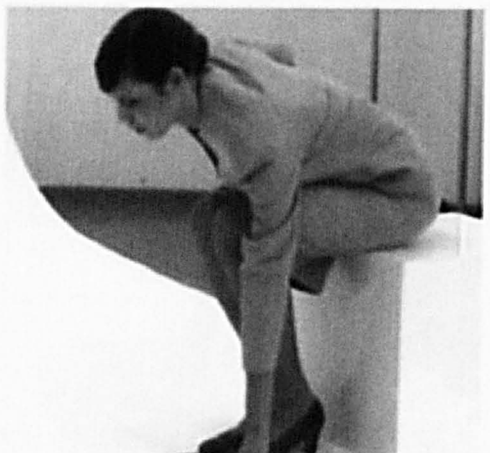
10.5.17 Visual Comparison 5 - Six Flat-pattern Cutting Systems and Prototype Jackets

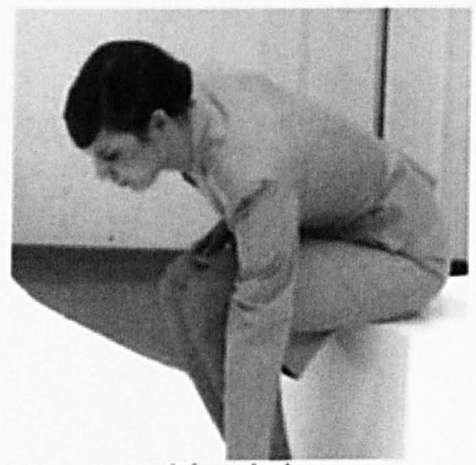

Aldrich


Bray


Prototype 1

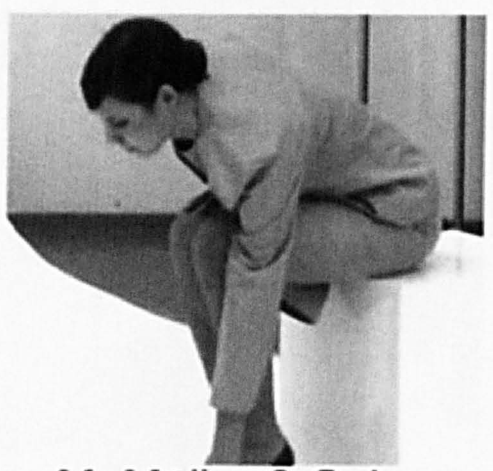

Prototype 2

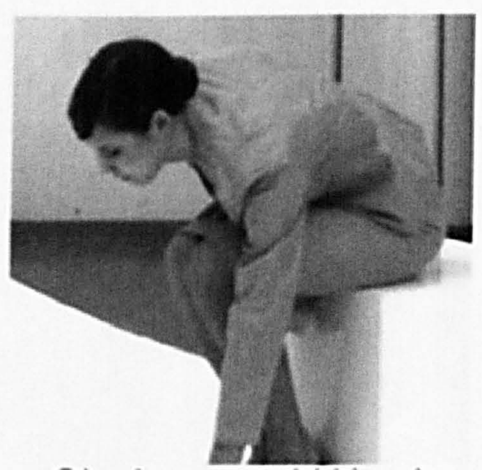

Jansen and Rüdiger


Kunick


Prototype 3


Prototype 4


M. Müller & Sohn

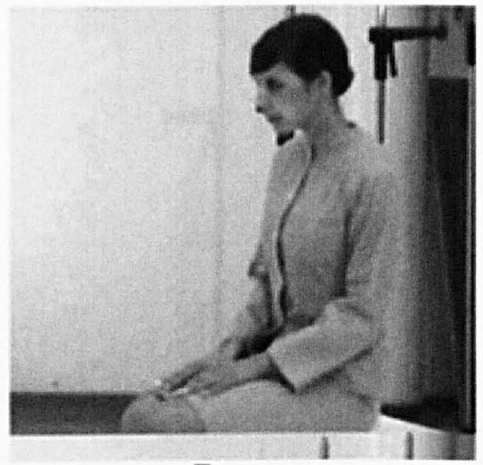

Shoben and Ward

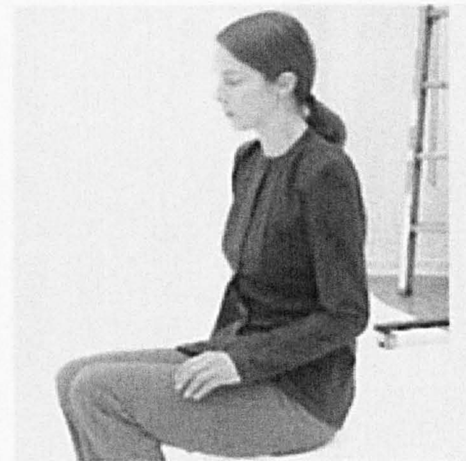

Prototype 5

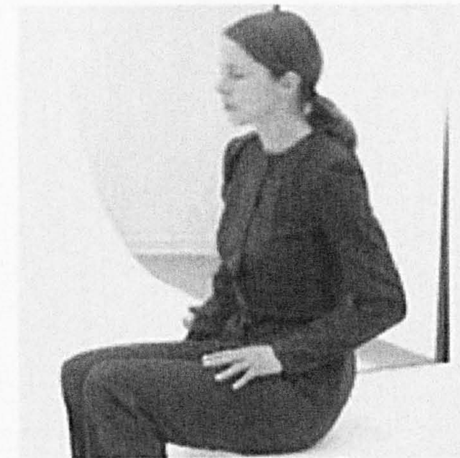

Prototype 6

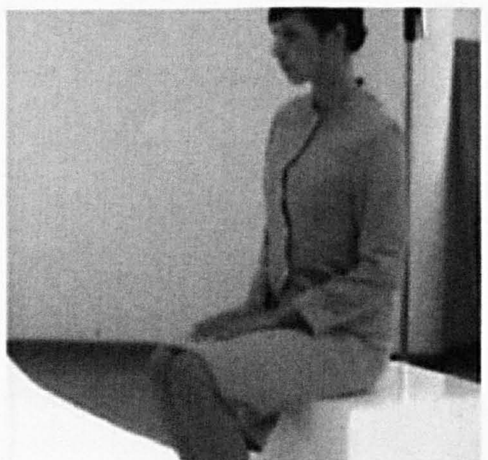
10.5.18 Visual Comparison 6 - Six Flat-pattern Cutting Systems and Prototype Jackets

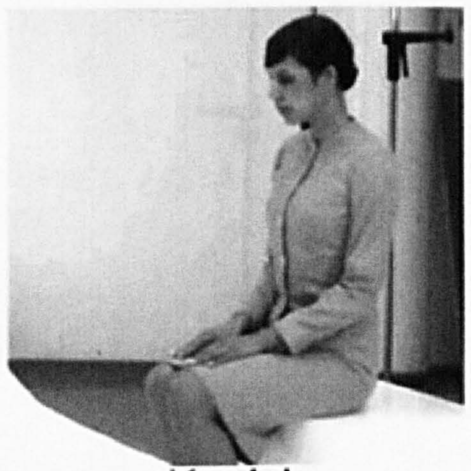

Aldrich


Bray


Prototype 1

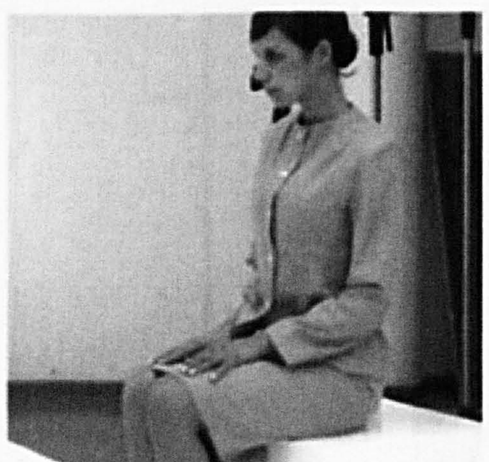

Prototype 2

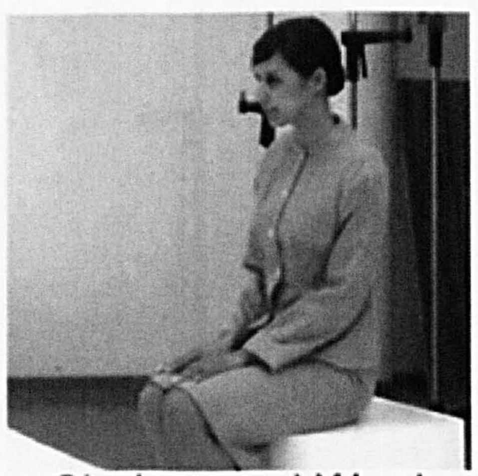

Jansen and Rüdiger

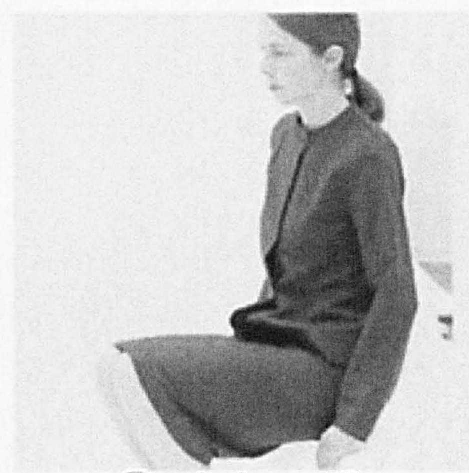

Kunick

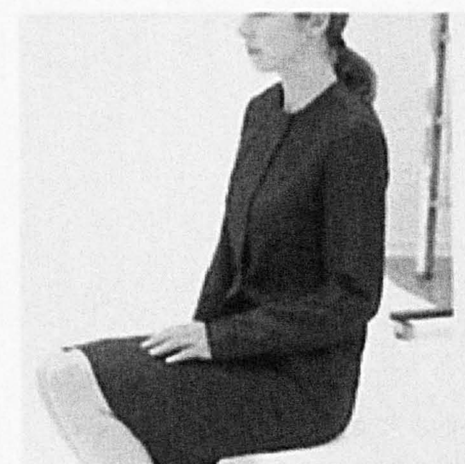

Prototype 3


Prototype 4


M. Müller & Sohn


Shoben and Ward


Prototype 5

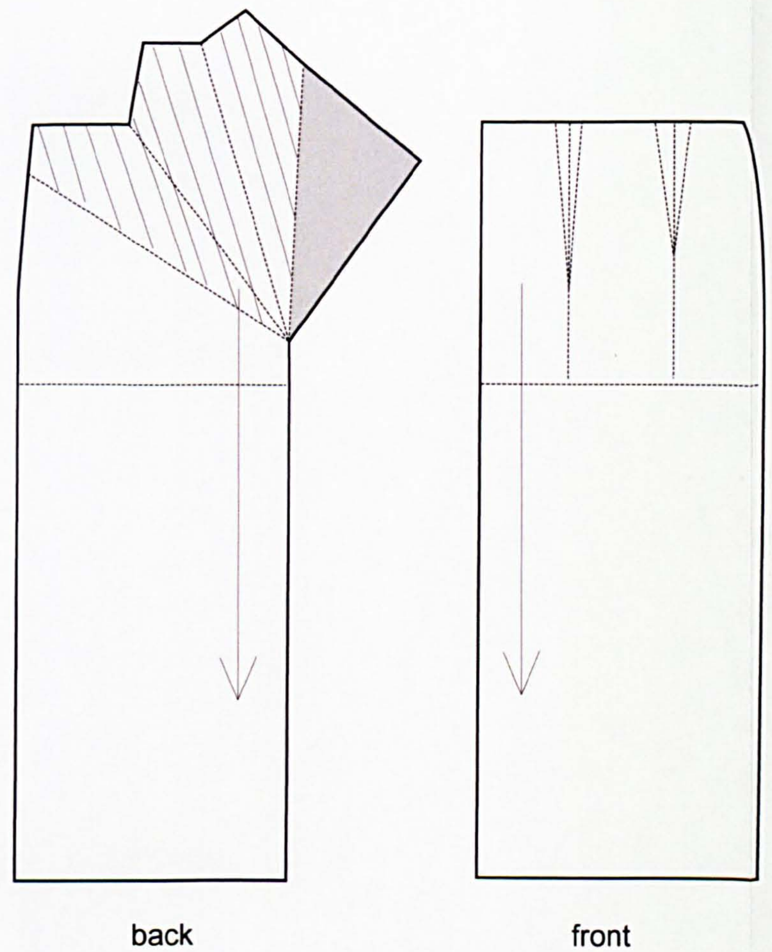

Prototype 6

10.6 Prototype Skirts

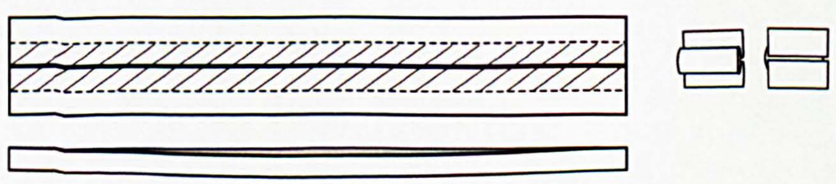
10.6.1 Visual analysis chart: Skirt Prototype 1

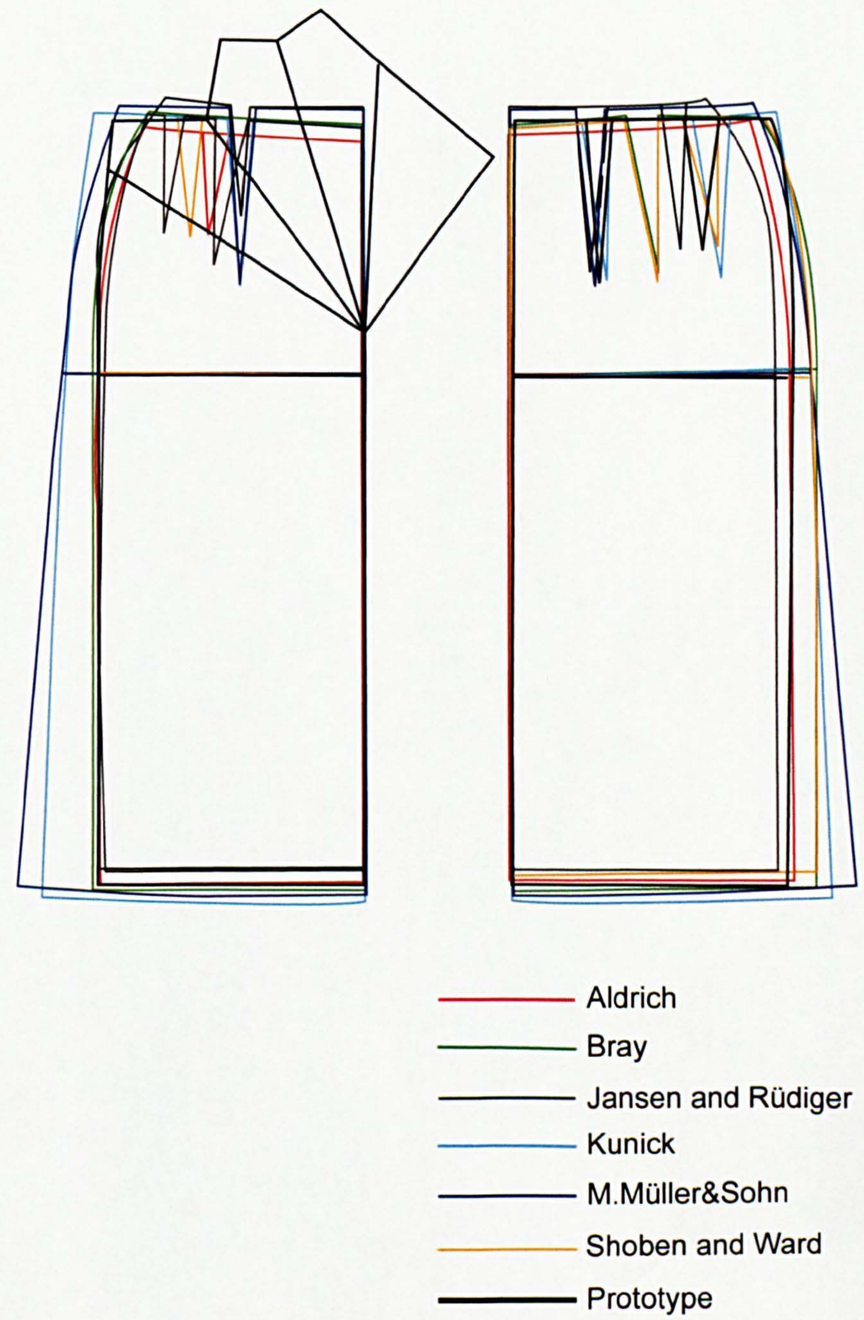
1. Curved upper and lower sleeve at the elbow line

2. Inserted gusset at lower part of the two-piece



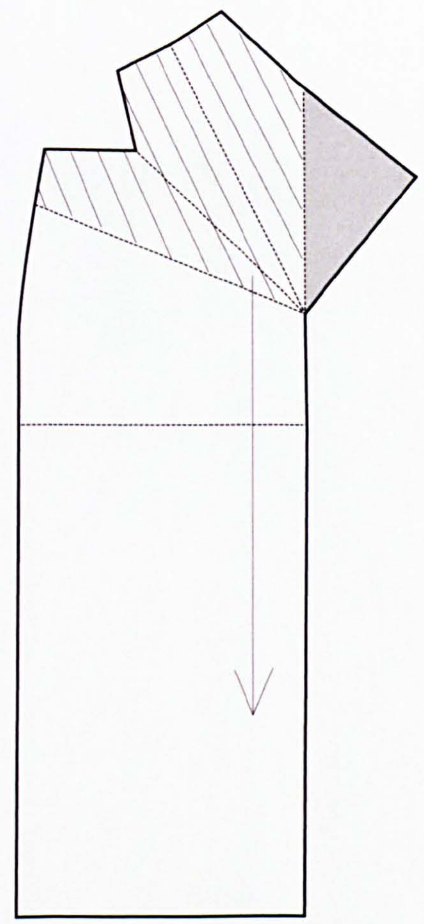
1. Waistband pattern piece 16 cm (finished waistband 4 cm)





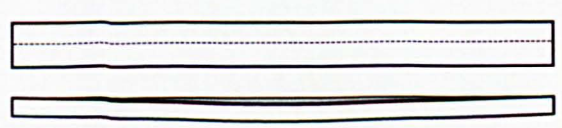
10.6.2 Visual analysis chart: Skirt Prototype 2

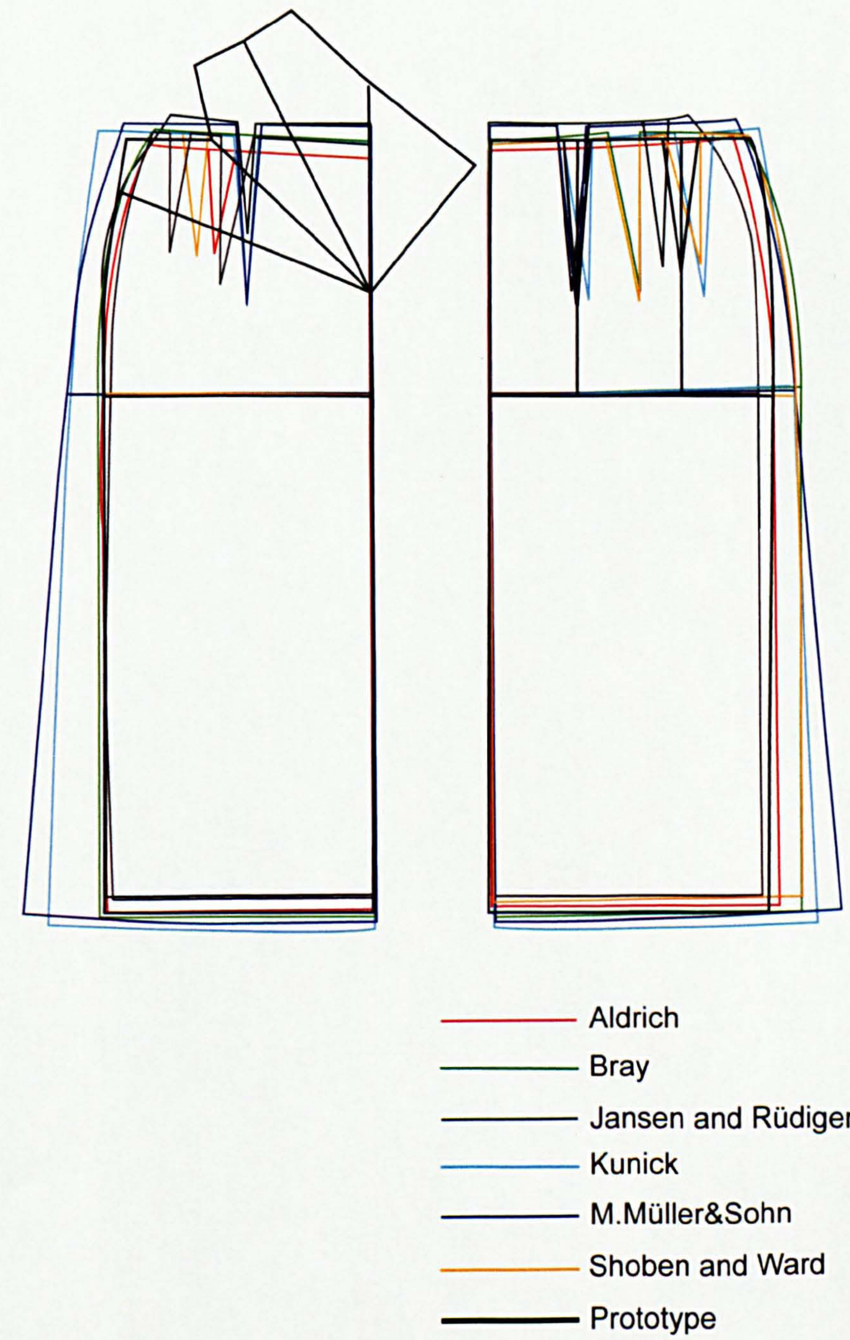
1. Diagonal fold from waist line to centre back (hatched area indicates the depth of the fold)



back front

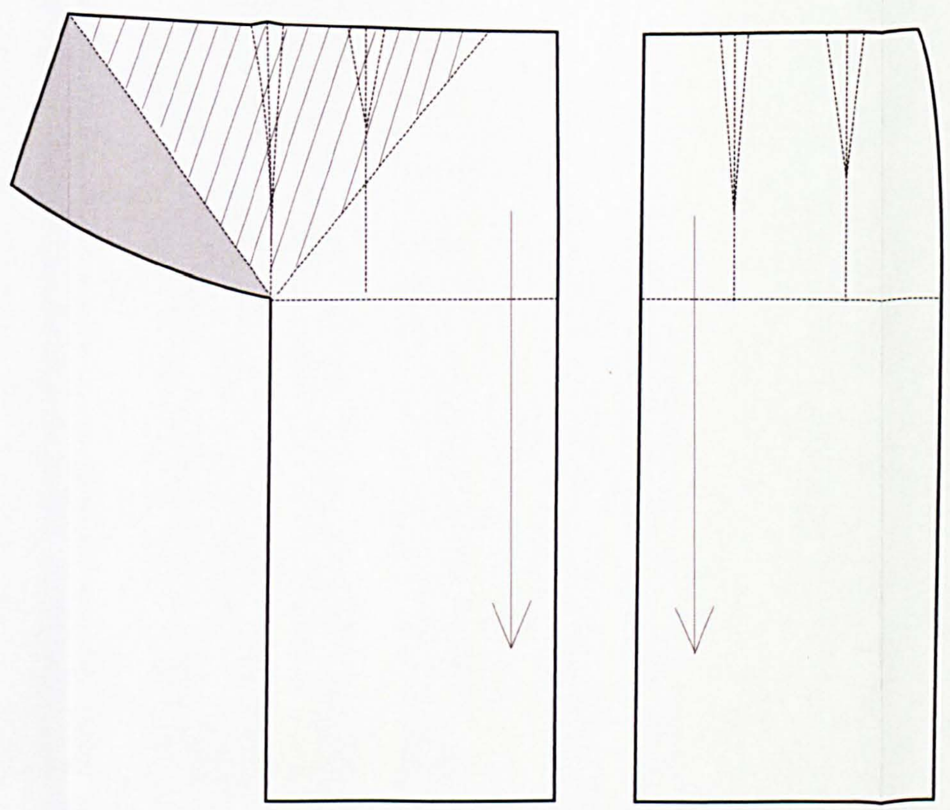
1. Waistband pattern piece 6 cm (finished waistband 2 cm)





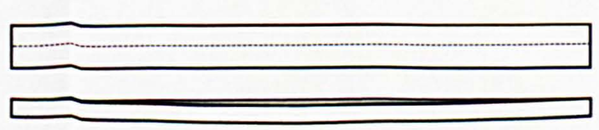
10.6.3 Visual analysis chart: Skirt Prototype 3

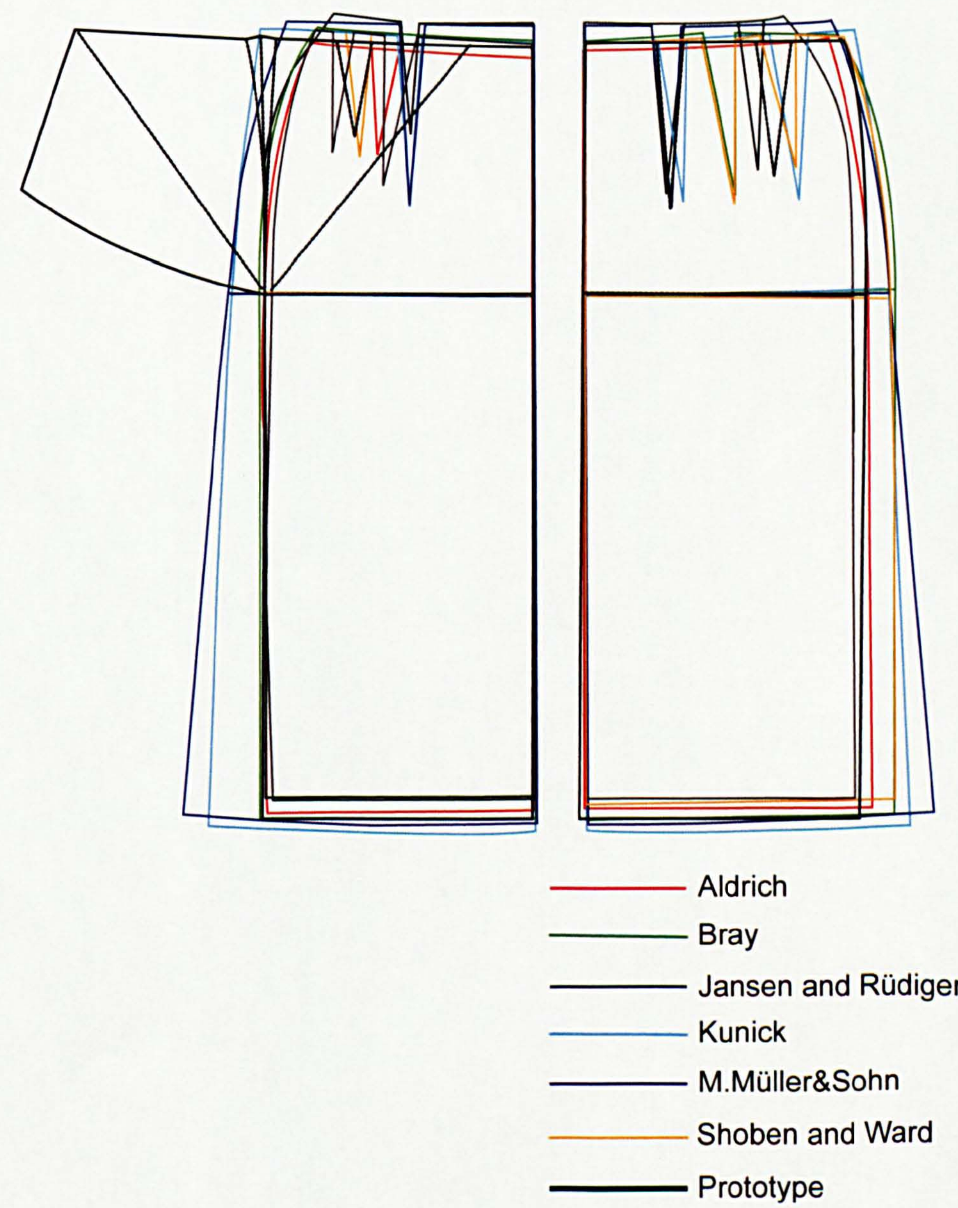
1. Fold at side seam of the back panel (Hatched area indicates the depth of the fold)



back front

1. Waistband pattern piece 6 cm (finished waistband 2 cm)

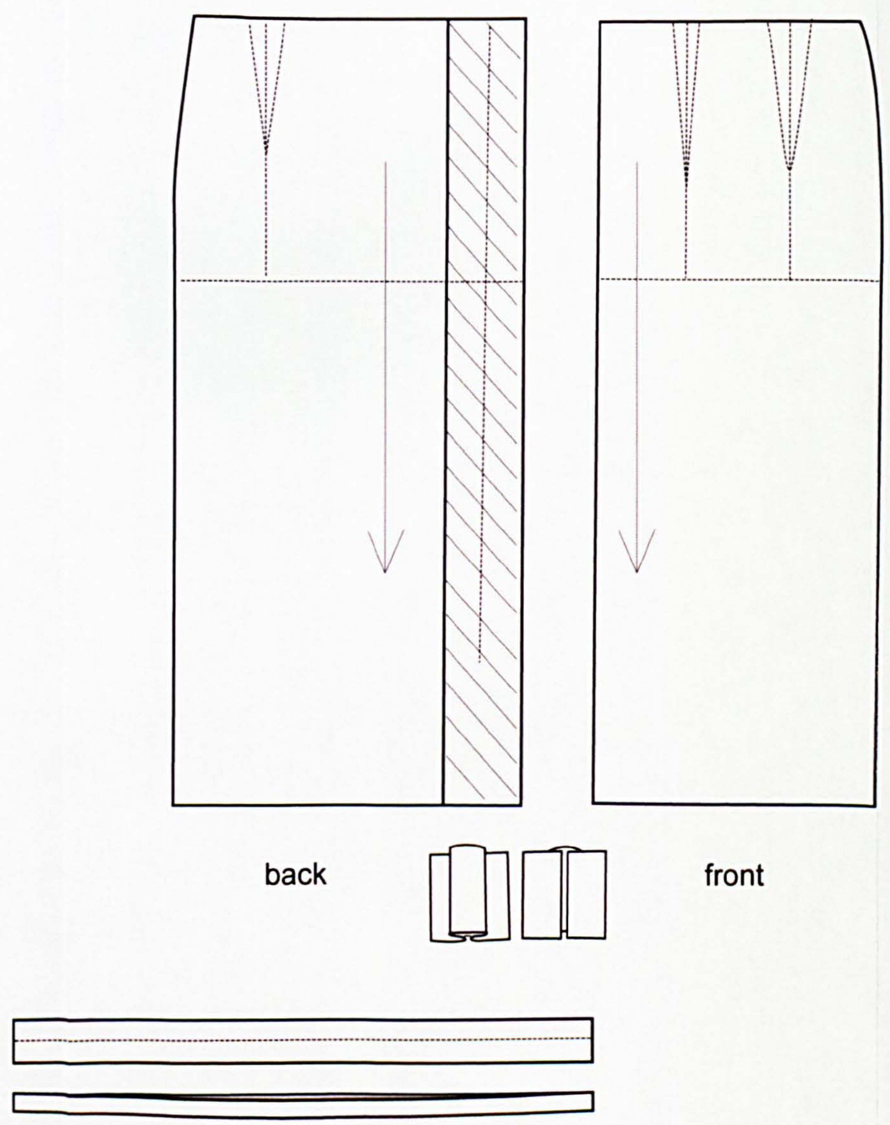


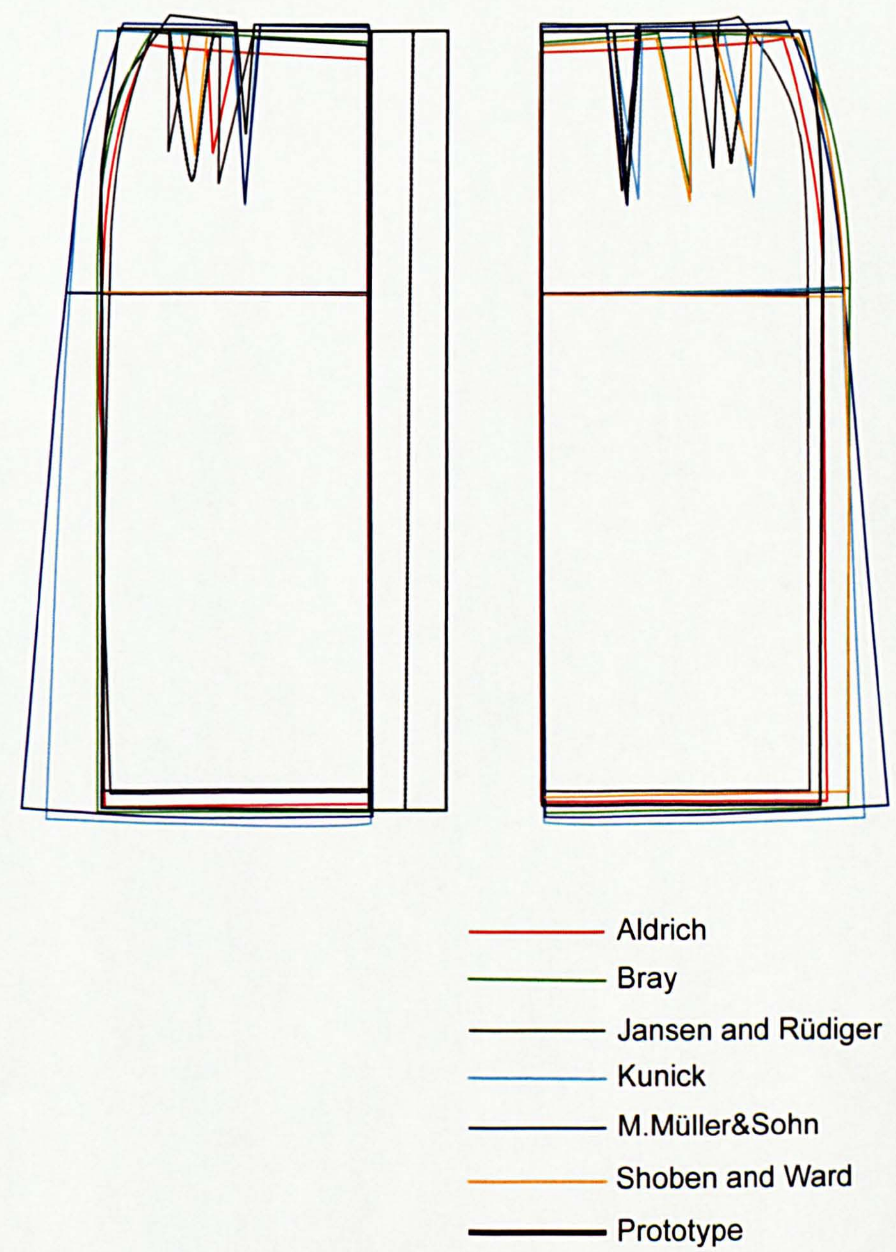


10.6.4 Visual analysis chart: Skirt Prototype 4

1. Vertical fold along the centre back seam (hatched area indicates the depth of the fold)

1. Waistband pattern piece 6 cm (finished waistband 2 cm)

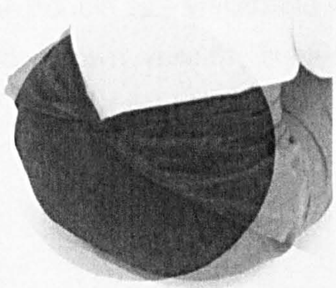




10.6.5 Visual analysis prototype skirts - back

Prototype Skirt 1

Prototype Skirt 1



Prototype Skirt 3

Prototype Skirt 4

	Strongly Disagree	Disagree	Agree	Strongly Agree
Waist fit	P3 (N5) P1 (N1)	P1 (N2) P3 (N7)		P4 (N4)
Pelvis fit				P4 (N4)

Figure 128, Comparison of six flat-pattern cutting systems and prototype skirt 1

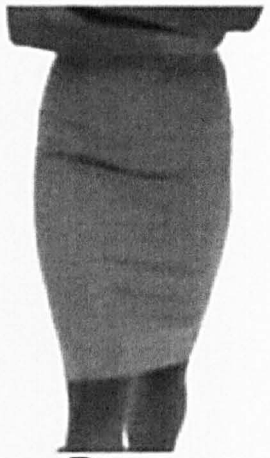
Prototype trousers 1 and prototype skirts 1 and 4 keep their position at the waistline without being pulled down while the subject is sitting down. The first of the above are constructed with a double sized waistband. The inserted fold within the waistband opens when more fabric is needed. This can be seen to great extend in prototype trousers 1.

A dropped waist line can be seen in prototype trousers 2 and prototype skirts 2 and 3. Of which prototype skirt 3 shows the most severe pulling down of the waistline.
All prototype trousers and skirts show the need for additional fabric when the subject is sitting down through an opening of the different folds. Within this, all prototypes constructed with inserted folds at the centre back do function without distorting the natural silhouette of the body. The folds inserted at the side seam of prototype skirt 3 changes the silhouette.
The inserted box pleat which opens from right underneath the waist down to the crotch line of prototype skirt 4 works well while the subject is sitting down.

The comparison shows, that the pattern cutting solutions of the above most successful prototypes do reflect the tension of the widened hips in the sitting position. The renewed pattern allows for a free enlargement of the bottom area with the help of folds.
The double size waistband with the inserted fold, prevent the waistline from being pulled down while the subject is sitting and bending over.

10.6.6 Visual Comparison 1: Six Flat-pattern Cutting Systems and Prototype Skirts

Aldrich



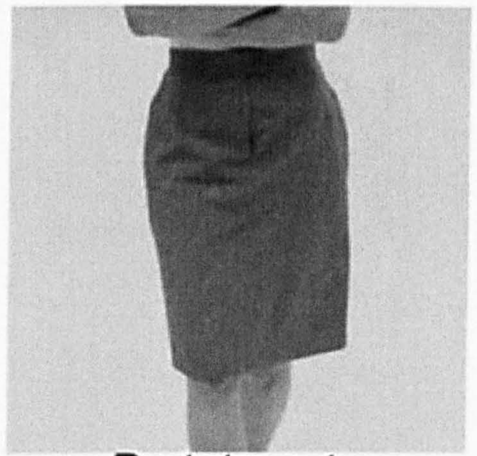
Bray

Jansen and Rüdiger

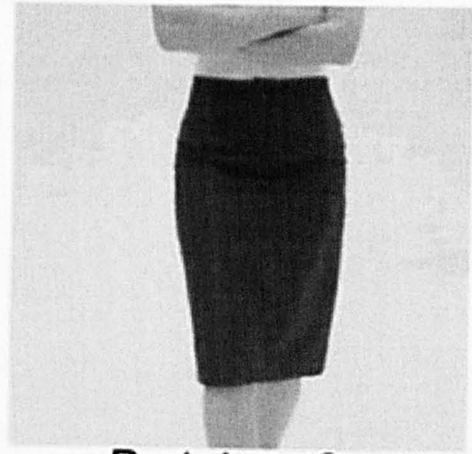
Kunick

M. Müller & Sohn

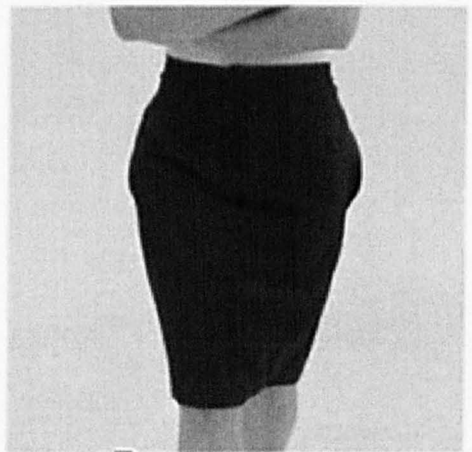
Shoben and Ward



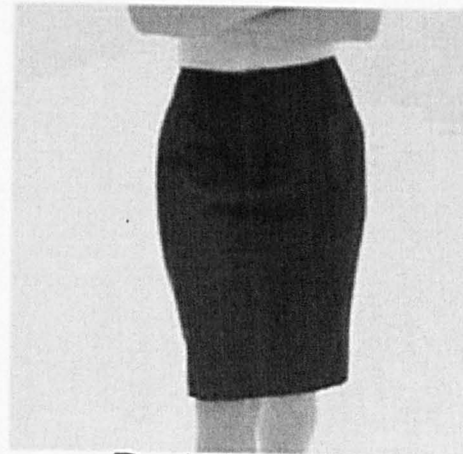
Prototype 1



Prototype 2



Prototype 3

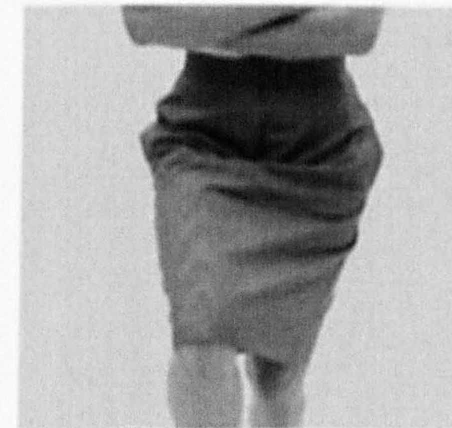


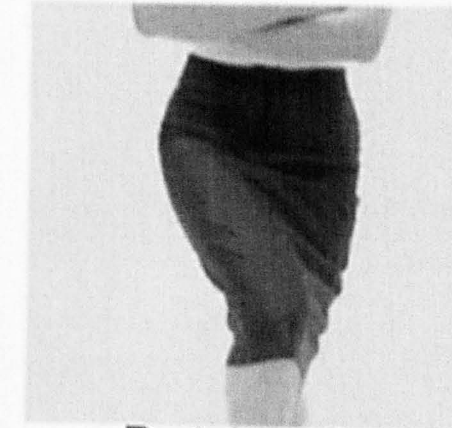
Prototype 4

10.6.7 Visual Comparison 2: Six Flat-pattern Cutting Systems and Prototype Skirts


Aldrich

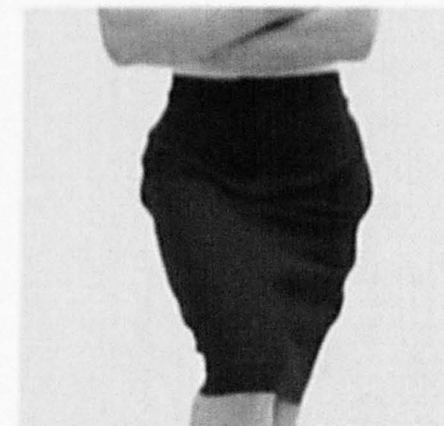

Bray

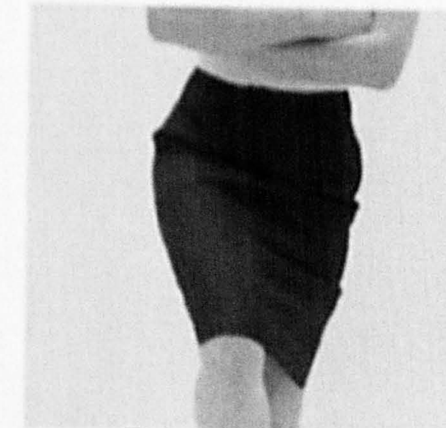

Prototype 1


Prototype 2


Jansen and Rüdiger


Kunick


Prototype 3


Prototype 4

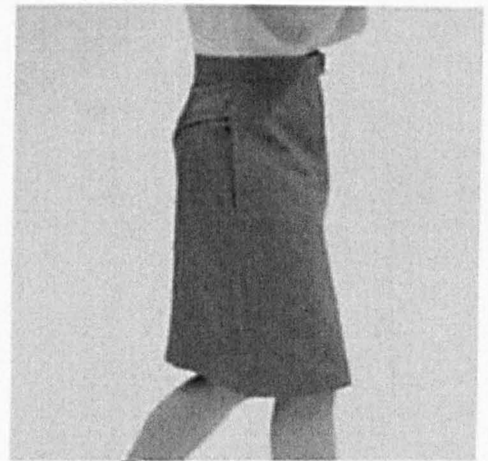

M. Müller & Sohn

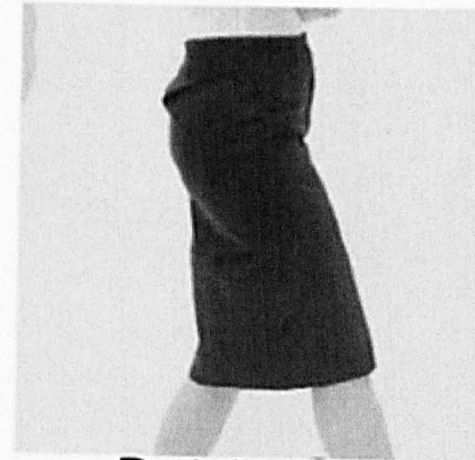

Shoben and Ward

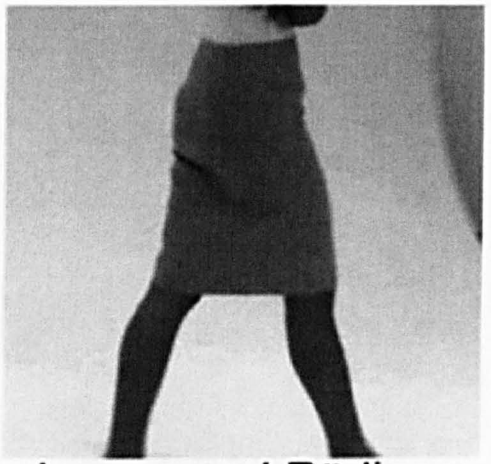
10.6.8 Visual Comparison 3: Six Flat-pattern Cutting Systems and Prototype Skirts

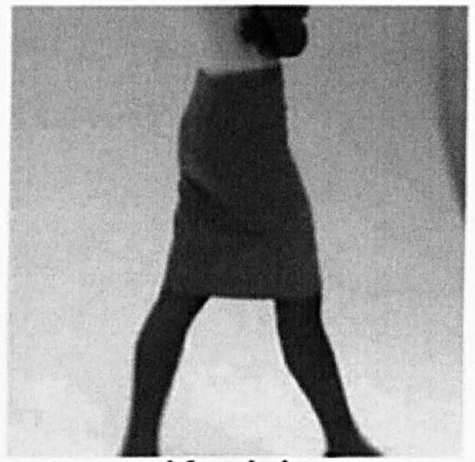

Aldrich

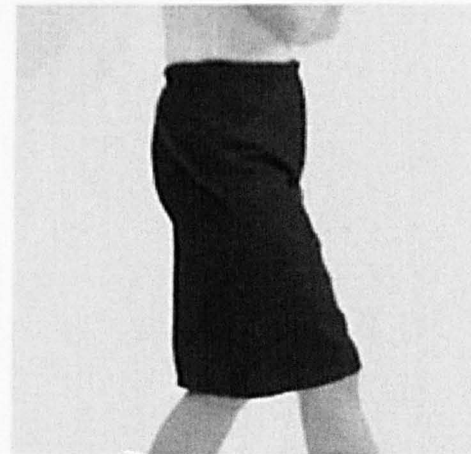

Bray

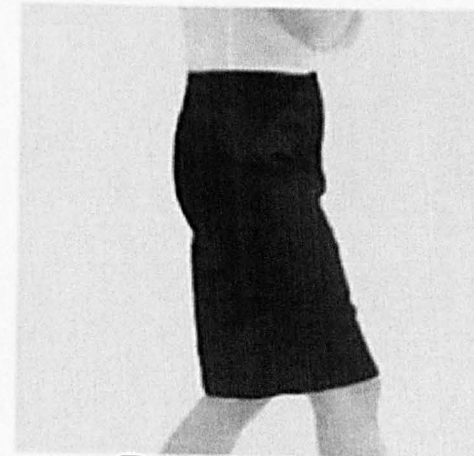

Prototype 1

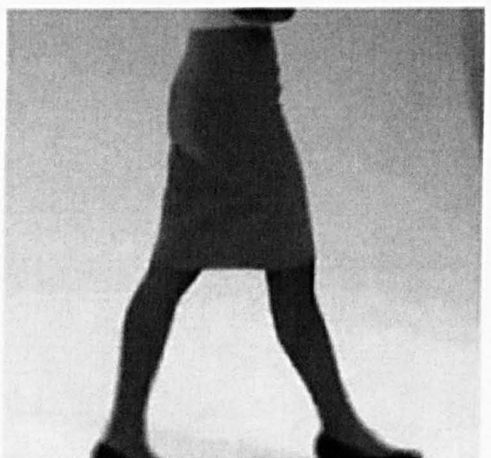

Prototype 2

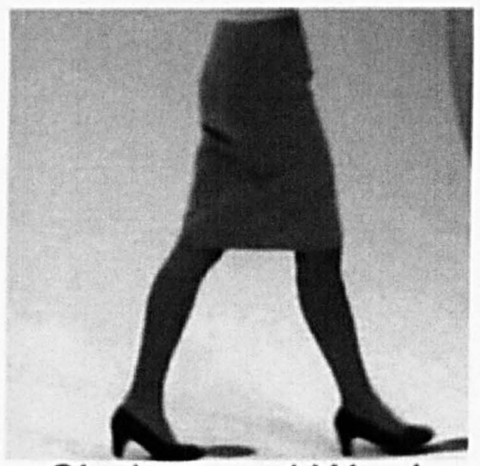

Jansen and Rüdiger


Kunick

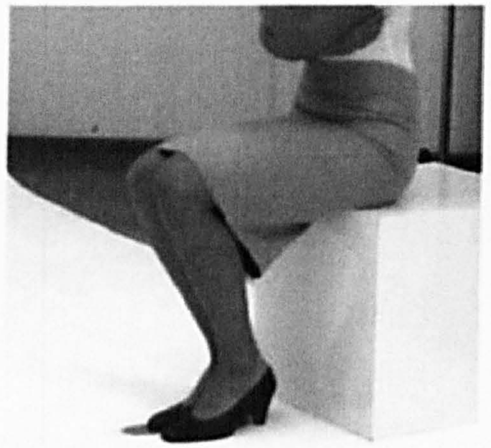

Prototype 3

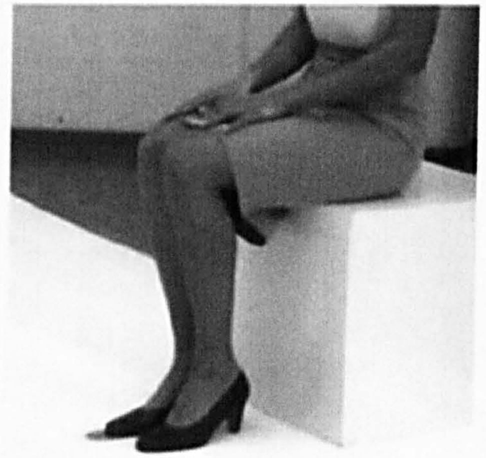

Prototype 4


M. Müller & Sohn


Shoben and Ward

10.6.9 Visual Comparison 4: Six Flat-pattern Cutting Systems and Prototype Skirts


Aldrich

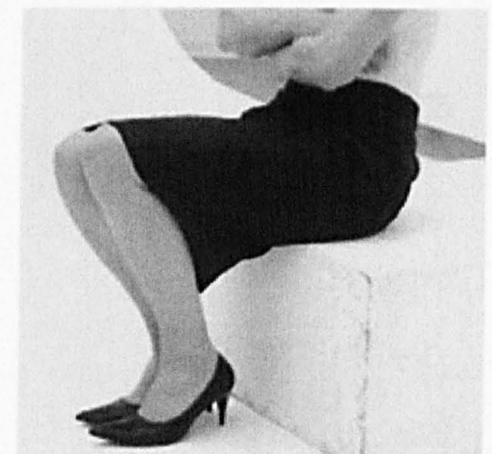

Bray

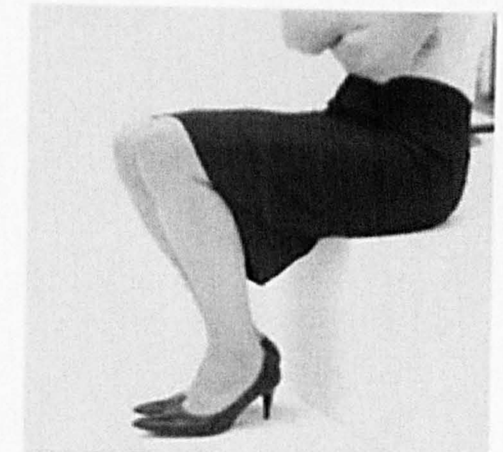

Prototype 1


Prototype 2


Jansen and Rüdiger


Kunick


Prototype 3


Prototype 4

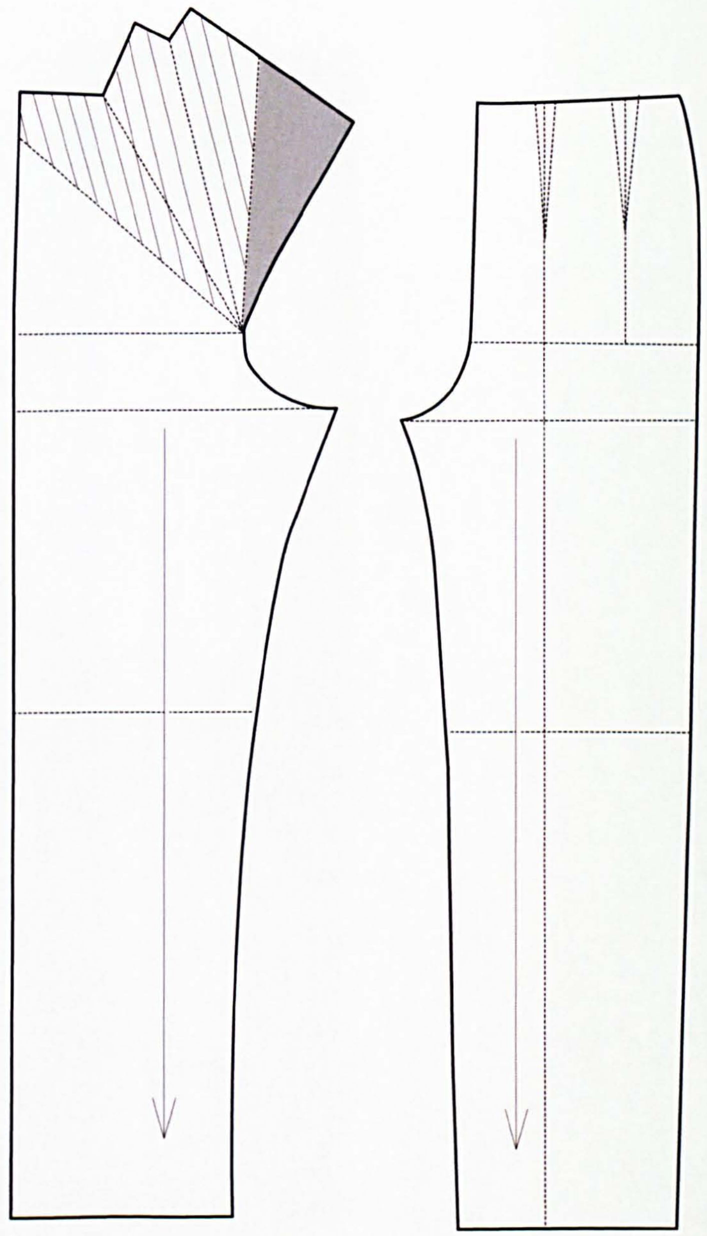

M. Müller & Sohn


Shoben and Ward

10.7 Prototype Trousers

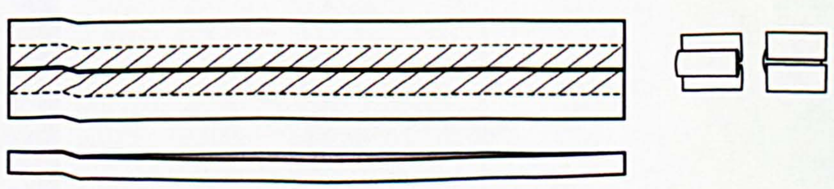
10.7.1 Visual analysis chart: Trousers Prototype 1

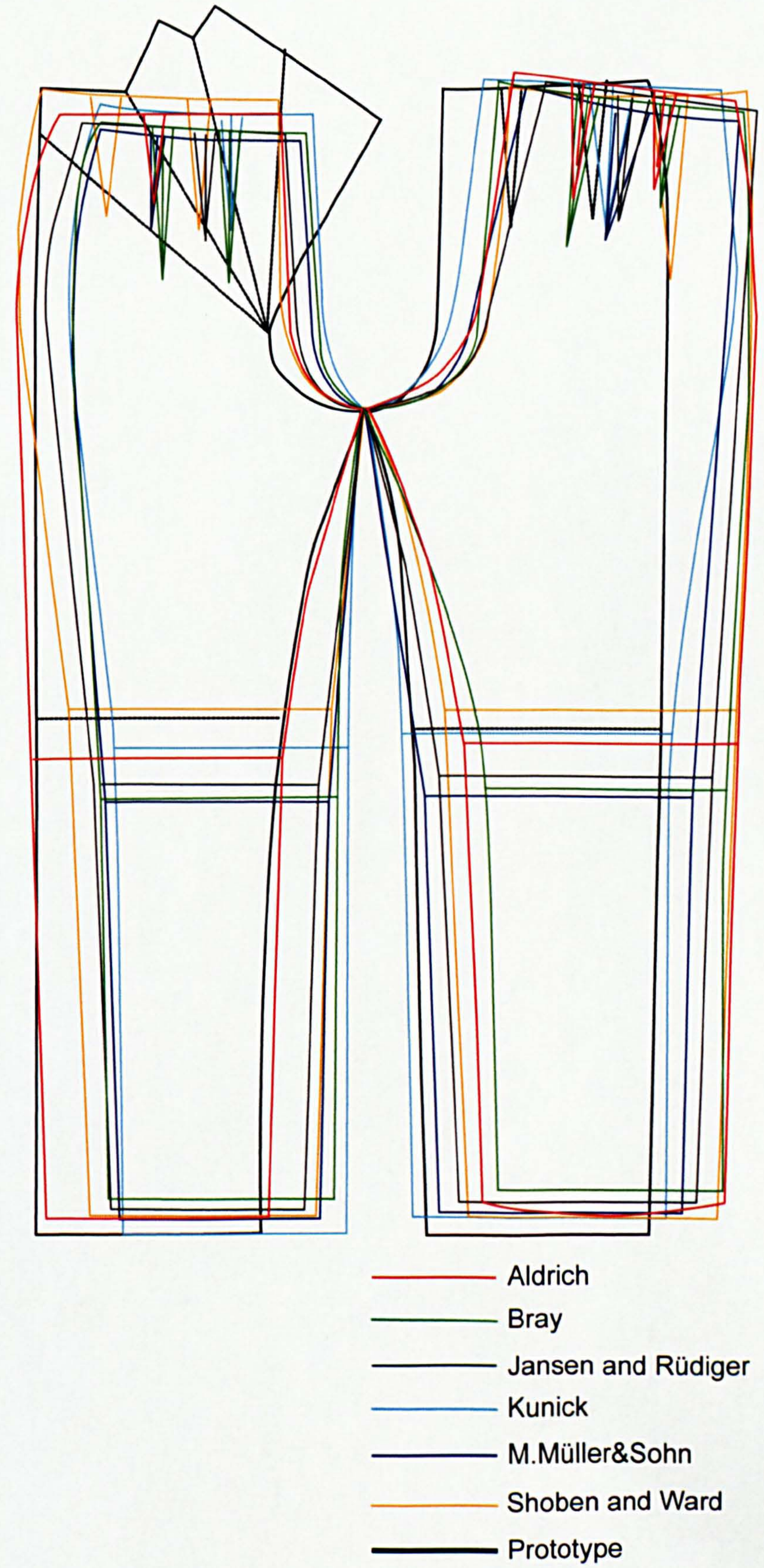
1. Fold at the centre back line down to hip line (hatched area indicates the depth of the trousers).



back front

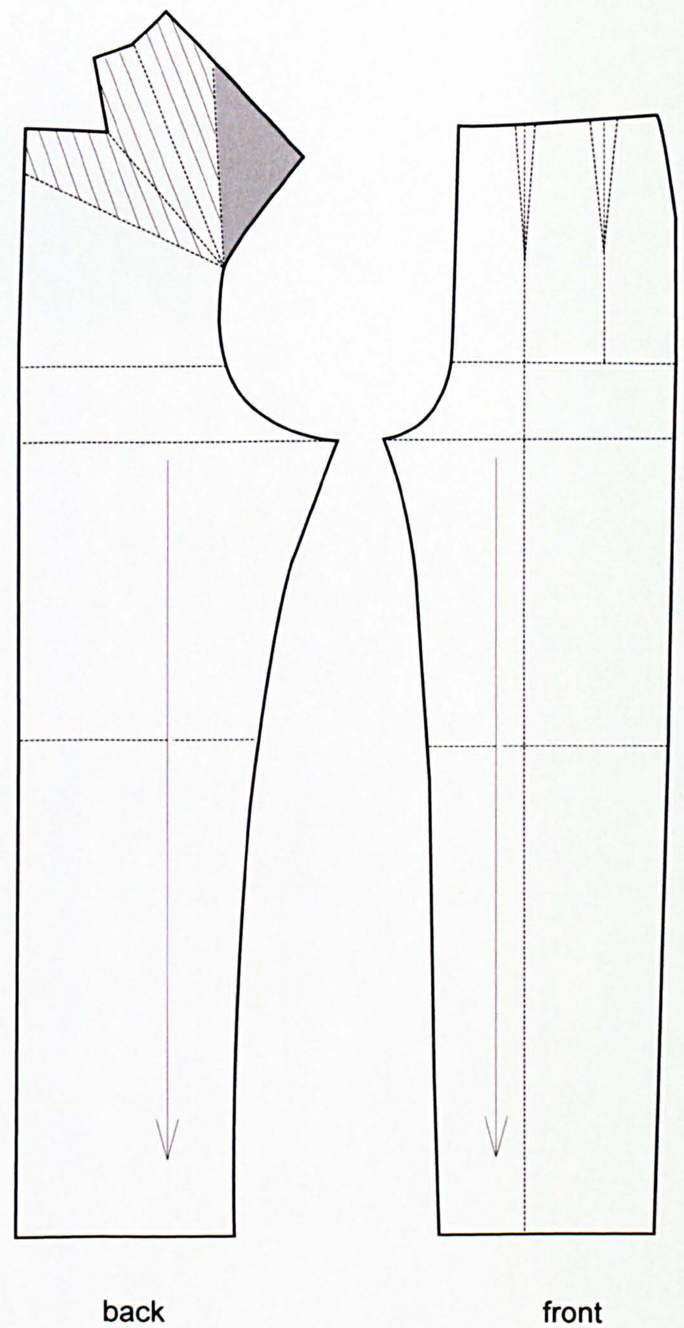
1. Waistband pattern piece 16 cm (finished waistband 4 cm)



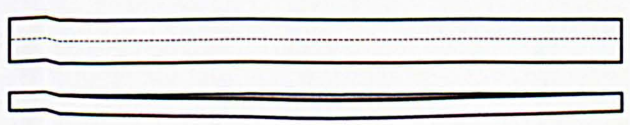


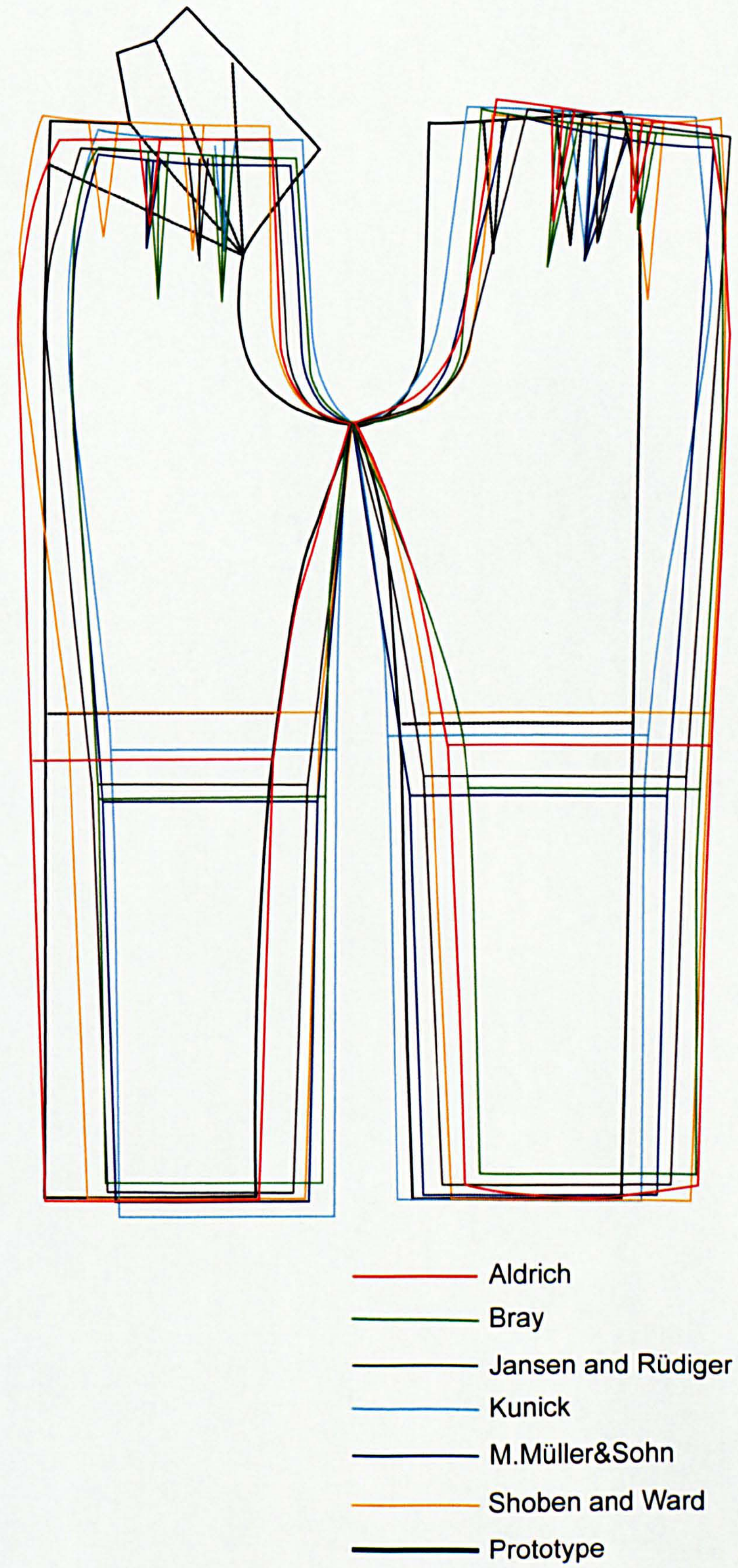
10.7.2 Visual analysis chart: Trousers Prototype 2

1. Fold at the centre back seam (hatched area indicates the depth of the fold)



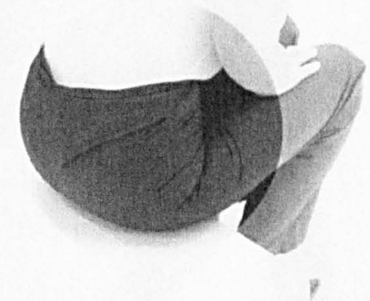
1. Waistband pattern piece 6 cm (finished waistband 2 cm)





10.7.3 Visual analysis prototype trousers – back

Prototype Trousers 1



Prototype Trousers 2

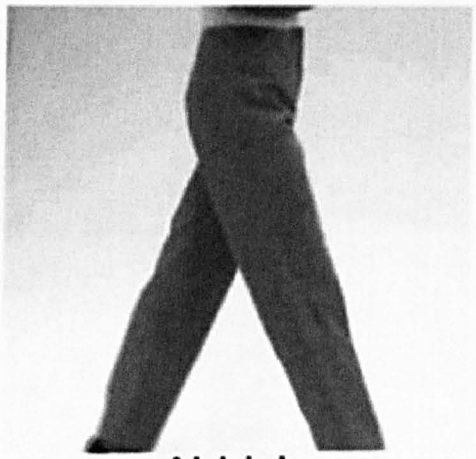
	Strongly Disagree	Disagree	Agree	Strongly Agree
Waist fit		P2 (N2)		P1 (N9)
Pelvis fit				

Figure 133, Comparison of six flat-pattern cutting systems and prototype skirt 1

The added vertical fold at the waist in Prototype 1 keeps this area in place when the torso is bending forward. The unfolding pleat allows for the extra fabric needed while the back of the body elongates into the movement. When standing up, the fold does not automatically close.

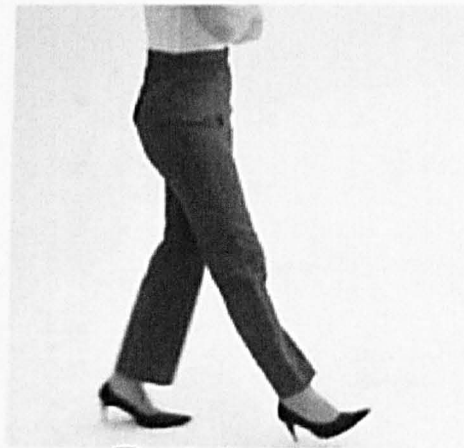
The added diagonal fold in Prototype 2 does not allow the waist to stay in place while the movement is performed.

10.7.4 Visual Comparison 1: Six Flat-pattern Cutting Systems and Prototype Trousers



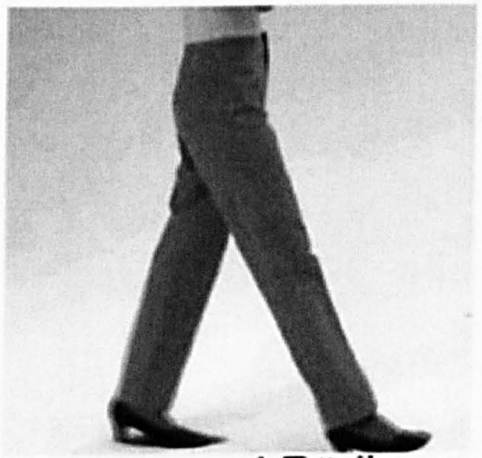
Aldrich

Bray

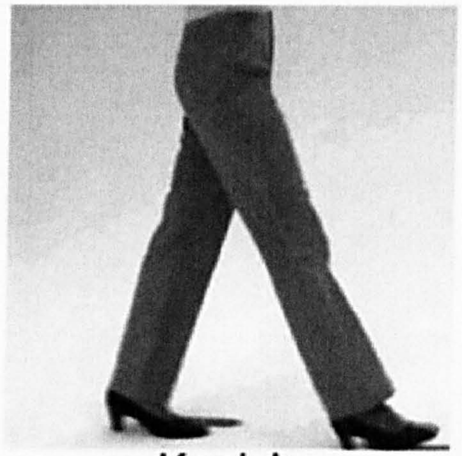


Prototype 1

Prototype 2

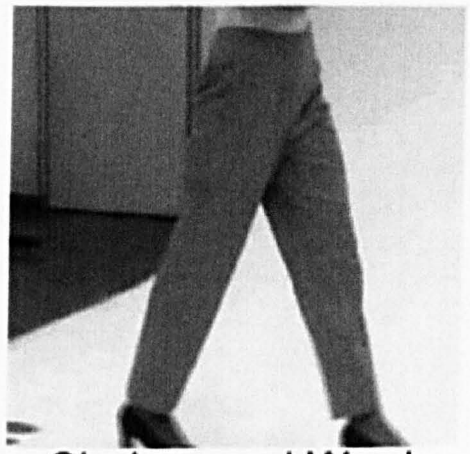


Jansen and Rüdiger



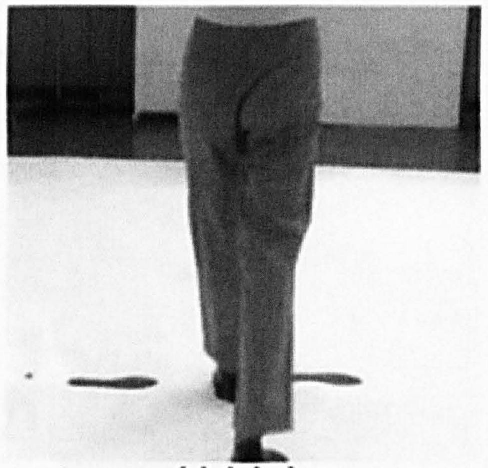
Kunick

M. Müller & Sohn

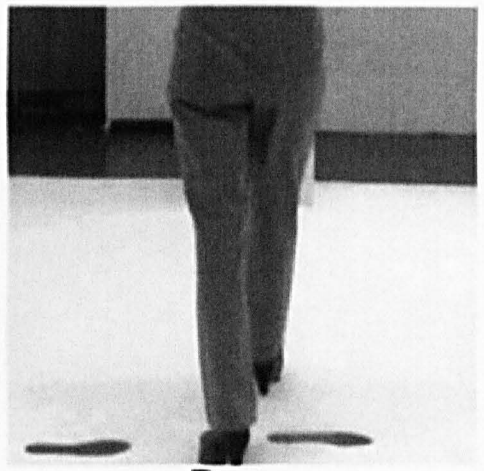


Shoben and Ward

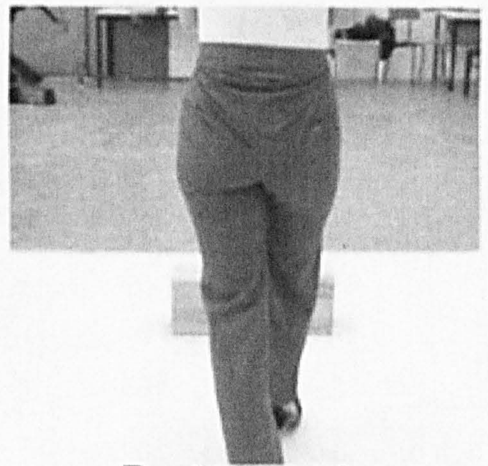
10.7.5 Visual Comparison 2: Six Flat-pattern Cutting Systems and Prototype Trousers



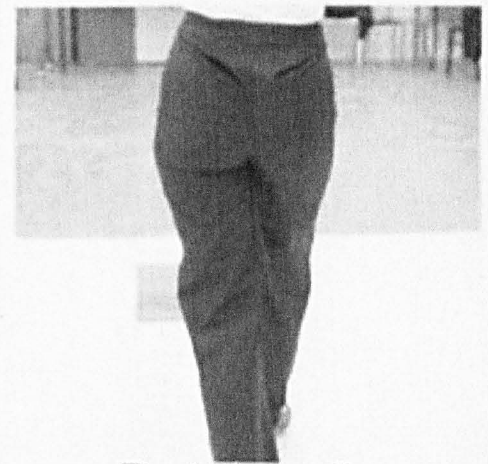
Aldrich



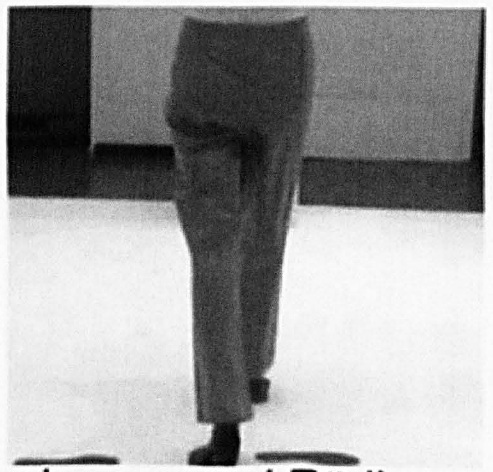
Bray



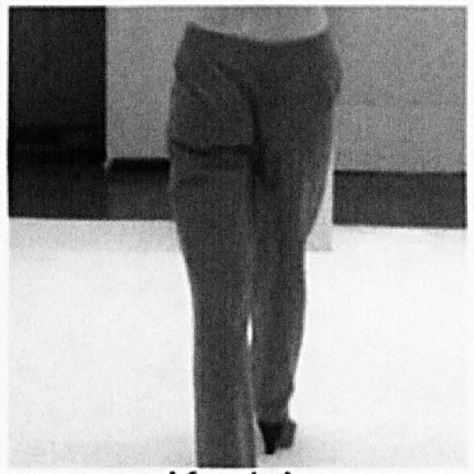
Prototype 1



Prototype 2



Jansen and Rüdiger



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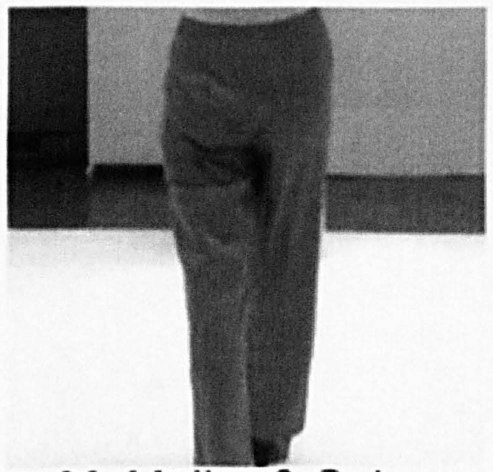
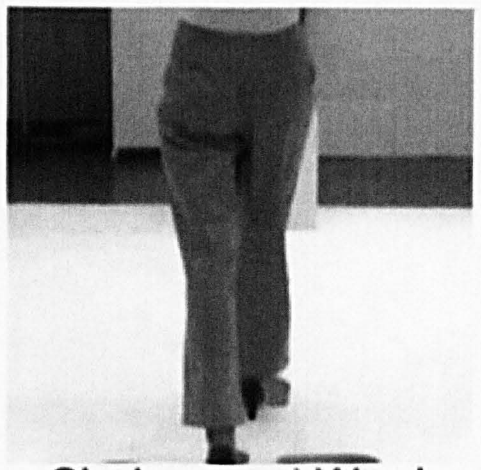
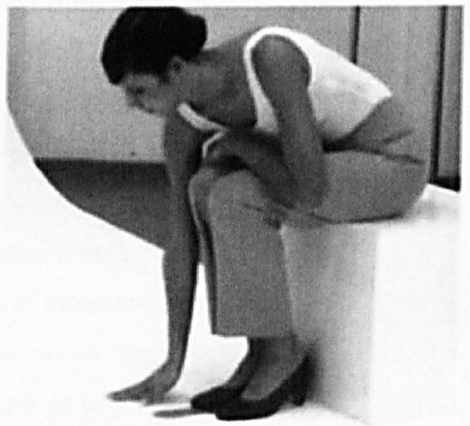


M. Müller & Sohn

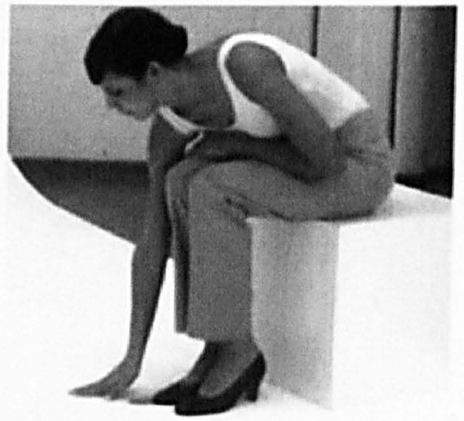


Shoben and Ward

10.7.6 Visual Comparison 3: Six Flat-pattern Cutting Systems and Prototype Tousers



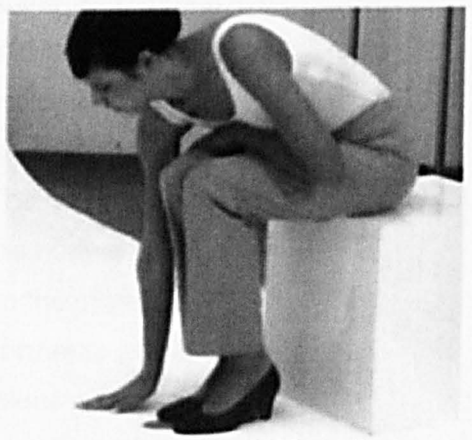
Aldrich



Bray

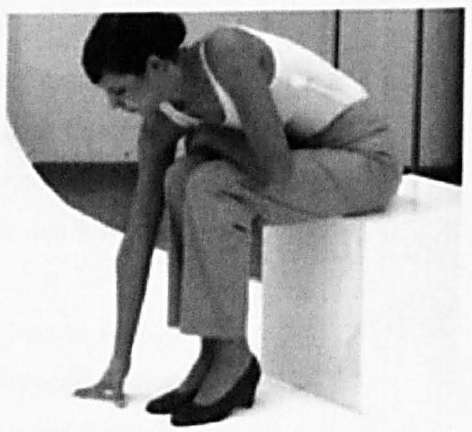
Prototype 1

Prototype 2

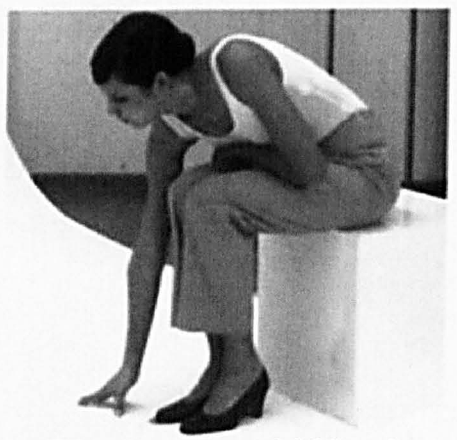


Jansen and Rüdiger

Kunick



M. Müller & Sohn



Shoben and Ward

10.8 Summary of Chapter 10

The outcomes of the questionnaire handed out to 32 people who are involved in fashion education and production, showed interest in the pattern amendments. The widening of the range of movement through the grown-on-gusset, as in the jacket prototype 2, the vertical folds, as in jacket prototype 6 and skirt prototype 4, and the horizontal folds in jacket prototype 2 and trousers prototype 1 are accepted by the interviewees.

The interviewees (N6) agreed that the jacket prototype 2, consisting of an under-arm-gusset in combination with diagonal folds at the front and back shoulder enables the wearer to lift up the arm without the strain which is there in the traditionally constructed jackets from video analysis 1. For the reaching forward movement of the arm and the upper body part out of a sitting position it was agreed (N9) that the same prototype 2 shows less strain. A similar outcome for the same movement reached the jacket prototype 6, consisting of an under-arm-gusset plus a vertical pleat along the centre back (N8).

The jacket prototypes 1 (N3) and 2 (N4) were judged as fitting the elongated back of the body while leaning forward. A similar agreement for the same movement is found on the skirts prototype 4 (N4) and the prototype trousers 1 (N9), of which both garments consist of a double layered waistband which unfolds into the movement releasing extra fabric to cover the elongated area of the lower back. Nevertheless, it has to be said that these double layer waistbands do not fold back neatly.

In regard to mass-production, it is possible to construct the block-pattern either manually or with CAD CAM systems. Next to this their size can be changed to different sizes (to grade a pattern), which is of great importance for the mass-market in which a style is produced in a variation of sizes. The flat-patterns are two dimensional, which allows for making lay plans or cutting the pieces in staples.

It has to be said that for the production of these prototypes the amount of necessary material increased. After having made up the experimental prototypes it was found that the process of making up is more time consuming because of more, or longer, seams needed to be sewed and ironed or pressed. Consequently, the costs for an industrial production would increase. But still, the amount of extra fabric for the grown-on-gusset is minimal in comparison to its effect on the ability to move the arm.

Another argument for the grown-on-gusset used in mass-production is, that it is not visible when the arm is in its natural position, which makes this amendment ideal because the structured appearance is not disturbed.

From an informal discussion of 18 people at a presentation of this project at the London College of Fashion in October 2011, it was agreed, that the most successful grown-on-gusset for lifting up the arm, the vertical pleat at the centre back for allowing to adjust to the different body measurements for the arm movements to the front and the diagonal folds at the shoulder for allowing the shoulder to move to the front and back. These diagonal folds attached to the skirts and trousers do allow for movement but not to the same extend as the folds at the shoulder. The question was raised whether the diagonal folds at the front and back shoulder were leading to a kind of uniform impression of the prototypes. It was discussed whether these could be seen as block-pattern in the traditional sense of allowing for further manipulation into derived- or fashion-pattern.
In contrast to the above, the horizontal pleat inserted in the waistband for covering the elongated back while bending over, was seen as a possible solution even though it does not fold back neatly into place when standing up at this stage of experimental prototyping.

Despite the outcomes of the questionnaire mentioned above, a general discussion of the experimental prototypes is stated in the following Chapter 11.In this suggestions for further study in the field of allowing for a wider range of movement in soft-tailored womenswear, are stated, as they emerged from the practical experimental body of work and from how this is observed and judged by representatives with knowledge about fashion design and pattern cutting in academics and the industry.

11 DISCUSSION

In this chapter the outcomes of the research journey and especially of the practical body of work of Part 2, are discussed. The proposed hypotheses was that today's mass-produced woven womenswear is not constructed to follow every-day movements, but, by contrast, to resemble the static, non-moving, body.
The assumption that women's business-wear restricts body movement was tested and areas of restriction were identified. The overall question was, whether such problems are solvable through the construction of block-pattern for womenswear, in order to give a better fit for the moving body, while at the same time follow general methods of industrial production and whether it is possible to extend the range of movement in wear for women's soft-tailored jackets, trousers and skirts by the addition of folds and gussets to existing flat-pattern cutting methods.

11.1 The Need for a Modernisation of existing Block-pattern for soft-tailored Women's Business-wear

In the following the applicability of a wider range of movement in soft-tailored woven womenswear as found out through the course of the research is summed up. This is divided into the three areas of main findings, as there are:

i. the modern travel and transit related life-style

ii. the unmodified way of flat-pattern construction for mass-market soft-tailored womenswear

iii. the role of static body measurements for the clothing production.

The findings in these areas are based on an evaluation time frame from the 1950s until the year 2011

11.1.1 Travel and transit life-style

This research project is justified by the changes in modern life-style, consisting increasingly of being in travel and transit situations. Furthermore, the ongoing increase in female employment in Europe since the Second World War, as explained in Chapter 3.3, means that a high number of females constantly leave the home surroundings for the workplace which involves taking various modes of travel, as stated in Chapter 3.4. This phenomenon is observed through empirical and visual evidence. The data gained from observation and experimentation allows addressing the areas within the clothing where a widening of the range of movement is mostly needed. The first preliminary case study, introduced by stills extracted from a video documentation by the researcher at the beginning of this research project, as stated in Chapter 1, Figure 1, underlined the researcher's own experience that mass-market women's business-wear restricts every-day movements performed during travel and transit situations. The changed daily routine of commuting to and from work wearing the same garments which are adequate as business-wear, is shown by research on the historic, sociological and economical context of female work-wear in Chapter 3 together with opinions of working women on the matter, gained from outcomes of questionnaire 1, stated in Chapter 3.7.

The problem identified is that contemporary, woven soft-tailored womenswear is made to suit the standing, non-moving body, as it can be seen in general fitting situations and how clothing is presented in shops. Nevertheless, daily life consists of travel and transit situations that demand a high level of flexibility and movement, as shown in Chapter 3, which is not reflected by the clothing.

It was felt by the researcher, that investigating special requirements evoking from a modern life-style, is a starting point for researching whether the necessity of updating existing flat-pattern cutting principles for soft-tailored business-wear made from woven fabric, is indicated. The obvious solution to the problem, as it has been frequently practiced by the textile producing industry since the 1990s, was the use of stretchable material, such as knitted fabric or the use of woven fabric made from stretch blend fibers. Woven fabrics, generally accepted as being suitable for formal business-wear have been blended with stretch fibers to allow for more comfort but this still only enhances a generally restricted range of movement.

This information derived from first hand information gained by the outcomes of a questionnaire with working women, as stated in Chapter 3.7. Even though the overall opinion of the women asked was, that stretchable fabrics are practical for obtaining comfort, they were not chosen as work-wear.

Knit fabrics and stretch blend fibres for woven material were discounted from this research because they are judged to be informal and too casual for the use for formal business-wear and because the interest of this research project concentrates on the construction, the flat-pattern.

The outcomes of questionnaire 1 also underlined the personal experience of the researcher that soft-tailored womenswear restricts every-day movements, especially the ones performed in travel and transit situations. Further research in this field made clear that block-pattern construction for woven womenswear has not seen many changes, but is still strongly related to the way of construction for the simplified silhouette as it has been invented in the 1920s, as stated in Chapter 3.2.2.

11.1.2 The unmodified pattern construction principles in clothing mass-production

The way flat patterns for formal women's business-wear are constructed has not significantly changed since the streamlining of the silhouette in the early twentieth century.

Early examples for the flat-pattern for womenswear created in a rectangular shape, which is a useful solution for various parts of mass-production, can be seen from 1924 onwards (Aldrich: 2007). Primarily, the shape allows for making the most use of the fabric, because the fabric itself is rectangular.

Through the practical comparative part of the project, in which the block-patterns of six existing flat-pattern cutting systems were evaluated for the womenswear jacket, trousers and skirt (Chapter 8), it can be said that the construction principles of all of the systems are similar, in the case of the jacket, also similar to the flat-pattern for the sack-shaped womenswear jacked from the early 1920s.

This specific comparative method has not been used before and the outcome, that despite minor differences the basic construction is similar stresses the researcher preliminary impression of flat-pattern cutting being an accepted tool for developing pattern, which has never been questioned.

Through developing a design methodology of observation of case studies mimicking reality enabled the gathering of valuable information.

The first practical case study, video analysis 1, for which the researcher selected a series of everyday movements as a test base, underlined the former assumption that the use of purely static measurements for the construction of block-pattern, caused similar restriction in movement in all of the prototypes made up following the instructions of the six flat-pattern cutting systems, even though their time of invention span a time of over five decades, starting from before the Second World War.
Even though considerations such as a changes in temperature are reflected in clothing, for example by integrating zippers which allow for a shortening of sleeves and legs, every day movements as they are performed by contemporary working females, are in this project addressed for the first time in the construction of block-pattern.

The neglect of reflecting every-day movements in the construction of womenswear is exemplified by the way patterns are constructed, manually or with the help of a computer. Digital flat-pattern construction makes use of the same principles of construction and of the same static body measurements, as manual pattern cutting does. Even though CAD CAM technology allows for a faster way of constructing, grading or electronically sending the patterns, the rectangular base as it was developed in the beginning of the twentieth century, still pertains. Neither ways of constructing has consequences on the fit of the garments.

Recent technical inventions such as 3D body scanning, as stated in Chapter 6.6, are aimed at improving efficiency. Nevertheless, the clothing industry is one in which the quantity of garments produced at a minimum cost is the most important factor. Staples (1993: 7) discovered that, despite technological advancements, labor-intensive pattern cutting is key to the general mass-market production of clothing.
Further, Staples (1993: 13) reasoned that mass-producing companies make greater use of the computer for patternmaking functions and are less likely to introduce new garment styles.

11.1.3 The role of static body measurements for clothing production

The principle of dress fitting is traditionally based either on the dress-stand or on the upright standing body. Generally, the most that is done to fit the moving body is walking while wearing the garment. This way of judging the fit of clothing is also reflected in the way it is presented on the catwalk or in photographic images. The latter allows for unnatural arrangement of the garments around the chosen static posture.

Ulrich and Bryant (2006: 65) stated that a conference in 2004 on apparel fit found that there is much research prospective in the fields of 3D body scanning technology and CAD patternmaking for mass-production.
Furthermore, the authors clarified that investigation was necessary in order to identify and relate body shapes and pattern shapes, to find ways of improving mass-produced fit. They highlighted the limited number of scholarly publications in these fields.

Bye, LaBat and DeLong (2006: 67) pointed out that, through body scanning, the usual linear body measurements can be enhanced by a shape analysis which provides landmarks for different measurements. The authors agreed that consumer satisfaction, and therefore the success of mass-produced clothing, is dependent on a continued development and conservation of traditional skills, technological inventions and intellectual resources.
For this research project, the design methodology of direct observation and the case studies on flat-pattern cutting systems enabled the gathering of valuable information, on which the development of experimental flat-pattern prototypes which aim for widening the range of movement in certain parts of woven soft-tailored womenswear for every-day movements were based on. In the following these prototypes, as part of the contribution to new knowledge, are discussed.

11.2 Contribution to New Knowledge

Through first hand information gained through observation and mimicking reality, a methodology design has been developed to inform the fit of soft-tailored women's business-wear through amending the construction principles of block-pattern. Through this a wider range of movement can be performed in formal womenswear, adding to the comfort and well-being of the wearer. The findings from the research and development process are grouped in:

i. the static body measurements and anatomical phenomena

ii. the extending the range of movement through flat-pattern amendments

iii. the adaptability of flat-pattern amendments for mass-market production.

11.2 1 Static body measurements and anatomical phenomena

Past research has targeted the differences between existing block-pattern constructions without touching on the area of body movement as reflected in pattern construction. Gray (2002) investigated the bodice construction without sleeves of the systems by Aldrich, Bray and Kunick. Hereby Gray placed two patterns of the same system onto each other in order to compare the measurements given in the different editions of the publications. A comparison of six different flat-pattern cutting systems altogether, as it is done in this research project stated in Chapter 8, is not part of her study.

A related study by Aldrich, Smith and Dong (1997) condensed every-day movements involved in a working environment down to five single static movements, which were analysed in regard to the consequences they had on the fit of a formal womenswear jacket.

In contrast to the above, this research project found that every-day movements can be grouped into six basic movements. Furthermore, these movements were not evaluated separately and statically, but performed in a natural flow, one after the other. The documentary medium of choice for this is the video, which captures all movements and enables to extract stills for further visual analysis, as seen in Chapters 9 and 10.

The way of visual documentation enabled to identify three areas in which the natural range of movement is restricted by formal soft-tailored womenswear. As outlined in Chapter 9 these areas are the torso, the shoulder and arm and the pelvis and leg area. This research project proofed that the fit of different areas of formal womenswear depends on the various every-day movements performed with the result of a restricted range of body movement. Nevertheless, the need to reflect a wider range of body movements in block-pattern construction for female business-wear was initially neglected by interviewed professionals and academics (Appendix 3).

11.2.2 Extending the range of movement through flat-pattern amendments

The practical innovations of this research exploit the possibilities of block-pattern construction for soft-tailored womenswear, as shown in Chapter 10.4. The designs of the innovative principles of flat-pattern cutting for widening the range of movement in formal attire were developed for the three identified areas in the womenswear jacket, trousers and skirt.

By using an empirical approach to block-pattern cutting and by questioning traditional flat-pattern construction in identified areas, a set of prototypes has been developed that offered a wider range of movement to the model without distorting the accepted formal appearance of the garments, as seen in Chapter 10. Hereby the given examples of existing examples of integrating a wider range of movement into woven sports clothing, as introduced in Chapter 9, functions as an inspiration for the design of the prototypes. The additional integrated folds and gussets match a previous excursion into the human anatomy for movements, as shown in Chapter 9. Evaluated information on the changes of the human body's silhouette goes through while performing a range of basic movements is reflected by the new principles of block-pattern construction. The approach was to translate the range of movement of the human anatomy into the construction of clothing. As these changes of the body involve an increase of the measurements compared to the ones taken while the body is standing upright, the additional flat pattern aspects allow for such increase.
Contemporary mass-market women's business-wear restrict during daily travel and transit situations. Through reinventing the existing flat-pattern cutting principles of the fold or the gusset, which allow for a greater range of movement, the range of movements could be extended, as seen in Chapter 10.

By using an empirical method for the changing the block-pattern the resulting prototypes are successful in the way that they allow for a greater range of movement in the identified areas of the body. This approach is different to other design orientated mass-market products, such as additional zippers to adapt the length of sleeves and legs of sportive trousers that allows for adaptation to different outer circumstances but not necessarily to the ability of performing movements.

Changing the block-pattern construction through an integrated fold at the centre back is a design that adapts the findings of Hirokawa and Miyoshi (1997) in Wang, Newton, Ng and Zhang (2006: 247)). They revealed that the relation between ease quantity and wearing feeling of a jacket in stationary standing posture and in moving condition both require different ease for better wearing comfort across the body.
In this research the additional amount for ease of movement is partly achieved by integrated folds which allow for a greater range of movement because of the extra amount of fabric but do not result in a looser shape of the garments.

In the following it is discussed, whether the experimental flat-pattern amendments are conform to mass-market production standards.

11.2.3 The adaptability of flat-pattern amendments for mass-market production

This research project targets mass-produced womenswear in which the versatility of the block-pattern is of great importance to the mass-market production process. Consideration of the context of mass-production is present in the existing flat-pattern cutting systems examined, as shown in the comparative study in Chapter 8. The production of the experimental prototypes followed the pre set specifications for mass-production as it was previously done with the prototypes in Chapter 9, as far as it was possible for this individual project

Mass-production is not generally known for using any other inventions than the ones that provide efficiency for the various steps of production. It uses size-charts in order to encompass a specific range of measurements for the designated size. To make part of a garment suitable for the average size, this can be done by deepening and widening the arm scye for fitting different forms of arms. In contrast to this, made-to-measure production uses individual measurements in order to fit the garments onto the upright standing body. By comparison with the enlarging of the arm scye in mass-production, this area is cut high and close to the natural arm pit. Neither way allows for the maximum range of movement of the human arm and shoulder.

This research has used industrial CAD CAM technology to construct the existing block pattern, as stated in the comparative study in Chapter 8, as well as for the development of the experimental prototypes in Chapter 10. Even though these flat-pattern constructions involve untypical principles, such as the integrated gusset and folds, especially the diagonal folds at the front and back shoulder, the used CAD CAM technology is the same as it is used in industrial production. The technology was used in a creative way, not completely bound to the ordinary construction principles.

The amended block-patterns were constructed based on the selected system by M.Müller&Sohn. The amendments were created manually before constructing them digitally with a CAD CAM system. This ensured that the construction of shapes, different to the traditional shapes is possible with CAD CAM technology. Furthermore the flat-patterns were printed out in full size on a professional plotting division.

According to interviewees in the mass-market clothing industry, CAD CAM technology enables efficient working with fashion patterns but was generally found to be too restrictive by comparison with manual flat pattern cutting, as stated in Chapter 6.8.

11.3 The Adaptability of the Renewed Flat-pattern Principles for Mass-production

Staples (1993: 89) argued that the organizational strategy of pattern cutting can be divided into two groups, the *defenders* and the *prospectors*. She characterized the defenders as the ones for whom a stable form of organization with maximum profit and minimum risk is appropriate, whereas the prospectors tend to seek new market opportunities with maximum risk and minimum profit.

Because of the main criteria for successful mass-production being the efficiency in regard to the needed material and the time of assembly, as shown in Chapter 6, this is considered in the discussion of the experimental flat-pattern amendments. The discussion is grouped into:

i. the experimental flat-pattern amendments used in mass-production

ii. the evaluation of styles

iii. the fine line between block- , derived-, and fashion-pattern

11.3.1 The experimental flat-pattern amendments used in mass-production

As can be seen in the descriptions of each prototype in Chapter 10, except for the cut on gusset of the lower sleeve, all amendments proposed take up an estimated ten percent increase in fabric than ordinary block-pattern. This is obvious for the vertical and horizontal pleats, but also for the diagonal folds at the shoulders because the front and back pieces of the block-pattern cannot be laid out in the same way as traditional pattern pieces in order to minimise wasted fabric. Furthermore, all folds require ironing which means an extra step within the production process.

The sewing together of the parts which consist of each of the amendments are more time-consuming because the folds need to be pinned or held in place and also require additional notches to be made up correctly.

However, the proposed 'grown-on' gusset only requires a minimum of added fabric, because the material saved from deepening the armhole needs to be subtracted. Nevertheless, as the gusset is of a round shape the sewing is more time-consuming than stitching a straight seam. Furthermore, the seam allowance needs to be cut in repeatedly in order to iron the curve flat.

Even though the fabric employed for the amendments is increased in comparison to ordinary block-pattern, as seen in Chapter 10, the suggestions for the experimental flat-pattern constructions do extend the range of movement.

11.3.2 Evaluation of styles

The evaluation of the style of the different renewed block-pattern principles is divided into two parts. The first includes the diagonal, vertical and horizontal pleats which allow for a greater range of movement by the amount of the depth of the folds. The second consists of vertical folds in the centre back of the jacket and the skirt, which are clearly visible because they open up when extra width of fabric is needed as caused by certain movements, such as sitting down for the skirt or stretching out the arm for the jacket. The horizontal pleats in the waistband are not clearly visible when the extra length of the fabric is not used, as in the upright standing position. However, the fabric unfolded while sitting enables the skirts and trousers to adapt to the different body measurements of the area between the waist line and the lower back, but sometimes fails to rebound into the closed pleat when standing up.

By contrast, the diagonal pleats at the back and front shoulder are obvious and clearly noticeable changes because the fabric is folded on the outside of the shoulder. As the block-pattern jacket does not have a collar or lapels that might cover up the diagonal folds to a certain extent when used in a fashion-pattern, they are here quite noticeable. The folds could be criticised as appearing uniform-like and it was felt that they were part of fashion pattern rather than block pattern.

The underarm gusset is the one renewed block-pattern cutting principle that meets the criteria for widening the range of movement in mass-produced womenswear because of the close-to-normal way of cutting and sewing in the sleeve whilst still widening the range of movement for the shoulder and arm.

The underarm curve for sewing the sleeve onto the bodice is two centimeters cut out deeper than normal. Furthermore, this construction principle is hardly noticeable when the arm is in its natural position and therefore the overall appearance of a women's business jacket is retained. Through adding this adapted sportswear application, as described in Chapter 9, a maximum range of movement of the shoulder and arm is achievable with the least impact on traditional mass-market production processes.

11.3.3 The fine line between block-, derived- and fashion-pattern

When comparing the jacket block-patterns it was found that one of the six flat-pattern cutting systems investigated can be called a derived- or fashion-pattern because of the centre front being angled from the waist up to the neck. Following the definition for derived- or fashion-pattern as being manipulated from a block-pattern, as stated in Chapter 4.6 to 4.8, the block-pattern for the jacket by Jansen and Rüdiger is a derived- or fashion-pattern.

Even though the very first pattern in the process of mass-production (the block-pattern) is often transferred into the final fashion-pattern through the attachment of collars, pockets and fastenings without changing the actual block-pattern, the block-pattern construction itself is not the basis for improving the fit.

Key areas for discussing differences between the stages of flat-pattern are the armhole scye and the overall width of the sleeve. As a block-pattern is traditionally to follow the body measurements with only necessary ease, a deepening, or widening, of the armhole and of the sleeve is a fashionable manipulation, as can be seen in the broad shoulders and general enlargement of women's wear jackets in the 1980s, shown in Chapter 9.

In addition, it might be presumed that the different widths at the trouser leg in all of the six flat-pattern cutting systems are also dependent on the fashion of the time of invention of the systems. Shoben stated in an interview on the 17th of February 2011 that a good fit in garments can only be achieved in manipulated derived or fashion pattern and that block pattern cannot fit the moving body.

As argued above, some of the garments tested for this research can be seen as derived- or fashion-pattern but the resulting fit is not changed for the better in comparison to the remaining garments made using the other systems which are judged to be pure block-pattern.

Nevertheless, the four groups of amended pattern cutting principles developed in this research project allow for further prototyping of different combinations and dimensions of the single principles.

11.4 Suggestions for Future Research

During the course of the experimental part of this project areas came up which were not part of the research outline, but are of interest for future research. In the following these areas are grouped in the manipulation of the experimental amendments for derived- and fashion-pattern, the process of making up, the development of further prototypes and of aspects which need to follow the changed flat-pattern cutting principles, such as shoulder pads for the front and back vertical folds of the jacket. The suggestions for future research on the matter are grouped as:

i. the manipulation of the experimental amendments for derived- and fashion-pattern

ii. the process of making up

iii. the development of further prototypes

iv. the development of new aspects of making up

11.4.1 The manipulation of the experimental amendments for derived- and fashion-pattern

The research was concerned with adapting the construction of block-pattern for soft-tailored womenswear for basic every-day movements. After evaluating first-hand information from professional working women, the fitted jacket, the knee length straight skirt and the long trouser were identified as suitable and appropriate for business wear. Nevertheless, the changed block-patterns could also be transferred into derived or fashion pattern, such as the flared skirt or tight-fitting or extra-wide trousers. A valuable further area of research would be to test the suggested flat-pattern amendments for various derived-patterns of the different garment types.

Consequently the amendments could be integrated in fashion-pattern. This is of particular interest, because some of these flat-pattern experiments are judged as being fashionable and not as block-pattern, as stated by people involved in the fashion industry and in academic institutes (Chapter 10). However, addressing any of these was not part of this research project which concentrated on the basic block-pattern for soft-tailored womenswear.

11.4.2 The process of making up

Further research could be done in the way the changes of the block-pattern impact the general process of making up the garments. The front and back shoulder fold was constructed in two versions. In the first one the folds met in a pointed angle which was stitched onto the shoulder line at the neck. The second version integrated the fold into the neckline. This resulted in a restriction of the range of movement which could be performed within the first version. A further prototyping to find the best angle for allowing the shoulder to move freely would be of interest.

Similar prototyping for the design of the vertical and horizontal folds, in order to achieve the best results in widening the range of movement while keeping the depth of the folds to a minimum.

11.4.3 Development of further prototypes

The prototypes discussed earlier can be developed further. As this research concentrates on the block pattern, which, in the case of the jacket, consists of a front and a back panel, the changes were not tested on a jacket with a separate side panel.

The changed block-pattern needs to be developed further into fashion-pattern with additional features such as collars and pockets. Especially the folds at the front and back shoulder should be tried out in combination with different collars or lapels. As previous comments on these folds suggested that they can be seen as design features rather than the block-pattern construction, the use of lapels, covering the folds at the front might lead to a different point of view.

The integrated gusset might also be tried out in men's wear as it is not visible while the arm is hanging down. By contrast with this, the folds at the front and back shoulder seem to be too obvious for use in men's wear. Through further development and adjustment of the integrated folds this might be solved.

Further testing of the above changes for more than one size could be useful to determine the variations of the changes according to the different sizes. In order to fulfill the requirement for mass-produced garments to be made up in a great variety of sizes, it would be helpful to test all changed block-pattern in different sizes. An evaluation of this could be part of further research.

11.4.4 Development of new aspects of making up

The construction of the front and back diagonal fold at the shoulder proved to be non restrictive for movement but this function cannot be when a traditional shoulder pad is used between the outer fabric and the lining of the jacket. For the experimental prototype jackets which consist of these folds ordinary shoulder pads were cut smaller manually so that they did not stop the folds from opening.

A further testing of the best size and shape of a shoulder pad is necessary for further prototyping.

A similar testing on interlining materials is also useful, in order to see whether the front part of the jackets could be interlined to get a stiffer appearance for traditional tailored jackets in contrast to the softer shape of the soft-tailoring jacket.

11.5 Evolving Limitations

The decision to undertake this research project in a country (UK) in which different flat-pattern cutting systems exist next to each other and in another European example(Germany) in which flat-pattern construction relies on one single system, enabled the accumulation of controversial opinions and perspectives in the area. Through this research project the researcher understood that there are different opinions

When interviewed, the now-retired Prof. Eric van de Kleijenberg suggested that the concentration on two-dimensional CAD CAM flat-pattern construction systems limits the way of construction down to two to three variations only. He especially referred to the construction of set-in sleeves. According to him the use of CAD CAM limits and restricts the development of different styles because of the software being designed for mass-production and not for prototyping.

A similar perspective was seen by the researcher when interviewing pattern cutting professionals and teachers in Germany. Using one system primarily, effects flat-pattern construction in many ways. A different approach to the topic or a critique on specific areas is not appreciated. Consequently, experiments in flat-pattern construction are rather limited. The fashion-pattern is generally seen as more important than the block-pattern.

Further limitations to the study were found in the use of the three-dimensional body scanning technology. This technology could not be used to gain accurate data about the differentiation of the various body dimensions for the various set of chosen movements, as shown in Chapter 7.5.

As the flat-pattern for the prototypes are two-dimensional, the same as traditional flat-patterns, there is no restriction for using them in any stage of mass production.
Even though the researcher recommends the manual method of constructing further experimental prototypes, they could be constructed with CAD CAM systems. As the prototypes were made up to fulfill the specifications of industrial mass-production they could also be produced in any industrial production environment. Further on the patterns can be graded or laid out as a lay-plan. The pattern can be plotted out and cut out manually or with machinery.

11.6 The Potential of Experimental Flat-pattern Cutting

Over the course of time it was discovered by the researcher that the field of block-pattern cutting is treated differently in European clothing production as well as academic institutes. Hereby, the block-pattern is generally not seen as important as the fashion-pattern, even though the construction of the former is of great importance for the fit of the garment. A common practice is to try to enhance the fit of mass-produced garments through a wider shape of the whole or areas within the fashion-pattern. It has been proven that even though the body might move underneath a loser shape style, some of the important every-day movements, such as uplifting the arm is even more restricted. It is unquestionable a wider and deeper cut armhole enable to sell the garment to a broader number of people of the same size.
It is believed by the researcher that the mass-market industry consequently stresses a simple design of womenswear, because the rectangular sack-shape jacket with less curved lines guarantees time sufficiency in all steps of production. As academic institutes prepare students for future work, the general way of flat-pattern cutting which suits the industry is necessarily part of the curriculum. To experiment not only with the silhouette, colour or fabric, but with the traditional construction principles of flat-pattern is often neglected. The increased use of traditional woven fabric blended with elastic fibres since the early 1990s addresses the wish for comfort in formal womenswear.

This research project has shown that changes to the block-pattern construction can be employed for soft-tailored mass-market womenswear, in order to widen the range of movement. As the experimental prototype patterns can be used with any woven fabric, the range of movement is extended in a way that could not be done by adding stretch fibers to the material.

This research project introduces a new concept of garment construction implied on traditional flat-pattern cutting systems. This can be seen as the continuation and development for mass-market flat-pattern cutting for womenswear since the introduction of the simplified silhouette in the early 1920s. In a similar way the sack-shaped simple shape reflected the necessities on womenswear in the beginning of the twentieth century in a similar way as the initial idea for this research project is based on the modern women's life style, in which the soft-tailored business-wear needs to allow for a wider range of movement of the basic every-day movements for the daily travel and transit situations.

This research project fits into a series of publications and events which show that there is interest in creative and experimental flat-pattern cutting. After the long period of acceptance of traditional rules and principles, flat-pattern cutting finally is seen as a design element for creating womenswear which allows for significant outcomes. The recent publication of Dennic Chunman Lo, published at the end of 2011, is an example of taking a creative turn on pattern cutting.

Another indicator for a growing interest in flat-pattern cutting can be seen in the first international symposium for creative pattern cutting, taking place at the University of Huddersfield in the beginning of February 2013. Even though, this event and the latest publications on the matter fall out of the time line for this research project, they underline that the traditional technique of pattern cutting is on its way of becoming revitalised and that the outcomes of this research project matches this development. This project showed that experiments in block-pattern are of great interest and hold the possibility to inform the general design process of womenswear.

Glossary

Anthropometry is defined in the Oxford English Dictionary as the measurement of the human body with a view to determine its average dimensions, and the proportion of its parts, at different ages and in different races or classes. (Oxford English Dictionary, 1989, Vol.1, 2nd edn.)

Body scanning is intended for precise three-dimensional scanning of human posture. It can be used for detecting irregularities in human posture and for monitoring the effects of curative interventions. The different body scanning technologies are: 3D laser scanning, scanning based on white light projection, photogrammetric and millimeter waves technology. The mostly used technology for 3D body scanning is 3D laser scanning. Laser scanning technology consists of using lasers to project onto the human body one or more thin and sharp stripes. Simultaneously, light sensors acquire the scene and by applying simple geometrical rules the surface of the human body is measured. The measuring system is highly accurate, easy to use and portable. The software enables a wide range of analyses with a simple display of numerical and graphical results.

Block-pattern/standard block is a 2D template, constructed using measurements taken from a size chart or an individual model. It has no style lines or seam allowances and is the first pattern made. The block consist of a front, back and a set in sleeve, in case of a block-pattern for a jacket the sleeve consists of two parts, the under- and the upper-arm sleeve. A block pattern is versatile as it can be used as a basic template or for further pattern construction. There are a number of different standard blocks, varying in details for different areas of the body and types of garments.

Trade blocks are made to suit the requirements of the clothing industry. May follow either a standard size chart or be adapted to fit the requirements of a company's target market, fit model or a customised dress stand. It may include details and proportions based on the accepted fashion silhouette of the time.

Tailoring blocks include special features and proportions characteristic of most jacket patterns drafted by tailors, which involves some moulding of the garment during the making-up process to give it its correct final shape.

Soft-tailoring blocks are looser and less structured than the more formal tailoring block. The sleeve can be of either a two-piece or a one-piece construction type.

Calico is a cotton fabric available in different weights, used for making toiles.

CAD CAM (computer aided design, computer aided manufacturing) describes the integration of designing and manufacturing by computer. The electronic image of products designed in CAD programs are translated into a numerical control programming language, which generates the instructions for the machine that makes it.

Next to CAD CAM other digital solutions for highly efficient pattern grading are Product Lifestyle Management (PLM) and Product Data Management (PDM).

Derived-patterns/Intermediate blocks make use of the basic form of the block-pattern which is then manipulated for the requirements of the garment style. Different shapes are constructed, examples are the creation of a separate side panel or different sleeve forms.

Ease of Movement/Tolerance is added onto the measurements of the body in order to allow for breathing and movement while wearing the garment. These tolerances can vary for the different garment types. A coat which is worn over other garments would have more tolerance than a blouse.

Ergonomics is defined in the Oxford English Dictionary as the scientific study of the efficiency of man in his working environment. Taken from: Oxford English Dictionary, 1989, Vol. 5, 2nd Edn.

Facing is used to finish a raw edge of a garment. Facings are mostely used when the edge is shaped. A facing is usually developed from the same pattern piece, but a narrow bias-cut strip of fabric can also be used as a facing.

Fashion-patterns include all seasonal changes, such as collars, pockets and fastenings. Their shape is following a fashion silhouette and not necessarily the shape of the body.

Flat –pattern are two-dimensional flat pieces that are constructed using the measurements of specific areas of the human body, in order to be laid out on the fabric and then used as a template and cut around them.

Flat -pattern Cutting is the technique of constructing all sorts of flat-patterns, which might base on a design sketch that includes style lines.

Grading means the increase or decrease of a pattern into different sizes. The technique involves grade rules for certain point or lines of a garment.

Grain line indicates the direction in which a pattern piece is laid onto fabric before being cut out. Woven non-stretch fabric only stretches in the bias directions.

Interlining/fusing is made from woven or non-woven material that is used between the lining and the outer fabric of a garment. It is either fusible (iron-on) or non-fusible (to be sewn-in). It is used to stabilize the fabric or to stiffen particular areas of the garment. A steam form finisher with tensioning can then be used in outerwear for example to mold the stiffened areas into the required shape.

Lay-plan is the arrangement of the different flat-pattern pieces on the cloth in order to use most of the fabric and prevent wastage.

Lining is an extra layer of light weight fabric, used on the inside of a garment to hide the construction. It extends the garment's life as it helps to retain the shape because it is cut with minor differences from the original flat pattern.

Made-to-measure garments are made specially to fit a particular person.

Making up describes the process of garment construction.

Over-locking is a quick and efficient way of stitching, trimming and over edging fabrics in a single action to neaten seams. Over-locking strengthen and prevent fraying of at the edge of cloth by over-sewing it. Over-locking is often used in mass-production of clothing.

Plastron originally is a man's starched shirt front without pleats. It also describes the stiff front of a tailored jacket.

Ready-to-wear is the term for factory-made clothing, sold in finished condition, in standardized sizes manufactured.

Seam allowance is added during the pattern construction to enable the pieces of the garment to be sewn together. These allowances vary depending on the position of the seam on the garment and the seam construction type.

Stand/Workroom stand/Dress stand is a dressmaking mannequin or dummy. The stand usually reflects the torso of the body with no arms, legs or head. Dress stands for the industry are made following a size of which the figures are taken from average measurements of a size chart.

Scye is the technical name for the sleeve head.

Soft-tailoring was invented by the Italian Designer Giorgio Armani in the 1970s and describes a construction for mens- and womenswear that is looser and less structured without the stiff interlining, used in traditional tailoring.

Specifications are the details needed for making up. For this project the specifications relate to the measurements required for the different block pattern construction methods used all of which are for the mass-production of clothing.

(Woven) Stretch Fabric consists of stretch fibers in one or both directions of the fabric, which allows the garment to be cut without tolerances and still insure ease of movement. Stretch fibers are always combined with non-stretch fibers using a range of techniques.

Tailored womenswear describes formal- or business-wear including structuring features such as lining, interlining and shoulder pads The general appearance of tailored clothing is formal and very often conforms closely to the body contour.

A **Toile** is the fabric sample used for fitting a garment. A toile has no finished seams, no fastenings such as buttonholes and buttons and no lining or facings and is usually constructed from un-dyed calico.

Woven Fabric is composed of two sets of yarns. One set of yarns, the warp, runs along the length of the fabric. The other set of yarns, the fill or weft, is perpendicular to the warp. Woven fabrics are held together by weaving the warp and the fill yarns over and under each other.

A woven fabric is a cloth formed by weaving. It only stretches in the bias directions (between the warp and the weft direction), unless the threads are elastic. Woven cloth usually frays at the edges, unless measures are taken to counter this, such as the use of over-locking.

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Appendices

Appendix 1 Detailed information on the six lat-pattern cutting systems:

- i. Block-pattern instructions for jackets and two-seam sleeves taken from the six flat-pattern cutting systems
- ii. Block-pattern instructions for trousers taken from the six flat-pattern cutting systems
- iii. Block-pattern instructions for skirts taken from the six flat-pattern cutting systems
- iv. Illustrations and instructions for measuring the body taken from the investigated six flat-pattern cutting systems
- v. Size charts as given by the six flat-pattern cutting systems

Appendix 2 Outcomes of questionnaire 1 with 35 working women

Appendix 3 Transcripts of interviews with 20 professionals working in the fashion industry or in academic institutions

Appendix 4 3D body scans with extracted measurements

Appendix 5 Video analysis 1 and 2 (two CDs)

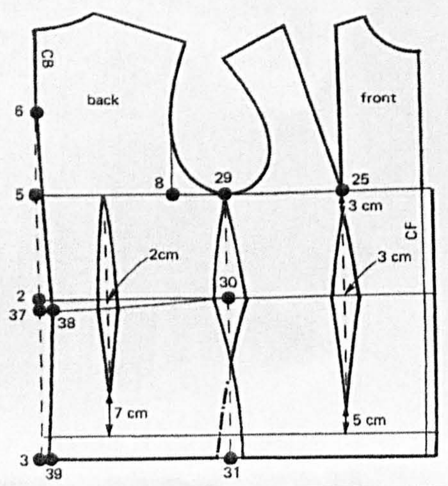
Appendix 1, i. – v.

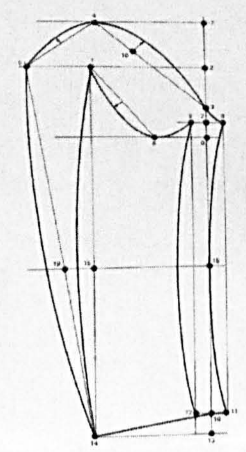
Block Pattern Constructions for Jackets

The following illustrations are the original instructions taken from the different textbooks.

Winifred Aldrich

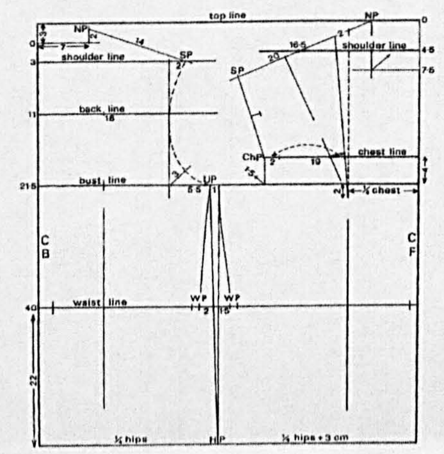
Metric Pattern Cutting, 1997

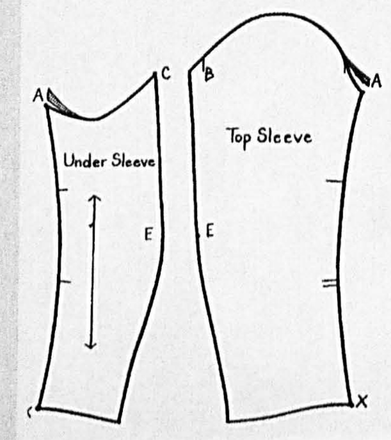




Natalie Bray

Dress Pattern Designing, 1974

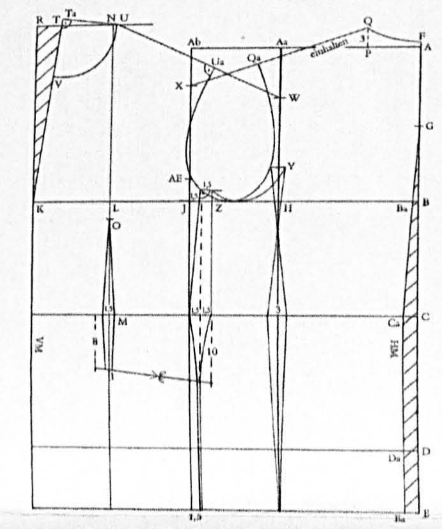


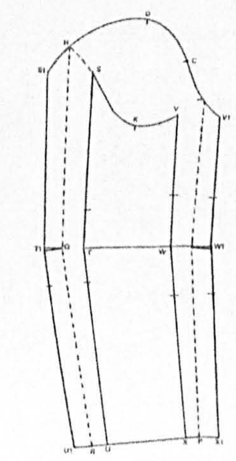


Jutta Jansen and Claire Rüdiger

Systemschnitt – Modeschnitte mit System

(Eng.: Systemschnitt – Systematic Fashion Patterns), 1990

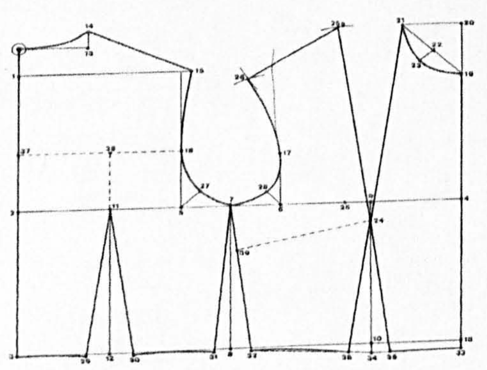


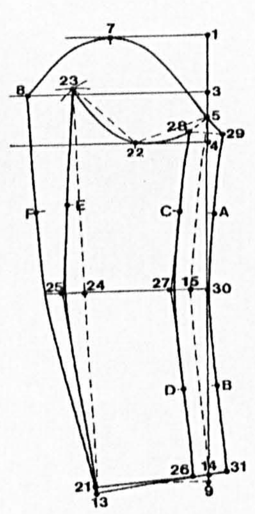


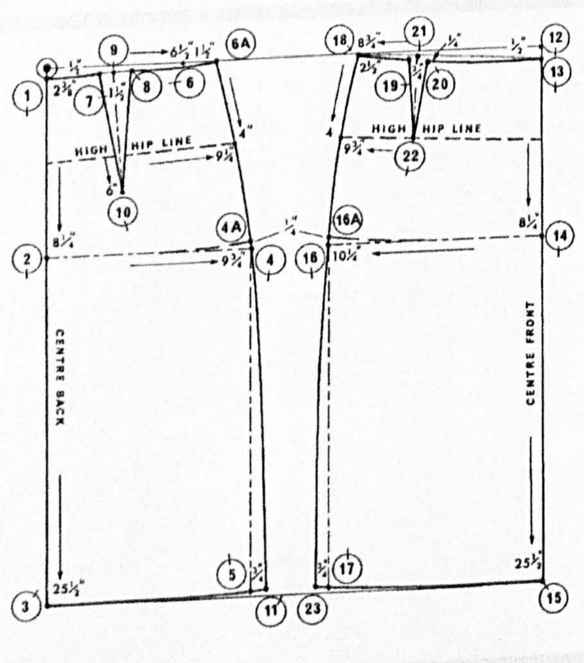
To obtain clearity, the grid lines of the sleeve construction are replaced by dashed lines.

Philip Kunick

Sizing, Pattern Construction and Grading for Women's and Children's Garments, 1967





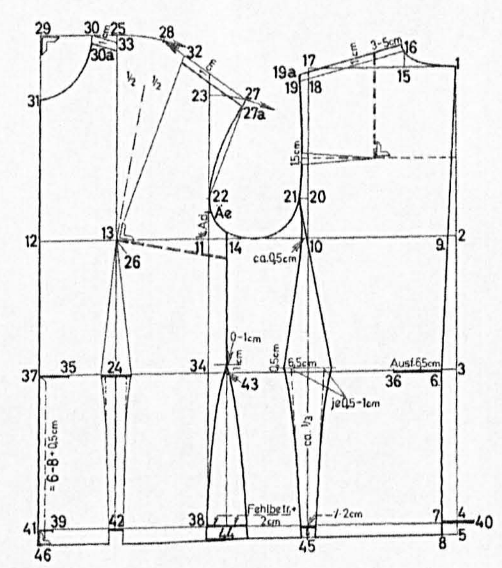


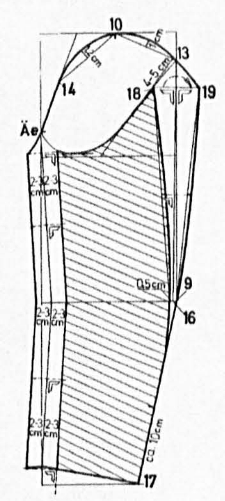
The bodice is constructed first. The waist to hip area is taken from the skirt construction which is then attached to the bodice.

M. Müller & Sohn

Konstruktionen für Jacken und Mäntel

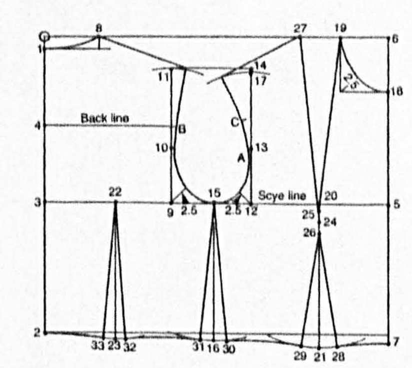
(Eng.: Pattern Constructions for Jackets and Coats), 1984

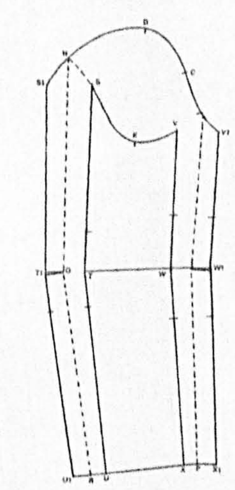


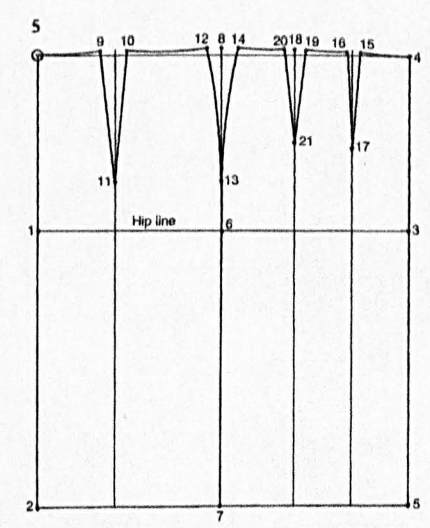


Martin Shoben and Janet Ward

Pattern Cutting and Making Up – The Professional Approach, 1987







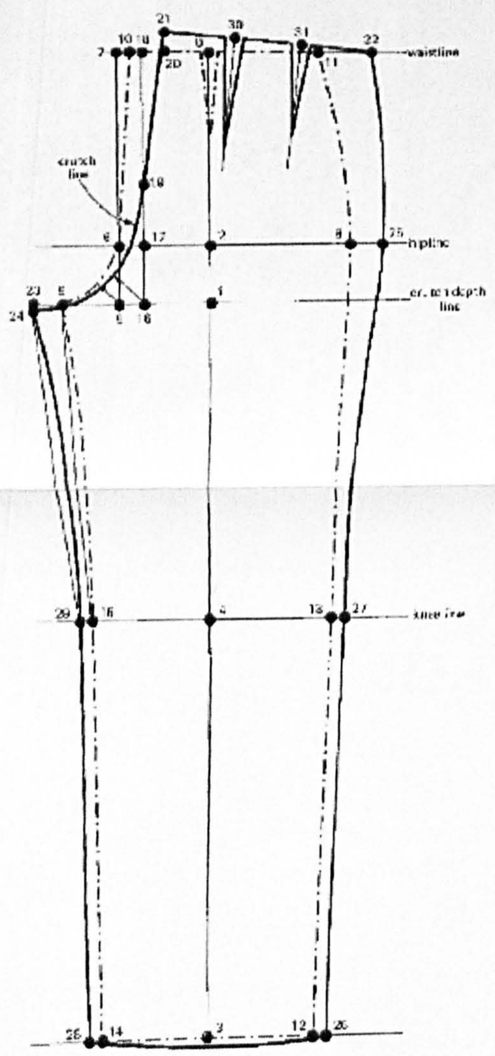
The bodice is constructed first. The waist to hip area is taken from the skirt construction which is then attached to the bodice.

Block Pattern Constructions for Trousers

The following illustrations are the original instructions taken from the different textbooks.

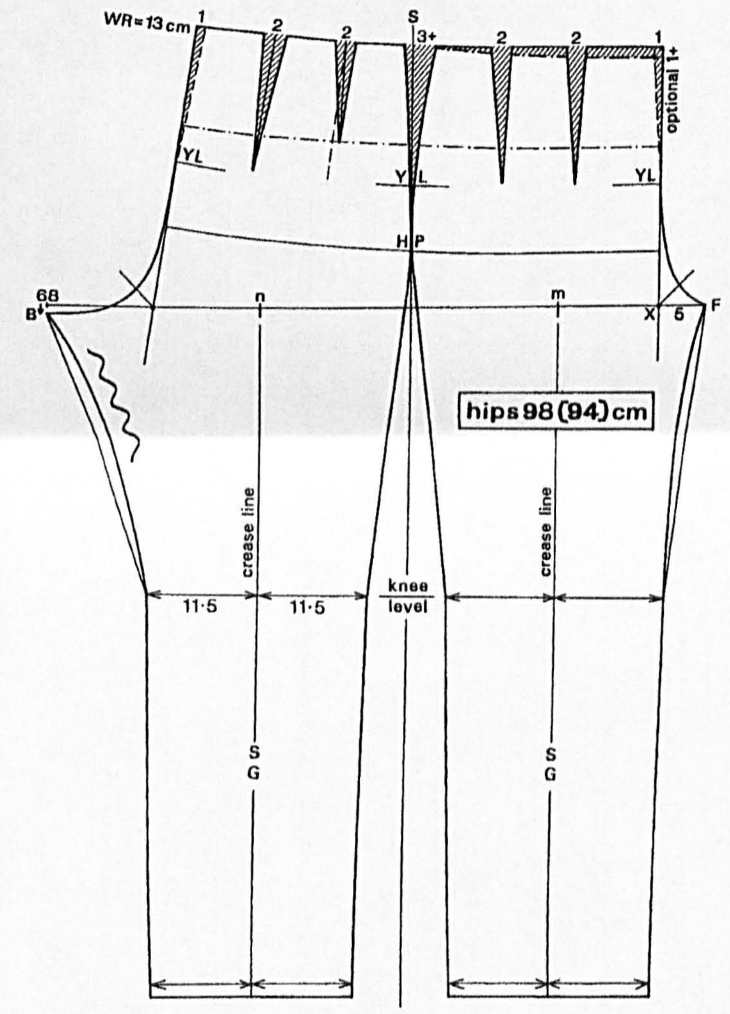
Winifred Aldrich

Metric Pattern Cutting, 1997



Natalie Bray (with Fashion Supplement by Ann Haggar)

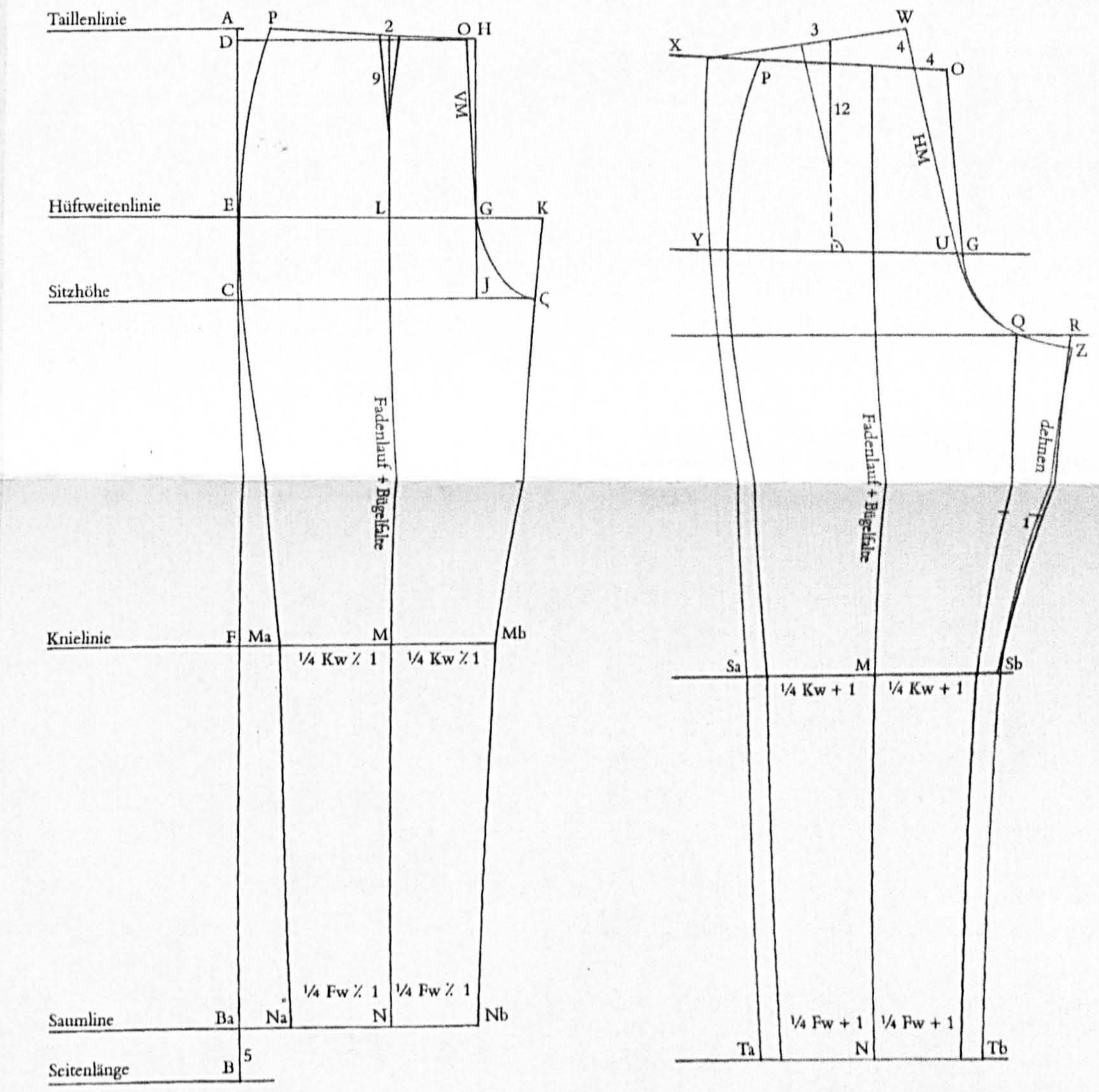
More Dress Pattern Designing, 1974



Jutta Jansen and Claire Rüdiger

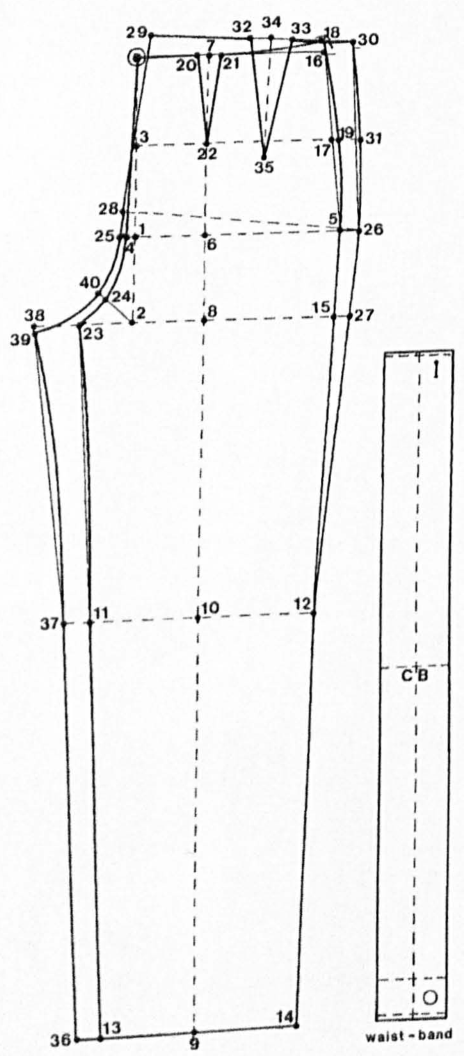
Systemschnitt – Modeschnitte mit System

(Eng.: Systemschnitt – Systematic Fashion Patterns), 1990



Philip Kunick

Sizing, Pattern Construction and Grading for Women's and Children's Garments, 1967

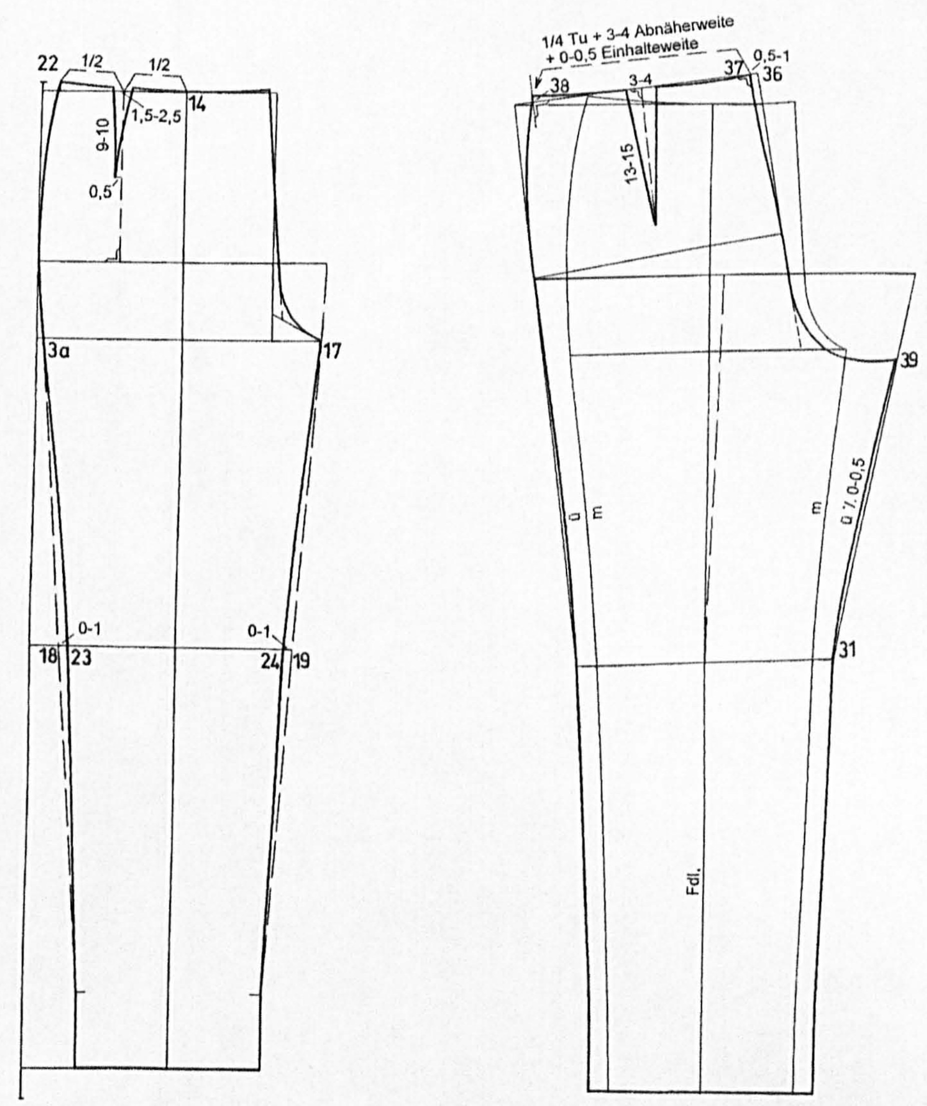


The construction of the trousers is based on the waist to hip area of the skirt construction, as shown on poster Block Pattern Jackets.

M. Müller & Sohn

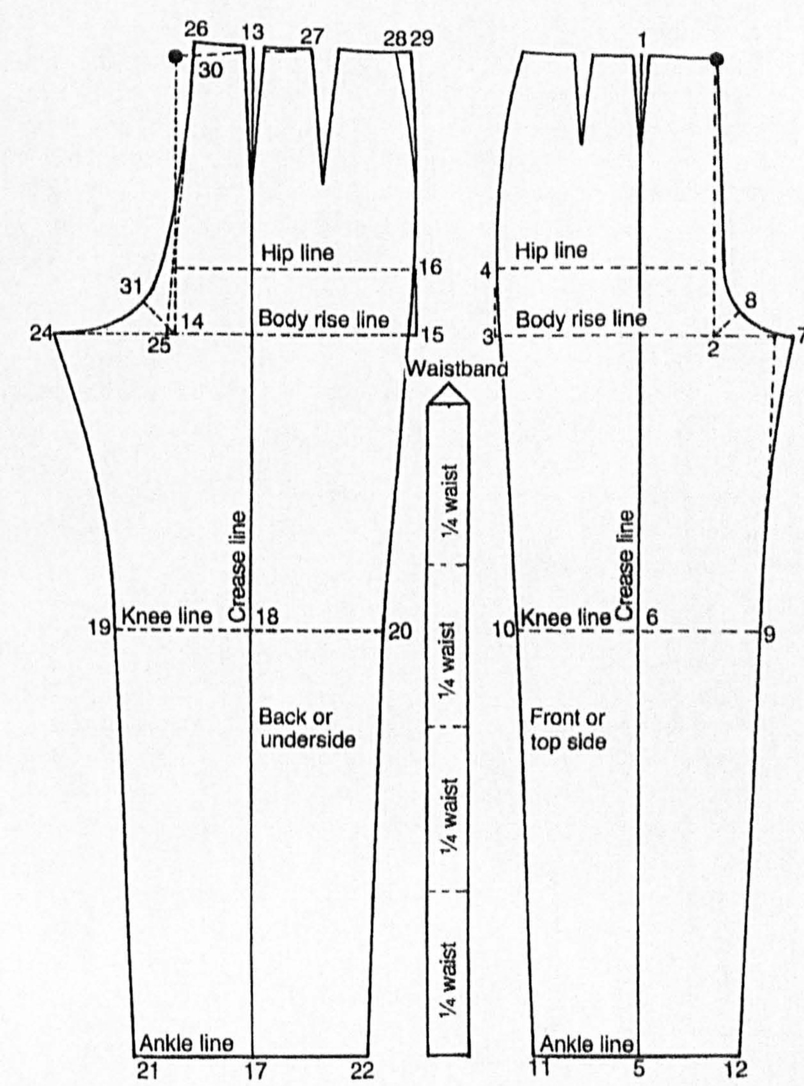
Konstruktionen für Röcke und Hosen

(Eng.: Pattern Constructions for Skirts and Trousers), 1996



Martin Shoben and Janet Ward

Pattern Cutting and Making Up – The Professional Approach, 1987

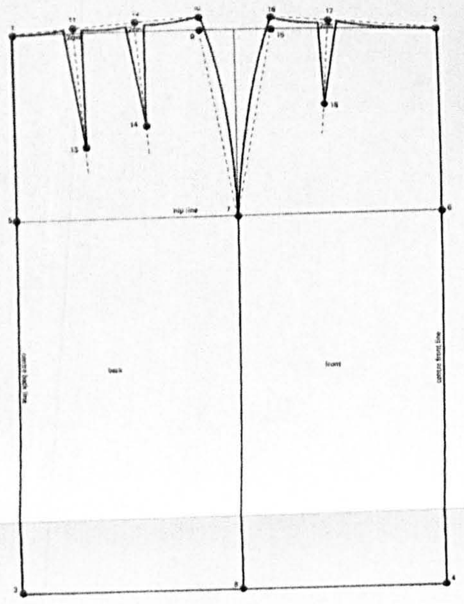


The construction of the trousers is based on the waist to hip area of the skirt construction, as shown on poster Block Pattern Jackets.

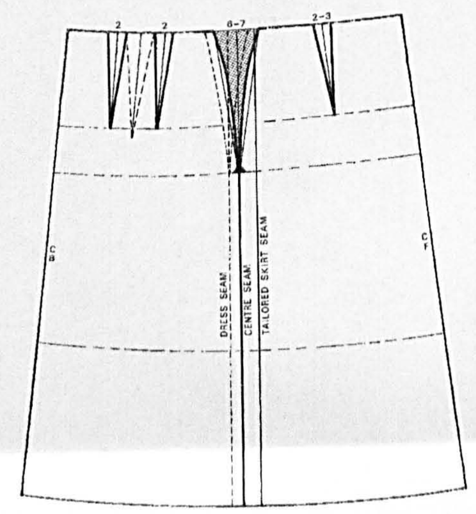
Block Pattern Constructions for Skirts

The following illustrations are the original instructions taken from the different textbooks.

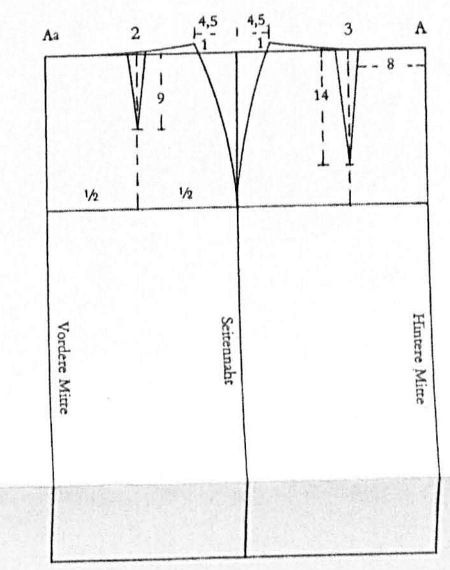
Winifred Aldrich
Metric Pattern Cutting, 1997



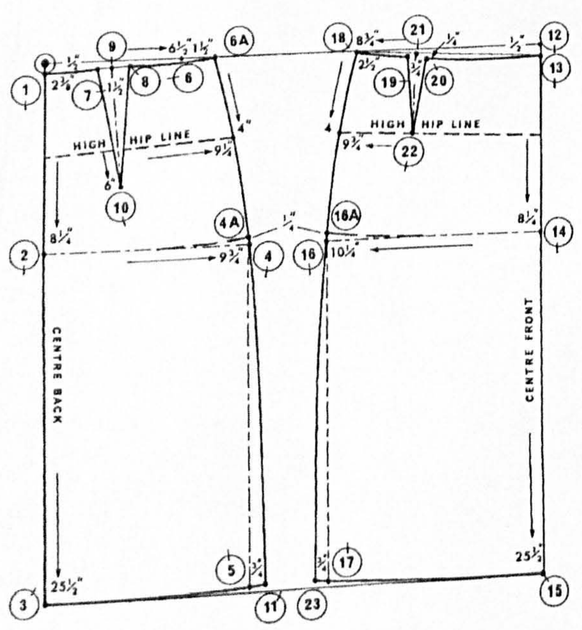
Natalie Bray
Dress Pattern Designing, 1974



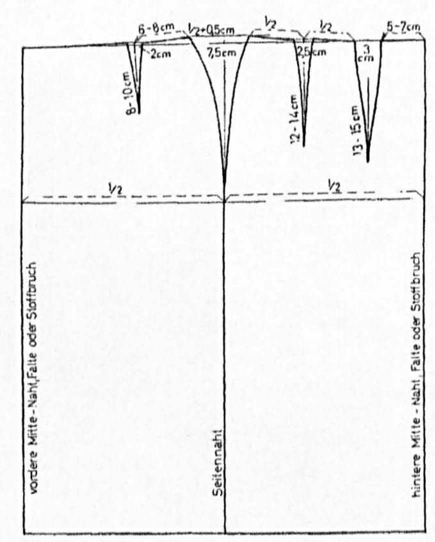
Jutta Jansen and Claire Rüdiger
Systemschnitt – Modeschnitte mit System
(Eng.: Systemschnitt – Systematic Fashion Patterns), 1990



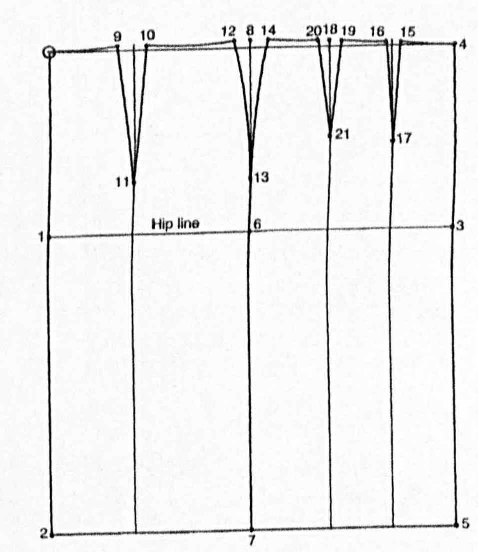
Philip Kunick
Sizing, Pattern Construction and Grading for Women's and Children's Garments, 1967



M. Müller & Sohn
Schnittkonstruktionen für Röcke und Hosen
(Eng.: Pattern Constructions for Skirts and Trousers), 1996



Martin Shoben and Janet Ward
Pattern Cutting and Making Up – The Professional Approach, 1987



Size Charts

The given size charts are taken from the textbooks of the different at pattern cutting systems. All given measurements are in centimetres, pounds and kilograms. Measurements indicating individual design decisions, such as the length of skirts are left out. When possible, changes within the measurements from one publication to the other are indicated by more than one size chart.

Winifred Aldrich

Metric Pattern Cutting, 1997

	Women Of Medium Height 160cm - 170cm											
English Size	**8**	**10**	**12**	**14**	**16**	**18**	**20**	**22**	**24**	**26**	**28**	**30**
Bust	80	84	88	92	97	102	107	112	117	122	127	132
Waist	60	64	68	72	77	82	87	92	97	102	107	112
Hips	85	89	93	97	102	107	112	117	122	127	132	137
Back Width	32.4	33.4	34.4	35.4	36.6	37.8	39	40.2	41.4	42.6	43.8	45
Chest	30	31.2	32.4	33.6	35	36.5	38	39.5	41	42.5	44	45.5
Shoulder	11.75	12	12.25	12.5	12.8	13.1	13.4	13.7	14	14.3	14.6	14.9
Neck Size	35	36	37	38	39.2	40.4	41.6	42.8	44	45.2	46.4	47.6
Dart	5.8	6.4	7	7.6	8.2	8.8	9.4	10	10.6	11.2	11.8	12.4
Top Arm	26	27.2	28.4	29.6	31	32.8	34.4	36	37.8	39.6	41.4	43.2
Wrist	15	15.5	16	16.5	17	17.5	18	18.5	19	19.5	20	20.5
Ankle	23	23.5	24	24.5	25.1	25.7	26.3	26.9	27.5	28.1	28.7	29.3
High Ankle	20	20.5	21	21.5	22.1	22.7	23.3	23.9	24.5	25.1	25.7	26.3
Nape to Waist	39	39.5	40	40.5	41	41.5	42	42.5	43	43.2	43.4	43.6
Front Shoulder to Waist	39	39.5	40	40.5	41.3	42.1	42.9	43.7	44.5	45	45.5	46
Armhole Depth	20	20.5	21	21.5	22	22.5	23	23.5	24.2	24.9	25.6	26.3
Waist to Knee	57.5	58	58.5	59	59.5	60	60.5	61	61.25	61.5	61.75	62
Waist to Hip	20	20.3	20.6	20.9	21.2	21.5	21.8	22.1	22.3	22.5	22.7	22.9
Waist to Floor	102	103	104	105	106	107	108	109	109.5	110	110.5	111
Body Rise	26.6	27.3	28	28.7	29.4	30.1	30.8	31.5	32.5	33.5	34.5	35.5
Sleeve Length	57.2	57.8	58.4	59	59.5	60	60.5	61	61.2	61.4	61.6	61.8

Natalie Bray

Dress Pattern Designing, 1974

	MEASUREMENTS								PROPORTIONS					
Size	Bust B +10	Hips H +6	Waist W	Waist Length LW	xBack xB	Chest Ch	Shoulder Sh	Top Arm TA	Point O CB	Back Neck Width	Depth of Armhole	Back UP	Dart	Arm-hole
1.	80	86	64	38/40	33/34	35	12-	28	2	6.5-	20.5	5	6	40
2.	84	90	66	39/41	34/35	36	12	29	2.5	6.5	20.5+	5	6.5	41
3.	88	94	68	39.5/41.5	35/36	37	12.5-	30	3	7-	21	5	7	42
4.	92	98	70	40/42	36/37	38	12.5	31	3	7	21.5	5.5	7.5	43
5.	96	102	72	40.5/42.5	37/38	39	13-	32	3.5	7.5-	22	6	8	44.5
6.	100	106	76	41/43	38/39	40	13	33	3.5	7.5	22.5	6	8.5	46
7.	104	110	80	41.5/43.5	39/40	42	13.5	34.5	4	8-	23	6.5	9	47
8.	108	114	84/86	42/44	40/41	43	13.5	36/37	4	8	23.5	7	9.5	48
9.	112	118	88/90	42.5/44	41/42	44.5	14	38	4.5	8.5-	24	7	10	50
10.	116	122	92	43/45	42/43	46	14.5	39/40	4.5	8.5	24.5	7	10.5	51/52

Bray adds 10 cm ease allowance to each bust measurement and 6 cm to each hip measurement. There are no definitions given for any other marks.

Jutta Jansen and Claire Rüdiger

Systemschnitt – Modeschnitte mit System
(Eng.: Systemschnitt – Systematic Fashion Patterns), 1990

German Size	**36**	**38**	**40**	**42**	**44**	**46**	**48**	**50**	**52**	**54**
English Size	**8**	**10**	**12**	**14**	**16**	**18**	**20**	**22**	**24**	**26**
Height	168	168	168	168	168	168	168	168	168	168
Bust Girth	84	88	92	96	100	104	110	116	122	128
Waist Girth	64	68	72	76	80	84	90	96	102	108
Hip Girth	90	94	98	102	106	110	116	122	128	134
Arm length	59	59	59.5	59.5	60	60	60.5	60.5	61	61
Wrist Girth	15.5	16	16.5	17	17.5	18	18.5	19	19.5	20
Back Length	40.7	41	41.3	41.6	41.9	42.2	42.5	42.8	43	43.2
Front Length	44	45	46	47	48	49	50	51	52	53
Breast Depth	26	27	28	29	30	31	31.5	32.5	33.5	34.5
Shoulder Width	13	13	13	13	13.5	13.5	14	14	14	14
Body Rise	26.5	26.5	27	27	28	28	29	29	29	29
Side Length	106	106	106	106	106.5	106.5	106.5	106.5	106.5	106.5
Knee Girth	42	46	50	54	56	58	60	62	62	62

Philip Kunick

Sizing, Pattern Construction And Grading for Women's And Children's Garments, 1967
(As the original data is given in inches, all measurements in the table are converted into centimetres)

Nearest British Standard Size	**8**	**12**	**14**	**16**	**18**	**20**	**22**	**24**	**26**	**28**
German Size	**36**	**40**	**42**	**44**	**46**	**48**	**50**	**52**	**54**	**56**
Hip Size	86	91	96	101	106	111	116	121	127	132
Horizontal Measurements										
Bust Girth	81	86	91	96	101	106	111	116	121	127
Waist Girth	58	63	68	73	78	83	88	93	99	104
Hip Girth	86	91	96	101	106	111	116	121	127	132
High Hip Girth	78	83	88	93	99	104	109	114	119	124
Across Back	31	33	34	35	36	38	39	40	41	43
Across Chest	27	30	30	33	33	35	36	38	38	40
Scye Width	10	10	10	10	12	12	13	14	15	15
Bust Arc Front	44	47	50	53	57	60	63	66	69	73
Chest Girth at Scye	77	81	85	88	92	96	100	104	107	111
Arm Scye Girth	35	37	39	41	43	45	46	8	50	52
Neck Base Girth	35	36	38	39	40	41	43	44	45	46
Width Bust Prominence	17	17	19	20	21	22	22	24	25	26
Shoulder Length 40	11	11	10	10	12	12	10	12	12	12
Up. Arm Girth	22	25	27	27	30	33	35	37	38	40
Elbow Girth	24	25	26	25	28	27	30	30	32	33
Wrist Girth	14	15	15	15	15	15	16	15	17	18
Maximum Thigh Girth	50	53	57	57	63	66	69	73	76	79
Knee Girth	33	34	35	36	38	39	40	41	43	44
Calf Girth	31	33	34	35	36	38	39	40	41	43
Ankle Girth	22	23	24	24	25	26	26	27	27	28
Vertical Measurements										
Stature	161	162	162	163	163	164	165	165	166	167
Depth of Scye	17	18	19	19	20	21	21	22	23	23
Nape to Waist	38	38	39	39	39	39	40	40	41	41
Neck to Bust	24	25	26	27	28	28	30	31	32	33
Centre Shoulder to Waist	38	38	40	41	41	42	43	43	44	45
Cervical to Front Waist	48	49	50	50	51	52	52	53	53	54
Front Waist Length	33	33	34	34	34	34	35	35	36	36
Arm Length	57	57	58	58	59	59	59	60	60	60
Under Arm Length	44	44	44	44	44	44	44	44	44	44
Arm Scye to Waist	20	20	19	19	19	19	18	18	18	17
Waist to Hip	21	21	22	22	22	23	23	23	24	24
Side Seam	102	103	104	104	105	106	106	107	107	108
Body Rise	25	28	29	30	31	32	33	34	34	36
Supplementary Measurements										
Cervical Height	139	139	139	139	140	140	140	140	141	141
Knee Height	81	81	81	82	81	82	83	83	83	84
Interacromion Width	43	43	43	43	43	43	44	44	44	44
Bitrochanteric Width	33	34	34	35	36	36	37	38	38	39
Abdomen- Seat Diameter	31	32	33	34	36	37	38	40	41	42
Shoulder Slope	20	22	24	26	28	30	32	34	36	38
Weight Pounds	104	118	132	146	160	174	188	202	216	230
Weight KG	47	53	59	66	72	78	85	91	97	104

M. Müller & Sohn

Schnittkonstruktionen für Jacken und Mäntel
(Eng.: Pattern Constructions for Jackets and Coats), 1984

German Size	**32**	**34**	**36**	**38**	**40**	**42**	**44**	**46**	**48**	**50**	**52**	**54**	**56**	**58**	**60**
English Size	**4**	**6**	**8**	**10**	**12**	**14**	**16**	**18**	**20**	**22**	**24**	**26**	**38**	**30**	**32**
Height	168	168	168	168	168	168	168	168	168	168	168	168	168	168	168
Bust Girth	76	80	84	88	92	96	100	104	110	116	122	128	134	140	146
Waist Girth	62	65	68	72	76	80	84	88	94.5	101	107.5	114	120.5	127	133.5
Hip Girth	84	87	90	94	98	102	106	110	114	118	124	130	136	142	148
Neck Base Girth	35	35.5	36	36.5	37	37.5	38	38.5	39.5	40.5	41.5	42.5	43.5	44.5	45.5
Half Front Neck	6.4	6.5	6.6	6.7	6.8	6.9	7	7.1	7.3	7.5	7.7	7.9	8.1	8.3	8.5
Back Height	17.5	18	18.5	19	19.5	20	20.5	21	21.5	22	22.5	23	23.5	24	24.5
Back Length	40.8	40.9	41	41.1	41.2	41.3	41.4	41.5	41.6	41.7	41.8	41.9	42	42.1	42.2
Hip Depth	59	59.5	60	60.5	61	61.5	62	62.5	63	63.5	64	64.5	65	65.5	66
Bust Depth	24.2	25	25.8	26.6	27.4	28.2	29	29.8	31.1	32.4	33.7	35	36.3	37.6	38.9
Front Length 2 (Shoulder-Breast Point-Waist)	43.7	44.1	44.5	44.9	45.3	45.7	46.1	46.5	47.4	48.3	49.2	50.1	51	51.9	52.8
Back Width	15	15.5	16	16.5	17	17.5	18	18.5	19.2	19.9	20.6	21.3	22	22.7	23.4
Armhole Diameter	8	8.5	9	9.5	10	10.5	11	11.5	12.5	13.5	14.5	15.5	16.5	17.5	18.5
Bust Width	15	16	17	18	19	20	21	22	23.3	24.6	25.9	27.2	28.5	29.8	31.1
Shoulder Width	11.6	11.8	12	12.2	12.4	12.6	12.8	13	13.3	13.6	13.9	14.2	14.5	14.8	15.1
Sleeve Length	59.8	59.9	60	60.1	60.2	60.3	60.4	60.5	60.6	60.7	60.8	60.9	61	61.1	61.2
Upper Arm Girth	25.6	26.5	27.5	28.5	29.5	30.5	31.5	32.5	34.2	35.9	37.6	39.3	41	42.7	44.4
Wrist Girth	15.1	15.3	15.5	15.9	16.3	16.7	17.1	17.5	18.1	18.7	19.3	19.9	20.5	21.1	21.7
Side Length (Waist-Sole)	106	106	106	106	106	106	106	106	106	106	106	106	106	106	106
Body Rise	25.5	25.5	25.5	26	26.5	27	27.5	28	28.7	29.4	30.1	30.8	31.5	32.2	32.9
Step Length (Crotch-Sole)	80.5	80.5	80.5	80	79.5	79	78.5	78	77.3	76.6	75.9	75.2	74.5	73.8	73.1
Ankle Girth	23.5	23.5	24	24.5	25	25.5	26	26.5	27	27.5	28	28.5	29	29.5	30

Schnittkonstruktionen für Röcke und Hosen
(Eng.: Pattern Constructions for Skirts and Trousers),1996

German Size	**32**	**34**	**36**	**38**	**40**	**42**	**44**	**46**	**48**	**50**	**52**	**54**	**56**	**58**	**60**
English Size	**4**	**6**	**8**	**10**	**12**	**14**	**16**	**18**	**20**	**22**	**24**	**26**	**38**	**30**	**32**
Height	168	168	168	168	168	168	168	168	168	168	168	168	168	168	168
Bust Girth	76	80	84	88	92	96	100	104	110	116	122	128	134	140	146
Waist Girth	62	65	68	72	76	80	84	88	94.5	101	107.5	114	120.5	127	133.5
Hip Girth	86	90	94	97	100	103	106	109	114	119	124	129	134	139	144
Neck Base Girth	35	35.5	36	36.5	37	37.5	38	38.5	39.5	40.5	41.5	42.5	43.5	44.5	45.5
Half Front Neck	6.4	6.5	6.6	6.7	6.8	6.9	7	7.1	7.3	7.5	7.7	7.9	8.1	8.3	8.5
Back Height	18.9	19.3	19.7	20.1	20.5	20.9	21.3	21.7	22.1	22.5	22.9	23.3	23.7	24.1	24.5
Back Length	41.4	41.4	41.4	41.6	41.8	42	42.2	42.4	42.7	43	43.3	43.6	43.6	43.6	43.6
Hip Depth	61	61.4	61.8	62.2	62.6	63	63.4	63.8	64.2	64.6	65	65.4	65.8	66.2	66.6
Bust Depth	25.7	26.5	27.3	28.1	28.9	29.7	30.5	31.3	32.5	33.7	34.9	36.1	37.3	38.5	39.7
Front Length 2 (Shoulder-Breast Point-Waist)	43.9	44.3	44.7	45.3	45.9	46.5	47.1	47.7	48.8	49.9	51	52.1	52.9	53.7	54.5
Back Width	15	15.5	16	16.5	17	17.5	18	18.5	19.2	19.9	20.6	21.3	22	22.7	23.4
Armhole Diameter	7.2	7.9	8.6	9.3	10	10.7	11.4	12.1	13.2	14.3	15.4	16.5	17.6	18.7	19.8
Bust Width	15.8	16.6	17.4	18.2	19	19.8	20.6	21.4	22.6	23.8	25	26.2	27.4	28.6	29.8
Shoulder Width	11.6	11.8	12	12.2	12.4	12.6	12.8	13	13.2	13.4	13.6	13.8	14	14.2	14.4
Sleeve Length	59	59.3	59.6	59.9	60.2	60.5	60.8	61.1	61.4	61.7	62	62.3	62.3	62.3	62.3
Upper Arm Girth	25.6	26.2	26.8	28	29.2	30.4	31.6	32.8	34.6	36.4	38.2	40	41.8	43.6	45.4
Wrist Girth	14.6	15	15.4	15.8	16.2	16.6	17	17.4	18	18.6	19.2	19.8	20.4	21	21.6
Side Length (Waist-Sole)	106	106	106	106	106	106	106	106	106	106	106	106	106	106	106
Body Rise	24.9	25.3	25.7	26.1	26.5	26.9	27.3	27.7	28.3	28.9	29.5	30.1	30.7	31.3	31.9
Step Length (Crotch-Sole)	81.1	80.7	80.3	79.9	79.5	79.1	78.7	78.3	77.7	77.1	76.5	75.9	75.3	74.7	74.1
Ankle Girth	23.5	23.5	24	24.5	25	25.5	26	26.5	27	27.5	28	28.5	29	29.5	30

Martin Shoben and Janet Ward

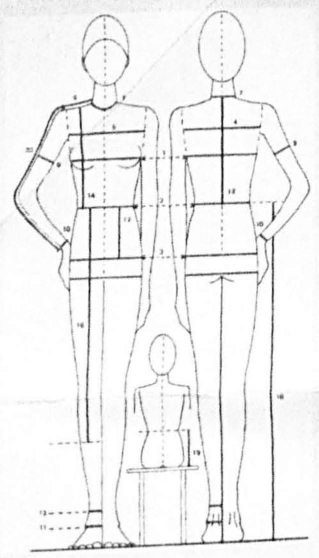
Pattern Cutting And Making Up – The Professional Approach, 1987

Area/ Size	**10**	**12**	**14**	**16**
Bust Girth	82	87	92	97
Waist Girth	60	65	70	75
High Hip Girth	81	86	91	96
Hip Girth	87	92	97	102
Half across Back	15	16.2	17.4	18.6
Armhole Width	10.1	11	11.9	12.8
Armhole Girth	40.6	42.6	44.6	46.6
Neck base Girth	35.8	37.0	38.2	39.4
Shoulder Length	11.3	11.5	11.7	11.9
Bicep Width	25.2	27	28.8	30.6
Elbow Girth	24	25.8	27.6	29.4
Wrist Girth	15.2	16	16.8	17.6
Height	160.1	162.5	164.5	167.3
Waist to Knee	56.7	57.6	58.5	59.4
Armhole Depth	17.4	18	18.6	19.2
Nape to Waist	39.8	40.4	41	41.6
Underarm Length	46.1	46.5	46.9	47.3
Waist to Hip	21.7	22	22.3	22.6
Nape to Bust Point	32.6	34	35.4	36.8

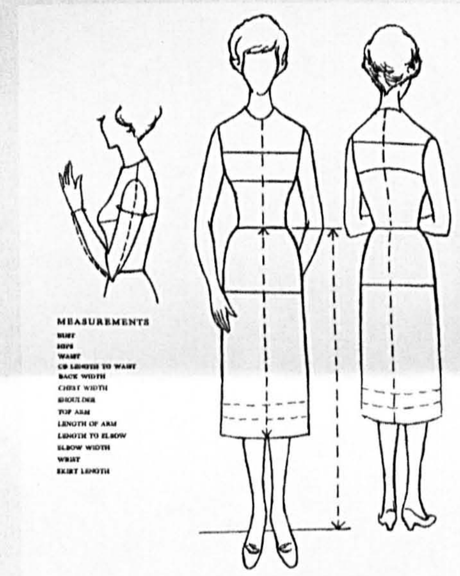
Illustrations of Body Measurements

The following illustrations are copied from the textbooks of the different at pattern cutting systems.
Because of the great variety of original illustrations, here, all graphics are shown in a scale 1:24., following the presumption of all systems that the average height of the female figure is 168cm.
In some cases, the authors combined the illustration of body measurements with instructions on how to take them directly from the human figure.

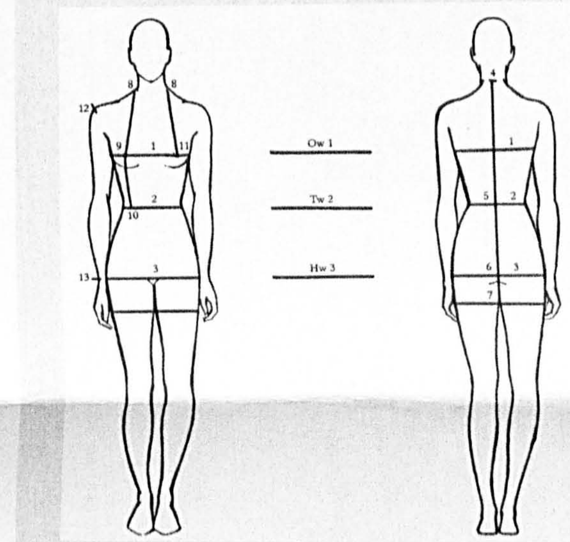
Winifred Aldrich
Metric Pattern Cutting, 1997

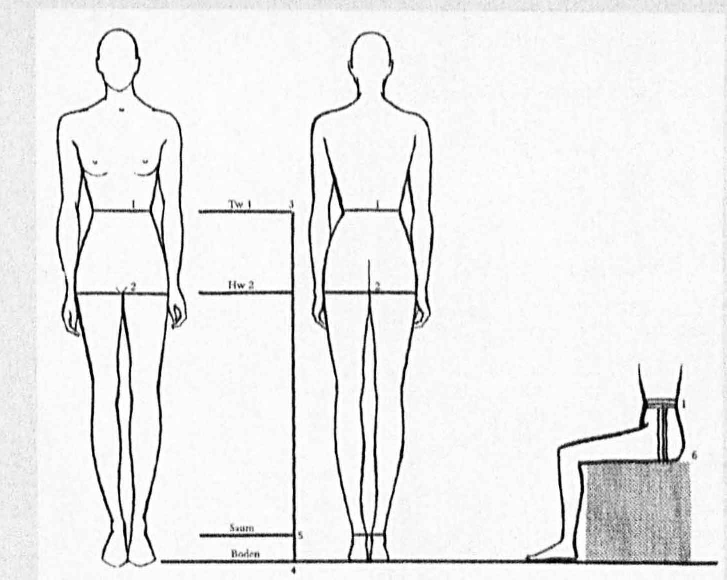


Natalie Bray
Dress Pattern Designing, 1974

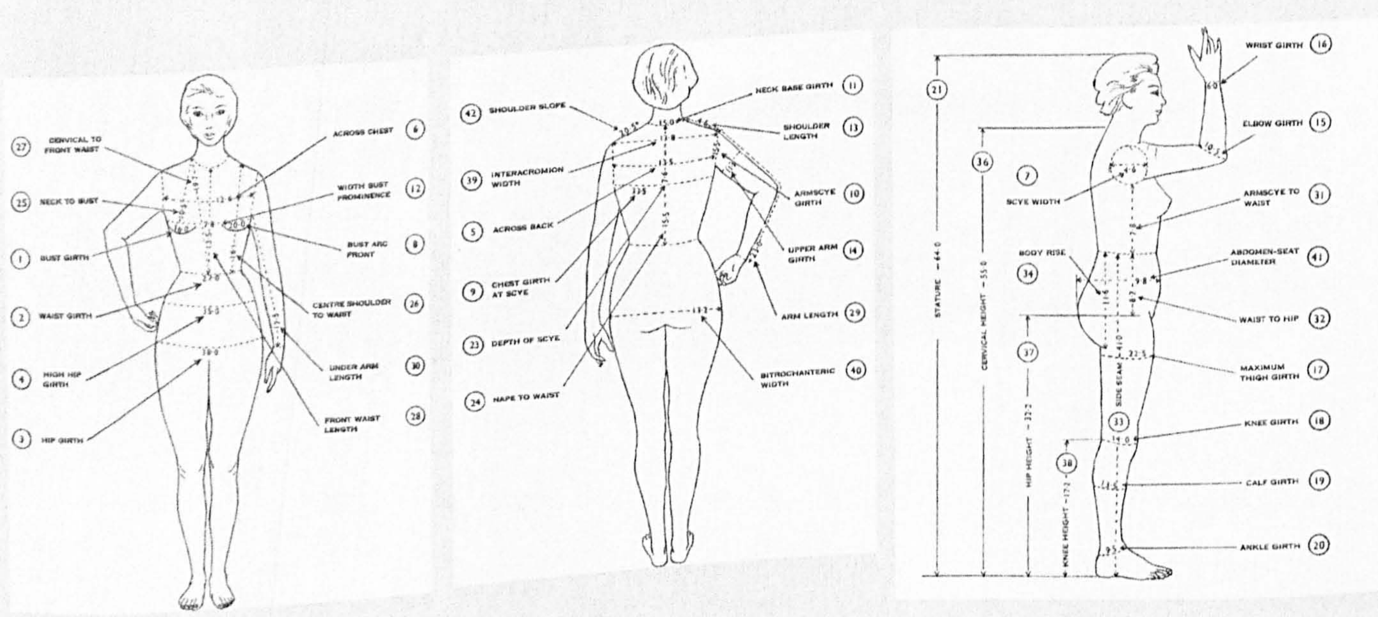


Jutta Jansen and Claire Rüdiger
Systemschnitt – Modeschnitte mit System
(Eng.: Systemschnitt – Systematic Fashion Patterns), 1990

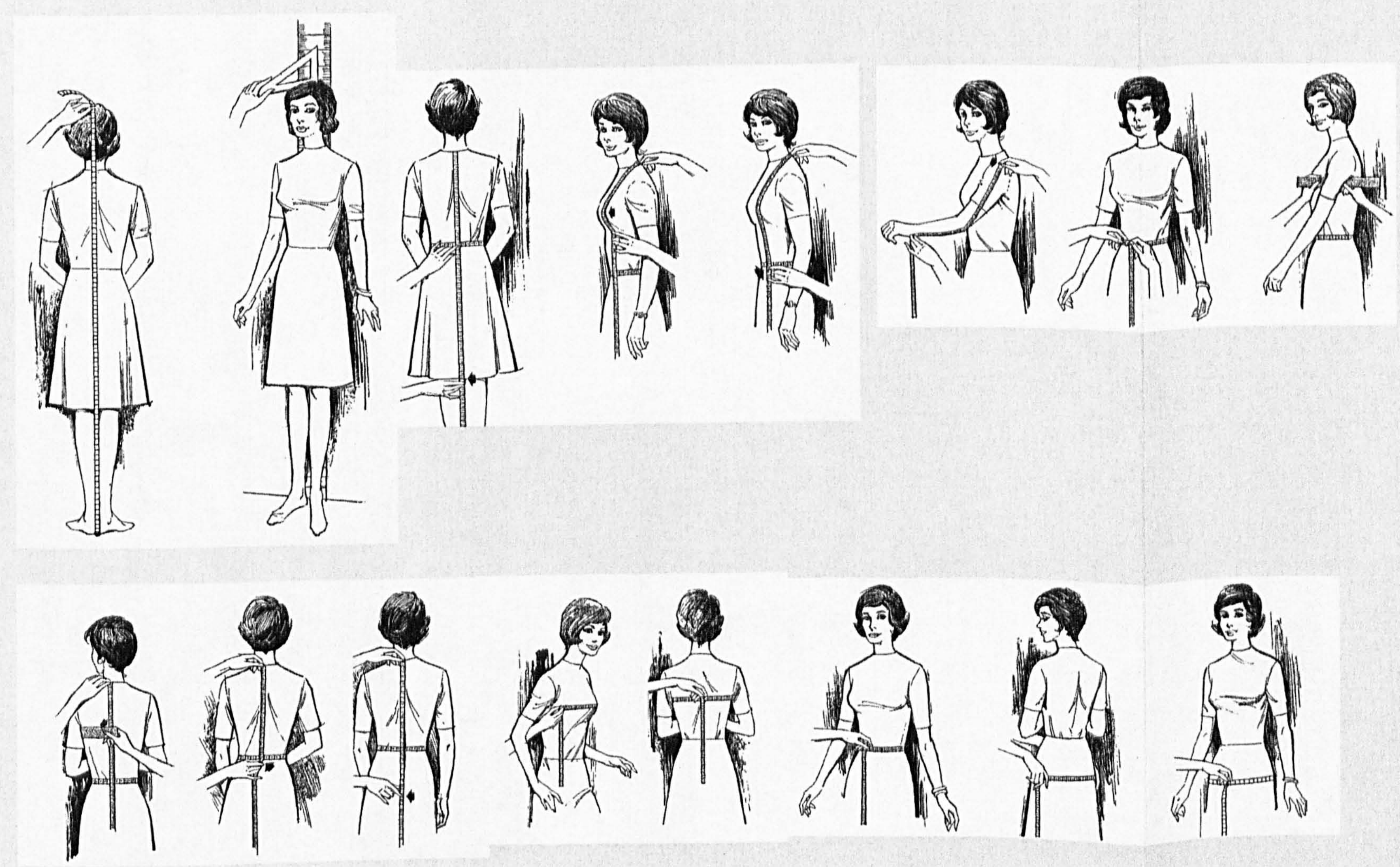




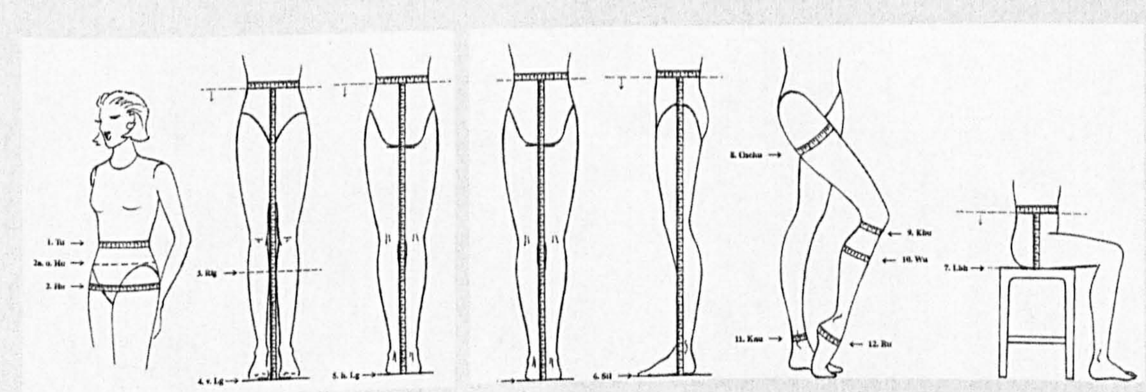
Philip Kunick
Sizing, Pattern Construction and Grading for Women's and Children's Garments, 1967



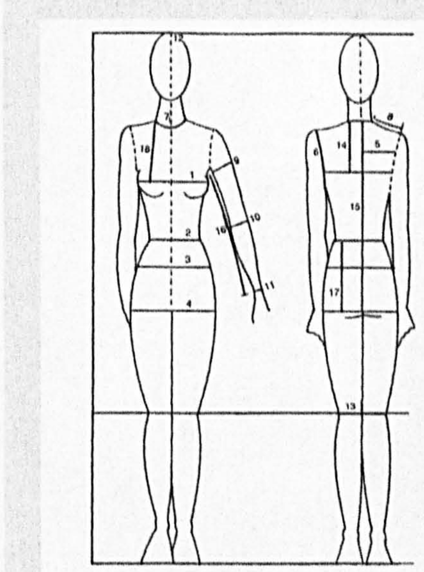
M. Müller & Sohn
Konstruktionen für Jacken und Mäntel (Eng.: Pattern Constructions for Jackets and Coats), 1984

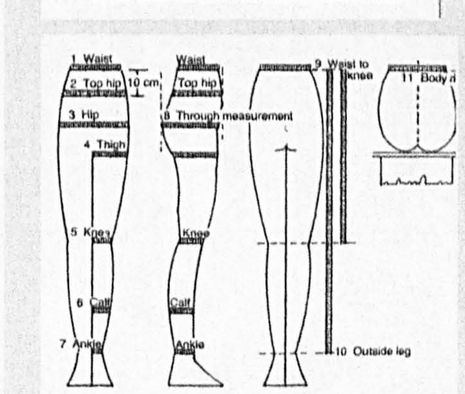


Konstruktionen für Röcke und Hosen (Eng.: Pattern Constructions for Skirts and Trousers), 1996



Martin Shoben and Janet Ward
Pattern Cutting and Making Up – The Professional Approach, 1987





Size Charts

The given size charts are taken from the textbooks of the different at pattern cutting systems. All given measurements are in centimetres, pounds and kilograms. Measurements indicating individual design decisions, such as the length of skirts are left out. When possible, changes within the measurements from one publication to the other are indicated by more than one size chart.

Winifred Aldrich
Metric Pattern Cutting, 1997

	Women Of Medium Height 160cm - 170cm											
English Size	**8**	**10**	**12**	**14**	**16**	**18**	**20**	**22**	**24**	**26**	**28**	**30**
Bust	80	84	88	92	97	102	107	112	117	122	127	132
Waist	60	64	68	72	77	82	87	92	97	102	107	112
Hips	85	89	93	97	102	107	112	117	122	127	132	137
Back Width	32.4	33.4	34.4	35.4	36.6	37.8	39	40.2	41.4	42.6	43.8	45
Chest	30	31.2	32.4	33.6	35	36.5	38	39.5	41	42.5	44	45.5
Shoulder	11.75	12	12.25	12.5	12.8	13.1	13.4	13.7	14	14.3	14.6	14.9
Neck Size	35	36	37	38	39.2	40.4	41.6	42.8	44	45.2	46.4	47.6
Dart	5.8	6.4	7	7.6	8.2	8.8	9.4	10	10.6	11.2	11.8	12.4
Top Arm	26	27.2	28.4	29.6	31	32.8	34.4	36	37.8	39.6	41.4	43.2
Wrist	15	15.5	16	16.5	17	17.5	18	18.5	19	19.5	20	20.5
Ankle	23	23.5	24	24.5	25.1	25.7	26.3	26.9	27.5	28.1	28.7	29.3
High Ankle	20	20.5	21	21.5	22.1	22.7	23.3	23.9	24.5	25.1	25.7	26.3
Nape to Waist	39	39.5	40	40.5	41	41.5	42	42.5	43	43.2	43.4	43.6
Front Shoulder to Waist	39	39.5	40	40.5	41.3	42.1	42.9	43.7	44.5	45	45.5	46
Armhole Depth	20	20.5	21	21.5	22	22.5	23	23.5	24.2	24.9	25.6	26.3
Waist to Knee	57.5	58	58.5	59	59.5	60	60.5	61	61.25	61.5	61.75	62
Waist to Hip	20	20.3	20.6	20.9	21.2	21.5	21.8	22.1	22.3	22.5	22.7	22.9
Waist to Floor	102	103	104	105	106	107	108	109	109.5	110	110.5	111
Body Rise	26.6	27.3	28	28.7	29.4	30.1	30.8	31.5	32.5	33.5	34.5	35.5
Sleeve Length	57.2	57.8	58.4	59	59.5	60	60.5	61	61.2	61.4	61.6	61.8

Natalie Bray
Dress Pattern Designing, 1974

	MEASUREMENTS								PROPORTIONS					
Size	Bust B +10	Hips H +6	Waist W	Waist Length LW	xBack xB	Chest Ch	Shoulder Sh	Top Arm TA	Point O CB	Back Neck Width	Depth of Armhole	Back UP	Dart	Arm-hole
1.	80	86	64	38/40	33/34	35	12-	28	2	6.5-	20.5	5	6	40
2.	84	90	66	39/41	34/35	36	12	29	2.5	6.5	20.5+	5	6.5	41
3.	88	94	68	39.5/41.5	35/36	37	12.5-	30	3	7-	21	5	7	42
4.	92	98	70	40/42	36/37	38	12.5	31	3	7	21.5	5.5	7.5	43
5.	96	102	72	40.5/42.5	37/38	39	13-	32	3.5	7.5-	22	6	8	44.5
6.	100	106	76	41/43	38/39	40	13	33	3.5	7.5	22.5	6	8.5	46
7.	104	110	80	41.5/43.5	39/40	42	13.5	34.5	4	8-	23	6.5	9	47
8.	108	114	84/86	42/44	40/41	43	13.5	36/37	4	8	23.5	7	9.5	48
9.	112	118	88/90	42.5/44	41/42	44.5	14	38	4.5	8.5-	24	7	10	50
10.	116	122	92	43/45	42/43	46	14.5	39/40	4.5	8.5	24.5	7	10.5	51/52

Bray adds 10 cm ease allowance to each bust measurement and 6 cm to each hip measurement. There are no definitions given for any other marks.

Jutta Jansen and Claire Rüdiger
Systemschnitt – Modeschnitte mit System
(Eng.: Systemschnitt – Systematic Fashion Patterns), 1990

German Size	**36**	**38**	**40**	**42**	**44**	**46**	**48**	**50**	**52**	**54**
English Size	**8**	**10**	**12**	**14**	**16**	**18**	**20**	**22**	**24**	**26**
Height	168	168	168	168	168	168	168	168	168	168
Bust Girth	84	88	92	96	100	104	110	116	122	128
Waist Girth	64	68	72	76	80	84	90	96	102	108
Hip Girth	90	94	98	102	106	110	116	122	128	134
Arm length	59	59	59.5	59.5	60	60	60.5	60.5	61	61
Wrist Girth	15.5	16	16.5	17	17.5	18	18.5	19	19.5	20
Back Length	40.7	41	41.3	41.6	41.9	42.2	42.5	42.8	43	43.2
Front Length	44	45	46	47	48	49	50	51	52	53
Breast Depth	26	27	28	29	30	31	31.5	32.5	33.5	34.5
Shoulder Width	13	13	13	13	13.5	13.5	14	14	14	14
Body Rise	26.5	26.5	27	27	28	28	29	29	29	29
Side Length	106	106	106	106	106.5	106.5	106.5	106.5	106.5	106.5
Knee Girth	42	46	50	54	56	58	60	62	62	62

Philip Kunick
Sizing, Pattern Construction And Grading for Women's And Children's Garments, 1967
(As the original data is given in inches, all measurements in the table are converted into centimetres)

Nearest British Standard Size	**8**	**12**	**14**	**16**	**18**	**20**	**22**	**24**	**26**	**28**
German Size	**36**	**40**	**42**	**44**	**46**	**48**	**50**	**52**	**54**	**56**
Hip Size	86	91	96	101	106	111	116	121	127	132
Horizontal Measurements										
Bust Girth	81	86	91	96	101	106	111	116	121	127
Waist Girth	58	63	68	73	78	83	88	93	99	104
Hip Girth	86	91	96	101	106	111	116	121	127	132
High Hip Girth	78	83	88	93	99	104	109	114	119	124
Across Back	31	33	34	35	36	38	39	40	41	43
Across Chest	27	30	30	33	33	35	36	38	38	40
Scye Width	10	10	10	10	12	12	13	14	15	15
Bust Arc Front	44	47	50	53	57	60	63	66	69	73
Chest Girth at Scye	77	81	85	88	92	96	100	104	107	111
Arm Scye Girth	35	37	39	41	43	45	46	8	50	52
Neck Base Girth	35	36	38	39	40	41	43	44	45	46
Width Bust Prominence	17	17	19	20	21	22	22	24	25	26
Shoulder Length 40	11	11	10	10	12	12	10	12	12	12
Up. Arm Girth	22	25	27	27	30	33	35	37	38	40
Elbow Girth	24	25	26	25	28	27	30	30	32	33
Wrist Girth	14	15	15	15	15	15	16	15	17	18
Maximum Thigh Girth	50	53	57	57	63	66	69	73	76	79
Knee Girth	33	34	35	36	38	39	40	41	43	44
Calf Girth	31	33	34	35	36	38	39	40	41	43
Ankle Girth	22	23	24	24	25	26	26	27	27	28
Vertical Measurements										
Stature	161	162	162	163	163	164	165	165	166	167
Depth of Scye	17	18	19	19	20	21	21	22	23	23
Nape to Waist	38	38	39	39	39	39	40	40	41	41
Neck to Bust	24	25	26	27	28	28	30	31	32	33
Centre Shoulder to Waist	38	38	40	41	41	42	43	43	44	45
Cervical to Front Waist	48	49	50	50	51	52	52	53	53	54
Front Waist Length	33	33	34	34	34	34	35	35	36	36
Arm Length	57	57	58	58	59	59	59	60	60	60
Under Arm Length	44	44	44	44	44	44	44	44	44	44
Arm Scye to Waist	20	20	19	19	19	19	18	18	18	17
Waist to Hip	21	21	22	22	22	23	23	23	24	24
Side Seam	102	103	104	104	105	106	106	107	107	108
Body Rise	25	28	29	30	31	32	33	34	34	36
Supplementary Measurements										
Cervical Height	139	139	139	139	140	140	140	140	141	141
Knee Height	81	81	81	82	81	82	83	83	83	84
Interacromion Width	43	43	43	43	43	43	44	44	44	44
Bitrochanteric Width	33	34	34	35	36	36	37	38	38	39
Abdomen- Seat Diameter	31	32	33	34	36	37	38	40	41	42
Shoulder Slope	20	22	24	26	28	30	32	34	36	38
Weight Pounds	104	118	132	146	160	174	188	202	216	230
Weight KG	47	53	59	66	72	78	85	91	97	104

M. Müller & Sohn
Schnittkonstruktionen für Jacken und Mäntel
(Eng.: Pattern Constructions for Jackets and Coats), 1984

German Size	**32**	**34**	**36**	**38**	**40**	**42**	**44**	**46**	**48**	**50**	**52**	**54**	**56**	**58**	**60**
English Size	**4**	**6**	**8**	**10**	**12**	**14**	**16**	**18**	**20**	**22**	**24**	**26**	**38**	**30**	**32**
Height	168	168	168	168	168	168	168	168	168	168	168	168	168	168	168
Bust Girth	76	80	84	88	92	96	100	104	110	116	122	128	134	140	146
Waist Girth	62	65	68	72	76	80	84	88	94.5	101	107.5	114	120.5	127	133.5
Hip Girth	84	87	90	94	98	102	106	110	114	118	124	130	136	142	148
Neck Base Girth	35	35.5	36	36.5	37	37.5	38	38.5	39.5	40.5	41.5	42.5	43.5	44.5	45.5
Half Front Neck	6.4	6.5	6.6	6.7	6.8	6.9	7	7.1	7.3	7.5	7.7	7.9	8.1	8.3	8.5
Back Height	17.5	18	18.5	19	19.5	20	20.5	21	21.5	22	22.5	23	23.5	24	24.5
Back Length	40.8	40.9	41	41.1	41.2	41.3	41.4	41.5	41.6	41.7	41.8	41.9	42	42.1	42.2
Hip Depth	59	59.5	60	60.5	61	61.5	62	62.5	63	63.5	64	64.5	65	65.5	66
Bust Depth	24.2	25	25.8	26.6	27.4	28.2	29	29.8	31.1	32.4	33.7	35	36.3	37.6	38.9
Front Length 2 (Shoulder-Breast Point-Waist)	43.7	44.1	44.5	44.9	45.3	45.7	46.1	46.5	47.4	48.3	49.2	50.1	51	51.9	52.8
Back Width	15	15.5	16	16.5	17	17.5	18	18.5	19.2	19.9	20.6	21.3	22	22.7	23.4
Armhole Diameter	8	8.5	9	9.5	10	10.5	11	11.5	12.5	13.5	14.5	15.5	16.5	17.5	18.5
Bust Width	15	16	17	18	19	20	21	22	23.3	24.6	25.9	27.2	28.5	29.8	31.1
Shoulder Width	11.6	11.8	12	12.2	12.4	12.6	12.8	13	13.3	13.6	13.9	14.2	14.5	14.8	15.1
Sleeve Length	59.8	59.9	60	60.1	60.2	60.3	60.4	60.5	60.6	60.7	60.8	60.9	61	61.1	61.2
Upper Arm Girth	25.6	26.5	27.5	28.5	29.5	30.5	31.5	32.5	34.2	35.9	37.6	39.3	41	42.7	44.4
Wrist Girth	15.1	15.3	15.5	15.9	16.3	16.7	17.1	17.5	18.1	18.7	19.3	19.9	20.5	21.1	21.7
Side Length (Waist-Sole)	106	106	106	106	106	106	106	106	106	106	106	106	106	106	106
Body Rise	25.5	25.5	25.5	26	26.5	27	27.5	28	28.7	29.4	30.1	30.8	31.5	32.2	32.9
Step Length (Crotch-Sole)	80.5	80.5	80.5	80	79.5	79	78.5	78	77.3	76.6	75.9	75.2	74.5	73.8	73.1
Ankle Girth	23.5	23.5	24	24.5	25	25.5	26	26.5	27	27.5	28	28.5	29	29.5	30

Schnittkonstruktionen für Röcke und Hosen
(Eng.: Pattern Constructions for Skirts and Trousers),1996

German Size	**32**	**34**	**36**	**38**	**40**	**42**	**44**	**46**	**48**	**50**	**52**	**54**	**56**	**58**	**60**
English Size	**4**	**6**	**8**	**10**	**12**	**14**	**16**	**18**	**20**	**22**	**24**	**26**	**38**	**30**	**32**
Height	168	168	168	168	168	168	168	168	168	168	168	168	168	168	168
Bust Girth	76	80	84	88	92	96	100	104	110	116	122	128	134	140	146
Waist Girth	62	65	68	72	76	80	84	88	94.5	101	107.5	114	120.5	127	133.5
Hip Girth	86	90	94	97	100	103	106	109	114	119	124	129	134	139	144
Neck Base Girth	35	35.5	36	36.5	37	37.5	38	38.5	39.5	40.5	41.5	42.5	43.5	44.5	45.5
Half Front Neck	6.4	6.5	6.6	6.7	6.8	6.9	7	7.1	7.3	7.5	7.7	7.9	8.1	8.3	8.5
Back Height	18.9	19.3	19.7	20.1	20.5	20.9	21.3	21.7	22.1	22.5	22.9	23.3	23.7	24.1	24.5
Back Length	41.4	41.4	41.4	41.6	41.8	42	42.2	42.4	42.7	43	43.3	43.6	43.6	43.6	43.6
Hip Depth	61	61.4	61.8	62.2	62.6	63	63.4	63.8	64.2	64.6	65	65.4	65.8	66.2	66.6
Bust Depth	25.7	26.5	27.3	28.1	28.9	29.7	30.5	31.3	32.5	33.7	34.9	36.1	37.3	38.5	39.7
Front Length 2 (Shoulder-Breast Point-Waist)	43.9	44.3	44.7	45.3	45.9	46.5	47.1	47.7	48.8	49.9	51	52.1	52.9	53.7	54.5
Back Width	15	15.5	16	16.5	17	17.5	18	18.5	19.2	19.9	20.6	21.3	22	22.7	23.4
Armhole Diameter	7.2	7.9	8.6	9.3	10	10.7	11.4	12.1	13.2	14.3	15.4	16.5	17.6	18.7	19.8
Bust Width	15.8	16.6	17.4	18.2	19	19.8	20.6	21.4	22.6	23.8	25	26.2	27.4	28.6	29.8
Shoulder Width	11.6	11.8	12	12.2	12.4	12.6	12.8	13	13.2	13.4	13.6	13.8	14	14.2	14.4
Sleeve Length	59	59.3	59.6	59.9	60.2	60.5	60.8	61.1	61.4	61.7	62	62.3	62.3	62.3	62.3
Upper Arm Girth	25.6	26.2	26.8	28	29.2	30.4	31.6	32.8	34.6	36.4	38.2	40	41.8	43.6	45.4
Wrist Girth	14.6	15	15.4	15.8	16.2	16.6	17	17.4	18	18.6	19.2	19.8	20.4	21	21.6
Side Length (Waist-Sole)	106	106	106	106	106	106	106	106	106	106	106	106	106	106	106
Body Rise	24.9	25.3	25.7	26.1	26.5	26.9	27.3	27.7	28.3	28.9	29.5	30.1	30.7	31.3	31.9
Step Length (Crotch-Sole)	81.1	80.7	80.3	79.9	79.5	79.1	78.7	78.3	77.7	77.1	76.5	75.9	75.3	74.7	74.1
Ankle Girth	23.5	23.5	24	24.5	25	25.5	26	26.5	27	27.5	28	28.5	29	29.5	30

Martin Shoben and Janet Ward
Pattern Cutting And Making Up – The Professional Approach, 1987

Area/ Size	**10**	**12**	**14**	**16**
Bust Girth	82	87	92	97
Waist Girth	60	65	70	75
High Hip Girth	81	86	91	96
Hip Girth	87	92	97	102
Half across Back	15	16.2	17.4	18.6
Armhole Width	10.1	11	11.9	12.8
Armhole Girth	40.6	42.6	44.6	46.6
Neck base Girth	35.8	37.0	38.2	39.4
Shoulder Length	11.3	11.5	11.7	11.9
Bicep Width	25.2	27	28.8	30.6
Elbow Girth	24	25.8	27.6	29.4
Wrist Girth	15.2	16	16.8	17.6
Height	160.1	162.5	164.5	167.3
Waist to Knee	56.7	57.6	58.5	59.4
Armhole Depth	17.4	18	18.6	19.2
Nape to Waist	39.8	40.4	41	41.6
Underarm Length	46.1	46.5	46.9	47.3
Waist to Hip	21.7	22	22.3	22.6
Nape to Bust Point	32.6	34	35.4	36.8

Appendix 2

Questionnaire 1, handed out 35 working females, undertaken in 2003

	yes	no
Question 1: Do you feel confident with what you are wearing today?	N 31	N 4
	do not change	change
Question 3: Is the clothing you are wearing at work comfortable or do you change?	N 21	N 14

	confident/comfortable/ practical/improve	unconfident/uncomfortable/ unpractical/decline
Question 2: What garment types or aspects of garments are relevant for you feeling confident or unconfident?	-not too tight garments (N 24) -shoulder pads (N 4) -long sleeves (N 2) -covering the figure (N 9)	-very tight garments (N 29) -short sleeves (N 2) -short jacket (N 2)
Question 4: What garment types or aspects of garments are relevant for you feeling comfortable or uncomfortable?	-long trousers (N 31) -structured garments (N 21) - jeans (N 3)	-anything thick, stiff or padded (N 3)
Question 5: In regard to your clothing, is there anything practical/comfortable or unpractical/uncomfortable on your journey to and from work?	-long trousers (N 8)	-skirts (N 28) -too tight garments (N 15) -long coats (N 1) -bulky garments (N 16) -layering garments (N 3)

Question 6. Can you think of anything what would improve/decline practicality and comfort while travelling?	-pockets (N 3) -stretch fabric or knitted textiles (N 2)	-no pockets (N 3) -layering garments (N 3) -tight trousers (N 1) -tight jackets (N 3)

Question 7. Which garment types have you found out are suitable as business-wear?	-structured garments (N 21) -fitted garments (N 21) -long trousers (N 31) -jackets covering the hip (N 9)
Question 8: Which garment types have you found out are unsuitable as business-wear?	-anything stiff, thick or padded (N 3) -anything too tight (N29) -anything showing too much skin (N 29)

Appendix 3

Interview with Barbara Wentzel, pattern technician at the London College of Fashion, October 2003

1.Do you see any difference when you compare manual to digital pattern construction?

The only difference is that through CAD CAM Technology I am able to me much faster in constructing a pattern.

Furthermore the fact that you can easily send and receive a pattern via the internet, makes it very suitable for modern production, because the pattern cutter mostly is working in a different country than where the patterns are actually cut.

2.Do you use CAD CAM systems apart from constructing pattern?

Yes, we are co-operating with Gerber and they offer fashion design software where you can easily try out or develop different prints.

For the industrial production of clothing CAD CAM systems have made many stages easier.

Interview with Markus Schotte, of the made-to-measure department of the Windsor company, Bielefeld, Germany
13th of May 2004

1.Could you please tell me about your experiences with the 3D body scanner

We are lucky to ha a scanner installed in our premises since 2003. We achieve very accurate measurements by scanning. Our made-to-measure service which is offered in shops where our products from both, ready-to-wear and made-to-measure, are sold co-operate with us. The customer is measured in the shop and after he chose the style and fabric, the information is coming to us and we have the garments made. Unfortunately, most of the customers see the 3D scanner as an interesting gadget to try out. Most of the customers are not used to wear made-to-measure garments and we had quite a number of returns. The customers are of the impression that the garments are too tight, which actually is a characteristic of made-to-measure production. Because of these problems we decided to use the scans plus have the customer try on sample sizes to figure out how loose he really wants to have the garments. Doing it this way, there is no real use for the scanner any more. Most of the shops keep them, first there are expensive and the technology attracts customers.

2.Do you use the 3D scanner for your ready-to-wear range?

At the moment we try to target a problem that we have for quite a while. As the population is of a greater variety of shape and size as it was the case in the 1980s, we have problems to find the correct length of our ready-to-wear menswear jackets. As there are currently no new information on the development of sizes available, I scan individuals with specific features based on different cultures, in and compare them to the measurements we are using for the specific size.

Interview with Marc Ludwig, Pattern Development at STRELLSON, menswear, Kreuzlingen, Switzerland
Pattern Development at HEIN GERICKE, motor-cycle clothing, Duesseldorf, Germany, Telehpone Conversation, 18th of September 2004

Can you tell what the difference is in constructing a pattern for a tailored suit and motor cycle garment?

M.L.: For the motor bike garments I will cut the garment for the position on the bike, not for standing upright.

Do you remember anything, which is different in the way how you construct the garment, when you compare the two jobs?

M.L.: No, I can't think of anything, except the fact that for the motor cycle outfit you try to achieve a garment, which fits in the position while riding the bike. Things like the waistline. It is always quite difficult to work against a waistline, which tends to open up at the back. But the way in which I construct the garments is the same.

That would mean that you had the same problems developing a pattern for a suit, which should be worn while the person is running.

M.L.: That is true, such things as an overall for riding a bike would be cut after certain measurements, we called that 'racing cut'. This garment would fit perfectly on the bike, but it nearly hurts when the person stands upright. The front length is so much shorter than within an ordinary one piece garment.

Can you describe the process of how you developed such a 'racing cut' garment?
M.L.: I got the scrabbles first. I mainly drew the separate pattern pieces first by hand. More or less accurate and then I decided, after what I already knew, where to take out and where to allow more fabric. That meant that we had to try the prototypes a lot. Unfortunately we did not have the time to do studies on the way how the body behaves in this certain situation while riding a bike, so we had to try each prototype on a model a few times. We did not really document the results, so we went through this process mainly with each new garment. There is always a problem to balance a garment. For myself, I would not say that I can tell just by constructing a pattern, that I already know, within having fittings, how to get the balance right. That is the same for the work at STRELLSON now.

Did you use a computer programme to make the pattern at HEIN GERICKE?
M.L.: I worked with *Graphis*, I already learned to make the pattern with the help of the computer while I was at University. Here in Switzerland they mainly use the *Unicut* system. I studied at a more technically orientated University. Of course we also learned how to do a pattern on paper. Today I use both. If I try out something in my free time at home I do make a paper pattern and if I like the result I would take that to my workplace at the company and redo this pattern on the computer. It does not make any difference in how you work with the pattern cutting system.

Do you think the cut of a pattern is important for the look of a piece of clothing?
M.L.: The pattern is very important not only for the fit of a garment, but also the look of it.

When you compare your work now for STRELLSON men's wear to what you did for HEIN GERICKE, do you see any differences in how you construct a pattern, in the way you use the pattern cutting?

M.L.: No, I do not see any differences. The thinking process while you start constructing a garment is the same, so the way I use the cutting system is also the same.

Interview with *Christa Weber*, Teacher for Pattern Cutting at the University of Applied Sciences in Bielefeld, Germany, 16th of December 2004
1: What pattern cutting system do you use?
I use the Mueller & Sohn system.

2: *Why this one? Which advantages does it have in comparison to other systems?*

Because the fit is much better compared to other systems. For me it is more exact. Hohenstein, for example, is more complicated, especially for beginners, because it is based on many mathematical steps, such as A, B and C.
It is difficult to learn as a beginner. It also does work less with body measurements. The structure of the Mueller & Sohn system is much easier to understand and to learn. On the other hand Mueller & Sohn is difficult to use for more leger garments. In this case it is complicated to construct the loosely cut garment.

3: Have you tried different systems?
I know the Hohenstein system because I learned it during my training. I also used the Junix/Unicat system on the computer lately. Unicat is much easier for more casual and leger clothing. For fitting clothing I still prefer the Mueller & Sohn system, because it is based on body measurements. Originally it had been a system which was developed for the tayloring trade. In comparison to this the Swiss Unicat system is developed to use on the computer only. The University of Applied Sciences in Niederrhein developed the Graphis system for the CAD construction. But it is not used by the industry because it is not flexible enough in ist use. It is only useful for a professionally trained taylor.

4: Have you learned this system during your training?
No, during my training I have learned the Hohenstein system.

5: The University of Applied Sciences is strongly connected to the clothing industry. Do you think this is why you teach a special system?
Yes, next to others.I worked as a pattern cutting teacher at Mueller & Sohn.

Mueller & Sohn does have several institutes to learn pattern cutting in Germany. First they started in Munich and know they also have institutes in Duesseldorf and Hamburg. They are the only institute in Germany where it is possible to get trained as a pattern cutter or as a directrice. Therefore most of the professionals working in the clothing industry use their system because they have been trained with the system. Before Mueller & Sohn opened their institutes it was common to have no system for the pattern cutting at all. Mueller & Sohn have been the first who introduced a step by step manual for developing a flat pattern. As the system had been developed with taylors, many of these steps have been developed by tailors. They tried to put their every day tricks of cutting a pattern into a system. Next to this most of the clothing industries in Germany use the Mueller & Sohn system.

6: Which advantages does have this system for the production process in the clothing industry?
The Mueller & Sohn system did not change in construction since its invention. Because it is based on body measurements, it is possible to use the system for all body measurements. Therefore it can be used all over the world. In contrast to this Hohenstein uses measurements from size charts. Nevertheless it is possible to use the Mueller & Sohn system for mass production. Ever company I know uses it.

7: Do you know pattern cutting systems which were used before the mass production? What differences are to systems used in the mass market industry?
No, and I never learned of historic pattern cutting systems during my training.

8: Did the system have to be changed for the CAD use?
No, because the system is also based on a mathematical construction, it is possible to use it with the computer and on a computer screen.

9: You also teach to work with the on the CAD system. Which advantages and disadvantages are there between the manual and the computer generated way of developing a flat pattern?
The result will be the same, either if you constructed the flat pattern with a computer program or if you did it manually. The process of working is a different one. On the screen the process is more mathematically, there you are not able to do something out of your hand as you are used from the manual process. When I construct an armhole manually I do not measure everything, I draw out of my experiences. When you work with the computer you have to tell every measurement to the computer. The creation of a block pattern does take longer on the computer. But as soon as you have the block pattern changes are made more quickly on the computer. That is why the industry digitalises manually made pattern into the computer. The trained pattern cutter is able to construct the pattern by his own hand more easily. This is especially important for curved lines, such as armholes. Still today, a lot of companies use both, the manual and the computer generated way to construct their pattern.
At the university we teach the manual way first but later the student also has to learn the CAD system. I think that the student has to get a feeling for the proportion first before working with the computer, therefore the manual way to construct a flat pattern is necessary because you work on full scale. You also get a feeling for the three dimensional garment because you are able to pin the paper pattern together.
As a CAD system we use Assyst, because it is used by the industry which surrounds us here at the University.

10: Which measurements do you use?
I use the same measurements as they are used in the clothing industry but my students use their own personal body measurements. Because of this they are able to try on their own garments and they are also able to identify problems within the fit.

11: *How important do you think is the pattern seen as a part of the production process?*
I think the pattern is extremely important. If the pattern is not acurrately made the following steps within the production cannot go on. It is not possible to explain a pattern to the person who is sewing the pieces together if one part is two centimetres longer than the other she won't ask why she will leave it as it is. And finally if the pattern does not fit the garment won't be selling. I think the pattern is an important part of the production process.

12. *Have you ever come across aspects of pattern which you think are in-sufficient or unpractical in any way?*
No, not really. I cannot think of anything specific right now, but I definately think that there still is a lot of potential in the area of creating a pattern. I think people stopped developing the existing systems because the clothing industry does not want to invest in any research. In this way it is quite different to other industries.

Interview with *Annegret Friehe*, Teacher for Pattern Cutting at the University of Applied Sciences in Bielefeld, Germany, 10th of January 2005
1: *What pattern cutting system do you use?*
I use the Mueller&Sohn system.

2: Why this one? Which advantages does it have in comparison to other systems?

A clear advantage of the Mueller & Sohn system is, that one does quite quickly achieve a good fit with it.
This is because this system uses the body measurements in a very practical way.

There you can see that they started the system with taking the body measurements and from there they work out the distances which are used in the pattern. With the Mueller & Sohn system it is easy to come up with a good fit at once. I do not want to try two or three times until I get a good fit. I can develop every type of garment, whatever style or silhouette it has, with this system. The bases needs to good. I always compare to the alphabet, if someone does not know the alphabet first, than he is not able to build sentences. For me Mueller & Sohn is the alphabet.
I also do draping with the same method. When I have a draped sketch I first make a tight fitting silhouette without the draping.
After that I look at the sketch again and mark the draping on the pattern and then I am cutting the pattern wherever it is needed and I tuck everything away what is not intended. I create a pattern for a draped garment with the help of a two dimensional paper pattern. This works very well. For me it works better to start every design with the bases, if that is well done then I will only need minor changes to finish the pattern. Of course this needs experience.

3: *Have you tried different systems, or have you ever came across them during your professional life?*
No, but during my professional life I met people who worked with other systems, such as Hohenstein. During the 1980s there had been only two systems in Germany, the Mueller & Sohn and the Hohenstein system. I found out that the Mueller & Sohn system works best for me because the reason I stated above. All good clothing manufacturers I know use the Mueller & Sohn system, because for them it also works best. This definitely is because of the good fit of their pattern. If I had not been satisfied with the Mueller & Sohn system I would have tried out others. I quite like the Systemschnitt system by .... Because all images of her fashion pattern show the basic construction underneath. That makes it easier to understand, especially for beginners. But this system also follows the Mueller & Sohn system.

4: *Have you learned this system during your training?*
Yes, I have been trained with the Mueller & Sohn system during my training.

5. *You worked for internationally orientated companies, which patten cutting system did you use then?*
I was working as an assistant for Karl Lagerfeld when he was teaching the final year of the fashion class in Vienna ('Hochschule der Kuenste'). That was between 1980 and 1982. My part was to renew every part of the whole process from the design to the production. Therefore I also introduced the Mueller & Sohn system. Before they used a mixture of Mueller & Sohn basics and whatever they thought would work. That was not very accurate and the results were often not wearable regarding the fit. They must have had some knowledge about the system before because otherwise it would had been much more complicated to introduce a new system.

6: *The University of Applied Sciences is strongly connected to the clothing industry. Do you think this is why you teach a special system?*
All good companies I know use the Mueller & Sohn system. But still, if the system would not satisfy me I would have used another one if it is used in the surrounding industry. I always like to combine practical projects with the industry with my teaching. Then the students learn how important the fit is.

7: *Do you know pattern cutting systems which have been used before the mass production? What differences are there to systems used in the mass market industry?* I do have books on historic pattern cutting. But all the time I look into them I am glad that I have the Mueller & Sohn system.

Lately I had a project here at the university where we did costumes for a fairy tale event. Some of the students wanted to construct the pattern following historic pattern. They soon gave up because the proportions of the human figure was too different to our figures today, especially around the armhole and around the breast (I had the impression that the women had absolutely no breasts in the medieval ages), and of course the way the pattern was constructed was very complicated, because it was no real system where you can follow a guideline. In the end we constructed all pattern by using the Mueller & Sohn system. The historic pattern systems cannot provide a garment in which someone can move as freely as we are used to. Maybe this is because we all grew up wearing a T-shirt, which allows various movements.

8: *You also teach to work with the CAD system. Which advantages and disadvantages are there in the comparison between the manual and the computer generated way of developing a flat pattern?*
I prefer to construct the basic pattern manually and then digitalise the pattern in the computer. I do believe that it is impossible to create a good proportion and a good fit on a flat computer screen. For that you do need to pin the paper pattern pieces on a stand and then mark your changes, this is the only way to see the right proportion. I think the fact that so many students nowadays are only trained to make pattern on the computer is why I get so many calls from people in the industry arguing that they cannot find good people for their pattern department. The human body is rounded and a computer screen is flat. It is only possible to create the intended proportion on the stand. You have to take the basic pattern onto the stand and then mark whatever the design needs. As long as it is not possible to create a three dimensional piece of garment on a computer, I would never develop a pattern with CAD. The manually developed pattern with all its marks and lines on it can then be checked on the computer. CAD is practical when it comes to checking all distances, but in the stage of developing I prefer to do it manually. I even create all pockets on the stand, not on the computer. The computer can help to separate all of the pattern pieces accurately. CAD is good for the technical aspects of pattern construction but not for the creative development. Therefore our students learn both the manual and the CAD way to create a pattern. Otherwise they would never get to see a good fit. My students create a basic pattern first. All the following pattern are then developed starting with their basic pattern. The resulting pattern is than the basic pattern for the individual design.

9: *Which measurements do you use?*
I use a mixture between the Hohenstein measurements and my own table of body measurements which is based on my own experience. Both Hohenstein and Mueller & Sohn renews these measurements on a regular bases every ten years. Both tables are very similar. For me it is all up to the lengths of the front and of the back together with the average higth of 1,64m. These are the most important measurements for getting a good proportion.

10: *Have you ever thought about aspects of pattern cutting as being unpractical or not sufficient?*
During the years I slightly changed some aspects of the Mueller & Sohn system. I do not let the students calculate any of the measurements which are normally used for the basic construction of the pattern. I noticed that if the students have to measure themselves the results are very likely inaccurate. Therefore I developed my own table. I let the students take, or better I help them take, their bust measurement. Then they can check this measurement on my table and they take all other measurements which belong to their specific bust measurement. I only let the students adjust their waist-

and hip measurement and sometimes the length of the back, if it is different to the ones in my table. This systems works best for me. This nearly guarantees a well fitting resulting garment. During my professional life I found out that the act of taking measurements is mostly the bases for a lot of problems regarding the fit.
Generally I think it is always better to start a design with the basic construction and to attach fashionable aspects, such as pockets and collars, onto it.

Further Correspondence:
I personally think that sportswear has an important influence on our daily clothing. When you have a closer look at how extravagantly a pair of sport trousers from Nike had been made, you will see how much developing and design work went this piece of garment. A lot of these pieces follow the human anatomy in a way that formal clothing never did.
To create a pattern for one of the named sport's trousers is much more complicated than to make a pattern for a pair of formal trousers. I know sportswear made by Bogner in the 1950s which have been as extravagant as the Nike sport's trousers today. I personally think that young people will keep on wearing sportswear. Of course this will stop at a certain age or at a certain point, such as the start of the professional life.

I think the problem with fashion is that we do not have a fashion dictation any more. And maybe fashion is not even important any more. Sometimes when I see members of the youth culture I think that fashion lost its sense of something which makes a person more beautiful.

INTERVIEW WITH PROF DR ROEDEL, DR SYBILLE KRZWINSKI, TECHNISCHE UNIVERSITAET DRESDEN, 22. Februar 2005

1. *In which product areas did you start to work with CAD programs?*

We started with the GRAVIS system in 1982. We needed a system for making tents. The GRAVIS system had been present in the DDR at that time. It was used for making shoes. We went into the shoe company and used their computer program after hours to develop pattern for our tents. For shoes you have a similar problem as with clothes, you need to work out a pattern for a three dimensional form. Mr Friedrich who made his dissertation here at the TU in the mid 1980s, went to East Berlin and developed the GRAVIS system for clothing there.
Since 1990, after the Wall came down and we got the new currency, we got the first GRAVIS system for clothing.
In 1980 we used the American MACRAMATIC system. Here in Dresden there was a huge production company which used INVESTRONICA. Before that I established the CAD technology in 1982-84 at an underwear company. That system was called ROBOTON. In 1986 we got the first LECTRA program. Since 1986 LECTRA was leading the market here in the DDR. In 1992 we got an INVESTRONICA system complete with free work stations and the design system KOPPERMANN from south Germany.

2. *Which restrictions had there been for the first patterns/garments developed with the computer?*

The first CAD system I used was created to develop shoes. I think all technical CAD programs are similar. Even if a program is not constructed for clothing, you are still able to construct a garment.

3. *What pattern cutting system do you use for your research?*

Since 2000 we updated our Investronica and Lectra workstations. All in all we are working on today's industrial level. The students use three Investronica and two lectra workplaces for three dimensional and one for two dimensional software.

We started the three dimensional software after we got introduced to it at the IMB in Cologne in 1997. After that we bought our first three dimensional workstation. The software was from CDI. Later Lectra took over CDI. We got updated and informed by Lectra regularly. At the moment we are working with the fourth software version. Therefore we here in Dresden are one of the best equipped institutes for garment technology in Europe. This is of course not because of the quantity of workstations, but because the latest versions we use.

4. *Which advantages does it have for you in comparison to other systems?*

We use a system by the Modeinstitut in Berlin (former East-Berlin). Its instructions for making the pattern are very logical and do not leave any questions open.

5. *Have you tried different systems, or have you ever came across them during your professional life? Why didn't you go on using it/them, why didn't you like it?*

When I compared it to the systems which were used in West Germany (Mueller & Sohn, Hohenstein), I found that our system describes absolutely everything. That was something I sometimes missed with the other systems. The students are able to create a pattern by exactly following the instructions. That makes it also more suitable for the use on the computer.

Every single line is described in detail. With other systems I found out that for students who start to create a flat pattern, some steps or certain points miss a detailed instruction. The system we use does not leave any questions within the construction open. It is very similar to every other CAD construction system for other industries. Because we are not a design school, we need a technically precise system which does not leave any questions open. It should be the same for our students whether they construct a jacket or anything else.

At the time of the DDR we had seminars from the Modeinstitut in Berlin, in order to demonstrate how to develop the latest fashion into flat pattern. After the Wall came down we compared the systems which have been used in West Germany. We realised garments which we constructed following the different systems.

Generally it is to say, that as soon as the students have learned how to use the CAD systems, they tend to not construct a flat pattern manually anymore.

6. *Have you personally been educated on this system during your training?*

Yes. That has been the system in the German Federal Republic. It was invented in the early 1960s.

7. *Which measurements are you using for your pattern and on which survey are they based on?*

We do use the HOHENSTEIN measurements. We also use the updated measurements as soon as they are available.

8. *When did you start to investigate CAD programs for developing pattern? Which pattern cutting system is it based on?*

We started with the GRAVIS system which comes from the University of Applied Science in Niederrhein. We first used it here in Dresden in 1982.

9. *How many percent of all the patterns are constructed with the help of the computer? Do you also use the manual system, if yes, in which case?*

Our students have a technological background only.

Therefore we need to introduce them to the basics of flat pattern cutting. We do this manually first, for six months. After a while we use both, the manual and the CAD system parallel. For the manual as well as for the CAD pattern construction we use a system which was developed by the *Modeinstitut in Berlin.*

11. *Have you ever thought about aspects of pattern cutting as being unpractical or insufficient in any way, maybe for specific garment types? If yes, please state why?*
In 1989 we worked together with the German army. They had problems regarding the fit of soldier's underwear. During this project we also compared the different international size charts. We found out that the Dutch people are the population which matches the international sizing the best, because their population consists of many different cultures and therefore of many different body measurements. We used CAD systems for this project. Still today, when I visit companies in the whole of Germany, I am sometimes shocked when I see that they still only use a manual pattern cutting system. Some companies, especially some in the western parts of Germany either started very late with using CAD technology or some are still not using it today.

This is possibly because the DDR was very related to technology in the 1980s. Of course this is connected to the huge mass market of fashion as we had it here in the DDR. In western Germany the companies had been much smaller and therefore they did not have the possibilities to afford CAD systems.

(We spoke about the Windsor company in Bielefeld where I made an internship in January 2005)
We here in Dresden tried to contact Mr Struck at the Windsor company in order to maybe co-operate with them with their 3D scanner. Unfortunately this never worked out. I think if there are problems with the pattern cutting, they are related to problems within the fit.

Interview with ANDREAS JAENICKE (CHEF-DESIGNER) and JULIA STUCKBERGER (HEAD OF PATTERN DEPARTMENT) at STRENESSE, 22nd March 2005

1: *What pattern cutting system do you use in the company?*
We are working with the ASYST system, version 7.0-o5-3. We started with this system at the end of 1997. Before that we worked with the LECTRA system.

2: *Which advantages does it have in comparison to other systems?*

At that time ASYST made the better offer and we also had some problems with missing construction lines on the computer screen within the LECTRA system. Today they do not have this problem anymore. I am positive that both systems do have the same level of quality in every aspect of the use of it. Since then a lot of technicians have been sent away to get used to the system. Two years ago we had the last reminded group of pattern technicians sent out to learn to work with the program.

3: *Have you personally been educated on this system during your training?*
No, I have been trained using the manual MUELLER &SOHN system and later I have been trained with the ASYST system.

4: *Have you tried different systems, or have you ever came across them during your* professional life?
I partly tried out the HOHENSTEIN system.

The only time we use a different ways of constructing the pattern is, when we do drape pieces for the evening wear collection on the stand. We do this from time to time but not on a regular base.

5. *Why didn't you go on using it/them, why din't you like it?*
It was different to work with calculated added measurements instead with body measurements. I personally always preferred the MUELLER &SOHN system.

6. *Which measurements are you using for your pattern and on which survey are they based on?*
We are working with the HOHENSTEIN standards from 1994. We use the size 34/36 for our prototypes. A couple of years ago (ca. 1998) we used to have our own STRENESSE standards, in which we reduced the bust measurement in order to have a more masculine look, but we started using the HOHENSTEIN standards at some point, as the proportions got more female again.

7. *How many percent of all the patterns are constructed with the help of the computer? Do you also use the manual system, if yes, in which case?*
We use the CAD system for developing over ninety percent of all our flat patterns, even for the prototypes.

We do have a couple of pattern cutters who do construct their flat pattern manually. They work for the more exclusive main collection GABRIELE STREHLE line. They do the pattern manually, whenever we need a more structured tailored look with an excellent fit. I would say that these pattern cutters do have a better position within all the technicians, because they are treated as a rare species and because they develop the higher quality designs.

I personally do not think that there is a difference regarding the quality of a flat pattern, either it is constructed on the computer or by hand. I do think that it purely depends on the technician who is developing the pattern. Mrs Gabriele Strehle (together with her husband owner of the STRENESSE company) was suspicious when we started to construct our flat pattern with the computer. She had the impression that the technician might lose a certain relation to the pattern, purely because it is not pictured in the right size. She thought that some of them would also the view of proportion. She generally has been thinking that the construction with the computer means that something gets lost, which normally would be there if the pattern would still be constructed manually. I personally do not share her impression. I am great fan of controlling the pattern. We did this with manually constructed flat pattern and we still do it with the computer generated ones. We at least print out a new prototype pattern between three and five times to pin it together and to put it on the stand to correct it. For this the only difference between manually made or computer generated flat pattern is, that it is faster and sometimes more accurate to print out the computer generated ones. I generally think that to work with the computer does not necessarily come together with having disadvantages. It is not that only our technicians who do work manually are able to develop a flat pattern for a well fitted jacket. But still, in my position as a designer, I think that the manual way of developing a flat pattern does give my more options. For example on the computer I have to work with one type of line or curve, but by hand I have the choice.

9. *Have you ever thought about aspects of pattern cutting as being unpractical or in-sufficient in any way, maybe for specific garment types? If yes, please state why?*
We just had some problems with too deep armholes and with the fit of the sleeves within jackets. But we worked on this and therefore we solved the problem.

We solved it through corrected by putting the pattern on the stand and rearranging the lines.
Up to the end of 2003 we had two different groups of pattern technicians, one for the prototypes and one for the production. Since then they do work together in both areas within our BLUE collection. The exception is still our main collection GABRIELE STREHLE, there the two groups are still separated. Since the two groups have built one, we do have less problems when it comes to production. This reduction of the pattern technician tool has not only been a purely economically one. The situation between these groups is a different one today. Before that there was nearly no contact or conversation between them. This has changed by now.
I generally think that it is difficult to achieve a well fitting pair women's wear of trousers. Here at STRENESSE we do have the luxurious situation that we are allowed to try out every prototype at least three times on the dummy.
I personally prefer to work at the computer. It is much easier to control the distances and to work more exact. After a time you will be able to read the proportions of the garment, even if you have it on the small scale screen. I will definitely plot out a pattern at least three times. Then we are going to put it on the dummy and there I am able to check the proportion in full scale. And later on I am present during the fitting.

I personally pay attention to the proportion of a pattern. I normally look for the original centre back and then I put the original centre front at the waist line over the back piece. I do have a look at these three points. I do not only check the length of the pieces but also the proportion between them. I will also check the neck-line, the front neck line is normally 0.5 cm smaller than the back one.
I will also check the front and the back shoulder line and the front armhole in relation to the back armhole. It is easier to check all these points on the computer screen because here I am able to layer the different pieces, which is not possible when you work on hard board.

INTERVIEW WITH KARIN SCHILLER, LECTRA, ISMANING, MUNICH, 22. April 2005

1 *In which areas did LECTRA start to work with CAD programs?*

The main company in France was founded in 1973 by the brothers Jean and Benard Echepa. At that time there weren't a lot of companies around which were offering systems for the clothing industry, there were Kampsco, Suse and Gerber. All of them were very expensive systems. Because of that there was an urge for a cheaper product which should be able to read and cut stencils. From there LECTRA turned into LECTRA SYSTEMS. In the early 80s the LECTRA system was priced 250.000 DM (ca. 75.000 GBP).

Clothing products were the starting point for establishing the company. Because Lectra had their own hardware coming with the system it was cheaper for the customer. Later we changed that and used our system on a Hewlett Peckard computer working with the Linux system. Finally we had to change to Microsoft, because the consumer is used to it. Seven years later, in 1980, they opened a German office in Cologne as their first non-French office.
Later, with the 3D program, we took on working with other products, such as car seats, a project in co-operation with the TU in Dresden, parachutes and any other product which is made from fabric.

I am working with the 3D program for three years now. During the years LECTRA bought products from other companies, such as CDI, a Canadian company which was the first to investigate the three dimensional pattern construction within their software. They developed a good program which ran on a Silicon Graphics software. From there we developed the system in two different directions, one for the design of the pattern and one for creating a three-dimensional pattern. In the design area we bought Prima Vision and Colorado, two systems for designing the pattern. We also started to have strategic co-operations with Data Color and Storck (print) to develop the design area. The aim was to be able to use the LECTRA system from the beginning of the design up to the grading within the production.

2 *Had there been restrictions for the first patterns/garments developed with the computer?*

In comparison to the manual development of a pattern, it seemed to be completely modern and much more sufficient to work with the computer. But there had been lots of restrictions for that. For example the first tables for digitizing the pattern into the system had been difficult because the technology fast sometimes not as fast in sending the information over to the computer. Another problem was that it was only possible to lable the pattern pieces with eight, or later nine, characters. We saved the patterns on five and a half inch floppy disc. Sometimes it was possible to store the patterns of a whole season on one of them.

3 *Which manual pattern cutting system is the LECTRA system based on?*

Actually, we do not provide any patterns with our software system. When we do install the program we help the customer to digitalize their own patterns so that they have their own individual basic pattern on which they can do modifications on. LECTRA does not want to be used as a construction tool, it is supposed to be used as a tool for modifying existing pattern.

When the technician modifies the pattern the different sizes will all be modified automatically. You do not have to spend time on doing the changes in every size.

4 *Have you tried different systems, both, manual or computer generated ones? Why didn't you go on using it/them, why didn't you like it?*

There weren't a lot of computer generated systems around. Kampsco was really unpractical with its punched cards. Manually I only worked with the MUELLER&SOHN system.

5. *Have you personally been educated on this system during your training?*

I have been trained following the MUELLER&SOHN SYSTEM. I went to one of their courses at their own institutes. My background is the one of a pattern technician.

6. *Which measurements are you using for your pattern and on which survey are they based on?*

Again, when we install the system we also use the company's own measurements, the ones they have been used for their target group. I know that it is popular to construct a pattern in size 40 and label it 38. If the customer is satisfied and used to the company's sizes, than it does not make any sense to start using the correct measurements for the sizes coming from a sizing survey.

7. *How many clothing companies you know, which do construct there patterns with the help of the computer? Do you know if some still construct pattern manually?*

I cannot give you any figures, but I would say that at least 80 per cent of all the clothing producing companies in Germany use computer generated pattern cutting systems. This is approximately the case since ten years (1994).

8. *Have you ever thought about aspects of pattern cutting as being unpractical or insufficient in any way, maybe for specific garment types? If yes, please state why?*

I always say it is probably problematic to change a sufficient neck- and shoulder line. This is a very difficult area. The arm and the armhole is also a delicate area.

What sometimes occur are problems with the making up of the garments. We are not able to tell before in what way the fabric will react when glued together with different sorts of interlining. This is always problematic for the technicians.
Our 3D program is used to see the pattern on the figure. Therefore the customer is able to judge if he generally likes it or not. You do save a lot of time because you do not have to make as many prototypes.
We have one program for developing very tight fitting clothing such as bras or swimwear with our DESIGN CONCEPT, which works on the three dimensional model first and later transfers this into a two dimensional flat pattern. For garments not as tight, we use our VIRTUAL GARMENTS systems with which the two dimensional pattern is designed first and later the design can be seen on the three dimensional model on the screen. The 3D program allows to have quick first idea of what the garment might look like. You are also able to use the different fabrics or colours on the design. Therefore the decision between them, or between different aspects of the pattern itself, such as the form of the collar or the length of the sleeve, can be made much faster. LECTRA does not want to serve the designer. This may be different to other 3D concepts. At the moment the 3D program is a tool for having a view of the design or pattern worn by the virtual model. It also helps to see the pattern in various sizes on the matching virtual model. All changes have to made on the two dimensional pattern not on the three dimensional model.
LECTRA generally wants to follow the traditional way of making a flat pattern with a piece of paper and various lines on it. The main important figures are the length of the back, the width of the back and the width of the chest.
These parameters are still the same with our program. The program does not aim to design garments, because we think the designers themselves would not be satisfied with purely working on the computer.

Interview with *Dipl. Ing. Eva Hillers*, Teacher for Pattern Cutting at the University of Applied Sciences Niederrhein, Germany, 24th August 2005
1: *What pattern cutting system do you use?*
Our students learn to construct pattern of three different systems. First there is the OPTIKON system which was developed in the early 90s by my colleague Prof. Pohl. Then we use the COMTEC system which basically consists of the use of the body measurements as they are used in the MUELLER & SOHN system. Finally we use the OPTIMASS system which was invented in 1998 by the OPTIMASS group, of which I am a member. I personally prefer to work with the latest system.

2: *Why this one? Which advantages does it have in comparison to other systems?*

We developed the OPTIMASS system because we were not satisfied neither with the resulting fit of the garments, nor with the lack of logic of systems such as MUELLER & SOHN. For example the position, the size and the angle of a bust dart stands in relation to other measurements. In the above system all these aspects and the resulting dart seem to lack all logic. The same with the bust point. I think it is not useful to have a general measurement for the distance from the shoulder line down to mark the bust point, when this position is only right for a small amount of people.

3: *Have you tried different systems, or have you ever came across them during your professional life?*
As I have been working as an pattern instructor for many companies on an international bases, I came across many different pattern cutting systems. I quite like the Chinese system, but of course I was made to suit the Asian figure, not the European one. Another one of the systems I think is very useful is the system which was used in the Federal Republic of Germany. It is actually quite similar to our OPTIMASS system.

4: *Have you learned this system during your training?*
No, I learned to construct a pattern, following the HOHENSTEIN system.

5. *You worked for internationally orientated companies,which patten cutting system did you use then?*
I am familiar with every, or nearly every, pattern cutting used anywhere where mass production of clothing is made. They are all similar. Differences can only be seen in the various body measurements and the resulting sizes for the different nationalities. Most of the times the pattern cutters of the various companies use a mixture of different systems together with their own personal changes of the various systems.

6: *The University of Applied Sciences is strongly connected to the clothing industry. Do you think this is why you teach a special system?*
I think that it is important to prepare the students on their future job. We try to do that in the way that we teach three different pattern cutting systems. I think it is not helpful to know only one system which is popular in Germany, because as the production of fashion is nowadays mainly done abroad, the student or the future pattern cutter needs to be flexible. Whenever I meet an excellent pattern cutter anywhere in the world, he will probably have developed his own tricks on how to construct a pattern for a certain garment. Sometimes it is not easy to recognise the original pattern cutting system after all these individual changes.

7: *You also teach to work with the CAD system. Which advantages and disadvantages are there in the comparison between the* manual and the computer generated way of developing a flat pattern?
For my opinion the computer generated construction of a pattern as only advantages. Just think about the possibilities when it comes to sending the pattern to the company where the garments are produced. Of course the invention of CAD for the clothing industry definitely helped the current development, in which not only the production, but also the pattern department is relocated to the place of production.
During the last years of education I teach a made to measure course. The pattern for this course are the only ones which a constructed manually by the students. I think it is helpful for the understanding that the pattern needs to fit the human body. I start with a rectangular piece of paper which the students have to put onto the body, in order to understand the basic principles of pattern cutting.

8: *Which measurements do you use?*
I use my own measurements, which are based on my

9: *Have you ever thought about various aspects of pattern cutting as being unpractical or in-sufficient in any way?*
There are a lot of aspects which I think are insufficient. I can't even think of all of them at once. To name just a couple I would say that good fitting trousers for females are difficult to make because of the different ways of shrinking of the various parts of the garment when it is worn. I also think that is not easy to construct the pattern for a well fitted women's wear shirt.
Further Correspondence:
The OPTIMASS system was only developed because a group of critical students I had at that time argued that they are not satisfied with the pattern cutting systems they used at that time. At that time our students were very critical and always tried to come up with better solutions. Today this is different. Our students today generally take what is offered to them without questioning anything. But at that time to work with the students was very inspirational. We started with developing a simple sleeve and from there we said that a sleeve also needs an armhole.

Interview with Martin Shoben, former teacher for pattern cutting at the London College of Fashion, 17th February 2010

1: *Could you please tell me about your professional background?*
I have been working in the fashion industry for all my life, following my father who was a tailor. In July 1970 I started working at the *London College of Fashion* as a flat-pattern cutting teacher, a time when Philip Kunick still was on the board of the institute. At that time the college employed around fifty pattern cutters as teachers. I started to work on publications a couple of years after I came to the college. Since 1980, when I published my first book together with my colleague Janet Ward, I have written more than twenty different books on pattern cutting.
I left the London College of Fashion in 1997 because I wanted to establish my own school, *The London Center for Fashion Studies*, in Islington, London. I recently sold his *London Centre for Fashion Studies* to the *Northumbria University* with in Newcastle.
Today my company publishes ready-to-use block-pattern charts for womens-, mens- and childrenswear. All of these multi size pattern charts include the British sizes 10 to 22 for womenswear and 92 to 108 cm chest girth for menswear at shobenfashionmedia.com. For the menswear charts I have worked together with Alan Cannon Jones, who is currently Principle Lecturer at the *London College of Fashion*

2: *What is it you wanted to do differently when you developed your flat-pattern system?*
I wanted to avoid the common scale systems and also those unsupportable theoretically aspects – in order to concentrate on direct measurements for almost all block construction. Even though, Ihave to say that I think that a scale for the inside seam length of trousers can be helpful.

3: *What is your approach on flat-pattern cutting?*
My written work is aimed at the clothing industry and at industry training. Despite this I assume that none of the published flat-pattern cutting systems is directly used in the process of clothing production. A textbook for cutting patterns can only be a guideline for explaining the overall construction. There is likely to be a personal adaptation of aspects taken from one or more flat-pattern cutting systems together with further individual developments of the construction depending on the personal experiences of the pattern cutter.

4: *Why do you construct a block-pattern for a jacket from a bodice block with attaching the part down to hip in a later construction?*
I think that by starting with the bodice you will achieve a better jacket pattern. I personally do not appreciate the systems which construct down to the hip in one step.

5: *Why do you think is body movement so much un-reflected in block-pattern cutting?*
I am of the opinion that a block-pattern does not fit while being worn. I think that the aspect of allowing for movement starts with the fashion-pattern, not with the block.

Interview with Claire Rüdiger, former teacher for pattern cutting at the Lette Verein, Berlin, Germany, 31st March 2010

1: *Which measurements do you use?*
We used the size charts by the Hohenstein Institut.

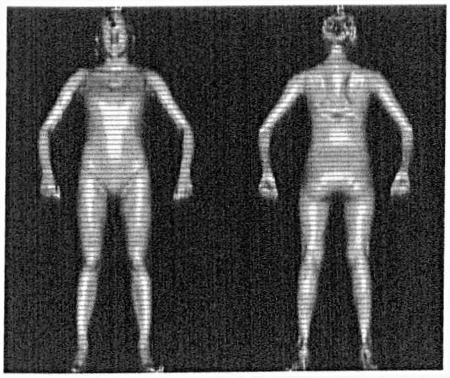
2: *Have you tried different systems, or have you ever came across them during your professional life?*
No, we invented our own system at the Lette Verein, simply because we did not want to pay for using the MMüller&Sohn system. The idea for developing our own system grew out of the fact that me and my colleague, Jutta Jansen, collected so much teaching material and as we both were not satisfied with the Müller system, we decided to develop our own system. Hereby it was important for us to develiop a simple system which could be understood and used easily by the students. I joined the Lette Verein in 1979 and Jutta Jansen in 1981. You can imagine the amount of material which we collected until our first book was published in 1990.
3: *Have you learned the Müller system during your training?*
Yes and I thought it was quite complicated as instructions for students..
4. *What in particular did you not like when constructing with the Müller system?*
I do criticise the M.Müller&Sohn teaching recommendations of working in a 1:25 scale.
5. In what way is your system different to the Müller?
We introduced flat-pattern construction on a full scale with which we got better results because beginners are not able to spot mistakes on a small scale.
The instructions given are less scientific in describing each step, compared to the M.Müller&Sohn system and the easy to understand graphics in combination with a clear structure and only the most necessary instructions make it easier for being used at the institute. The aim of the written work was to ease the way from the block-pattern to fashion-pattern.

Interview with Prof. *Dr. Otto Niemann*, Professor for Textiles at the University of Paderborn, Germany, 21st April 2010

1: *Prof. Dr. Niemann, you are a specialist in the field of historic pattern cutting. Could you explain why the MMüller&Sohn flat-pattern cutting system achieved the status of the system for German speaking countries?*
I store around 300 different flat-pattern cutting systems in my archive, dating from before the Second World War. The MMüller&Sohn system is not the best because it is sometimes complicated in the way the construction is explained, but it is said that the Xaver Müller was a great follower of the Nazi party during the Third Reich. As the Nazis wanted to control every part of live of the German people and of course they needed flat-pattern for the mass production of uniforms,
it was arranged that the concentration in this field would be for a single system which could be used in all ways of clothing production, either by the industry or by the seamstress at home. Of course this is all rumour, even though if one would search at the archive of the state in Munich, he might find some proofing documents.
2: *Is it still part of the Master examination to be able to construct a pattern by the MMüller&Sohn system?*

I am not sure. I think it is not asked explicidly for that system, but as it is still part of the curricula of most institutes, it will probably be the system of choice for the candidates.
3: *You wrote a very interesting booklet about the development of flat-pattern systems. Could you please tell me some background about this?*
I wrote this booklet in 1986 in behalf of the Braunschweiger Krankenkasse.
At that time Braunschweiger was the health fund for all people working in the textile and clothing industry. Because of the increased number of such occupations, the health fund was closed by the 1990s. What was very interesting to see, was, that there were tailoring schools in Germany before there were institutes for architects. One of the first was the Dresdner Akademie.

Appendix 4



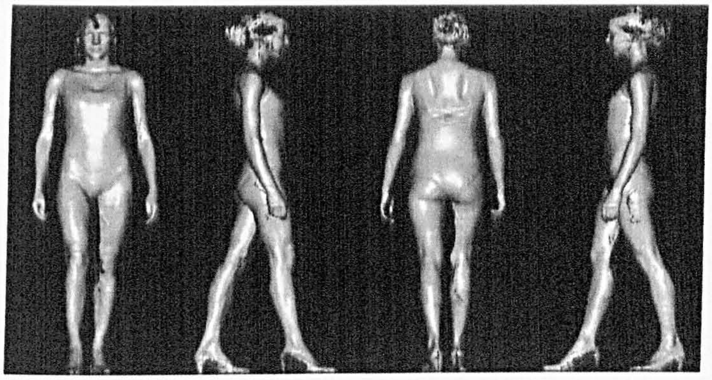
Measurement Names	Measurement IDs	
Body height (cm)	10	174,5
Head height (cm)	20	25,8
Neck height (cm)	30	148,7
Distance neck to hip (cm)	40	61,4
Distance neck-knee (cm)	50	102,2
Distance waist-knee (cm)	60	64,6
Distance waistband-knee (cm)	65	59
Waistband height (cm)	70	105,2
Waist height (cm)	80	111,1
High waist height (cm)	85	111,1
Buttock height (cm)	90	87,3
Hip height (cm)	95	81,3
Crotch height (cm)	100	80,6
Knee height (cm)	110	46,5
Ankle height (cm)	120	7,7
Belly circumference height (cm)	150	102,5
Maximum belly circumference height (cm)	155	101,5
Height of shoulder blades (cm)	160	136,7
scapula height 2 (cm)	165	133,5
Breast height (cm)	170	126,7
Neck height front (cm)	180	143,5
Distance 7CV - vertical (cm)	510	28,7
Distance neck front to vertical (cm)	515	37,6
Distance scapula to vertical (cm)	520	24
Distance waist back to vertical (cm)	530	29,9
Distance buttock to vertical (cm)	540	24,2
Distance abdomen to vertical (cm)	550	45,6
Distance breast to vertical (cm)	600	49,5

Distance back in breast height to vertical (cm)	610	26,4
Distance belly to vertical (cm)	620	48,8
Distance back in belly height to vertical (cm)	630	28,3
waistband front to vertical (cm)	640	48,8
3D waistband front to vertical (cm)	641	48,8
waistband back to vertical (cm)	645	29,1
3D waistband back to vertical (cm)	646	29,1
Distance back in maximum belly height to vertical (cm)	650	28
Distance maximum belly to vertical (cm)	660	48,7
Distance front in hip height to vertical (cm)	670	45,1
Distance back in hip height to vertical (cm)	680	25,6
waistband front height (cm)	690	104,8
3D waistband front height (cm)	691	104,8
waistband back height (cm)	695	105,5
3D waistband back height (cm)	696	105,5
3D waistband left to crotch (cm)	990	24,6
3D waistband right to crotch (cm)	995	24,6
Upper torso torsion (°)	996	-0,3
Distance crotch to waistband (cm)	997	24,6
Neck diameter (cm)	1010	12,1
Mid neck girth (cm)	1510	30,8
Neck at base girth (cm)	1520	36,2
Head circumference (cm)	1530	
Side upper torso length left (cm)	2010	24,7
Side upper torso length right (cm)	2020	24,5
Torso width at waist (cm)	2030	36,9
Total torso girth (cm)	2510	157,4
Cross shoulder over neck (cm)	3010	40,3
Cross shoulder (cm)	3020	43,2
Shoulder width left (cm)	3030	14,5
Shoulder width right (cm)	3031	13,7
Shoulder angle left (°)	3910	26,1
Shoulder angle right (°)	3911	22,2
Across front width (cm)	4010	38,3
Width armpits (cm)	4020	40,4
Bust points width (cm)	4030	18
Neck right to waist over bust (cm)	4040	44,5
Neck front to waist (cm)	4050	35,8
Neck front to waist over bust line (cm)	4060	35,8
Bust points around neck (cm)	4070	69,7

Bust point to neck left (cm)	4080	28,2
Bust point to neck right (cm)	4081	27,9
Bust/chest girth (horizontal) (cm)	4510	90,3
Bust/chest girth (cm)	4515	85,8
Underbust circumference (horizontal) (cm)	4520	79,5
Across back width (cm)	5010	34,6
Across back width (armpit level) (cm)	5020	32,9
Neck to across back width (armpit level) (cm)	5030	13,5
Neck to waist center back (cm)	5040	37,9
Neck left to waist back (cm)	5050	41,6
Neck right to waist back (cm)	5051	41,2
Distance across back width (armpit level) - waist (cm)	5060	24
Waist to high hip back (cm)	5070	10,3
Distance waistband-high hip back (cm)	5075	4,8
Waist to buttock (cm)	5080	24
Distance waistband - buttock (cm)	5085	18,2
Crotch length (cm)	6010	75
Crotch length, front (cm)	6011	36,4
Crotch length, rear (cm)	6012	38,6
Crotch length at waistband (cm)	6015	62,8
Crotch length at waistband A (cm)	6016	62,8
Dev. waist band from waist (front) (cm)	6020	-6,4
Dev. waist band from waist (back) (cm)	6030	-5,7
Dev. waist band from waist (side) (cm)	6040	-5,5
Waist girth (cm)	6510	71,8
High waist girth (cm)	6515	71,8
Waist band (cm)	6520	77
3D waist band (cm)	6525	77
Waist to buttock height left (cm)	7010	24,3
Waist to buttock height right (cm)	7011	24,1
Waistband to buttock height left (cm)	7015	18,2
Waistband to buttock height right (cm)	7016	18
Waist to hip/thigh left (cm)	7020	35,1
Waist to hip/thigh right (cm)	7021	34,9
High hip girth (cm)	7510	84
Buttock girth (cm)	7520	93,4
Hip girth (cm)	7525	95,5
Hip/thigh girth (cm)	7530	94,2
Belly circumference (cm)	7540	81,5
Maximum belly circumference (cm)	7545	82,9

Arm length to neck back left (cm)	8010	82,7
Arm length to neck back right (cm)	8011	82,5
Arm length to neck left (cm)	8020	76,7
Arm length to neck right (cm)	8021	76,3
Arm length left (cm)	8030	62,2
Arm length right (cm)	8031	62,6
Upper arm length left (cm)	8040	33,3
Upper arm length right (cm)	8041	34,6
Forearm length left (cm)	8050	28,9
Forearm length right (cm)	8051	28
Upper arm girth left (cm)	8520	25,2
Upper arm girth right (cm)	8521	24,9
Ellbow girth left (cm)	8530	23,4
Ellbow girth right (cm)	8531	24,2
Forearm girth left (cm)	8540	23,2
Forearm girth right (cm)	8541	23,8
Wrist girth left (cm)	8550	15,5
Wrist girth right (cm)	8551	15,9
Upper arm diameter left (cm)	8910	9,2
Upper arm diameter right (cm)	8911	9,3
Inside leg-ankle left (cm)	9010	73,7
Inside leg-ankle right (cm)	9011	73,7
Inseam left (cm)	9020	81,3
Inseam right (cm)	9021	81,2
Sideseam left (cm)	9030	105,9
Sideseam right (cm)	9031	105,7
sideseam 3D waistband left (cm)	9032	106
sideseam 3D waistband right (cm)	9033	105,7
Sideseam at waist left (cm)	9035	112
Sideseam at waist right (cm)	9036	111,7
Sideseam ankle left (cm)	9040	98,2
Sideseam ankle right (cm)	9041	98
Thigh girth left (horizontal) (cm)	9510	52,1
Thigh girth right (horizontal) (cm)	9511	51,6
Knee girth left (cm)	9520	34,9
Knee girth right (cm)	9521	34,5
calf girth left (cm)	9540	34,9
calf girth right (cm)	9541	34
Ankle girth left (cm)	9550	25
Ankle girth right (cm)	9551	25,3
min. leg girth left (cm)	9580	21,2

min. leg girth right (cm)	9581	21,1
Weight (kg)	9800	



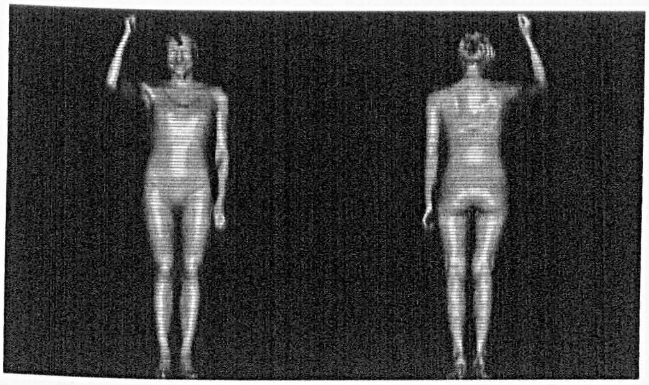
Measurement Names	Measurement IDs	
Body height (cm)	10	176,8
Head height (cm)	20	25,1
Neck height (cm)	30	151,7
Distance neck to hip (cm)	40	63,3
Distance neck-knee (cm)	50	104,6
Distance waist-knee (cm)	60	63,5
Distance waistband-knee (cm)	65	59,9
Waistband height (cm)	70	106,7
Waist height (cm)	80	110,7
High waist height (cm)	85	112,6
Buttock height (cm)	90	88,4
Hip height (cm)	95	78,9
Crotch height (cm)	100	81,8
Knee height (cm)	110	47,1
Ankle height (cm)	120	7,8
Belly circumference height (cm)	150	103,7
Maximum belly circumference height (cm)	155	102,7
Height of shoulder blades (cm)	160	138,2
scapula height 2 (cm)	165	135,5
Breast height (cm)	170	129,4
Neck height front (cm)	180	145,1
Distance 7CV - vertical (cm)	510	38,9
Distance neck front to vertical (cm)	515	47,9
Distance scapula to vertical (cm)	520	33,6
Distance waist back to vertical (cm)	530	40,4
Distance buttock to vertical (cm)	540	36,9
Distance abdomen to vertical (cm)	550	59,3
Distance breast to vertical (cm)	600	58,6

Distance back in breast height to vertical (cm)	610	35,8
Distance belly to vertical (cm)	620	59,6
Distance back in belly height to vertical (cm)	630	39,2
waistband front to vertical (cm)	640	59,5
3D waistband front to vertical (cm)	641	59,5
waistband back to vertical (cm)	645	40
3D waistband back to vertical (cm)	646	40
Distance back in maximum belly height to vertical (cm)	650	38,8
Distance maximum belly to vertical (cm)	660	59,5
Distance front in hip height to vertical (cm)	670	61,7
Distance back in hip height to vertical (cm)	680	37,1
waistband front height (cm)	690	106,4
3D waistband front height (cm)	691	106,4
waistband back height (cm)	695	107,1
3D waistband back height (cm)	696	107,1
3D waistband left to crotch (cm)	990	24,9
3D waistband right to crotch (cm)	995	24,9
Upper torso torsion (°)	996	-0,1
Distance crotch to waistband (cm)	997	24,9
Neck diameter (cm)	1010	11,6
Mid neck girth (cm)	1510	31,4
Neck at base girth (cm)	1520	37,4
Head circumference (cm)	1530	
Side upper torso length left (cm)	2010	25,3
Side upper torso length right (cm)	2020	24,3
Torso width at waist (cm)	2030	36,9
Total torso girth (cm)	2510	165
Cross shoulder over neck (cm)	3010	39,8
Cross shoulder (cm)	3020	43,8
Shoulder width left (cm)	3030	13,6
Shoulder width right (cm)	3031	13,9
Shoulder angle left (°)	3910	23,7
Shoulder angle right (°)	3911	22,1
Across front width (cm)	4010	36,1
Width armpits (cm)	4020	39,8
Bust points width (cm)	4030	19
Neck right to waist over bust (cm)	4040	46,8
Neck front to waist (cm)	4050	37,5
Neck front to waist over bust line (cm)	4060	37,5
Bust points around neck (cm)	4070	68,7

Bust point to neck left (cm)	4080	27,8
Bust point to neck right (cm)	4081	27,5
Bust/chest girth (horizontal) (cm)	4510	90,8
Bust/chest girth (cm)	4515	86,7
Underbust circumference (horizontal) (cm)	4520	79,2
Across back width (cm)	5010	34,7
Across back width (armpit level) (cm)	5020	34,5
Neck to across back width (armpit level) (cm)	5030	16,6
Neck to waist center back (cm)	5040	42,1
Neck left to waist back (cm)	5050	45,6
Neck right to waist back (cm)	5051	45,1
Distance across back width (armpit level) - waist (cm)	5060	25
Waist to high hip back (cm)	5070	8,5
Distance waistband-high hip back (cm)	5075	5,1
Waist to buttock (cm)	5080	22,2
Distance waistband - buttock (cm)	5085	18,6
Crotch length (cm)	6010	79,3
Crotch length, front (cm)	6011	36,7
Crotch length, rear (cm)	6012	42,5
Crotch length at waistband (cm)	6015	71,7
Crotch length at waistband A (cm)	6016	71,7
Dev. waist band from waist (front) (cm)	6020	-4,2
Dev. waist band from waist (back) (cm)	6030	-3,6
Dev. waist band from waist (side) (cm)	6040	-3,7
Waist girth (cm)	6510	73,9
High waist girth (cm)	6515	71,8
Waist band (cm)	6520	79,3
3D waist band (cm)	6525	79,2
Waist to buttock height left (cm)	7010	22,6
Waist to buttock height right (cm)	7011	22,5
Waistband to buttock height left (cm)	7015	18,5
Waistband to buttock height right (cm)	7016	18,5
Waist to hip/thigh left (cm)	7020	33,5
Waist to hip/thigh right (cm)	7021	33
High hip girth (cm)	7510	86,2
Buttock girth (cm)	7520	95,5
Hip girth (cm)	7525	92
Hip/thigh girth (cm)	7530	92,3
Belly circumference (cm)	7540	84,1
Maximum belly circumference (cm)	7545	85,2

Arm length to neck back left (cm)	8010	84,9
Arm length to neck back right (cm)	8011	84,9
Arm length to neck left (cm)	8020	78,9
Arm length to neck right (cm)	8021	78,6
Arm length left (cm)	8030	65,3
Arm length right (cm)	8031	64,7
Upper arm length left (cm)	8040	34,9
Upper arm length right (cm)	8041	34,6
Forearm length left (cm)	8050	30,4
Forearm length right (cm)	8051	30,1
Upper arm girth left (cm)	8520	24,2
Upper arm girth right (cm)	8521	24,3
Ellbow girth left (cm)	8530	22,4
Ellbow girth right (cm)	8531	23,5
Forearm girth left (cm)	8540	22,9
Forearm girth right (cm)	8541	23,8
Wrist girth left (cm)	8550	15,6
Wrist girth right (cm)	8551	16
Upper arm diameter left (cm)	8910	9,8
Upper arm diameter right (cm)	8911	10,1
Inside leg-ankle left (cm)	9010	75,8
Inside leg-ankle right (cm)	9011	76,6
Inseam left (cm)	9020	83,3
Inseam right (cm)	9021	84,2
Sideseam left (cm)	9030	111,1
Sideseam right (cm)	9031	108,2
sideseam 3D waistband left (cm)	9032	111,1
sideseam 3D waistband right (cm)	9033	108,2
Sideseam at waist left (cm)	9035	115,2
Sideseam at waist right (cm)	9036	112,3
Sideseam ankle left (cm)	9040	103,4
Sideseam ankle right (cm)	9041	100,3
Thigh girth left (horizontal) (cm)	9510	52,9
Thigh girth right (horizontal) (cm)	9511	52,1
Knee girth left (cm)	9520	32,7
Knee girth right (cm)	9521	32,4
calf girth left (cm)	9540	33,2
calf girth right (cm)	9541	33,3
Ankle girth left (cm)	9550	36,5
Ankle girth right (cm)	9551	37,4
min. leg girth left (cm)	9580	

min. leg girth right (cm)	9581	
Weight (kg)	9800	



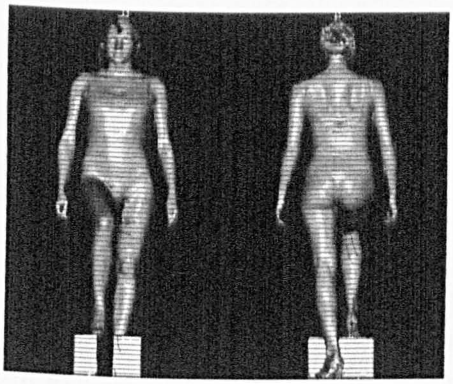
Measurement Names	Measurement IDs	
Body height (cm)	10	185,8
Head height (cm)	20	
Neck height (cm)	30	
Distance neck to hip (cm)	40	
Distance neck-knee (cm)	50	
Distance waist-knee (cm)	60	
Distance waistband-knee (cm)	65	
Waistband height (cm)	70	
Waist height (cm)	80	
High waist height (cm)	85	
Buttock height (cm)	90	93,3
Hip height (cm)	95	
Crotch height (cm)	100	83,8
Knee height (cm)	110	49,7
Ankle height (cm)	120	8,2
Belly circumference height (cm)	150	109
Maximum belly circumference height (cm)	155	108
Height of shoulder blades (cm)	160	
scapula height 2 (cm)	165	142,1
Breast height (cm)	170	
Neck height front (cm)	180	147,5
Distance 7CV - vertical (cm)	510	
Distance neck front to vertical (cm)	515	37,5
Distance scapula to vertical (cm)	520	
Distance waist back to vertical (cm)	530	
Distance buttock to vertical (cm)	540	26,5
Distance abdomen to vertical (cm)	550	47,8

Distance breast to vertical (cm)	600	
Distance back in breast height to vertical (cm)	610	
Distance belly to vertical (cm)	620	50,7
Distance back in belly height to vertical (cm)	630	30,8
waistband front to vertical (cm)	640	
3D waistband front to vertical (cm)	641	
waistband back to vertical (cm)	645	
3D waistband back to vertical (cm)	646	
Distance back in maximum belly height to vertical (cm)	650	30,7
Distance maximum belly to vertical (cm)	660	50,8
Distance front in hip height to vertical (cm)	670	
Distance back in hip height to vertical (cm)	680	
waistband front height (cm)	690	
3D waistband front height (cm)	691	
waistband back height (cm)	695	
3D waistband back height (cm)	696	
3D waistband left to crotch (cm)	990	
3D waistband right to crotch (cm)	995	
Upper torso torsion (°)	996	11,1
Distance crotch to waistband (cm)	997	
Neck diameter (cm)	1010	
Mid neck girth (cm)	1510	
Neck at base girth (cm)	1520	
Head circumference (cm)	1530	
Side upper torso length left (cm)	2010	
Side upper torso length right (cm)	2020	
Torso width at waist (cm)	2030	
Total torso girth (cm)	2510	
Cross shoulder over neck (cm)	3010	
Cross shoulder (cm)	3020	38,1
Shoulder width left (cm)	3030	14,4
Shoulder width right (cm)	3031	12,8
Shoulder angle left (°)	3910	31,2
Shoulder angle right (°)	3911	20,5
Across front width (cm)	4010	46,4
Width armpits (cm)	4020	19,9
Bust points width (cm)	4030	21
Neck right to waist over bust (cm)	4040	45

Neck front to waist (cm)	4050	34,8
Neck front to waist over bust line (cm)	4060	43,8
Bust points around neck (cm)	4070	
Bust point to neck left (cm)	4080	24,4
Bust point to neck right (cm)	4081	25,8
Bust/chest girth (horizontal) (cm)	4510	91,1
Bust/chest girth (cm)	4515	86
Underbust circumference (horizontal) (cm)	4520	83,7
Across back width (cm)	5010	25,2
Across back width (armpit level) (cm)	5020	29
Neck to across back width (armpit level) (cm)	5030	
Neck to waist center back (cm)	5040	46,1
Neck left to waist back (cm)	5050	
Neck right to waist back (cm)	5051	
Distance across back width (armpit level) - waist (cm)	5060	
Waist to high hip back (cm)	5070	
Distance waistband-high hip back (cm)	5075	
Waist to buttock (cm)	5080	21,8
Distance waistband - buttock (cm)	5085	
Crotch length (cm)	6010	76,1
Crotch length, front (cm)	6011	36
Crotch length, rear (cm)	6012	40,1
Crotch length at waistband (cm)	6015	76,1
Crotch length at waistband A (cm)	6016	76,1
Dev. waist band from waist (front) (cm)	6020	
Dev. waist band from waist (back) (cm)	6030	
Dev. waist band from waist (side) (cm)	6040	
Waist girth (cm)	6510	72,6
High waist girth (cm)	6515	
Waist band (cm)	6520	
3D waist band (cm)	6525	
Waist to buttock height left (cm)	7010	22,6
Waist to buttock height right (cm)	7011	
Waistband to buttock height left (cm)	7015	
Waistband to buttock height right (cm)	7016	
Waist to hip/thigh left (cm)	7020	
Waist to hip/thigh right (cm)	7021	
High hip girth (cm)	7510	82
Buttock girth (cm)	7520	92,6

Hip girth (cm)	7525	
Hip/thigh girth (cm)	7530	
Belly circumference (cm)	7540	79,5
Maximum belly circumference (cm)	7545	80,6
Arm length to neck back left (cm)	8010	86,1
Arm length to neck back right (cm)	8011	77,8
Arm length to neck left (cm)	8020	76,1
Arm length to neck right (cm)	8021	74,4
Arm length left (cm)	8030	57,8
Arm length right (cm)	8031	63,5
Upper arm length left (cm)	8040	31,2
Upper arm length right (cm)	8041	34,5
Forearm length left (cm)	8050	25
Forearm length right (cm)	8051	23,5
Upper arm girth left (cm)	8520	24,7
Upper arm girth right (cm)	8521	25,9
Ellbow girth left (cm)	8530	
Ellbow girth right (cm)	8531	
Forearm girth left (cm)	8540	
Forearm girth right (cm)	8541	
Wrist girth left (cm)	8550	16,1
Wrist girth right (cm)	8551	15,8
Upper arm diameter left (cm)	8910	6,1
Upper arm diameter right (cm)	8911	8,9
Inside leg-ankle left (cm)	9010	68,4
Inside leg-ankle right (cm)	9011	69,2
Inseam left (cm)	9020	
Inseam right (cm)	9021	
Sideseam left (cm)	9030	110,9
Sideseam right (cm)	9031	110,7
sideseam 3D waistband left (cm)	9032	
sideseam 3D waistband right (cm)	9033	
Sideseam at waist left (cm)	9035	
Sideseam at waist right (cm)	9036	
Sideseam ankle left (cm)	9040	
Sideseam ankle right (cm)	9041	
Thigh girth left (horizontal) (cm)	9510	54,3
Thigh girth right (horizontal) (cm)	9511	54,4
Knee girth left (cm)	9520	32,6
Knee girth right (cm)	9521	32,5

calf girth left (cm)	9540	34,1
calf girth right (cm)	9541	34,7
Ankle girth left (cm)	9550	36,7
Ankle girth right (cm)	9551	37,2
min. leg girth left (cm)	9580	22
min. leg girth right (cm)	9581	21,9
Weight (kg)	9800	



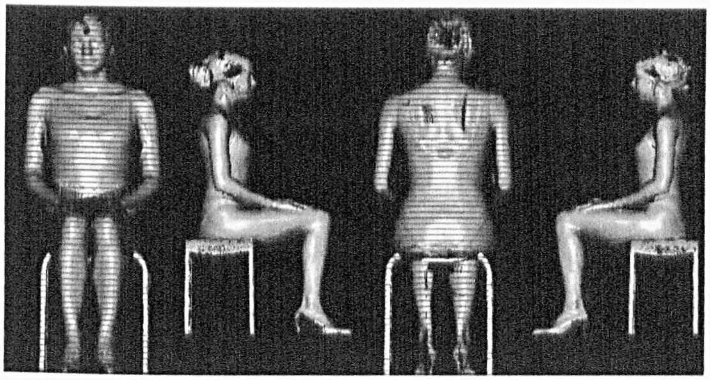
Measurement Names	Measurement IDs	
Body height (cm)	10	177,9
Head height (cm)	20	24,7
Neck height (cm)	30	153,2
Distance neck to hip (cm)	40	62,5
Distance neck-knee (cm)	50	104,8
Distance waist-knee (cm)	60	66,5
Distance waistband-knee (cm)	65	61,1
Waistband height (cm)	70	106,1
Waist height (cm)	80	114,9
High waist height (cm)	85	114,9
Buttock height (cm)	90	90,7
Hip height (cm)	95	80,7
Crotch height (cm)	100	77,1
Knee height (cm)	110	48,3
Ankle height (cm)	120	7,8
Belly circumference height (cm)	150	105,9
Maximum belly circumference height (cm)	155	104,9
Height of shoulder blades (cm)	160	140,5
scapula height 2 (cm)	165	136,2
Breast height (cm)	170	131
Neck height front (cm)	180	146,1
Distance 7CV - vertical (cm)	510	30,4
Distance neck front to vertical (cm)	515	39,7
Distance scapula to vertical (cm)	520	25,2
Distance waist back to vertical (cm)	530	31,1
Distance buttock to vertical (cm)	540	25,6
Distance abdomen to vertical (cm)	550	59

Distance breast to vertical (cm)	600	50,5
Distance back in breast height to vertical (cm)	610	27,8
Distance belly to vertical (cm)	620	48,6
Distance back in belly height to vertical (cm)	630	28,4
waistband front to vertical (cm)	640	48,1
3D waistband front to vertical (cm)	641	48,1
waistband back to vertical (cm)	645	29,9
3D waistband back to vertical (cm)	646	29,9
Distance back in maximum belly height to vertical (cm)	650	27,9
Distance maximum belly to vertical (cm)	660	48,5
Distance front in hip height to vertical (cm)	670	73,7
Distance back in hip height to vertical (cm)	680	28,2
waistband front height (cm)	690	102,8
3D waistband front height (cm)	691	102,8
waistband back height (cm)	695	109,4
3D waistband back height (cm)	696	109,4
3D waistband left to crotch (cm)	990	29
3D waistband right to crotch (cm)	995	29
Upper torso torsion (°)	996	1,2
Distance crotch to waistband (cm)	997	29
Neck diameter (cm)	1010	11,8
Mid neck girth (cm)	1510	31,4
Neck at base girth (cm)	1520	38,4
Head circumference (cm)	1530	
Side upper torso length left (cm)	2010	22,8
Side upper torso length right (cm)	2020	22,2
Torso width at waist (cm)	2030	36
Total torso girth (cm)	2510	207,2
Cross shoulder over neck (cm)	3010	39,9
Cross shoulder (cm)	3020	42,8
Shoulder width left (cm)	3030	13,9
Shoulder width right (cm)	3031	14,1
Shoulder angle left (°)	3910	26,6
Shoulder angle right (°)	3911	22,2
Across front width (cm)	4010	38,4
Width armpits (cm)	4020	42,2
Bust points width (cm)	4030	19,4
Neck right to waist over bust (cm)	4040	44,6
Neck front to waist (cm)	4050	34,5

Neck front to waist over bust line (cm)	4060	34,5
Bust points around neck (cm)	4070	69,4
Bust point to neck left (cm)	4080	27,7
Bust point to neck right (cm)	4081	27,9
Bust/chest girth (horizontal) (cm)	4510	90,6
Bust/chest girth (cm)	4515	88,2
Underbust circumference (horizontal) (cm)	4520	85,2
Across back width (cm)	5010	33,6
Across back width (armpit level) (cm)	5020	32,4
Neck to across back width (armpit level) (cm)	5030	16,6
Neck to waist center back (cm)	5040	38,9
Neck left to waist back (cm)	5050	42,9
Neck right to waist back (cm)	5051	42,3
Distance across back width (armpit level) - waist (cm)	5060	21,9
Waist to high hip back (cm)	5070	11,1
Distance waistband-high hip back (cm)	5075	5,2
Waist to buttock (cm)	5080	24,8
Distance waistband - buttock (cm)	5085	18,7
Crotch length (cm)	6010	92,8
Crotch length, front (cm)	6011	
Crotch length, rear (cm)	6012	
Crotch length at waistband (cm)	6015	76,7
Crotch length at waistband A (cm)	6016	76,7
Dev. waist band from waist (front) (cm)	6020	-12,3
Dev. waist band from waist (back) (cm)	6030	-5,7
Dev. waist band from waist (side) (cm)	6040	-7,6
Waist girth (cm)	6510	71,1
High waist girth (cm)	6515	71,1
Waist band (cm)	6520	81,2
3D waist band (cm)	6525	81,2
Waist to buttock height left (cm)	7010	30,3
Waist to buttock height right (cm)	7011	28,1
Waistband to buttock height left (cm)	7015	15,7
Waistband to buttock height right (cm)	7016	15,5
Waist to hip/thigh left (cm)	7020	42,6
Waist to hip/thigh right (cm)	7021	52,7
High hip girth (cm)	7510	84,8
Buttock girth (cm)	7520	107,9
Hip girth (cm)	7525	117,6

Hip/thigh girth (cm)	7530	119,4
Belly circumference (cm)	7540	82,5
Maximum belly circumference (cm)	7545	83,7
Arm length to neck back left (cm)	8010	83,6
Arm length to neck back right (cm)	8011	83,9
Arm length to neck left (cm)	8020	77,6
Arm length to neck right (cm)	8021	78
Arm length left (cm)	8030	63,7
Arm length right (cm)	8031	63,9
Upper arm length left (cm)	8040	33,7
Upper arm length right (cm)	8041	32,8
Forearm length left (cm)	8050	30
Forearm length right (cm)	8051	31,1
Upper arm girth left (cm)	8520	24,2
Upper arm girth right (cm)	8521	24
Ellbow girth left (cm)	8530	22,4
Ellbow girth right (cm)	8531	22,5
Forearm girth left (cm)	8540	23,1
Forearm girth right (cm)	8541	23,8
Wrist girth left (cm)	8550	15,5
Wrist girth right (cm)	8551	
Upper arm diameter left (cm)	8910	8,8
Upper arm diameter right (cm)	8911	9,8
Inside leg-ankle left (cm)	9010	84
Inside leg-ankle right (cm)	9011	77,6
Inseam left (cm)	9020	
Inseam right (cm)	9021	
Sideseam left (cm)	9030	107,8
Sideseam right (cm)	9031	107,8
sideseam 3D waistband left (cm)	9032	107,8
sideseam 3D waistband right (cm)	9033	107,8
Sideseam at waist left (cm)	9035	116,4
Sideseam at waist right (cm)	9036	116,6
Sideseam ankle left (cm)	9040	100,1
Sideseam ankle right (cm)	9041	100,2
Thigh girth left (horizontal) (cm)	9510	110,3
Thigh girth right (horizontal) (cm)	9511	43,1
Knee girth left (cm)	9520	31,8
Knee girth right (cm)	9521	27,4
calf girth left (cm)	9540	33,3

calf girth right (cm)	9541	26,6
Ankle girth left (cm)	9550	133,5
Ankle girth right (cm)	9551	92,6
min. leg girth left (cm)	9580	
min. leg girth right (cm)	9581	
Weight (kg)	9800	



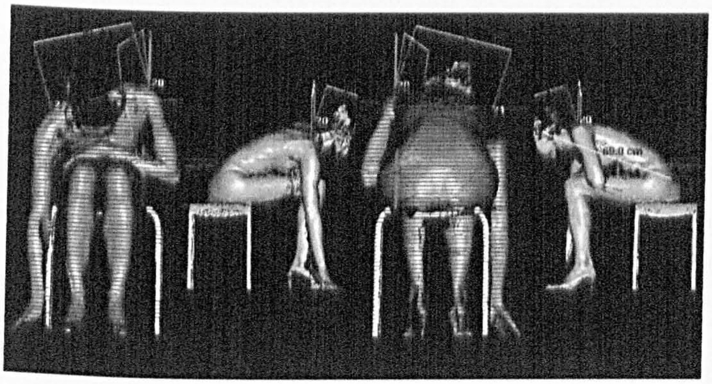
Measurement Names	Measurement IDs	
Body height (cm)	10	136,3
Head height (cm)	20	
Neck height (cm)	30	
Distance neck to hip (cm)	40	
Distance neck-knee (cm)	50	
Distance waist-knee (cm)	60	
Distance waistband-knee (cm)	65	36,6
Waistband height (cm)	70	75,9
Waist height (cm)	80	
High waist height (cm)	85	
Buttock height (cm)	90	60,1
Hip height (cm)	95	51,6
Crotch height (cm)	100	47,8
Knee height (cm)	110	42,5
Ankle height (cm)	120	6
Belly circumference height (cm)	150	72,8
Maximum belly circumference height (cm)	155	78,8
Height of shoulder blades (cm)	160	
scapula height 2 (cm)	165	104,7
Breast height (cm)	170	
Neck height front (cm)	180	104,2
Distance 7CV - vertical (cm)	510	
Distance neck front to vertical (cm)	515	41,6
Distance scapula to vertical (cm)	520	
Distance waist back to vertical (cm)	530	
Distance buttock to vertical (cm)	540	27,6
Distance abdomen to vertical (cm)	550	81,9

Distance breast to vertical (cm)	600	
Distance back in breast height to vertical (cm)	610	
Distance belly to vertical (cm)	620	49,1
Distance back in belly height to vertical (cm)	630	29,9
waistband front to vertical (cm)	640	49,6
3D waistband front to vertical (cm)	641	49,6
waistband back to vertical (cm)	645	29,9
3D waistband back to vertical (cm)	646	29,9
Distance back in maximum belly height to vertical (cm)	650	29,9
Distance maximum belly to vertical (cm)	660	49,9
Distance front in hip height to vertical (cm)	670	85,4
Distance back in hip height to vertical (cm)	680	27,3
waistband front height (cm)	690	75,6
3D waistband front height (cm)	691	75,6
waistband back height (cm)	695	76,3
3D waistband back height (cm)	696	76,3
3D waistband left to crotch (cm)	990	28,2
3D waistband right to crotch (cm)	995	28,2
Upper torso torsion (°)	996	0
Distance crotch to waistband (cm)	997	28,2
Neck diameter (cm)	1010	
Mid neck girth (cm)	1510	
Neck at base girth (cm)	1520	
Head circumference (cm)	1530	
Side upper torso length left (cm)	2010	
Side upper torso length right (cm)	2020	
Torso width at waist (cm)	2030	
Total torso girth (cm)	2510	
Cross shoulder over neck (cm)	3010	
Cross shoulder (cm)	3020	74,2
Shoulder width left (cm)	3030	
Shoulder width right (cm)	3031	
Shoulder angle left (°)	3910	
Shoulder angle right (°)	3911	
Across front width (cm)	4010	83
Width armpits (cm)	4020	37,7
Bust points width (cm)	4030	37,7
Neck right to waist over bust (cm)	4040	40,1
Neck front to waist (cm)	4050	31,8

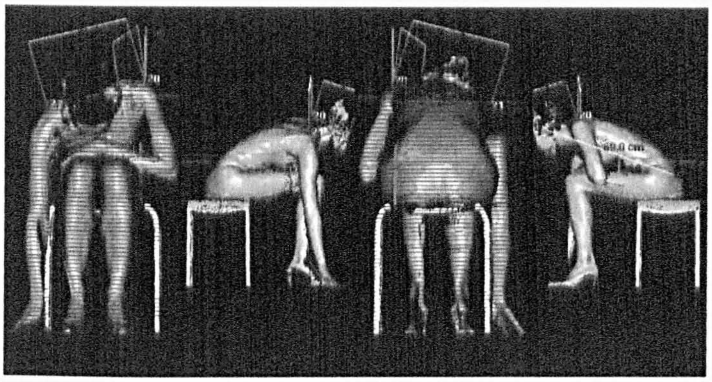
Neck front to waist over bust line (cm)	4060	
Bust points around neck (cm)	4070	70,1
Bust point to neck left (cm)	4080	44,5
Bust point to neck right (cm)	4081	44,1
Bust/chest girth (horizontal) (cm)	4510	88,8
Bust/chest girth (cm)	4515	86
Underbust circumference (horizontal) (cm)	4520	79,9
Across back width (cm)	5010	32,8
Across back width (armpit level) (cm)	5020	27,7
Neck to across back width (armpit level) (cm)	5030	
Neck to waist center back (cm)	5040	40,2
Neck left to waist back (cm)	5050	38,5
Neck right to waist back (cm)	5051	37,4
Distance across back width (armpit level) - waist (cm)	5060	
Waist to high hip back (cm)	5070	
Distance waistband-high hip back (cm)	5075	4,8
Waist to buttock (cm)	5080	
Distance waistband - buttock (cm)	5085	16,1
Crotch length (cm)	6010	106
Crotch length, front (cm)	6011	
Crotch length, rear (cm)	6012	39,3
Crotch length at waistband (cm)	6015	98
Crotch length at waistband A (cm)	6016	98
Dev. waist band from waist (front) (cm)	6020	11,1
Dev. waist band from waist (back) (cm)	6030	22,6
Dev. waist band from waist (side) (cm)	6040	
Waist girth (cm)	6510	71,5
High waist girth (cm)	6515	
Waist band (cm)	6520	73,1
3D waist band (cm)	6525	73,2
Waist to buttock height left (cm)	7010	
Waist to buttock height right (cm)	7011	
Waistband to buttock height left (cm)	7015	
Waistband to buttock height right (cm)	7016	
Waist to hip/thigh left (cm)	7020	
Waist to hip/thigh right (cm)	7021	
High hip girth (cm)	7510	71,7
Buttock girth (cm)	7520	146,5
Hip girth (cm)	7525	158,1

Hip/thigh girth (cm)	7530	159,2
Belly circumference (cm)	7540	71,2
Maximum belly circumference (cm)	7545	76,4
Arm length to neck back left (cm)	8010	90,1
Arm length to neck back right (cm)	8011	87,5
Arm length to neck left (cm)	8020	
Arm length to neck right (cm)	8021	
Arm length left (cm)	8030	61,3
Arm length right (cm)	8031	61,6
Upper arm length left (cm)	8040	34,7
Upper arm length right (cm)	8041	35,1
Forearm length left (cm)	8050	26,4
Forearm length right (cm)	8051	26,4
Upper arm girth left (cm)	8520	20,8
Upper arm girth right (cm)	8521	
Ellbow girth left (cm)	8530	
Ellbow girth right (cm)	8531	
Forearm girth left (cm)	8540	
Forearm girth right (cm)	8541	
Wrist girth left (cm)	8550	
Wrist girth right (cm)	8551	
Upper arm diameter left (cm)	8910	32
Upper arm diameter right (cm)	8911	31,3
Inside leg-ankle left (cm)	9010	42,1
Inside leg-ankle right (cm)	9011	42,2
Inseam left (cm)	9020	48,5
Inseam right (cm)	9021	48
Sideseam left (cm)	9030	77,9
Sideseam right (cm)	9031	82,6
sideseam 3D waistband left (cm)	9032	77,9
sideseam 3D waistband right (cm)	9033	86,2
Sideseam at waist left (cm)	9035	
Sideseam at waist right (cm)	9036	
Sideseam ankle left (cm)	9040	72,2
Sideseam ankle right (cm)	9041	76,8
Thigh girth left (horizontal) (cm)	9510	130,2
Thigh girth right (horizontal) (cm)	9511	123,7
Knee girth left (cm)	9520	131,7
Knee girth right (cm)	9521	128,8
calf girth left (cm)	9540	24,2

calf girth right (cm)	9541	24
Ankle girth left (cm)	9550	121,5
Ankle girth right (cm)	9551	119,8
min. leg girth left (cm)	9580	29
min. leg girth right (cm)	9581	33,7
Weight (kg)	9800	



Measurement Names	Measurement IDs	
Across back width (cm)	5010	32,9
Across back width (armpit level) (cm)	5020	33
Neck to across back width (armpit level) (cm)	5030	13,8
Neck to waist center back (cm)	5040	51,5
Neck left to waist back (cm)	5050	51,5
Neck right to waist back (cm)	5051	36,5
Distance across back width (armpit level) - waist (cm)	5060	35,5
Waist to high hip back (cm)	5070	11,6



Measurement Names	Measurement IDs	
Body height (cm)	10	97,7
Head height (cm)	20	
Neck height (cm)	30	
Distance neck to hip (cm)	40	
Distance neck-knee (cm)	50	
Distance waist-knee (cm)	60	
Distance waistband-knee (cm)	65	
Waistband height (cm)	70	
Waist height (cm)	80	
High waist height (cm)	85	
Buttock height (cm)	90	47,1
Hip height (cm)	95	
Crotch height (cm)	100	
Knee height (cm)	110	54,8
Ankle height (cm)	120	11,2
Belly circumference height (cm)	150	50,7
Maximum belly circumference height (cm)	155	54,7
Height of shoulder blades (cm)	160	
scapula height 2 (cm)	165	75,4
Breast height (cm)	170	
Neck height front (cm)	180	49,3
Distance 7CV - vertical (cm)	510	
Distance neck front to vertical (cm)	515	64,9
Distance scapula to vertical (cm)	520	
Distance waist back to vertical (cm)	530	
Distance buttock to vertical (cm)	540	30,6
Distance abdomen to vertical (cm)	550	86,6

Distance breast to vertical (cm)	600	
Distance back in breast height to vertical (cm)	610	
Distance belly to vertical (cm)	620	87,4
Distance back in belly height to vertical (cm)	630	30,6
waistband front to vertical (cm)	640	
3D waistband front to vertical (cm)	641	
waistband back to vertical (cm)	645	
3D waistband back to vertical (cm)	646	
Distance back in maximum belly height to vertical (cm)	650	30,7
Distance maximum belly to vertical (cm)	660	87,7
Distance front in hip height to vertical (cm)	670	
Distance back in hip height to vertical (cm)	680	
waistband front height (cm)	690	
3D waistband front height (cm)	691	
waistband back height (cm)	695	
3D waistband back height (cm)	696	
3D waistband left to crotch (cm)	990	
3D waistband right to crotch (cm)	995	
Upper torso torsion (°)	996	-73,7
Distance crotch to waistband (cm)	997	
Neck diameter (cm)	1010	
Mid neck girth (cm)	1510	
Neck at base girth (cm)	1520	
Head circumference (cm)	1530	
Side upper torso length left (cm)	2010	
Side upper torso length right (cm)	2020	
Torso width at waist (cm)	2030	
Total torso girth (cm)	2510	
Cross shoulder over neck (cm)	3010	
Cross shoulder (cm)	3020	32,2
Shoulder width left (cm)	3030	20,6
Shoulder width right (cm)	3031	
Shoulder angle left (°)	3910	
Shoulder angle right (°)	3911	
Across front width (cm)	4010	43,9
Width armpits (cm)	4020	52,1
Bust points width (cm)	4030	
Neck right to waist over bust (cm)	4040	
Neck front to waist (cm)	4050	

Neck front to waist over bust line (cm)	4060	
Bust points around neck (cm)	4070	
Bust point to neck left (cm)	4080	
Bust point to neck right (cm)	4081	
Bust/chest girth (horizontal) (cm)	4510	
Bust/chest girth (cm)	4515	
Underbust circumference (horizontal) (cm)	4520	
Across back width (cm)	5010	42,8
Across back width (armpit level) (cm)	5020	32,5
Neck to across back width (armpit level) (cm)	5030	
Neck to waist center back (cm)	5040	
Neck left to waist back (cm)	5050	
Neck right to waist back (cm)	5051	
Distance across back width (armpit level) - waist (cm)	5060	
Waist to high hip back (cm)	5070	
Distance waistband-high hip back (cm)	5075	
Waist to buttock (cm)	5080	
Distance waistband - buttock (cm)	5085	
Crotch length (cm)	6010	
Crotch length, front (cm)	6011	
Crotch length, rear (cm)	6012	
Crotch length at waistband (cm)	6015	
Crotch length at waistband A (cm)	6016	
Dev. waist band from waist (front) (cm)	6020	
Dev. waist band from waist (back) (cm)	6030	
Dev. waist band from waist (side) (cm)	6040	
Waist girth (cm)	6510	
High waist girth (cm)	6515	
Waist band (cm)	6520	
3D waist band (cm)	6525	
Waist to buttock height left (cm)	7010	
Waist to buttock height right (cm)	7011	
Waistband to buttock height left (cm)	7015	
Waistband to buttock height right (cm)	7016	
Waist to hip/thigh left (cm)	7020	
Waist to hip/thigh right (cm)	7021	
High hip girth (cm)	7510	164,5
Buttock girth (cm)	7520	161,1
Hip girth (cm)	7525	

Hip/thigh girth (cm)	7530	
Belly circumference (cm)	7540	164,1
Maximum belly circumference (cm)	7545	171,1
Arm length to neck back left (cm)	8010	
Arm length to neck back right (cm)	8011	
Arm length to neck left (cm)	8020	
Arm length to neck right (cm)	8021	
Arm length left (cm)	8030	
Arm length right (cm)	8031	
Upper arm length left (cm)	8040	
Upper arm length right (cm)	8041	
Forearm length left (cm)	8050	
Forearm length right (cm)	8051	
Upper arm girth left (cm)	8520	
Upper arm girth right (cm)	8521	
Ellbow girth left (cm)	8530	
Ellbow girth right (cm)	8531	
Forearm girth left (cm)	8540	
Forearm girth right (cm)	8541	
Wrist girth left (cm)	8550	
Wrist girth right (cm)	8551	
Upper arm diameter left (cm)	8910	19,5
Upper arm diameter right (cm)	8911	57
Inside leg-ankle left (cm)	9010	
Inside leg-ankle right (cm)	9011	
Inseam left (cm)	9020	
Inseam right (cm)	9021	
Sideseam left (cm)	9030	
Sideseam right (cm)	9031	
sideseam 3D waistband left (cm)	9032	
sideseam 3D waistband right (cm)	9033	
Sideseam at waist left (cm)	9035	
Sideseam at waist right (cm)	9036	
Sideseam ankle left (cm)	9040	
Sideseam ankle right (cm)	9041	
Thigh girth left (horizontal) (cm)	9510	
Thigh girth right (horizontal) (cm)	9511	
Knee girth left (cm)	9520	133,3
Knee girth right (cm)	9521	132,2
calf girth left (cm)	9540	

calf girth right (cm)	9541	
Ankle girth left (cm)	9550	112,4
Ankle girth right (cm)	9551	116,8
min. leg girth left (cm)	9580	
min. leg girth right (cm)	9581	
Weight (kg)	9800	

Appendix 5