Maintaining Design Aesthetics

Case studies investigating grading for body shape variation; the translation of garment designs to fit fuller figured women

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Abstract

Fit problems continue to plague the women's fashion design industry. Complete garment fit for women whose bodies are not the standard size or shape can be difficult to find or non-existent. Yet, fit is an essential design feature. In this design-led research project, I have used techniques of grading to translate design details into other sizes, while maintaining the design aesthetic. This mode and process of grading and fitting complex designs to a variety of body shapes is sensitive to line, shape and form and ultimately reveals the potential to cater to a wider garment-wearing audience.

Selecting various fuller figured women's body shapes to use for parallel case studies allowed techniques for analysis of shape and its effect on pattern to be developed, and shape-based-grading rules created. A collection of draped dresses developed in the base size acts as a challenging test for this shape-based-grading model. During shape-based-grading, pattern pieces are morphed to reflect the underlying body shape of the fit models in the case studies. Using Gerber Accumark pattern design software facilitates the incorporation of body shape into grading practice and the translation between the 2D and 3D realms. Shape-based-grading is used to develop patterns that fit fuller figured women and yet maintain the design aesthetic.

The process of shape-based-grading has been successfully implemented when applied to non-complex designs of fitted straight grained dresses. When applied to an intricate draped dress, shape based grading was successful in achieving fit, however, the design aesthetic was partially compromised by complications related to fabric behaviour. Fabric behaviour was incorporated into the grading for the draped dress, and patterns fully maintaining the design aesthetic are presented for each fit model in the case studies.

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Ethics

This project is a series of parallel case studies requiring the participation of human subjects to act as fit models during the design and fitting process. The ethical requirements set out in the Massey University ethics application, information sheet, and consent form has been followed. Following approval for my application to use four human fit models, I have removed any identifying markers on the fit models. For this purpose, I developed a stand-in face that would allow the reading of the garments and images to be consistent and unimpeded by the disguising of the face. This face is a merging of several different faces. This was only possible for front view images. For the side images the face has been disguised by blurring the image of the face.

Terms and Abbreviations

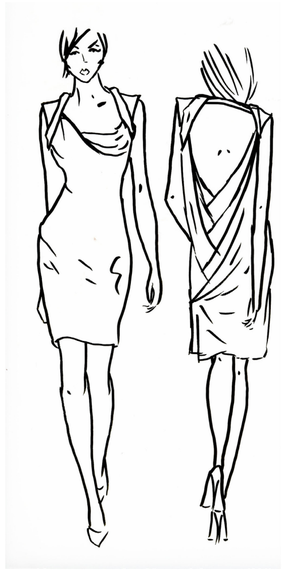
Terms	
Anthropometry	The scientific study of the measurements and proportions of the human body (Oxford University, 2010).
Axes (x/y)	The straight lines on a graph that are used as reference for the measurement of an object. The x axis is horizontal and the y axis is vertical. These x and y axes are at right angles to one another (Moore, et al., 2001).
Base Size	The starting reference for grading. Master patterns are developed and trued for the sample size and then graded to other sizes within the given size range (Moore, et al., 2001).
Balance lines	A general description, as the word suggests, for a lack of distortion (Taylor & Shoben, 1990).
Block	A template of the basic pattern/shape upon which design details can be superimposed (Cooklin, 1990). Blocks are used for flat pattern design and consist of the minimum number of pattern pieces for a basic fitted garment. They are free of fashion details. They do not have seam allowances and all darts extend to their respective pivot points. Known in America as slopers (Moore, et al., 2001).
Digitizing	The process of entering the pattern piece, along with its identifying information, into the computer. The information is translated into the format required by the specific computer so that shape and size of each pattern piece can be worked with and manipulate (Moore, et al., 2001).
Drape	A patternmaking system that relies on fabric in creating design (Joseph-Armstrong, 2008).
Ease	The amount of ease in a garment necessary to allow the wearer to move freely (Moore, et al., 2001).
Fit model	An individual whose body measurements reflect those of the sample size for the target market for which a manufacturer produces. The fit of garments is tested and perfected on the fit model (Moore, et al., 2001).

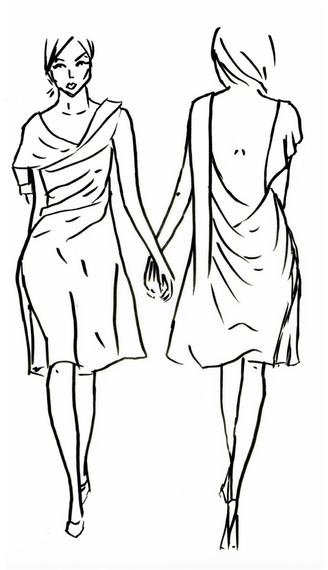
Girth	Circumference body measurement (Moore, et al., 2001).
Grading	The process of systematically increasing and decreasing the dimensions of a master pattern into a range of pattern sizes for a specific design (Moore, Mullet, & Prevatt Young, 2001).
Grade rules	The written record of the designated movement required to grade a pattern for a range of sizes. Each grade point on a pattern piece requires a grade rule (Moore, et al., 2001).
Hand/ Handle	How the fabric feels to the touch, its weight and responsive movement (Joseph-Armstrong, 2008).
Lining	An additional layer of material attached to the inside of a garment (Oxford University, 2010).
Morphing	Undergo or cause to undergo a gradual process of transformation (Oxford University, 2010).
Mannequin	A model of a human body representing a specific size (Campbell, 2005).
Nest	An illustration of a set of pattern pieces showing all sizes within a size range stacked along a common reference line. The nest illustrates the differences in each successive size (Moore, et al., 2001).
Pattern	A diagram of each of the component pieces required to construct a garment (Moore, et al., 2001).
Prototype	A test sample of actual materials used to test the product for fit, durability and design translation. Provides the most accurate measure of materials and production costs (Fasanella, 1998).
Shape-based-grading	A system of grading that morphs the master pattern to various underlying body shapes (Freeth, 2010).
Toile	An early version of a finished garment made up in cheap material so that the design can be tested and perfected (Oxford University, 2010).

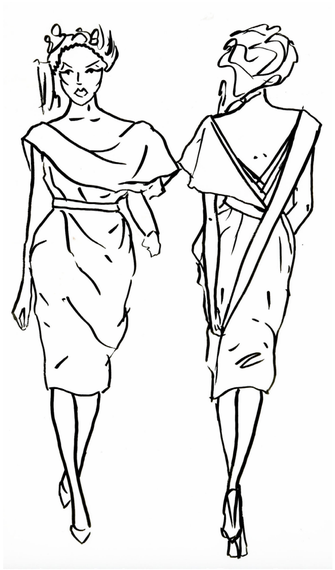
Abbreviations

Centre Back	CB
Centre Front	CF
Side Seam	SS
Computer Aided Design	CAD
Ready To Wear	RTW
Made To Measure	MTM
Two-Dimensional	2D
Three-Dimensional	3D
centimetre	cm
millimetre	mm
Bust	B
Under Bust	UB
Waist	W
High Hip	HH
Hip	H

Table of Contents







Introduction

Fit problems continue to plague consumers in the women's fashion design industry. Complete garment fit for women whose bodies are not the standard size or shape can be difficult, if not impossible to find. This is a well acknowledged international problem within the fashion industry.

> *Even into the 21st century we have not achieved the goal of providing the same quality of fit for "everybody." Instead, we have dismissed the unique body and expect all bodies to fit into standard-sized garments. The unfortunate result is that we have come to expect the human body to match the clothing standard rather than develop clothing to fit each human body (E. Bye, Labat, & Delong, 2006, p. 66).*

In fashion design, fit is an essential feature. Fit communicates the desired silhouette, line, form, shapes, and all details of the design aesthetic. Labat and Delong discuss how fit has a strong emotional component, with consumers frequently evaluating fit failure by interpreting it as a personal body fault (LaBat & Delong, 1990, pp. 46-47). When fit is lost in the grading process, the aesthetic is also lost. It is known that issues with the translation of a design aesthetic, including fit, occur with two or more sizes away from the base size (E. K. Bye & Delong, 1994). This is especially true with fuller figures, because larger sizes have the most variation in body shape. Without maintaining the desired fit, the beauty of the design aesthetic can be lost. Many hours are spent by the designer, getting the exact fit required by the original design into the pattern. With so much time and effort getting the pattern exact, to lose such an important aspect in the translation of the design to larger sizes is regrettable.

An investigation into the elements that create fit problems included sizing systems, grading, and its relation to design, and most importantly, shape. The scope of this problem is vast, so for the purposes of this research I have narrowed my focus to three parallel case studies. To investigate the problems in maintaining design aesthetic as sizes change, I have selected three distinctly different body shapes to represent variability among fuller figured women. Each body shape forms one case study,

and each body shape and therefore case study is represented by one fuller figured fit model.

As possible solutions to the problems with fit are debated, the importance of considering body shape is becoming more apparent. Schofield and LaBat (2005) concluded that “to fit real people, pattern shapes need to change as a garment is graded.” Current grading increases and decreases the sizes to replicate the base pattern shape. As a method of maintaining design aesthetic, grading is limited because in larger sizes body shape is such an important determinator of fit success. Grading for fit with fuller figured women requires complex changes in proportions. Even when they fall under the same size title or description, they are not necessarily the same shape as the base size. Under the current system, all three fuller figured fit models used within this project would be considered the same size. When a single pattern is produced for a larger size, only a single shape is catered for and other variations are excluded. Shape variation presents a daunting set of problems that until recently have been too difficult for most manufacturers to deal with (Henneburg, 2008, cited in Berry & Hennes, 2008). However, with consumer dissatisfaction pushing a need for change (Simmons, Istook, & Devarajan, 2004a), shape variation needs to be considered when grading. If variety of shape is introduced in a precise and defined way to grading, will it allow the process of shape based grading to develop?

This design-led research uses the methods of research for design and research through design (Frayling, 1993). It combines quantitative and qualitative methods; objective methods such as numerical measurement and analysis and subjective methods of sensory and visual analysis. (E. K. Bye & Delong, 1994, p. 1). This research and the data it produced were developed by using design tools and methods such as draping, drawing, pattern design, grading, construction, numerical analysis, and analysis of visual aesthetics and images. All pattern design and grading has used the Gerber Accumark Pattern Design System. Design development is led by visual aesthetics using the systematic framework of sensory evaluation set out by Bye and Delong (1994). This evaluation is used to assess maintaining, translating, and developing visual aesthetics of shape, form, silhouette, line, proportion, grainline, fullness, and fit.

An essential aspect of this research is the differences between the three fuller figured fit models who were selected to represent various body shapes from the New Zealand population. A fourth fit model whose body shape and dimensions exactly match the base size mannequin and base sized block acted as the ‘control’ to test the base size patterns. Without access to modern technology that determines shape, it is necessary to use alternative techniques to analyse shape. A more traditional method of using a sewn garment or shell is used to define the shapes of the selected fit models allowing the analysis of body shapes. The effect of various body shapes on pattern was determined to enable the development of shaped-based grading rules. Shape-based-grading is applied to a collection of draped dresses designed as part of this research to test how well it can maintain a design aesthetic. Each garment in the collection comprises a lining and a draped overdress. The linings acted as the initial test of the shape-based-grading. The successful application of the process to garments with a straight grain and non-complex design is detailed. A more extensive test of the shape-based-grading process was made by applying it to a draped design. Initial success in maintaining design aesthetic was affected by complications caused by fabric behaviour. Specific solutions have been determined and shape-graded patterns are presented and for all four fit models the complete draped design through to prototype are displayed.

This project is my personal journey of evaluating fit on differing body shapes and the effects and changes body shape has on patterns, grading, and design outcomes using computer aided design.

Note: Detailed photographs, diagrams and visual analysis images accompanying the sections of this essay can be found in the relevant appendices.

Research Aims and Questions

The aim of this project is to investigate techniques for grading women's apparel that maintain design aesthetic details, especially fit, for different body shapes in larger sizes. This investigation has been conducted as case studies using three body shapes to represent the range of variability among fuller figured women.

Grading is the manufacturing method used to translate the pattern, aesthetic and required fit of the design into the other sizes, but as research shows fit is a recognised problem for larger sizes therefore:

Is fit failure a result of grading? Can a grading model correlate the changes in shape and size usually associated with a fuller figured woman while maintaining the aesthetics and proportions of a design when fit is achieved or does garment design for a fuller figure need a different approach?

Consideration of these issues developed into the research question: *How can a system of grading based on an established system of sizing maintain an aesthetic of a design during the translation of sizes and achieve fit for fuller figured New Zealand women of various shapes?*

Context Review

Sizing Systems

Sizing systems divide a population into categories; each division is known as a sizing standard and depicts one body type category with specific measurements. (Nancy A. Schofield & Karen L. LaBat, 2005, p. 13). In theory, "The purpose of a sizing system for apparel should be to make clothing available in a range of sizes that fits as many people as possible" (Ashdown, 1998; LaBat, 1987, cited in Simmons, et al., 2004a, p. 2). In reality, each sizing standard, by defining a specific sub-population, excludes a much larger population.

Creating sizing systems is very difficult as a continuous population does not readily divide into separate ranges of measurements (Petrova & Ashdown, 2008, p. 229). A sizing system can only be as good as the method and creativity that go into the development of the system (Loker, Ashdown, & Schoenfelder, 2005, p. 3). Several authors acknowledge the "artificiality" of sizing systems, as there exists "no natural grouping of the population along body measurements" (Petrova and Ashdown, 2008, Pg 229). Unfortunately, the majority of sizing systems have not been created from scientific human measurements and therefore do not accurately represent the current shapes and sizes of the population. (Nancy A. Schofield & Karen L. LaBat, 2005). Almost all are based on the myth "that humans have mathematically proportional bodies and that they grow in proportional ways" (Simmons, et al., 2004a, p. 1), whereas the majority of people's body proportions deviate from standard sizes (Alexander, Connell, & Presley, 2005, p. 56). In the last five years, SizeUSA and SizeUK anthropometric surveys have scientificly recorded human measurements, and these will lead to sizing systems that reflect these measurements, however, these have not yet been released into the general public. Furthermore, most sizing systems fail to include any explicit reference to body shape because body shape categorization is extremely difficult. Since "existing sizing systems do not include significant portions of the population whose silhouette (body shape) differs from that of the fit model" (Simmons, et al., 2004a, p. 13), academics and industry in both USA (Simmons, et al., 2004a) and New Zealand (Joseph, Neimcyzk, & Reilly, 2008) believe that

the “basic sizing systems are not adequate” (Simmons, et al., 2004a, p. 13). For most sizing systems “within a population, only a few consumers have a body type, which exactly fits the standard forms” (CAD Modelling, quoted in Simmons et al. 2004, pg 3). With all the recognised problems in standardized sizing systems, manufacturers and retailers prefer to select their own, using it as a “marketing tool, convinced that this is a differential advantage of their product for their market” (Simmons, et al., 2004a, p. 1), maintaining the exclusion aspect of sizing.

New Zealand does not have a consistent sizing system created specifically for its overall population. There has been no published anthropometric study of the New Zealand population, so American and European sizing standards are often an available default. Many American academics, researchers, and industry based personnel believe the standards do not represent the current population of the USA (Simmons, et al., 2004a, p. 13), and therefore they are even less likely to be representative of New Zealand’s specific population. “The issues of sizing standards and practices within the New Zealand context are not fully researched or understood” (Joseph, et al., 2008, p. 513). The recent anthropometric study run in the USA and UK, SizeUSA and SizeUK, used 3D body scanners, an innovative new way to undertake an anthropometric study, the results of which were released for sale and are just starting to impact the industry. Within New Zealand there have been a few specific anthropometric surveys undertaken when the need has been deemed worth the cost. The Standards Association of New Zealand developed sizing standards for the New Zealand population in 1973 (Standards Association of New Zealand, 1973); however, these were an anthropometric estimate (Slappendel & Wilson, 1992), and are now out of date. In the last couple of years New Zealand based academics and researchers have been discussing the need for a wide and full scale anthropometric survey using a 3D body scanner with fashion industry personal. Originating at Auckland University of Technology, a New Zealand sizing project (Auckland University of Technology, 2008; Joseph, et al., 2008) was recently investigated. New Zealand based companies have been working with academics and university researchers to develop sizing and grading information specific to their target market (Mulrooney, 2008). One of these surveys was a study of forestry workers (Laing, Holland, Niven, & Webster, 2003), another was a survey of the New Zealand Fire Service (Laing, Holland, Wilson, & Niven, 1999). Both studies were undertaken to develop protective clothing for a specific proportion of the New Zealand population. Rembrandt undertook extensive research into New Zealand sizing in conjunction with the International Standards Organisation and Massey University, resulting in

reports called Sizing Analogy for Men and Sizing Analogy for Ladies (R. Downes, Personal Communication, December 8, 2010). Many of the privately undertaken studies are confidential. In Australia, an anthropometric survey was undertaken by Berry in 2001, the results of which developed into the book The Fashion Design System, by K. Berry and L. Hennes, and RMIT has just completed an extensive anthropometric survey using 3D body scanners (R. Downes, Personal Communication, December 8, 2010). The closest system to relate to New Zealand is probably the Berry and Hennes in Australia, which defined five shapes although their results are only presented on a single base size.

Research into ways to combat the problems with the current sizing system suggests that development of new sizing systems must take into account many more factors than previously used and shape based sizing systems are beginning to gain popularity. In a shape based system “the size model does not need to be the same for different shape groups”, however, this could lead to a “complicated sizing and grading system... but its implementation would be possible in cases where pattern grading is computer aided” (Petrova & Ashdown, 2008, p. 247).

Sizing System Used in This Research

The sizing system for this research uses a base size of 89-71-99 centimetres (bust-waist-hip measurements) that corresponds to the standard mannequin, and uses size increments of 5cm. The standard mannequin is named a size 12 by Purfex (the manufacturer), I will use this nomenclature. A control fit model was found to match the base size measurements. To represent the variety of body shapes within the New Zealand population, the fuller figured fit models used in this research were selected from this population with the aim of covering a range of body shapes similar to the Berry and Hennes system definition and are a standard four sizes larger than the base size. Because of the variety of shapes, not all dimensions correspond exactly to the size 20 standard, however, there is a close correspondence.

Fit

Garment fit is about the relationship between the body and the garment, the shell surrounding the body (Loker, et al., 2005, p. 1). Perception of garment fit varies. Emotional components can cause judgements about fit to be both individual and subjective, influenced by factors such as the specific garment design, its location and the wearers intended activity. Fit can be evaluated differently by the person wearing the garment, an external viewer, a salesperson, or an expert analyzing the fit relationship. Every company working within fashion industry defines fit according to their individual perspective, and the definition varies according to the current aims and aesthetic of their designs. Academics try to define fit more accurately: as “a matter of length and width in each part of the pattern being correct for your figure” (Minott, 1978, cited in Simmons, Istook, & Devarajan, 2004b, p. 2). Another technical definition is “a correspondence in three dimensional form and in placement of detail between the figure and its covering to suit the purpose of the garment, to provide for activity, and to fulfil the intended style” (Berry, 1963, cited in Simmons, et al., 2004b, p. 2). Traditionally, fit is described in terms of five components; ease, line, grain, balance, and set (Erwin, 1949). As each component interacts with all others, “it is often hard to define one component without referencing another” (Petrova & Ashdown, 2008, p. 230).

The innovative research completed by Bye and Delong (1994) produced methodologies for assessing and partially quantifying appearance. “Much of the expert knowledge needed in production of apparel is related to visual decisions required to create a garment. Visual thinking is not grounded in intuition, but grows from logical reasoning” (E. K. Bye & Delong, 1994, p. 1). Sensory evaluation provides a “systematic framework to assess an often intuitively perceived physical characteristic: appearance. Categorizing garment designs according to horizontal, vertical and proportion of details was important to systematic analysis” (E. K. Bye & Delong, 1994, p. 6). “Experts analyze fit by visually assessing a garment on a body” (Leibowitz & Post, 1982, cited in Ashdown & O’Connell, 2006, p. 139) but even with definitions, rules and guidelines, the process requires human judgments. Consumers have been dissatisfied with fit for sometime (Simmons, et al., 2004a, p. 2). Sixty two percent of American women surveyed in 2004 complained about the difficulty of getting a garment that fits properly (Kurt Salmon Associates, 2004). This suggests that there are many problems with the fit of garments currently on the market and “a garment that does not fit well, will not sell” (Newcomb & Istook, 2004, p. 1) . It is understandable that many women would prefer, especially within the larger sizes, that a garment does not emphasize perceived body flaws but does emphasize areas of body image comfort. These are subjective notions key to each individual, and impossible to quantify. Therefore, these sorts of decisions or requirements should be left to a designer, rather than incorporated into a grading model.

Fit Criteria of Pattern makers.

The following list of fit criteria was defined in Joseph-Armstrong (2006) and Joseph-Armstrong (2008);

- centre front and centre back aligns with the body centre;
- armscye fits smoothly;
- the waist level aligns with body waist;
- no stress or gapping at neckline;
- side seam hangs vertically;
- shoulder seam centred on the shoulder;
- skirt hangs straight from the hip to the hem and cross grain parallel to the floor;
- no strain at bust, waist, or hip.

Fit definition for this Research

For the purpose of this project I have defined the fit criteria as follows:

A garment fits when it follows the contours of the body it relates to, by the correct amount of ease, i.e. positive or negative amounts of ease as required by the design of the garment. For example:

- If a garment is designed to have no excess fullness, then the garment would match the contours of the body depending on the amount of ease designed into the garment.
- If the garment has excess fullness, the fullness will be the required amount, and the fullness will be in the area designed to have the fullness. It will also have the ease required by the design. This will be created in the base size, but the grading model will ensure that the areas of fullness are translated to each size and each body shape in the case study.
- If the garment was designed to have negative fullness/ ease (e.g. a corset) then the pattern and garment would have the correct amount, in the areas where the negative fullness was designed.

Fit is both the aim and the consequence of the interaction of all the factors discussed above. Fit is a crucial part of any design aesthetic; it is affected by many different factors including the shape of the underlying body, and the system and method of translating the design into the other sizes.

Shape

The importance of body shape is becoming more apparent as possible solutions to the problems with fit are examined. Body shape affects the fit of a garment, and since fit is determined by sizing systems and grading, shape needs to influence both. In this research body shape is defined as the silhouette of an individual both in 2D and 3D. Within a population, body shape is continuous with one shape morphing into another, thus “making body shape categorization extremely difficult” (Petrova & Ashdown, 2008, p. 229). Despite this, Petrova and Ashdown believe the significance of body shape is beginning to be widely recognized and that emphasis on shape will lead to the “construction of shape/size dependent grading rules for garments” (Petrova & Ashdown, 2008, p. 247). Historical definitions of Body Shape have been both scientific and visual. Simmons, Istook and Devarajan found that the

> majority of methods used a simple visual process of classification with a vague list of descriptors to define the bodies that fell in each category. Somatometry, as a sub-study of anthropometry has defined shapes as endomorphs, ectomorphs and mesomorphs. Visual based definitions have resulted in names such as hourglass, apple, pear, triangle, X, O, H, etc. None of the methods used mathematical formulas, ratios, or expressions to aid in the determination of body shapes (Simmons, et al., 2004a, p. 11).

Creation of more accurate representations of the variable shape of the human body has been investigated in recent years, using methods both visually representative as well as scientifically and mathematically measurable. Two new, more advanced but different software systems are FFIT for Apparel (Simmons, et al., 2004a) and BSAS (Connell, Ulrich, Brannon, Alexander, & Presley, 2006). While limitations are acknowledged, the academic teams behind each system feel they accurately cover the entire (American) population. Both systems define nine shapes to describe the female body, but the two systems produce distinctly different definitions .

New technology is beginning to make possible the creation of a female figure identification technique using mathematically defined ratios. “The most recent female body shape categorization systems for use in the apparel industry appear to be based on one of two major methods: (a) proportions of front and/or side silhouette widths—a method reported by Connell et al.

(2003) or (b) proportions of body circumferences—a method developed by Simmons, Istook, and Devarajan (2004)" (Petrova & Ashdown, 2008, p. 230).

In Australia, an anthropometric survey completed in 2001 by Berry created a better base for this work, as the Australian population is a closer match to New Zealand. Berry and Hennes developed a sizing system based on five body shapes they named X, I, A, H and XH. This study has the largest percentage (31.20%) of the population being classified as H whereas the fashion industry concentrates on X which is only 19% of the population. (Berry & Hennes, 2008, p. 42). Berry and Hennes definitions of X and H, corresponds to FFIT for Apparel's definitions of Hourglass and Rectangle as shown in Fig. 1 and Fig. 2. Further correspondence between these definitions are shown in Fig. 6, page 41. Berry and Hennes suggest a shape based pattern development system would then be graded using currently available grading methods. Women come in all shapes and sizes, with no two women having exactly the same body shape, and problems seem to be occurring because of the unrepresention of differing shapes of the population. From a proper understanding of body shapes, an effective, wide ranging, shape based system with more complex grading based on advanced anthropometric studies will address many of the identified problems with fit.

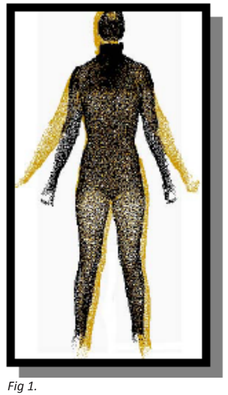


Fig 1.

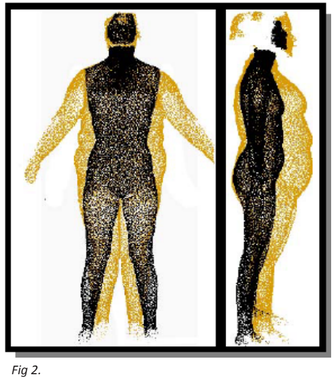


Fig 2.

Fig 1. "Hourglass shape (black) superimposed onto a bottom hourglass shape (yellow)" (Simmons, et al., 2004b, p. 7).
Fig 2. "Hourglass shape (black) superimposed onto a rectangle shape (yellow)" (Simmons, et al., 2004b, p. 10).

Grading, Fit and Design

Grading is the process used during the manufacturing of clothing to produce garments in a range of sizes. The development of mass production necessitated "a system for developing sizes for women's apparel" (Nancy A. Schofield & Karen L. LaBat, 2005, p. 16) because "garments were no longer created specifically for individual women" (Nancy A. Schofield & Karen L. LaBat, 2005, p. 16). Grading takes a base size and through the use of grading rules creates the larger and smaller sizes required for production. Without grading a manufacturer would need to develop a pattern for each size to be produced. This would not be time or cost effective. Grading provides a more efficient way to size a design. Sizing systems do not provide grade rules, but define the measurements required when creating grade rules for different sizes. The basic common denominator of all sizing systems is a simple fixed linear increment. The most commonly reported girth increment used in women's wear is 5cm (Cooklin, 1990, 1995; Taylor & Shoben, 1990), but 4cm and 6cm are also used (Aldrich, 2008). USA uses an imperial measurements of 1", 1.5" and 2" girth increment grades across their sizes and size ranges, with women's wear generally using a 2" or 5cm grade increment (Hanford, 2003; Moore, et al., 2001; Price & Zamkoff, 1996). There are no reports about what grade increments are used by New Zealand manufacturers. Most sizing systems are more sophisticated, but a simple linear increment system will make this research more widely available to application and adaption without being locked into any specific existing system. Grading applies "increases or decreases at key locations, known as cardinal points, to create a pattern in the next size" (Nancy A. Schofield & Karen L. LaBat, 2005). Grading and sizing systems are now inter-dependent. Selected from within the sizing systems are standards from which grade rules are derived.

The first example of grading has been identified by Kidwell (1979) as the "proportional dressmakers' systems developed between 1820 and 1840" (Kidwell, 1979, cited in Nancy A. Schofield & Karen L. LaBat, 2005, p. 16) however there is a lack of documentation and "historical information" about the "source of grading practices" (Nancy A. Schofield & Karen L. LaBat, 2005, p. 14). Grade rules were developed before sizing systems and well before any anthropometric research had been undertaken. Necessarily, assumptions were made about the human body and rules were developed from identified best practices. Lack of documentation required knowledge to be passed by instruction or apprenticeship, or developed by trial and error.

This practice of trial and error is historically favoured over operating from a scientific base (Kunick, 1967, cited in Nancy A. Schofield & Karen L. LaBat, 2005, p. 17).

The following image is an example of traditional grading, proportional at each girth growth point. This image displays the most common grade increments in USA, 1”, 1.5” and 2” growth, displayed in nested form, used in the research completed by E. Bye, LaBat, McKinney, & Kim, 2008.

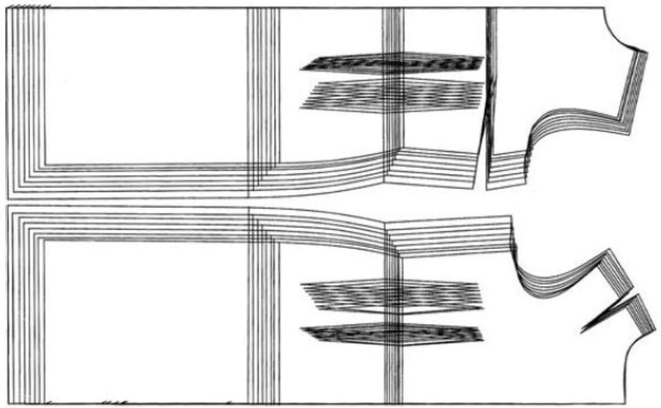


Fig 3. “Traditionally graded nest” (E. Bye, et al., 2008, p. 83).

Schofield and LaBat found that many of the assumptions originally used within historic grading are still being used today which they believe is part of the cause of fitting problems. Fortunately, “computer grading methods eliminate the need for

grade rules that are constant, linear, or proportional.” (Nancy A. Schofield & Karen L. LaBat, 2005, p. 149) and this allows the creation of a sizing system in which “grade rules can vary for every size” (Nancy A. Schofield & Karen L. LaBat, 2005, p. 149). The advancement of CAD patternmaking software enables the development of complex grade rules, facilitating the creation of sophisticated sizing systems (Ashdown & Dunne, 2006, p. 122) that can reflect the shape of the human body, allowing “methods of incorporating body shape into grading practice [to] be developed” (E. Bye, et al., 2008, p. 90).

Current size charts used to guide grading practices do not accurately reflect body measurements across sizes or changes in body shape, because the human body does not grow proportionally (Simmons, et al., 2004a, p. 1). As a result, grading practices contribute to fit problems (E. Bye, et al., 2008, p. 1); but jealously guarded sizing and grading rules also create difficulties in evaluating the origin of the problems of fit in the ready to wear market (Nancy A. Schofield & Karen L. LaBat, 2005, pp. 13-14). Schofield and LaBat (2005) concluded that “to fit real people, pattern shapes need to change as a garment is graded. Therefore patterns need the ability to morph and change shapes as they are graded through to different sizes”. However Fasanella believes that “grading cannot change shape… people’s bodies ‘morph’ as they mature, but grading cannot morph. It can only make an existing size larger or smaller” (Fasanella, 1998, p. 170).

The aim of grading is to maintain the exact visual aesthetic accurately through all the sizes. As an important part of any design aesthetic is the intended fit, grading should translate design aesthetic, design and fit proportions and the overall fit of a garment from the base size to all other sizes (Solinger, 1980, cited in E. K. Bye & Delong, 1994, pp. 1-2). Unfortunately, the goal of maintaining style sense and visual effect is often lost as research shows that a grading system is no better than the sizing specifications from which it is developed, (DesMarteau, 2000). Bye and Delong studied the effects of two different grading systems, traditional and proportional, on the vertical and horizontal proportions of a garment from a scientific angle. They found that aesthetics are not maintained when following traditional methods of pattern grading because visual details of a graded garment more than two sizes away from the fit model are noticeably different.

The difficultly in maintaining fit is a result of the variation of shapes within any female population. Grading cannot change the

shape of any garment; it can only size the original pattern up or down. Lapick (1949) believed "the art of correct grading . . . is the basis for a perfect fitting garment, for it is of real importance that a graded garment fit and look like the original model" (p. 87)" (Lapick, 1949, as cited in Nancy A. Schofield & Karen L. LaBat, 2005, p. 136). Bye and Delong, 1994, summarized this as "the goal of pattern grading needs to be redefined to account for the desired visual effect in a variety of size and body variations" (E. K. Bye & Delong, 1994, p. 1).

Grading Used In This Research

Current grading does not change the underlying body shape of the original design. Schofield and LaBat (2005) acknowledge that grading needs the ability to morph body shapes, but in current practice, it does not do so (Fasanella, 1998). I used this idea of morphing to introduce shape into the practice of grading. Morphing describes the process applied to pattern pieces during shape-based-grading. This should produce several different patterns all the same designated size but produced for different body shapes.

The grading used initially within this project was a simple proportional grade using 5cm increments, applied to the base pattern. Within the CAD environment of the Gerber Accumark Pattern Design System I investigated grading to produce different versions of the pattern to suit different body shapes. Starting with a base size I developed patterns that fit and maintained the design aesthetic for shapes such as pear, straight, and hourglass, in larger sizes.

Technological and Commercial Advances

Recent advances in technology have opened the way for the development of shape based sizing systems and several commercial entities have started to introduce the idea of shape into their retail environment.

[TC]2, who headed the SizeUSA study, scanning 10,000 Americans in 10 cities, offer 3D body scanners that can be used for accurate body measurements and shape definition, leading consumers to the selection of garments of appropriate shape and size (King, cited in Pullar-Strecker, 2010). The 3D body scanner was also used in the development of FFIT for Apparel technology and shape definitions. They have also been suggested for online clothes shopping, with the technology being used to "drive the generation of a 3-D avatar that represents an individual" (King, cited in Pullar-Strecker, 2010) Current research into 3D body modelling and automated computerized patternmaking "use scanned 3D dummy shapes, not 3D human body shapes"(Cho, et al., 2010, p. 17), far removed from automated MTM patterns created from 3D body scans. Only base body block and simple design alterations for fullness are able to be generated and a computer generated pattern does not adapt variance in the nature of fabric. This knowledge often has a subconscious effect on a patternmaker during the pattern design stage. Researchers are trying to quantifying the effects of 2D fabric, often unstable, into a 3D automated pattern creation realm. Gerber, Pad, Lectra, Investronica and Tukatech all offer 3D modelling of patterns created using their pattern development software, allowing the designer to view the pattern in 3D on a virtual model (Joseph-Armstrong, 2006, p. 8).

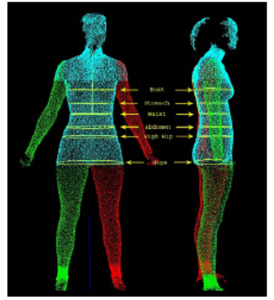


Fig 4. "Current Location of Measurements used in the Study" (Devarajan & Istook, 2004, p. 15)

With fit issues an acknowledged problem within the industry, many companies are working towards ways to combat them (Henneburg, 2008, cited in Berry & Hennes, 2008; Alderete, 2010, as cited in Ryan, 2010). As grading and sizing information is considered a selling point, many companies are unwilling to talk about their research and choices. Knowledge of the specific ways they are working towards solving this problem cannot be sourced; however some understanding of their solution methods can be derived from their advertising. Levi Strauss and Co. is the most prominently advertised company making changes to address current problems in sizing with the introduction of the "Curve ID System" (Levi Strauss & Co., 2010) which has been advertised as "a revolutionary fit system" (Ryan, 2010) that concentrates on shape not size. Levi's offer three shape styles, loosely based on the ectomorph, endomorph and mesomorph philosophy, that they call "slight curve, demi curve and bold curve" (Levi Strauss & Co., 2010). This system, like that described by Berry and Hennes in 2008, develops shape based patterns and then grades them to meet sizing needs. Levi's claim that implementation of the curve id system provides jeans to fit 80% of the women's jean market. Levi's research that "54 percent of women try on at least 10 pairs of jeans, yet when the jeans don't fit, women blame themselves" inspired this development. "Our research showed that 80 percent of women around the world fall into three distinct body shapes, so one size could never fit all" (Alderete, 2010, as cited in Ryan, 2010). Levi's and other companies are now implementing an online fitting room that will allow customers to obtain the best fit of garments from the privacy of their own home. Victoria's Secret and menswear store Brooks Brothers have also invested in 3D body scanners and installed these in some of their stores. Victoria's Secret use the 3D body scanners to help customers chose clothing and sizes that fit them, while Brooks Brothers uses the 3D body scanner to take a "3D image of your body in just 12 seconds yielding hundreds of measurements that are electronically transmitted to the factory where a personalized pattern is made specifically for you"(Brooks Brothers, 2010). InterActive Custom Clothes Company creates individual jeans from measurements supplied over the internet. Claiming that by using a "made-to-measure artificial-intelligence computer program, they can actually create a personalized pattern for every customer's body". However they add a caution saying the "technology is still new, and the jeans don't always fit perfectly". Landsend.com and Americanfit.com offer simple customization options.

In New Zealand Rembrandt and Cambridge Clothing, both menswear companies, use made to measure (MTM) alterations available within the CAD patternmaking software to individualize graded patterns to a customer's measurements. For women, Booker Spalding offers simple alterations to garments, but this also uses MTM alterations (Personal Communication).

Many of these solutions are using technology to step backwards to a time when MTM design was more prevalent, rather than addressing the problem within the ready to wear (RTW) field. Only Levi's solution fits within the RTW paradigm, not leading to increased prices for MTM alterations and individual garments. Emphasis on the RTW paradigm is an essential aspect of this research project.

Technology Available for this Research

Three-dimensional technology is not available within the Massey University environment, so has not been used within this project. I have used the Gerber Accumark Pattern Design System. Working within the pattern design system for all pattern design and grading development, from the digitizing pattern conversion through to the layplan and toileing/prototyping. As much as possible I was looking for the development of rules on the x/y axis to stay true to the precepts of grading. However, I was aware that radial rules or percentages of angle based rules might also be required. This CAD technology greatly facilitates the application of grading, allowing complicated grade rules to be investigated, developed and applied efficently. Gerber software will also assist the incorporation of body shape into grading practice and the translation between the 2D and 3D realms.

Materials Used in this Research

The materials used during this research cover a range of fabrics depending on the specific needs of the research at each stage. The collection design stage utilized a range of fabrics from silk and polyester lightweight chiffon through to a heavy wool, cotton and a silk dupion equivalent in polyester. The patternmaking stage utilized a white lightweight polyester chiffon and cream mid-weight cotton,and the required fusing. The shape repesentative block stage used calico fabric. The testing of the shape based grading used the same fabric as the patternmaking stage of the collection design, white lightweight polyester chiffon and cream mid-weight cotton. The prototype stage used a mid-range blue colour lightweight polyester chiffon. For details on the prototype fabric refer to Appendix C, Fabric, pg 183.

Summary

Design “contributes to the visual image elements of silhouette, proportion, colour, and texture” that makes “Clothing .. a unique and complex art form” (E. K. Bye & Delong, 1994, p. 2). Unfortunately, “In order to find a garment with sufficient room in the bust, large women may have come to expect necklines that are wide and armscye seams that hang off their shoulders” (Nancy A. Schofield & Karen L. LaBat, 2005, p. 149). For many women, especially larger sized women, design has become synonymous with misfit.

Grading to incorporate body shape changes is the focus for this research. In sizes closer to the base size, fit and shape variances are less problematic. Even for women with a different shape from the designed garment, there is a higher likelihood of successful fit as the shape variations are less pronounced. E. Bye, et al., (2008) found that the patterns two sizes away from the base required few changes to make them fit their fit models, supporting the findings of Loker, et al., (2005). In contrast, for larger sizes, shape variations become more obvious and divergent. A system of sizing that would allow for changes in shape would allow the designed garment to fit a larger portion of the population. No system will provide fit for everyone, as there are always variations outside the boundaries set by the shape definitions. The aim of RTW is to suit the largest percentage of the population with the smallest range possible.

Methods and Processes

The initial design development required a collection of draped dresses to be developed in the base size through to the pre-prototype stage. This collection was developed to act as a challenging test for the shape-based-grading. Essential to the research process, was the sourcing and selection of the fit models followed by the development of tunic blocks for each fit model that would allow an understanding of shape and proportion to be extrapolated. Techniques for analysis of shape and its effect on pattern were developed, and shape-based-grading rules created. These were applied to straight grained patterns, specifically the linings of the collection, then to the draped designs.

The evaluation method and assessment used throughout this project is visual evaluation, used for evaluating both of the garment fit on the body and the resulting 2D pattern shape. Visual evaluation analyzed form, fit, shape, silhouette, line, balance, and aesthetic. This visual evaluation is the method used by Bye and Delong (1994) in their research and fit evaluation is also described by Joseph-Armstrong in Draping for Apparel Design (2008) and Patternmaking for Fashion Design (2006) and my own definition of fit defined for this project.

Fit Models

This research implements case studies that will test the validity of the process being developed. Three fuller figured fit models were selected to represent different female body shapes determined to exist within the community. The chosen shapes correlate to 81.6% of the shapes defined by Berry and Hennes in Australia (2008), and 94.6% of the shapes defined by FFIT for Apparel in USA (2004a). The three selected fit models have similar measurements to allow the assessment of shape without the distraction of various sizes. Based on a 5cm increment principle, all three fit models sit within the tolerances of four size steps above the base size where they are considered a size 20.

Fit Model	Size	Size Dimensions **B**-UB-**W**-HH-**H**	Shape FFIT for Apparel	Shape Berry and Hennes	Shape Description
	12	**89**-76-**71**-91-**99**	Hourglass	X	Base Size and Mannequin Measurements
	20	**109**-96-**91**-111-**119**	Hourglass	X	Initial Grading, Size 20, Measurements (4 sizes x 5cm grading = 20cm growth at each key girth point from base size)
1	12	**89**-76-**71**-91-**99**	Hourglass	X	Matched the dimensions of Massey Size 12 and standard mannequin. The control for the base size, allowing for variation and movement to be assessed within the garments and designs.
2	20	**108**-95-**89**-109-**118**	Hourglass	X	4 sizes or 18-20cm above base size. Shape corresponds to mannequin and base shape. Hip measurement 10cm larger than bust, and viewed from front, her hips have the same visual width as her shoulders.
3	20	**108**-95-**95**-113-**116**	Rectangle/Spoon	H/XH	Similar measurements to F.M.2, but is larger through the abdomen, specifically the waist. Shape is on the boarder between rectangle and spoon, and therefore H and XH.
4	20	**102**-88-**84**-105-**121**	Bottom Hourglass	A	Hip measurement bigger than the other two fit models, but a smaller bust and waist. To qualify as a pear her hip measurement is almost 4 sizes or 20cm larger than her bust measurement under the initial sizing and grading system implemented for this project

Fig 5. Analysis of Fit Models (Freeth, 2010)

An analysis of the chosen fit models measurements and body shapes. By quantifying the visual shape and form of the fit models through numbers this allows for a comparison of shapes.

The following table demonstrates the relationship between the Australian shape definitions, the American shape definitions, and the fit models used in this project. An approximate correlation between the USA and Australian systems showing the variation of body shape frequency by population is shown in Fig 6, below. The relative proportion of the differing populations can be compared.

FITT for Apparel	% of US Population	Berry and Hennes	% of Australian population	Case Study Fuller-Figured Fit Models
Hourglass	21.6%	X	19.0%	33.3% (1/3)
Rectangle	15.8%	H	31.2%	33.3% (1/3)
Spoon	17.1%	XH	11.6%	
Bottom Hourglass	40.0%	A	19.6%	33.3% (1/3)
Top Hourglass, Oval, Triangle, Inverted Triangle, Diamond	5.4%	I	18.4%	0

Fig 6. Table of Shape Definitions: Fit Models in relation to percentage of population (Freeth, 2010).

Shape Variation

The simple dimensions above do not represent all the distinctive comparisons of the body shapes of the fit models that will influence the development of shape based patterns. Fit Model 4 is technically a pear shape, but she has a larger bust and a small back (Fig. 5), while the hourglass and straight fit models, 2 and 3, have a smaller bust and larger back in comparison. Fit Model 3 (straight) has the same bust and under bust measurement as the hourglass (Fit Model 2), and they both have similar shapes in this portion of the body, being a smaller cup size and broader back. The only difference is that the straight fit model

has smaller shoulders and a larger waist.

It would be ideal to use several fit models of each shape whose measurements could then be averaged, but this is a case study so only one fit model of each shape was investigated. A greater number of subjects would have created a more accurate view of the particular shapes; a possible feature of further study.

The silhouettes below were developed from photographs of the fit models bodies by colour blocking the shapes to get a visual portrayal of the body shape in 2D. While the measurements allowed me to quantify my visual assessment, the silhouettes were the main indicator of shape.

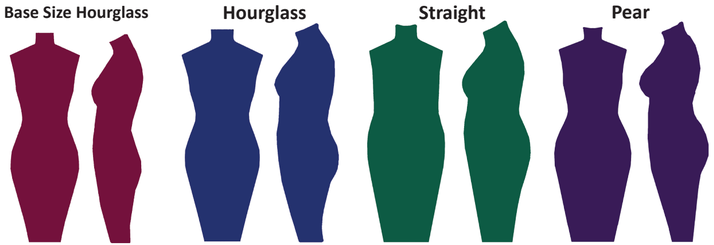


Fig 7. Body Shape Silhouettes (Freeth, 2010).

The Draped Collection: Design and Development

Creating complex designs with multiple design elements will test the maintenance of design aesthetic during shape-based-grading. If the designed grading model can grade highly complex patterns for body shape as well as size this will extend it beyond the range of conventional grade rules. Pushing its limitations and aiming to make it as comprehensive as possible will expand the range of designs to which the application of a successful method could be extrapolated. Therefore, the designs created to investigate and illustrate this research comprised a collection of three draped dresses.

The process of drape was used to develop the designs of the collection. The dresses were developed by draping a range of fabrics onto the standard size 12 mannequin. A constraint of not cutting the fabric allowed more interesting aspects of fit and fullness to emerge as shapes, drape, volume, silhouette, line and form. I was looking for fullness and fit and a transition between both within the same garment. Using an iterative process of draping and drawing and including aesthetic analysis and evaluation, I developed the collection. The evaluation was crucial, as in developing the design aesthetics I was guided by the aims of the project and requirements for the designs. The choice of the final three designs was based on their combining varying levels of visual complexity and technical difficultly. The innate nature of the fabric (drape, handle and body), combined with variations of fit and fullness (seams and pleats, taper and flare, cinching and volume), created designs both disparate and linked in the details. This created a cohesive collection reflecting a consistent aesthetic through the individual dresses.

Visual analysis of the developing aesthetic allows assessment of the designs for their ability to fulfil the needs of this project. While the designs work as a cohesive collection and are reflective of my liking for the hourglass silhouette, they were chosen from a practical perspective. They have the necessary transition between fit and fullness, but they also have different design features to test the shape-based-grading, some had side seams, others did not. The skirts have various levels of fit and fullness as do other areas of the dress, and a variety of ways are used to deal with the transition between fit and fullness.

In the initial draping to develop design I used a range of fabrics with obvious grainlines that allowed constant evaluation of

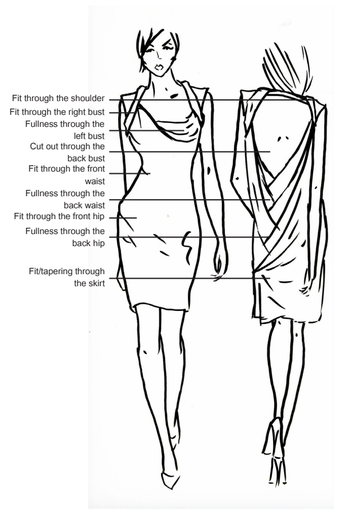
grain direction, fullness and shape. During the pattern development process, I worked with various white or cream fabrics. This colour choice is a common practice when draping as it allows the designer to mark the key lines and points of the design's pattern (balance lines, pattern markings, and seam lines) and avoids distraction from colour or pattern, therefore assisting analysis of the shape, line, form and volume and the coherence required for a collection.

Once finalized, fabric patterns were digitized into Gerber patternmaking software to allow development. As fabric is malleable, care was taken to ensure that fabric didn't skew and stretch on the cross grain. The key to translating the fabric pattern to a digital pattern is to ensure that the fabric returns to its original form, without showing any strain or stress on the fabric. During the toiling and testing stages adjustments were needed to correct the fit and fall of the fabric. Clearly, the more accurate the pattern is at the base size, the better the chances the grading has to work.

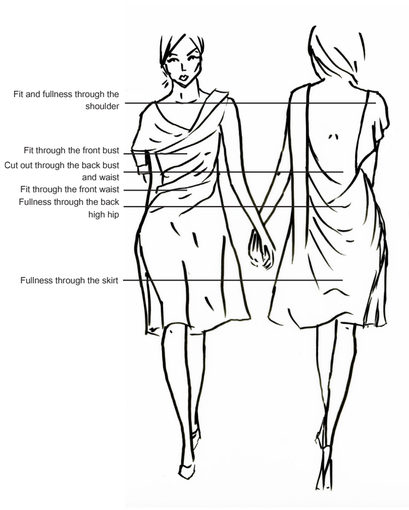
Each design required internal linings to help stabilize the exterior structure of the draped designs, and these provided the initial testing of the developed shape-based-grading model. The linings can stand alone as three designed dresses with less complex design details and a straight grain. They also avoid the complexities inherent in grading draped designs. Each lining used the same fabric as the draped dress.

The three selected designs are illustrated and shown on the following pages.

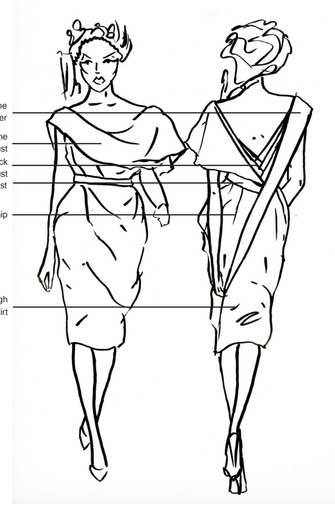
Collection: Visual Analysis and Evaluation



Design 1



Design 2



Design 3

These are the three selected designs to test the developed shape-based-grading. Shown here are the illustrations, including the visual analysis and evaluation of the designs based on the criteria for the selection of the designs. The criteria used to evaluate the designs was based on the requirements of the project for a test at various levels of complexity of the shape-based-grading to be designed and developed.

This method of visual analysis and evaluation and in particular this method of displaying the results of the visual evaluation is used throughout the rest of this essay.

Collection: Front

Collection: Back

Design One: Base Size Finished Garment

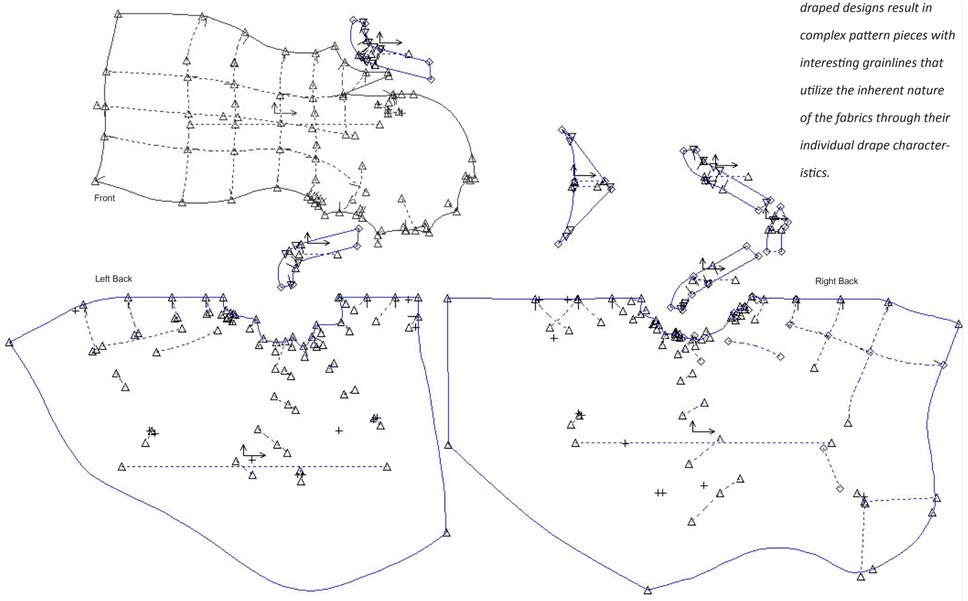
Base Size Hourglass

Size 12 Measurements:

Bust:	89 cm
Under Bust:	76 cm
Waist:	71 cm
High Hip:	91 cm
Hip:	99 cm

Design 1: The designs originally draped onto a mannequin are transferred and tested on the fit model where they demonstrate the design aesthetics of fit, fullness and the complementing and emphasizing the underlying hourglass shape.

Design One: Final Pattern Pieces



Design 1: The complicated draped designs result in complex pattern pieces with interesting grainlines that utilize the inherent nature of the fabrics through their individual drape characteristics.

Design Two: Base Size Finished Garment

Base Size Hourglass

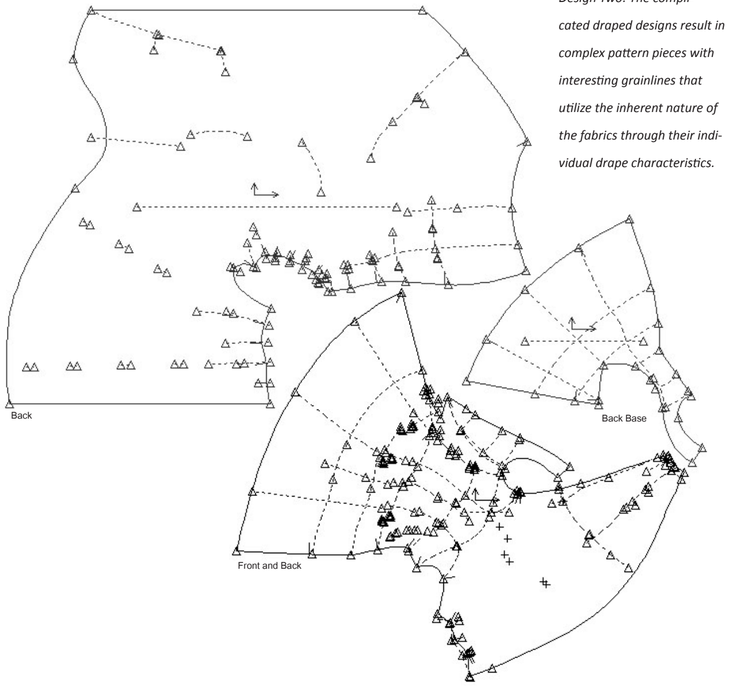
Size 12 Measurements:

Bust:	89 cm
Under Bust:	76 cm
Waist:	71 cm
High Hip:	91 cm
Hip:	99 cm

Design Two: The designs originally draped onto a mannequin are transferred and tested on the fit model where they demonstrate the design aesthetics of fit, fullness and the complementing and emphasizing the underlying hourglass shape.

Design Two: Final Pattern Pieces

Design Two: The complicated draped designs result in complex pattern pieces with interesting grainlines that utilize the inherent nature of the fabrics through their individual drape characteristics.



Design Three: Base Size Finished Garment

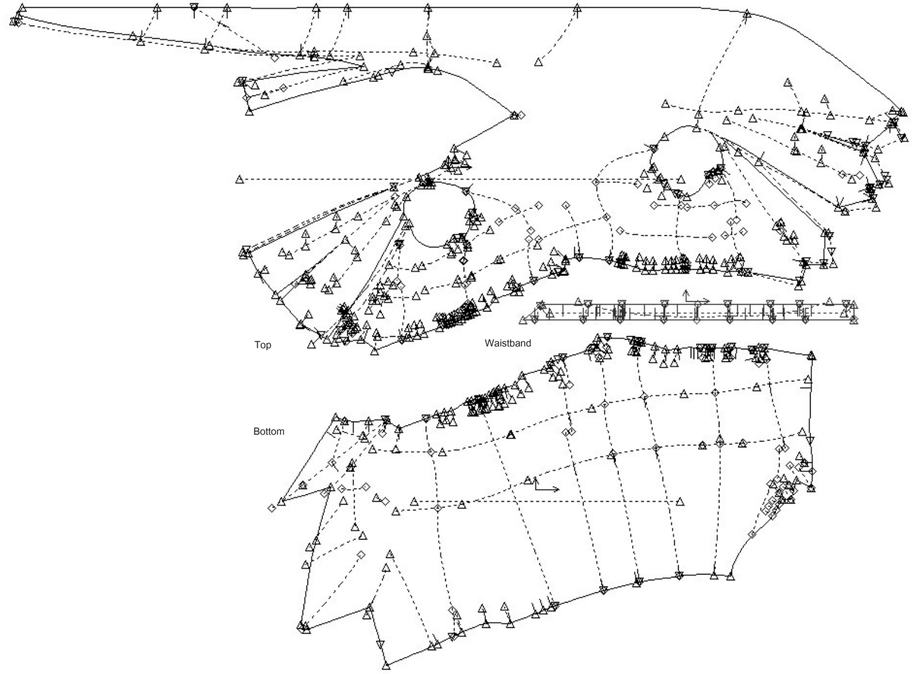
Base Size Hourglass

Size 12 Measurements:

Bust:	89 cm
Under Bust:	76 cm
Waist:	71 cm
High Hip:	91 cm
Hip:	99 cm

Design Three: The designs originally draped onto a mannequin are transferred and tested on the fit model where they demonstrate the design aesthetics of fit, fullness and the complementing and emphasizing the underlying hourglass shape.

Design Three: Final Pattern Pieces



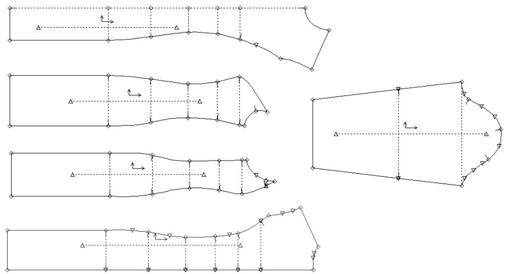
Design Three: The complicated draped designs result in complex pattern pieces with interesting grainlines that utilize the inherent nature of the fabrics through their individual drape characteristics.

Blocks and Initial Proportional Grading

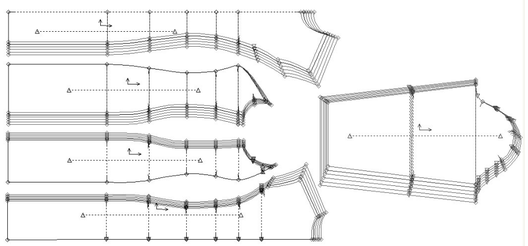
Creation of Tunic Blocks

Developing and designing a system that could size and yet maintain a design aesthetic, started with the basic tunic block. The original tunic block uses darts to create shape. When bust cup size increases, darts do not allow for a sufficiently smooth transition of shape, that follows the 3D form of a female body. I therefore chose to alter the tunic block slightly to include princess line panels allowing the 2D pattern to create a more exact representation of the 3D form. For each of the four fit models, a panelled tunic block was developed to allow an analysis of the underlying body shapes, creating a detailed understanding of the essential differences of body shapes within a single size.

Starting with the original base size tunic block, I applied simple proportional grading with 5cm grade increment, with the principle of proportioning out growth around each ¼ of the body, 60% growth through the front and 40% growth through the back. The standardized size 20 graded tunic block was toiled and tested on the three fuller figure fit models and assessed applying visual analysis to discover the areas of fit, and ill fit according to the fit definition for this research, on page 28. The visual analysis uses the same method applied during the collection design analysis shown on page 45, but uses different criteria. After the first initial fitting of the graded tunic block toile, I developed individual patterns for each of the fit models, allowing me to adjust them to suit the different and individual body shapes. Precision of fit informing the transference of line, shape and form, contributes to developing an understanding of how grading affects the translation of a design. At each fitting it was crucial that the shape of



The pattern for the base tunic block. Using a princess line shape allowed for more accurate representations around the bust and back of the body.



Proportional grading: i.e. proportional at each point of the body - bust, waist, hip, armhole, shoulder, etc. The front is grading more than the back; 60% growth through the front and 40% growth through the back, to try to take into account the proportional growth of the body.

First Fitting

Fit Model 2

Fit Model 3

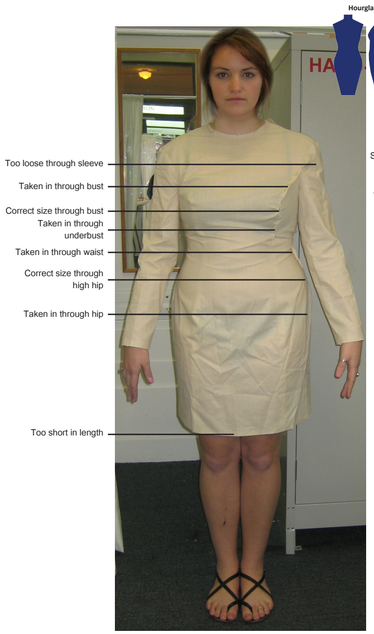
Fit Model 4

the underlying form informed the shape of developing the pattern. I was looking for stress or strain on the fabric, gapping or looseness in other areas, side seams and CF/CB hanging straight, balance lines that were horizontal to the floor. I was aiming to create patterns that, when transferred and constructed, would accurately represent the shape of the underlying form. Translating the marked changes to the pattern required me to work from a 3D form to a 2D representation of that shape, to visually define the changes needed in the digital realm. By the third fitting I was able to get a graphic and measurable sense of the differences in their body shapes showing in the pattern pieces of the tunic block. These differences form the basis for the development of the shaped based block patterns.

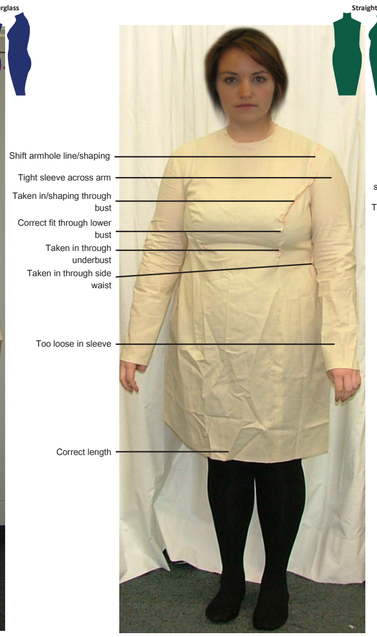
The first three fittings for each fit model were to get the pattern fitting like a second skin; an exact representation of the essential form, often tight and not allowing for a large range of movement. As this was not a developed design, but part of the process to create an exact representation of shape that would give a more accurate reading of the changes required by a pattern needing to be morphed the fit definition did not apply.

The visual analysis and evaluation of the fittings of the tunic blocks shown on the following pages is the method displayed earlier on the collection. This time the criteria for the analysis is the fit definition set out in the context review. The visual analaysis and evaluation of the fit was assessed both in person during the fittings and from the resulting photographs. Each individual point of the body was assessed for fit and ill-fit, and it was also assessed as a whole. Notes were taken on the results of the assessment, and changes required to the tunic blocks to alter and

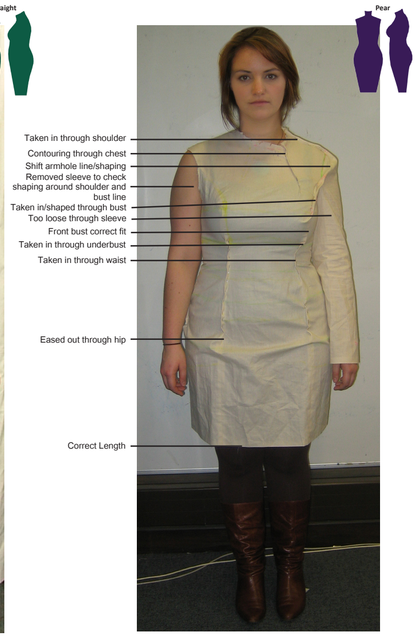
First Fitting: Front Comparison



Fit Model 2



Fit Model 3

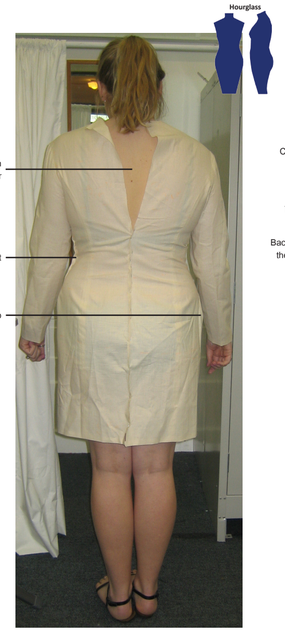


Fit Model 4

Originally graded size 20 panelled tunic block, same garment on the three fit models

Refer to appendices for a full record of the fittings and visual analysis and evaluations.

First Fitting: Back Comparison



Fit Model 2

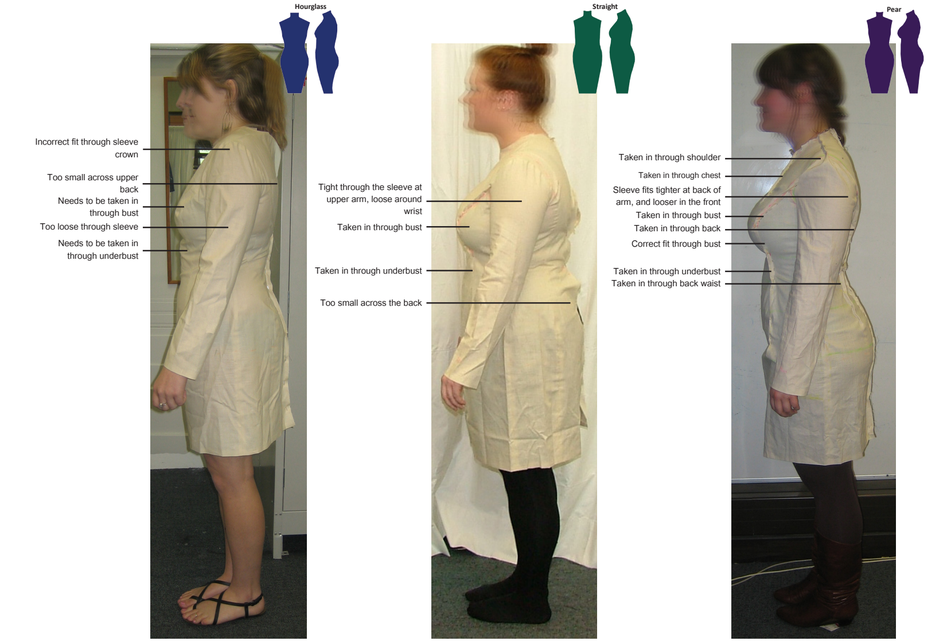
Fit Model 3

Fit Model 4

Originally graded size 20 panelled tunic block, same garment on the three fit models

Refer to appendices for a full record of the fittings and visual analysis and evaluations.

First Fitting: Side Comparison



Fit Model 2 | Fit Model 3 | Fit Model 4

Originally graded size 20 panelled tunic block, same garment on the three fit models

Refer to appendices for a full record of the fittings and visual analysis and evaluations.

Final Fitting: Including Ease

Fit Model 2

Fit Model 3

Fit Model 4

fix the fit were noted during the fitting, and from the resulting photographs.

After the first fitting using the basic size 20 graded block on each fit model, I used a MTM approach to get an exact representation of each underlying body shape, to inform and design a system that would ultimately work within the RTW market. However, this is not a MTM project, as I did not treat the fit models as individual bodies, but as representatives of a segment of the population. Therefore, asymmetry or personal body quirks were ignored and not incorporated into the shape representative patterns, by averaging right and left sides. These blocks should achieve a better fit for women considered to be that body shape compared to patterns developed from another body shape.

Once the fitted tunic blocks for each fit model was completed, ease was added for the final fitting. The tunic blocks created for each of the three specific shapes were analysed and the grade rules developed, discussed in results. These grade rules describe the relationship between the base hourglass pattern and the specific shaped pattern, being hourglass, pear or straight. The grading is then tested through application to the designed dresses, both the overdress and the lining.

Shape based grading

To develop the system of shape-based-grading I used the patterns created during the development and fitting of the tunic block. While not complex or aesthetically interesting, the patterns were designed with the precision of line and shape that was key to describing the distinctive underlying body shapes of the fit models. To develop a set of grade rules that would allow a pattern to be morphed as well as graded required an understanding of grading rules and principles, an ability to see patterns as numbers and a precise translation of body shape into the grading rules.

Overlaying the original base size pattern on to the shape representative patterns is a critical step for assessment and calculations. Manipulating the pattern pieces to find the best-fit relationship demonstrated how they worked together, displaying the changing grading / morphing sequence. The two patterns, the base size matched with each shape representative pattern, were overlayed and manipulated to find the best–fit. This was a key step through this stage of the design work, as it would ultimately affect the grade rules developed, influence the nesting of the patterns, and illustrate the relationship between the sizes and shapes. Therefore multiple interactions between every pair of related pattern pieces were evaluated, analyzed, assessed, considered and discarded, until the best-fit between two patterns across all the pieces of the pattern was decided upon. Once again, visual analysis was used for this assessment. This technique was successful in describing the relationship between the shapes, and how the base hourglass pattern needed to be graded to morph into a pear shape or straight body shape pattern of a fuller figured size.

Without the distraction of design details or a complicated aesthetic, the simple panelled tunic block pattern, clearly delineated the distance between the base and the shaped pattern shapes. Overlaid, they clearly display the extent of the shape change required to morph the base patterns allowing for sizing, while still holding true to the original design of the garment. The simplified details of CF/CB/side seams, as well as balance lines, neck shaping, shoulder and sleeve placement allowed the development of a system that worked with horizontal and vertical lines, and silhouettes that represented the underlying

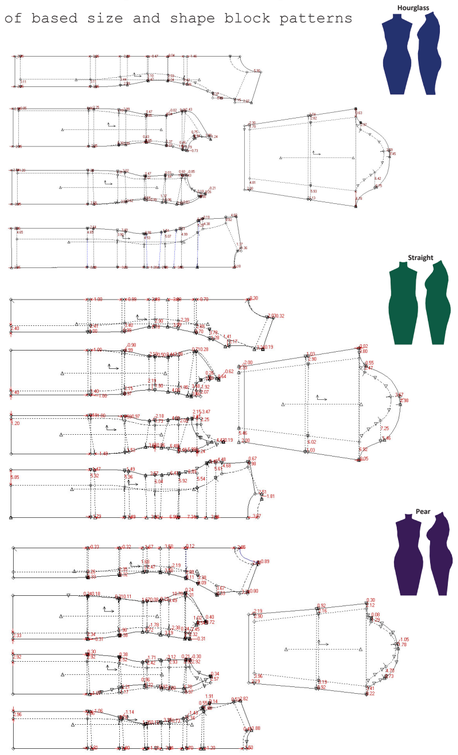
shapes. The overlaid patterns were used to calculate the distance between the base and the shape representative patterns as numerical representations, both on the angle and on the x/y grading axis. The development of the grade rules for morphing, illustrated as a numerical representation, the proportion of girth growth around the body. This allowed a further understanding of a quantitative representation of shape to make shape analysis and classification available without a body scanner.

The shape-based-grading rules derived from this process were then applied to the linings of the draped designs and the resulting patterns were toiled. Following this application, the same shape-based-grading rules were then applied to one of the draped designs which was then toiled and developed through to the prototype stage for all four fit models.

The morphing of the base size tunic block allows a visual representation and analysis of the shape difference between the three fit models. The differences illustrate why such a large percentage of women have problems with clothing based on traditional sizing systems. Shape-based-grading applied to the designs of the collection should provide a better fit for all fit models and prove the viability of the concept and process.

Blocks: Best-fit Shape Relationship;

Overlaying of based size and shape block patterns

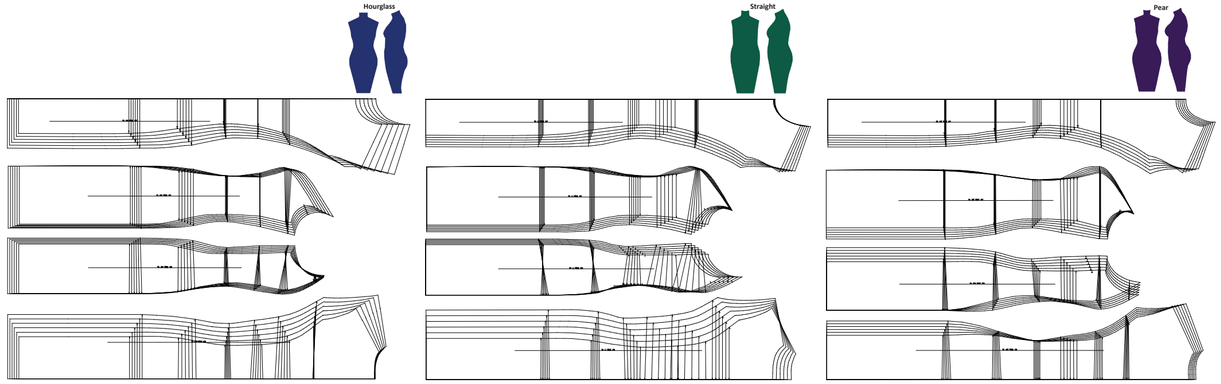


The process of overlaying the shape representative patterns with the base block and manipulating the connection to find the best relationship.

These three images are the resulting best-fit relationship between the base size (dotted line) and shape based block body pattern. The numbers are the difference on the X and Y axis between the base size pattern and the same point on the shape body block pattern. Showing the relationship between the base size and the gowth required by the grading to grade for shape. It also displays the proportional growth required around the body, at each key point.

These images display the comparisons in the relationship between the base size hourglass pattern and each of the larger size shape body patterns. The previous descriptors of numerical measurements and silhouette analysis are transposed to 2D patterns and they provide a strong 2D visual understanding of the differing 3D body shapes of this representative sample of the NZ female population. The significance of body shape and how this affects patterns for the shell surrounding the body (the garment) is clearly displayed in the individual differences to the base pattern.

Shape Based Grading



Fit Model 2 (Hourglass)

Fit Model 3 (Straight)

Fit Model 4 (Pear)

These images show the developed shape-based-grading. The grading also shows the change in shape like the overlaid best-fit images, however, it also displays the progress through the sizes.

Results

When viewing the garments created with the new system of shape-based-grading, I analyzed the garments against the original size 12 garment. The aim is to maintain the aesthetics of the design when sizing it up to fit the fuller figure size and shape, so that the smaller and larger garments will be read the same.

Shape and Fit Models

During this research I noticed something that I had not found commented on before; the definition of hourglass has changed over the last 50+ years. During the 1950's, Marilyn Munroe personified the ideal figure; the hourglass with measurements that became well known: '36-24-36', the bust having the same measurement as the hip. Today this would be considered top-heavy. Today's definition of hourglass has the bust as slightly smaller than the hips, 34-24-36. Viewed from the front, the shoulders and hips appear to be the same width.

Tunic Block

The development of the tunic blocks resulted in findings that demonstrate how the variation of women's shapes increases markedly through the sizes, and the effects this has on the pattern shapes required for fit.

The fitting of the first tunic block toile on the fuller figured fit models of all three case studies illustrates how different the body shape can be when the measurements are very similar and how this can affect fitting. It was clear that in all three of the fit models regardless of shape, the back is shorter and there is (proportionately) more curve through the back waist vertically than a smaller sized woman. The tunic blocks for all three fit models required repeated removal of excess material from the

horizontal back waist. Because of the way the back curves through the waist, the CB seam tends to curve and not lie straight. To compensate for this curve, I altered the curve of the panel seam that would be the back dart. This affected the shape of the CB and SB panels around the waist area.

The information gleaned from this initial fitting was the importance of cross-back / shoulders to bust / cup size ratio as an indicator of shape through the torso. This relationship is more an indicator of shape than the bust circumference measurement which is a one dimensional measurement. The only way simple bust circumference could be helpful is if it has the proportion of growth calculated and accounted for.

Historically hip to waist to bust has always been an indicator of shape, particularly hip to waist, as this defines the shape of the lower half of the body, allowing for classifications such as pear, apple, hourglass, straight. However, one-dimensional measurements do not give an accurate representation of shape, which is why it has always relied on a visual aspect as well. If proportional growth around each quarter of the body is added to the measurement readings, it would add a 3D aspect to the numbers representing shape.

Fit Model 2: The hourglass fit model is a perfect representation of a size 20 hourglass, as her height, shoulder width, and circumference measurements all grow proportionately. By these definitions, the graded tunic should have fit her perfectly. But, between the size 12 hourglass fit model and the size 20 hourglass fit model, the body shape has morphed, shown by the fit failures of the standard tunic block. While her bust measurement is the same as that of the garment, the difference arises from how the measurement is proportioned around the body. Fit Model 2 is proportionately broader through the back and shoulders, so the garment back was not able to close.

Fit Model 3: As her measurements are similar to Fit Model 2, she has a similar disparity in the relationship between body and toile. In this case, because of the broader back, and waist measurements, the back couldn't close at all.

Fit Model 4: As noted earlier, her bust measurement is significantly smaller than the other two fit models, so she had the opposite problem. While the toile could close, I needed to take large amounts of fabric out of the toile. The majority of the fabric being removed was through the back, at the cross back and bust balance lines.

Ease, Shape and the Fit Relationship

The last fitting of the tunic block was to allow ease into the garments. Ease is a quantifiable measurement that describes the space between the body and the garment, allowing for ease of movement. What I found particularly interesting was that the three size 20 fit models did not require the same amount of ease. It is common knowledge that the amount of ease required increases as the size increases, so my expectation at the beginning of this project was that more ease would be needed as the size increased, although no concrete values have been agreed upon by experts and published. During my research, I found no evidence that shape based ease increments has been calculated or quantified. Studies of shape have not included designed patterns to work with those shapes and sizes and therefore I have not found any relationship defined on ease increments.

Fit Model	Size and Shape	Shape	Ease
1	12	Hourglass (X)	4 mm
2	20	Hourglass (X)	24 mm
3	20	Straight (XH/H)	26 mm
4	20	Pear (A)	20 mm

This leads to the conclusion that the cross-back / shoulder to bust / underbust ratio impacts on the ease requirements as well as being an indicator of shape.

The two fit models with broader backs required more ease because of the way movement occurs through the arms and shoulder blades. Backs are not flat, especially as the size increases, and the movement of the arms pulls on the back of a garment more often than on the front. When the fit around the bust is correct in a woman with a larger bust, movement through the armhole/sleeve and arm itself is smoother, and I believe the amount of ease required lessens.

Shape Based Grading

This table shows the total growth of each size at each key girth point on the body for each shape. This allows for another method of shape comparison, and an understanding of growth amounts around the body therefore, shape based grading growth amounts.

Where the original proportional grading used in this project was a 5cm girth growth, the shapes require different growth amounts. Below is a simplified summary of the table above, allowing comparisons of size / grading growth amounts to be made between the body shapes.

LI (Straight)		1/2 Total	1/2 Growth	Total	Total Growth
XB	8	13.50		**27.00**	
	10	14.90	1.40	**29.80**	**2.80**
	12	16.30	1.40	**32.60**	**2.80**
	14	17.70	1.40	**35.40**	**2.80**
	16	19.10	1.40	**38.20**	**2.80**
	18	20.50	1.40	**41.00**	**2.80**
B	8	42.87		**85.74**	
	10	45.95	3.08	**91.90**	**6.16**
	12	49.14	3.19	**98.28**	**6.38**
	14	52.43	3.29	**104.86**	**6.58**
	16	55.79	3.36	**111.58**	**6.72**
	18	59.23	3.44	**118.46**	**6.88**
UB	8	36.08		**72.16**	
	10	38.90	2.83	**77.80**	**5.66**
	12	41.77	2.87	**83.54**	**5.74**
	14	44.68	2.91	**89.36**	**5.82**
	16	47.62	2.94	**95.24**	**5.88**
	18	50.59	2.97	**101.18**	**5.94**
W	8	32.98		**65.96**	
	10	36.23	3.25	**72.46**	**6.50**
	12	39.50	3.27	**79.00**	**6.54**
	14	42.78	3.28	**85.56**	**6.56**
	16	46.07	3.29	**92.14**	**6.58**
	18	49.38	3.31	**98.76**	**6.62**
HH	8	42.15		**84.30**	
	10	45.65	3.50	**91.30**	**7.00**
	12	49.19	3.54	**98.38**	**7.08**
	14	52.75	3.57	**105.50**	**7.14**
	16	56.34	3.59	**112.68**	**7.18**
	18	59.96	3.62	**119.92**	**7.24**
H	8	47.88		**95.76**	
	10	50.60	2.71	**101.20**	**5.42**
	12	53.34	2.74	**106.68**	**5.48**
	14	56.11	2.77	**112.22**	**5.54**
	16	58.91	2.80	**117.82**	**5.60**
	18	61.73	2.82	**123.46**	**5.64**

AR (Hourglass)		1/2 Total	1/2 Growth	Total	Total Growth
XB	8	13.59		**27.18**	
	10	14.9	1.32	**29.8**	**2.64**
	12	16.23	1.32	**32.46**	**2.64**
	14	17.55	1.32	**35.1**	**2.64**
	16	18.88	1.33	**37.76**	**2.66**
	18	20.21	1.33	**40.42**	**2.66**
B	8	43.07		**86.14**	
	10	45.95	2.88	**91.9**	**5.76**
	12	48.88	2.93	**97.76**	**5.86**
	14	51.86	2.97	**103.72**	**5.94**
	16	54.87	3.01	**109.74**	**6.02**
	18	57.91	3.04	**115.82**	**6.08**
UB	8	36.02		**72.04**	
	10	38.9	2.88	**77.8**	**5.76**
	12	41.8	2.9	**83.6**	**5.8**
	14	44.72	2.91	**89.44**	**5.82**
	16	47.65	2.93	**95.3**	**5.86**
	18	50.58	2.94	**101.16**	**5.88**
W	8	33.49		**66.98**	
	10	36.23	2.74	**72.46**	**5.48**
	12	38.97	2.74	**77.94**	**5.48**
	14	41.71	2.74	**83.42**	**5.48**
	16	44.46	2.75	**88.92**	**5.5**
	18	47.21	2.75	**94.42**	**5.5**
HH	8	43.02		**86.04**	
	10	45.71	2.69	**91.42**	**5.38**
	12	48.4	2.69	**96.8**	**5.38**
	14	51.09	2.69	**102.18**	**5.38**
	16	53.78	2.69	**107.56**	**5.38**
	18	56.48	2.69	**112.96**	**5.38**
H	8	48.13		**96.26**	
	10	50.6	2.47	**101.2**	**4.94**
	12	53.07	2.47	**106.14**	**4.94**
	14	55.54	2.47	**111.08**	**4.94**
	16	58.01	2.47	**116.02**	**4.94**
	18	60.48	2.47	**120.96**	**4.94**

AM (Pear)		1/2 Total	1/2 Growth	Total	Total Growth
XB	8	14.51		**29.02**	
	10	14.9	0.4	**29.8**	**0.8**
	12	15.31	0.4	**30.62**	**0.8**
	14	15.71	0.4	**31.42**	**0.8**
	16	16.11	0.4	**32.22**	**0.8**
	18	16.52	0.41	**33.04**	**0.82**
B	8	43.69		**87.38**	
	10	45.93	2.25	**91.86**	**4.5**
	12	48.19	2.25	**96.38**	**4.5**
	14	50.44	2.26	**100.88**	**4.52**
	16	52.7	2.26	**105.4**	**4.52**
	18	54.96	2.26	**109.92**	**4.52**
UB	8	37.09		**74.18**	
	10	38.85	1.76	**77.7**	**3.52**
	12	40.61	1.76	**81.22**	**3.52**
	14	42.37	1.76	**84.74**	**3.52**
	16	44.13	1.76	**88.26**	**3.52**
	18	45.89	1.76	**91.78**	**3.52**
W	8	34.74		**69.48**	
	10	36.16	1.42	**72.32**	**2.84**
	12	37.58	1.42	**75.16**	**2.84**
	14	39	1.43	**78**	**2.86**
	16	40.43	1.43	**80.86**	**2.86**
	18	41.87	1.43	**83.74**	**2.86**
HH	8	44.38		**88.76**	
	10	45.71	1.33	**91.42**	**2.66**
	12	47.04	1.33	**94.08**	**2.66**
	14	48.38	1.34	**96.76**	**2.68**
	16	49.72	1.34	**99.44**	**2.68**
	18	51.07	1.35	**102.14**	**2.7**
H	8	48.02		**96.04**	
	10	50.6	2.58	**101.2**	**5.16**
	12	53.18	2.58	**106.36**	**5.16**
	14	55.77	2.59	**111.54**	**5.18**
	16	58.36	2.59	**116.72**	**5.18**
	18	60.95	2.59	**121.9**	**5.18**

Table of Girth Growth Amounts for Shape Based Grading

Average Growth in cm	Bust	Under Bust	Waist	High Hip	Hip
Initial Proportional Grading	5	5	5	5	5
Hourglass	6	5.8	5.5	5.4	5
Straight	6.6	5.8	6.5	7.1	5.6
Pear	4.5	3.5	2.89	2.7	5.2

Design Linings

The application of the shape-based-grading was successful when applied to the straight grained linings of the design collection. Because the rules developed for the shape-based-grading were successful in morphing the underlying body shape to produce patterns for each case study, only a single toile was required. A close correspondence between the garment and the fit model body shape was observable, proving that the fit and therefore the design aesthetic had been maintained. However, one anomaly relating to the shape-based-grading is apparent. This is related to the shortness of the back waist of fit model 2, affecting the shape of the waistband for Design 3 lining. Also, when the linings were graded to larger sizes the resulting patterns exacerbated two minor faults in the base pattern that were not apparent in the base size. When the tapered skirt of Design 3 lining was graded, it illustrated an aspect of pattern design to be considered during shape based grading, as the point of tapering must move as body shape changes. Since this is only related to tapered skirts, it will not feed back into the shape-based-grading model.

The patterns for all linings have less complex design details than their corresponding draped designs. The differences between the design 3 lining pattern and the tunic block are a dropped and shaped neckline, a reshaped armhole, no sleeves, a tapered skirt, a shaped waistband and an angled back opening. These features add details that test the developed shape-based-grading model, but display aspects that require further development.

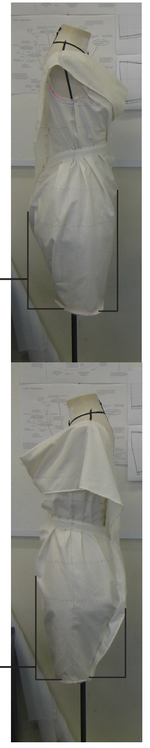
As noted earlier, the fit models' backs are proportionately shorter through the waist. This affects the reading of the waistband style lines in Design 3. With both the hourglass fit model and pear fit model (2 and 4) the shape of the design lines are still acceptable for the requirements of the design, in the sense that the aesthetic is maintained from base size to shape graded size. However, the effect that the shortness through the back has is most obvious with Fit Model 3 (straight). In this case, as

the grade rules were applied exactly as they were developed, this resulted in the waistband becoming almost straight and horizontal across the back waist, instead of angled. While this could be easily adjusted, using a slight shifting of the grading rules, this would be a decision for the designer. For the straight body shape, because of the shortness through the back, the shape-based-grading rules developed are required to grade the garment to fit that shape. Patternmaking knowledge needs to be applied to adjust the rules to allow the design lines to be maintained while still ensuring that the underlying body shape fit is unaffected.

Results: Design 3 Lining

Because Design 3 tapers through the leg, the front and back skirt of the lining also require tapering, otherwise the line of the draped garment would be distorted. In the base size, this tapering started from the hip, and continued through each seam,

Design 3: Base Size



Tapering through front and back of the skirt required the lining to also taper

Tapered through front and back of the skirt requiring the lining to taper to accomadate

mostly at the side seams, but a small amount through the front and back panel lines. This style detail fit on both the mannequin and the fit model. However, when the grading rules were directly applied, tapering from the hip caused problems for the patterns developed for the fuller figured fit models. The grading rules were developed on a straight skirt, where the thigh shaping did not have any influence. When the straight skirt grade rules were applied to a skirt tapered from the hip it adversely affected the fit on the fuller figured fit models, and emphasised that the thigh shaping was relevant to the grading process. The shaping of the thighs on all three of the fuller figured fit models, requires the tapering of the skirt to start from mid thigh rather than at the hip. Because this factor is the same with all three fit models, and is specific to the tapered skirt, I do not believe that it needs to be fed back into the shape-based-grading models. However, this knowledge needs to inform the grading of tapered skirts in general, but specifically any skirt that tapers as extremely as the Design 3 lining pattern does. This is patternmaking knowledge that needs to inform and feed into shape-based-grading for fuller figured women.

For all three body shapes the patterns required an adjustment along the top shaping of the bust line. All the patterns resulted in the upper bust seam line being slightly too big for the shape. On all three fit models the pattern needed to be adjusted by the same amount. A similar distortion at the shoulder seams occurred on all three patterns for all three body shapes. Since both these adjustments occurred for all three body shapes, at the same place and the same amounts, this is obvi-

ously an issue with the base pattern rather than the shape-based-grading, which indicates that the base pattern needs to be corrected for the grading to be sustained.

The lining of Design 2 also produced the same bust line and shoulder results as the lining of Design 3, emphasizing that this is an issue with the base pattern. The lining of Design 1 produced the same results through the bust line and it was a little tight through the thigh, because the skirt is slightly tapered. However, as it only tapers from the side seam, and not to the same degree as the lining for Design 3, the impact was not as extreme as the results with Design 3. However, because it tapers from the hip in the base size, the grading needs to be adjusted a small amount to allow the skirt to only taper from the mid thigh point.

Shape-based-grading was successful when applied to the non-complex garments of the linings, it was then applied to the more complex patterns of the draped designs.

Fit Model 2

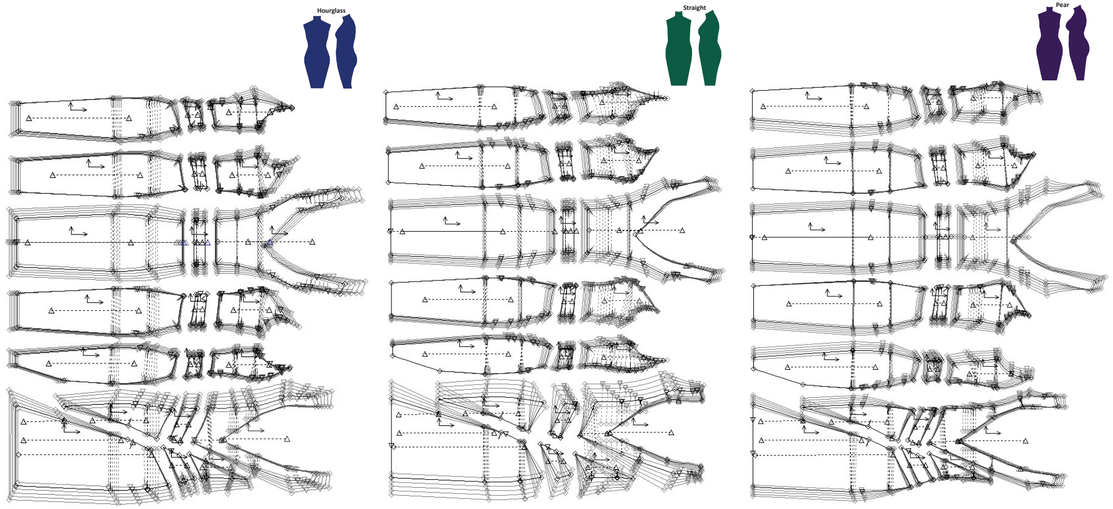
Fit Model 3

Fit Model 4

Results: Design 3 Linings

Lining Garments

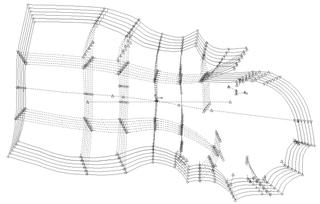
Results: Design 3 Lining, Shape Based Grading Patterns

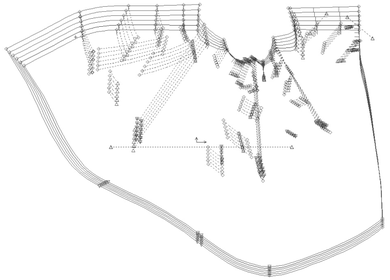


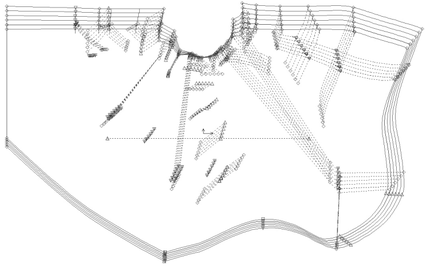
Shape based grading applied to a designed garment of more simplified design details

Draped designs

The application of shape-based-grading to the complex patterns of Design 1 was mostly successful. The first fitting of Design 1 on all fuller figured fit models showed that the design was successfully graded for shape and size, and a large part of the aesthetic was successfully portrayed. However, the shape-based-grading it did not completely maintain the design aesthetic; this was a direct result of the dependence of the design on the correct draping shape, and therefore, on fabric behaviour. Although it translated the design from the base size to the shape specific fuller figured size, the style of the design required adaptations to the shape-based-grading, because of the effect of fabric behaviour on fabric drape. Thus, when the graded design does not result in the same fabric behaviour and drape effect







Fit Model 2

Results: Design 1

Shape Graded Patterns

These images display the original shape based grading applied, without fabric behaviour calculated in.

Results: Design 1

Draped Garments

Fit Model 2

Fit Model 3

Fit Model 4

as the original size, the design aesthetic is not completely maintained. Ideally, the fabric drape behaviour needs to be calculated into the grading rules for this design.

Results: Design 1

Draped Garments Visual Comparisons

Fit Model 2

Comparison between shape-based-graded size and base size (Fit Model 2 and Size 12 mannequin)

Results: Design 1

Draped Garments Visual Comparisons

Fit Model 3

Comparison between shape-based-graded size and base size (Fit Model 3 and Size 12 mannequin)

Results: Design 1

Draped Garments Visual Comparisons

Fit Model 4

Comparison between shape-based-graded size and base size (Fit Model 4 and Size 12 mannequin)

Fabric Behaviour in Relation to Shape Based Grading

Fabric behaviour affected the visual aesthetic of the draped elements of Design 1. It caused distortion by skewing the drape effect. Because for two of the three the pattern pieces, the external edge traverses 180 degrees, therefore passing through the straight grain, the cross grain, and the bias of the fabric at least twice. For the front pattern piece of Design 1 the external edge of the cowling at the neckline traverses a 90 degree angle, so the cowling crosses through the fabrics, straight grain, cross grain and bias. Grading pattern pieces with this degree of drape, results in extreme variability in fabric behaviour.

All bias elements produce a weight based percentage of gravity induced distortion. Over a larger piece of fabric, this creates a larger distortion. However the height of the fit model has not changed, and in many cases the seam length is shorter because of the bodies shape, as detailed in the tunic block analysis, therefore the amount of drop has to be reduced. This can only be achieved on the larger piece of fabric, by changing the angle so that it reduces the drop percentage back to the original absolute value. The external edges of the piece had to alter to allow the fabric to drape and behave the in same way as the base size. This affected the grainlines relationship to the external edges of the pattern piece.

The pleating of the graded pattern pieces in all three larger sizes combined with the bias drape caused the fall of the fabric to skew, resulting in a different aesthetic. Often when I adjusted the pleats, folds and draped areas of the pattern, I was shifting all the pleats stitched seam edges in one area by a similar amount. To incorporate fabric behaviour, the pleating sometimes needed to change angles to get the same drape and fall from the fabric. This, combined with the curve of the back through the shoulder blade area, caused the shape of the stitched seam of the pleats underlay to change shape between a deep v and a straight line. The broader back maintained the proportions of the fabric drape while it was graded however the narrower back could not, so needed to be adjusted to stop the fabric skewing through this area.

The adjustments to the grading to take into account fabric behaviour were most extreme when morphing body shapes: for example when going from hourglass to pear and hourglass to straight. Conversely, they were less extreme when morphing from base size hourglass to fuller figured hourglass. The amount of change in body shape appears to be directly correlated to the adjustments required for fabric behaviour. Comparison of the images of the resulting grading, show how fabric behaviour has been incorporated into the shape-based-grading in relation to the drape of these particular pattern pieces for Design 1.

The analysis of the visual aesthetic of the design as it was shape-based-graded, led to the conclusion that the grading, without the incorporation of fabric behaviour, did not fully maintain the draped design aesthetic. Therefore adjustments were needed to the grading to work with the fabrics inherent drape and thus allow the design aesthetic to be translated and maintained. By making the adjustments required to the grading to work with the fabric, this research is taking a step towards quantifying the effects of the chiffon fabric behaviour. Visual analysis is key in allowing this to be developed.

Since the drape is also a part of the design, understanding how the grading incorporates fabric behaviour is informing the knowledge within the created grade rules as well as my own grading knowledge. The alterations to the shape-based-grading rules were specific to Design 1, therefore, they were not fed back into the rules for each shape-based-grading model.

This is illustrated in the following pages, to allow visual comparison of the resulting shape-based-grading with fabric behaviour incorporated.

The prototypes for Design 1 were completed in a mid-tone blue chiffon, in both sizes and all shapes. The colour was chosen to remove all connotations from the reading of the garment. White is known to make the wearer look visually bigger, black to make the wearer look smaller and many other colours have specific readings as well. A mid-tone blue colour is intended to allow the garments to be photographed easily while removing any unwelcome readings of the garments.

These images of the nested grading and the resulting prototypes illustrate the success of the shape-based-grading process and the success in incorporating fabric behaviour into this draped dress. The aesthetic of Design 1 when graded from an hourglass base size to a variety of body shapes for fuller figured women has been successfully maintained.

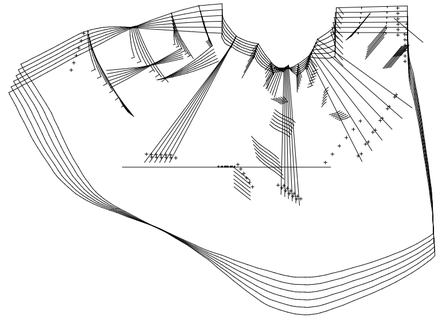
Base Size Prototypes

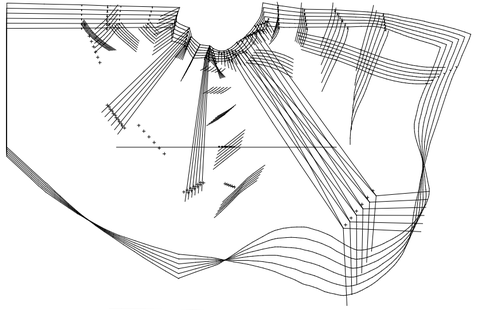
Fit Model 1

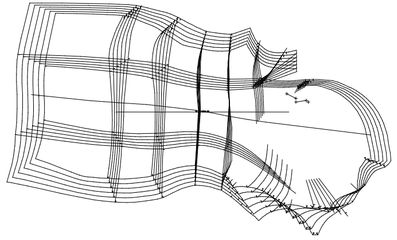
Fabric Behaviour in Relation to Shape Based Grading

Fuller Figure Prototype

Fit Model 2





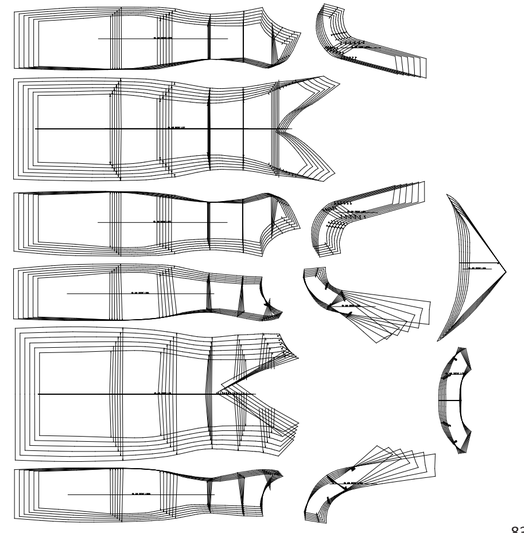


Fit Model 2

Design 1: Shape Based Grading

with Fabric Behaviour Calculated In

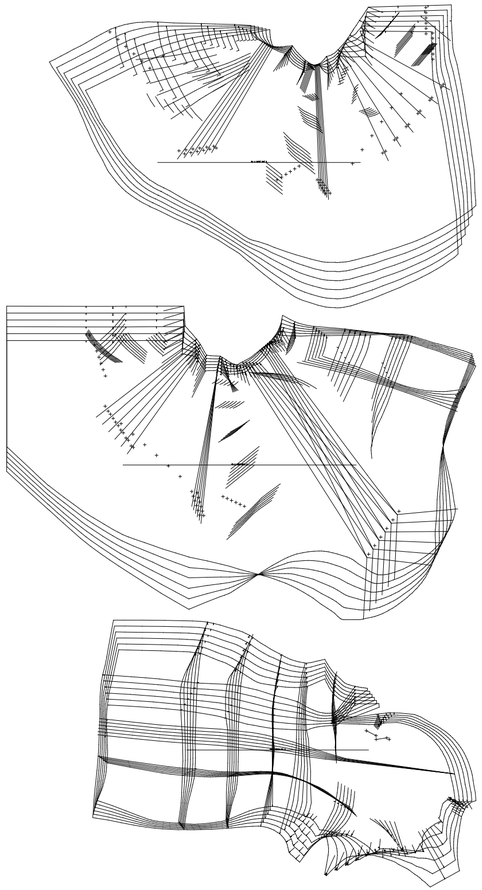
Hourglass to Hourglass



Fabric Behaviour in Relation to Shape Based Grading

Fuller Figure Prototype

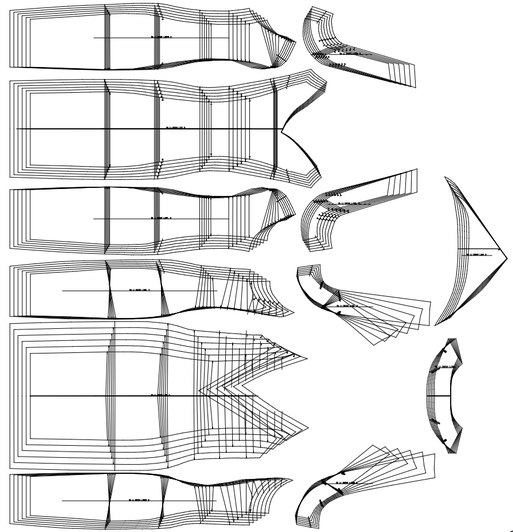
Fit Model 3



Fit Model 3

Design 1: Shape Based Grading with Fabric Behaviour Calculated In

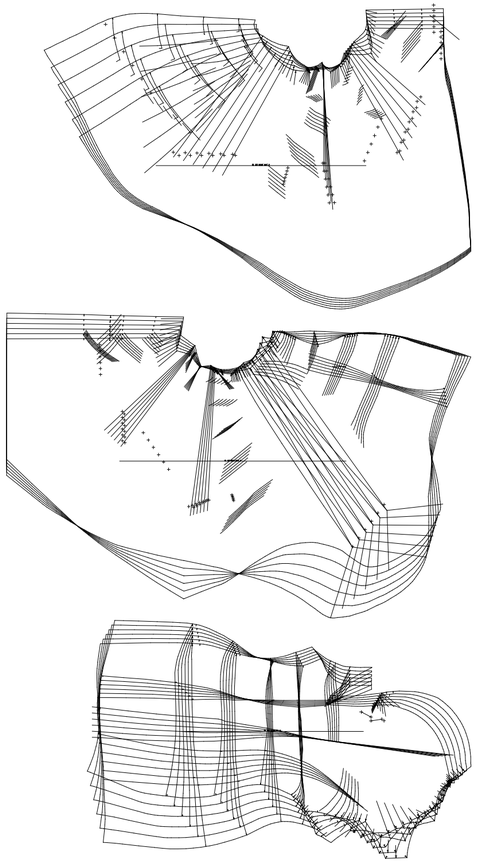
Hourglass to Straight



Fabric Behaviour in Relation to Shape Based Grading

Fuller Figure Prototype

Fit Model 4

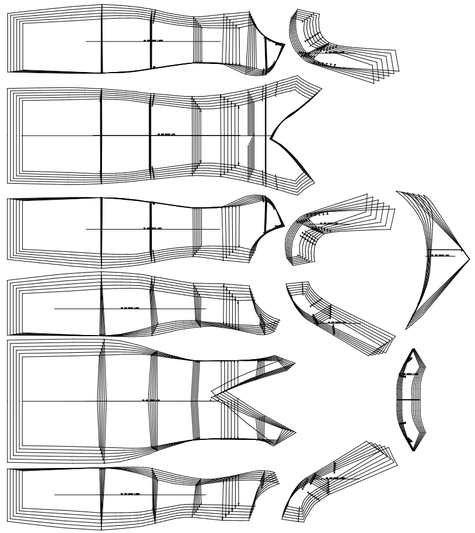


Fit Model 4

Design 1: Shape Based Grading

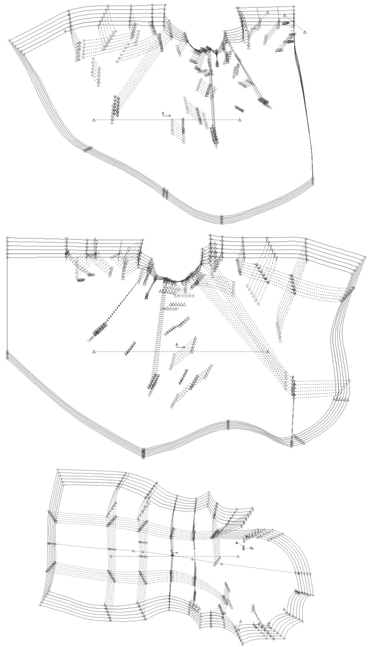
with Fabric Behaviour Calculated In

Hourglass to Pear



Design 1: Shape Based Grading

Fabric Behaviour Grading Comparisons



Shape Based Grading

On the left is the original grading that was applied to the first toile of Fit Model 2, the hourglass. While this has the shape based grading applied to it, it does not have fabric behavior calculated in.

On the right is the final grading used to create the prototype for Fit Model 2. Because this shape based grading is grading from an hourglass to an hourglass it is the best grading to view the effect that fabric behavior has on the overall shape of the grading.

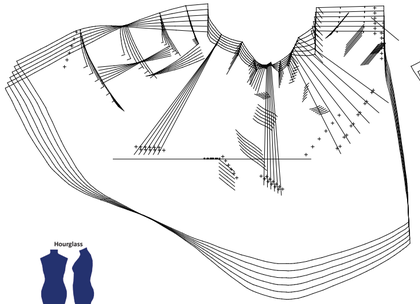
Comparison of the two shapes of the patterns allows initial visual conclusions about the effects that the fabric behavior and drape of the chiffon has on the shape based grading required to translate the size to the correct shape while maintaining the specific design aesthetic.

Shape Based Grading with Fabric Behaviour

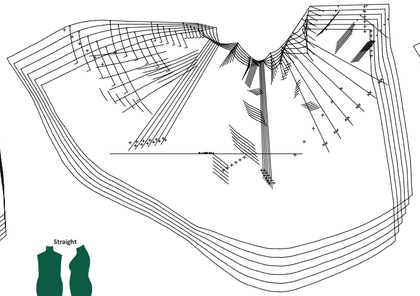
Design 1: Shape Based Grading

Fabric Behaviour Grading Comparisons

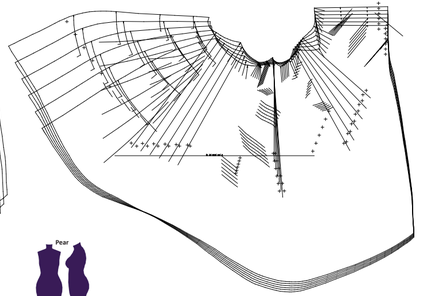
Back Left



Fit Model 2



Fit Model 3

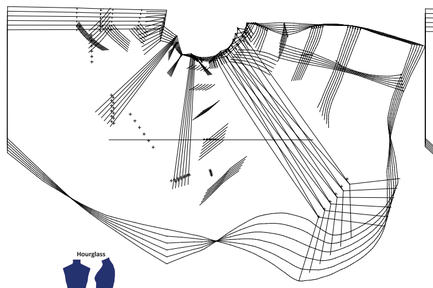


Fit Model 4

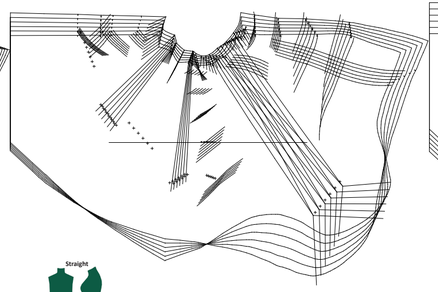
Design 1: Shape Based Grading

Fabric Behaviour Grading Comparisons

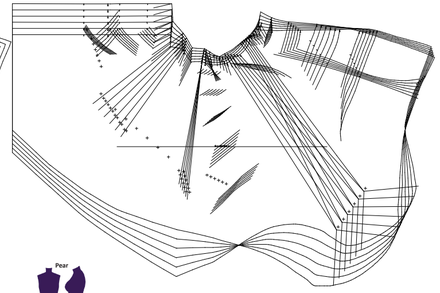
Back Right



Fit Model 2



Fit Model 3

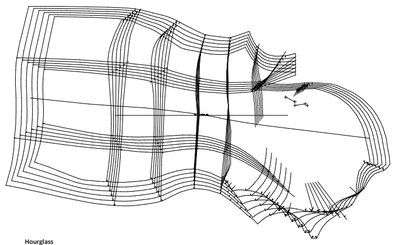


Fit Model 4

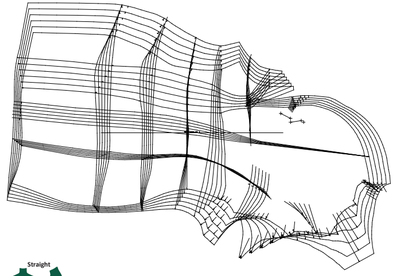
Design 1: Shape Based Grading

Fabric Behaviour Grading Comparisons

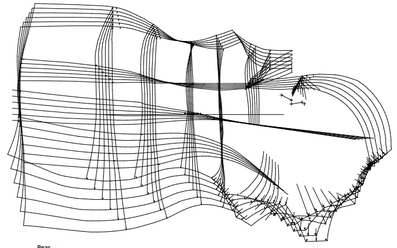
Front



Fit Model 2



Fit Model 3



Fit Model 4

Design 1: Shape Based Grading

Prototype Size and Shape Comparison

Fit Model 1 | Fit Model 2 | Fit Model 3 | Fit Model 4

Design 1: Shape Based Grading

Prototype Size and Shape Comparison

Fit Model 1 | Fit Model 2 | Fit Model 3 | Fit Model 4

Conclusion

Fit is necessary to convey all other design characteristics of a particular aesthetic as a part of grading for larger sizes. The reason that so many women have problems with fit is that any single sizing system and its grading rules does not accurately represent a large proportion of the population. A major shift is underway within the fashion design industry with consumers dissatisfaction compelling the need for change (Simmons, et al., 2004a). There is a move away from simple size classification in female garments, to a shape based classification. Garments produced for RTW under a shape based system will fit a larger percentage of women because it recognises the variability of women's body shapes.

A system of grading should maintain all aspects of a design aesthetic during the translation of sizes. To do this the grading model needs to incorporate body shapes and allow the pattern to be morphed from one body shape to another during the grading process. The aim of this project was to investigate techniques for grading women's apparel that maintain design aesthetic details, especially fit, for different body shapes in larger sizes. This investigation has been conducted as three case studies using three distinctly different body shapes to represent variability among fuller figured women. Each body shape forms one case study, and each body shape and therefore case study is represented by one fit model. By incorporating shape-based-grading into grading practices, it is possible to maintain design aesthetics including fit during the translation of sizes for fuller figured New Zealand women of various shapes. The resulting shape-based-grading model has allowed the patterns for three fuller figured body shapes to be developed from one original base size design.

The creation of shape-based-grading demonstrates a process that could allow companies working within the fashion industry in New Zealand to extend their existing grading methods. The relevance of body shape within the design and manufacturing process and the importance of shape-based-grading for larger sizes to maintain the design aesthetics in the dresses has been

validated. This shape-based-grading model has been successful in maintaining design details and fit, proportion and overall aesthetics. When designs are on a single straight fabric grain, application of the shape-based-grading is simple and easy, and a successful outcome should be expected. For designs on a single grain, not necessarily the fabrics straight grain, a successful outcome should also be expected, although, more effort may be required to adjust and calculate compensating shape-based-grading rules. For more complex designs incorporating fabric draped through multiple grainlines, all grading is usually problematic, because there are no generalized or published rules about how to incorporate fabric structure and drape behaviour when grading. Therefore, the same problems affect the outcome of applying shape-based-grading to a complex draped design. A specific solution to this problem was developed for Design 1. The complex draped designs tested the shape-based-grading at a high level difficulty, and it was successful at all levels, because the effects of fabric behaviour is not specific to shape-based-grading but all grading, and if generalized rules for this effect were created it would support all applications of grading to complex draped designs. Therefore it is important to take into consideration fabric grain-lines, behaviour and drape as well as the body shape, pattern shape and size requirements when grading.

My chosen research direction allowed me to explore of the effects of grading and morphing to develop a deeper understanding of the translation of a design aesthetic. Fit is an integral part of a chosen design aesthetic so it needs to be translated accurately. Some design aesthetics have the ability to suit and transcend body shapes, but many do not. My research has reiterated the importance of shape as a determinator of fit in a design. Shape must be acknowledged in a conscious and defined way when grading, a necessity that has been shown by the development of shape-based-grading.

Further research is necessary into fabric behaviour, shape classifications, body shape variability. As this research was based on case studies, I only used three fuller figured fit models to represent the three most common body shapes. There remain other body shapes to be investigated. More fit models to represent each body shape would allow a wider basis for the collection of

results and therefore would enable a more accurate representation of the New Zealand female population to be compiled. An anthropometric study in New Zealand with a spotlight on shape would inform further research in this area. Such a study would benefit from the use of a body scanner to source and record body data quickly and effectively. Quantifying fabric behaviour for all grading of draped garments requires further research. A CAD application that would allow fabric behaviour, drape and handle to be calculated into the grading for a designed garment would solve many problems in grading draped designs.

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- Simmons, K., Istook, C. L., & Devarajan, P. (2004b). Female Figure Identification Technique (FFIT) for Apparel: Part 2: Development of Shape Sorting Software. Journal of Textile and Apparel, Technology and Management, 4(1), 1-15.
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Appendix

MASSEY UNIVERSITY

28 May 2010

Michelle Freeth
2/33 Hawker Street
Mt Victoria
WELLINGTON

Dear Michelle

Re: HEC: Southern B Application – 10/07
Grading and design for women's fuller figures

Thank you for your letter dated 24 May 2010.

On behalf of the Massey University Human Ethics Committee: Southern B I am pleased to advise you that the ethics of your application are now approved. Approval is for three years. If this project has not been completed within three years from the date of this letter, reapproval must be requested.

If the nature, content, location, procedures or personnel of your approved application change, please advise the Secretary of the Committee.

Yours sincerely

Dr Karl Pajo, Chair
Massey University Human Ethics Committee: Southern B

cc Ms Deb Cummings
IDIE
WELLINGTON

Ms Holly McQuillan
IDIE
WELLINGTON

Ms Lilian Mutsaers
IDIE
WELLINGTON

Prof Rodney Adank, Acting HoI
IDIE
WELLINGTON

Massey University Human Ethics Committee
Accredited by the Health Research Council
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MASSEY UNIVERSITY
COLLEGE OF CREATIVE ARTS
TOI RAUWHARANGI

Grading and Design for Women's Fuller Figures

INFORMATION SHEET

Researcher Introduction

Research into grading and design for fuller figures is being undertaken by Michelle Freeth towards the completion of a Masters of Design degree at Massey University. This project aims to create a grading model that will accommodate for the range of shapes and sizes of fuller figured women through the implementation of a case study.

Project Description and Invitation

If you are one of the many female consumers who feel that the clothing available to you does not fit properly, then you are not alone. Research shows that more than 50% of consumers are unable to find well-fitting garments and that fit problems are the primary factors causing customers to return apparel products. The problem is worse for women with fuller figures and part of the reason is that traditional pattern grading (changing the pattern from one size to the next) assumes that a size 18 has the same body shape as a size 8!

So when we go to buy a dress in a shop, this means we are all assumed to have a B cup and no waist, so perhaps you agree that this needs to change. Would you like to be part of this change?

Would you like to participate, as a fit model, in the research necessary to develop this grading model? The activities involved will be identical to those that would be undertaken if you commissioned and purchased a made to measure garment.

Participant Identification and Recruitment

- Participants will be recruited through contacts within the wider Massey University community and through the connections that Massey staff and students have in the wider community.
- Participants will be selected from the age range 20-30, based on dress size and body shape.
- There will be four participants within this research, three will act as the fuller figure fit models and one as a control fit model for the base pattern.
- The first participant will be chosen to represent the average fit model used within the fashion industry. She will need to have the measurement of the pattern base size of 10, and be approx 170cm tall or taller. The other three participants will be selected more on size and shape than height. They will be selected by having the correct measurements and upon an evaluation of the shape of their bodies. All other factors including height, ethnicity, hair colour, skin colour etc are irrelevant.

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- Participants will not suffer any discomfort or harm from participation within this project. Anonymity will be preserved for the participants by referring to them as Fit Models A, B ,C and D and in all photographs, if their faces or any identifying marks can be seen, these identifiers will be blurred beyond recognition.
- Participants will give written consent for images to be taken and used within work for this project, i.e. the essay.
- There will be no payment to the participants during the process, however after the final assessment of the project, in March 2011, if the participants wish, the researcher will gift them with one of the garments created to fit them as a thank you present for their donation of time throughout the year.

Project Procedures

- As participants, you will be acting as fit models; having the patterns fitted to you to develop and test the grading model. This requires you to stand in the clothes, allowing the researcher to fit the clothes to your body, for a period of approximately 15-30 minutes for each fitting.
- The process that the research will follow is:

  Step 1: Take the measurements of the participants.

  Step 2: Develop and fit a base pattern to the participants. This will allow the researcher to create a body base of the participants to use on a mannequin, which will substitute for participants during the interim fitting stages.

  Step 3: When required, fit a pattern to the participants, pinning and marking any changes necessary. Document these stages using photographs. Repeat as many times as necessary.

  Step 4: Get participant to wear final garment. Photograph to document.
- Creating a shell of your bodies at the first stage of the project will allow you as participants to give less time to the project. You will need to provide approx 5-8 hours of your time at most over the course of 8 months.
- The fittings will take place on the Massey University Wellington campus, Block 10 room 10C06f, during the day in a private space set aside for fittings.

Data Management

Data collected during this research will be used only by the researcher (Michelle Freeth) in the development of the grading model and in any supporting documentation, i.e. the essay.
The data (images and measurements) will be used to develop patterns that fit the participants, and then used to develop the grading model. The images will be used in supporting documentation. The digital data will be stored on the researcher's private computer, or on the researcher's private files on the Massey University server, both of which require a password known only to the researcher.
The data obtained will be stored for the duration of the project and will be disposed by the researcher and the supervisor Deb Cumming in 2011.
A summary of the projects findings will be supplied with the thank you gift after the final assessment of the research.

The identity of any participants will remain anonymous to everyone except the researcher. This confidentiality will be maintained by the participants being referred to by a misnomer in all documentation, and any identifying features being obscured.

Participant's Rights

You are under no obligation to accept this invitation. If you decide to participate, you have the right to:

- withdraw from the study within the first two weeks (please do not accept if you cannot participate for 6-8 hours over the next 8 months)
- ask any questions about the study at any time during participation;
- provide information on the understanding that your name will not be used unless you give permission to the researcher;
- be given access to a summary of the project findings when it is concluded.

Project Contacts

Researcher's Contact Details:

Name: Michelle Freeth
Mobile Phone: 027 463 4934
Email Address: mafreeth@hotmail.com

Supervisors Contact Details:

Name: Deb Cumming
Department: Massey University Fashion Design
Email Address: d.m.cumming@massey.ac.nz

Please feel free to contact either the researcher or the supervisor should you have any questions about the project.

Committee Approval Statement

This project has been reviewed and approved by the Massey University Human Ethics Committee: Southern B, Application 10/07. If you have any concerns about the conduct of this research, please contact Dr Karl Pajo, Chair, Massey University Human Ethics Committee: Southern B, telephone 04 801 5799 x 6929, email humanethicsouthb@massey.ac.nz.

Appendix: B

Design Development - Draping and Drawing

The initial draping, developing shapes and silhouettes and the process of drawing into the photographed images.

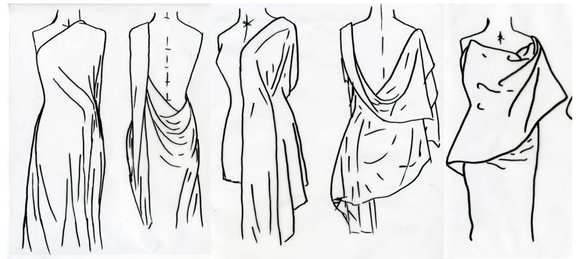
To a designer, their design aesthetic is a projection of their essence. Therefore every designer wants to stay true to their own design aesthetic, spending hours perfecting a design to their exacting standards. Each aesthetic has elements of specific shapes, line, drape, volume, pattern, and design details, depending on the designer and their current vision. Fit is a crucial characteristic in design. Fit can convey the silhouette, line, form, and shape of any aesthetic in a design field.

This was an investigative stage, working with the innate nature of the fabric to create shapes, lines, silhouettes and styles that I found pleasing and interesting, capturing this attraction through photography. Drawing into the photographed shapes and forms illuminated the aspects that I found appealing, allowing me to analyze further why I found them interesting.

Design Development - Drawing

Subsequently translating the developed images, shapes, lines, and forms into drawings on fashion models developed the intriguing shapes back into designed garments. When draping the fabric, I needed to work with the innate nature of the drape and body of the fabric, allowing the fabric to move naturally; allowing the design to develop from a more responsive and intrinsic place. This constant analysis allowed me to develop the designs through working with the fabric rather than against it.

As all my pattern and grading design was to occur in the digital realm of Gerber software, patterns were developed by digitizing the fabric patterns into the pattern design software, a process requiring patience and persistence.

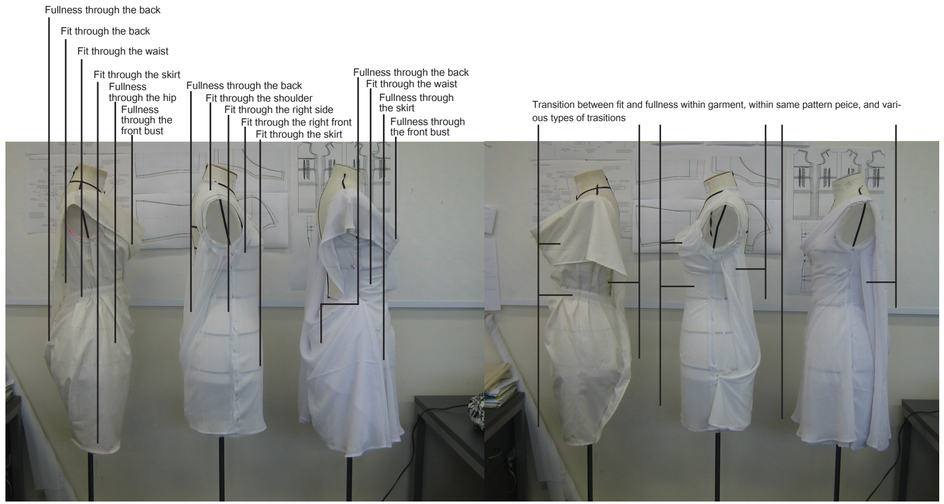


The drawing process; drawing shapes on the mannequin and then translating to drawn figures

Pattern Development – Draping Process

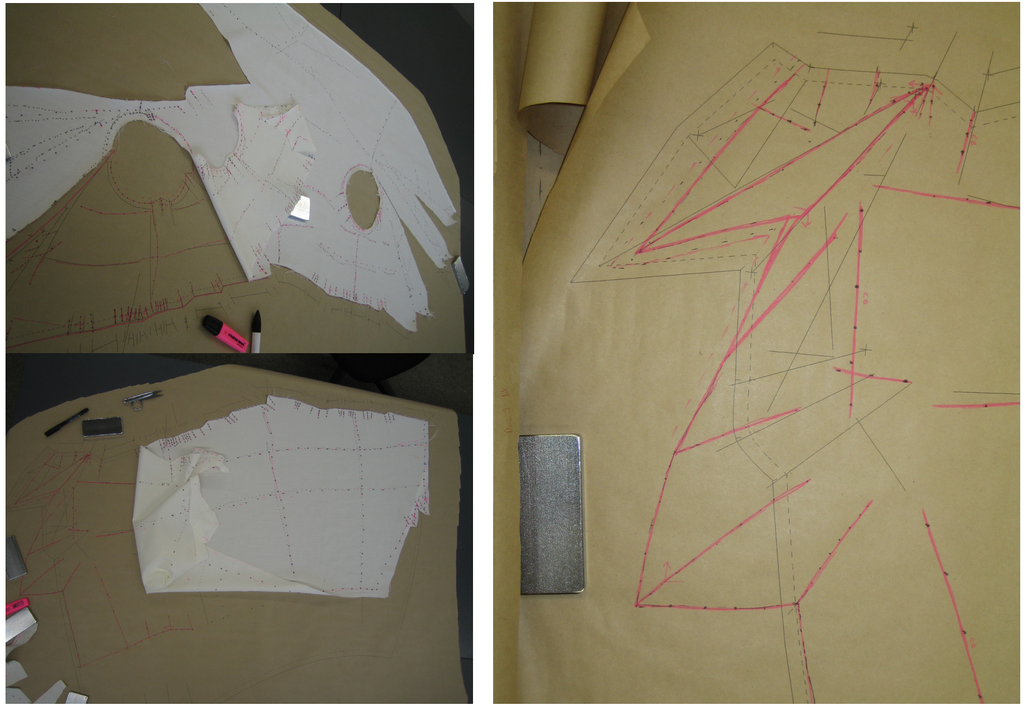
Design 1 Design 2 Design 3

Collection Visual Analysis



Design 3 Design 1 Design 2 Design 3 Design 1 Design 2

Pattern Conversion – Process of Making Adjustments to the Patterns



Changes are made to pattern, by transfering the changes through a paper pattern stage, to allow accurate translation into the digital relam

Tunic Block Development – The Fittings

Using fitting as a design process and tool to create a pattern that accurately represented the shape of the fit models form, I fitted the tunic block to the individual fit models in a trial, error, and adjustment process. Fitting garments to the various body shapes allows for an exact representation of form and silhouette of the sample fuller figured women.

With the precision of fit informing the transference of line, shape and form into the design of patterns and grading, a creative awareness of the impacts of a millimetre shift here, and a tweak there contributes to developing an understanding of how grading affects the translation of a design.

Each pin was placed with precision and care, often being adjusted by small increments, as a millimeter can make all the difference to comfort and fit. Each placement of the pin was evaluated on its own and as part of a whole.

During this precise adjustment stage I allowed the fabric to move freely. Often when pinned into the shape you think it should be, fabric reacts by pulling and straining. By working with the inherent nature of the fabric, without forcing or distortion, I was able to create patterns that when transferred and constructed would accurately represent the shape of the underlying form.

First Fitting

Fit Model 2

Fit Model 3

Fit Model 4

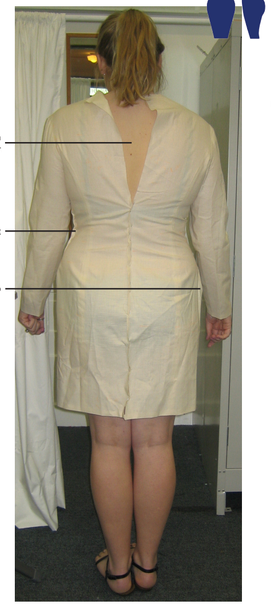
Tunic Block - Fitting 1

Fit Model 2

Hourglass

Fit Model 2

Hourglass



Fit Model 2

Hourglass

Originally graded size 20 panelled tunic block, same garment on the three fit models

Tunic Block - Fittings

2nd Fitting

3rd Fitting

Fit Model 2

Hourglass

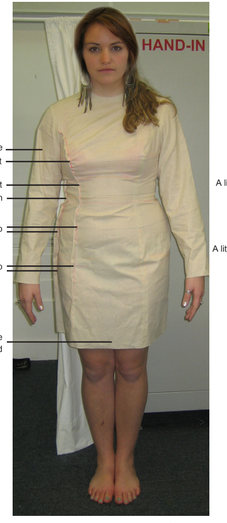
4th Fitting

Final Fitting + Ease

Tunic Block - Fitting 2,3,4 Front View

Fit Model 2

Hourglass



Fitting 2

Fitting 3

Fitting 4

Tunic Block - Fitting 2,3,4 Back View

Fit Model 2

Hourglass

Fitting 2

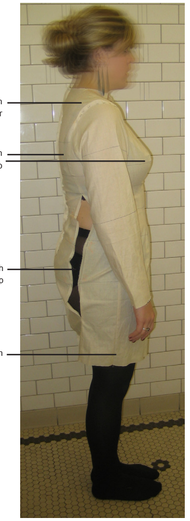
Fitting 3

Fitting 4

Tunic Block - Fitting 2,3,4 Side View

Fit Model 2
Hourglass

Fitting 2

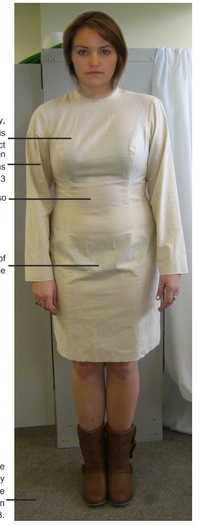


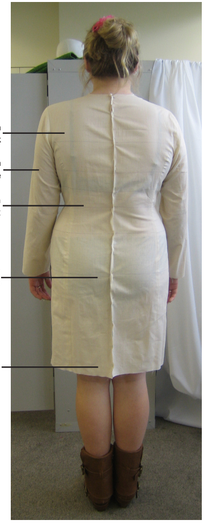
Fitting 3

Fitting 4

Tunic Block - Final Fitting + Ease

Fit Model 2
Hourglass





Correct fit with ease

The final fittings are displayed by individual fit models as they had their own shape specific patterns by this stage.

Tunic Block - Fitting 1

Fit Model 3

Straight

Fit Model 3

Straight

Fit Model 3

Straight

Originally graded size 20 panelled tunic block, same garment on the three fit models

Tunic Block - Fittings

Fit Model 3

Straight

2nd Fitting

3rd Fitting

Final Fitting + Ease

Tunic Block – Fitting 2, 3 Front View

Fit Model 3

Straight

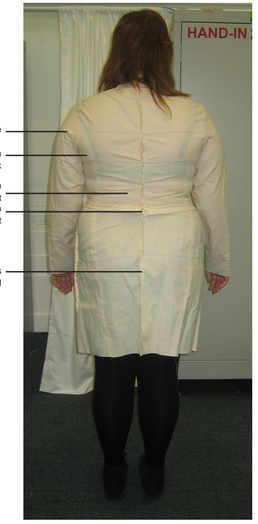
Fitting 2

Fitting 3

Tunic Block – Fitting 2, 3 Back View

Fit Model 3

Straight



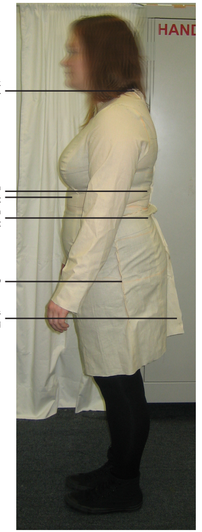
Fitting 2

Fitting 3

Tunic Block - Fitting 2, 3 Side View

Fit Model 3

Straight



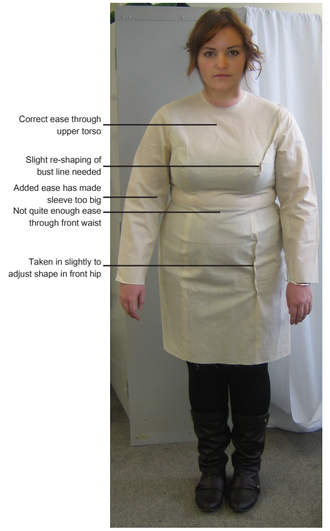
Fitting 2

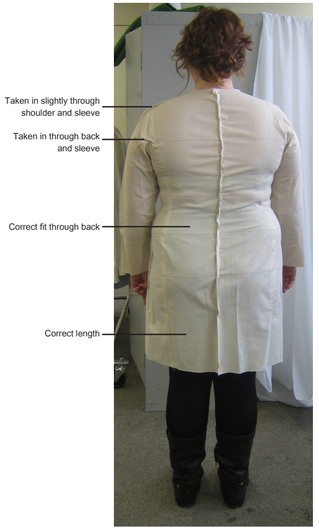
Fitting 3

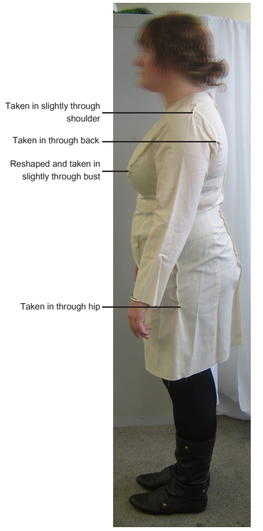
Tunic Block - Final Fitting + Ease

Fit Model 3

Straight





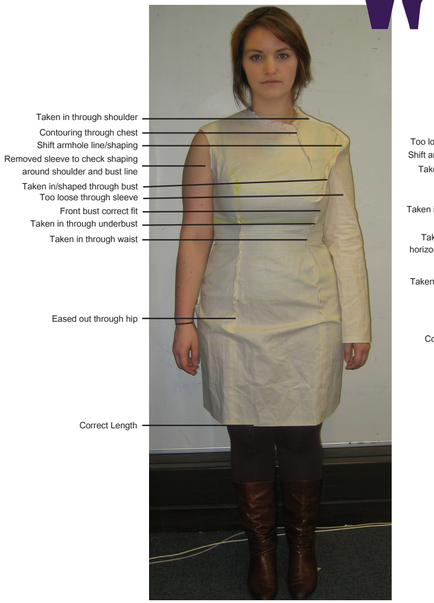


Overall correct ease just needs a few slight readjustments

Tunic Block - Fitting 1

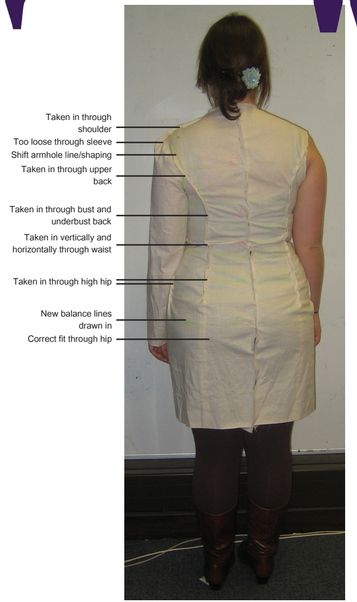
Fit Model 4

Pear



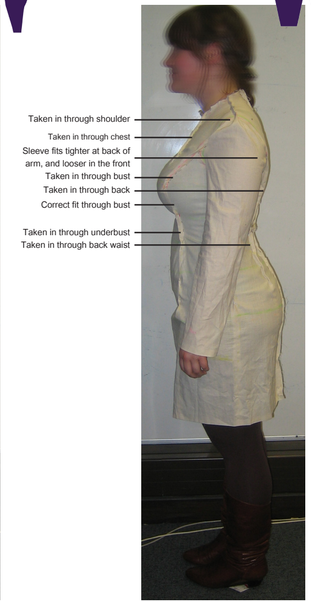
Fit Model 4

Pear



Fit Model 4

Pear



Originally graded size 20 panelled tunic block, same garment on the three fit models

Tunic Block - Fittings

Fit Model 4

Pear

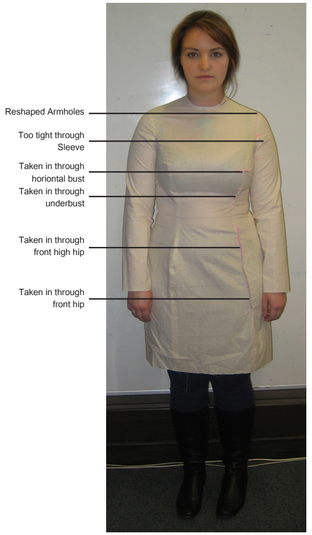
2nd Fitting

3rd Fitting

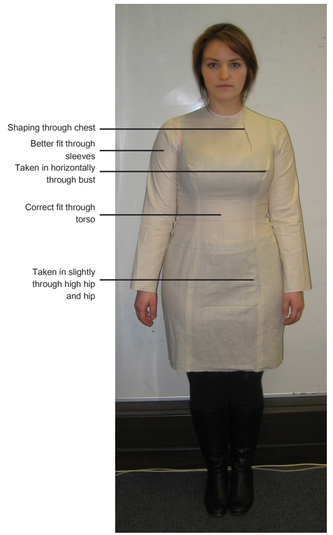
Final Fitting + Ease

Tunic Block - Fitting 2, 3 Front View

Fit Model 4
Pear



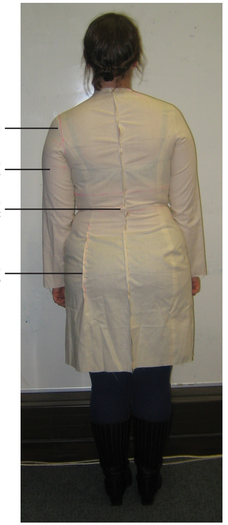
Fitting 2



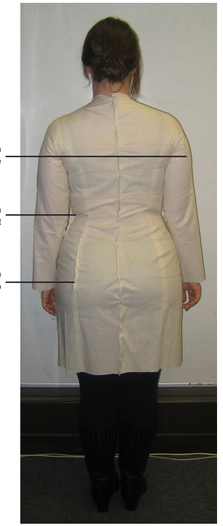
Fitting 3

Tunic Block - Fitting 2, 3 Back View

Fit Model 4
Pear



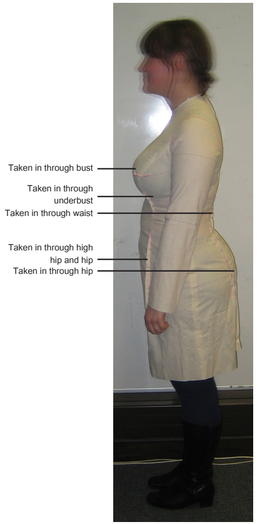
Fitting 2



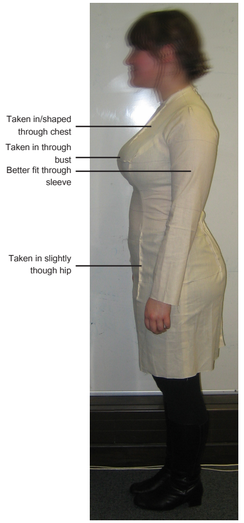
Fitting 3

Tunic Block - Fitting 2, 3 Side View

Fit Model 4
Pear



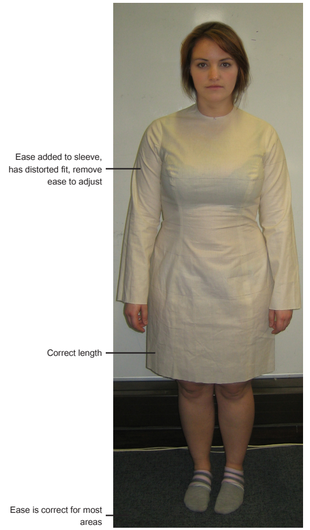
Fitting 2



Fitting 3

Tunic Block - Final Fitting + Ease

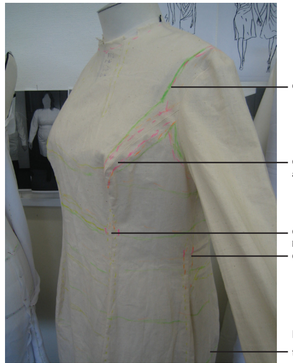
Fit Model 4
Pear



On all three women on the front of the body, there is fabric ruffling between the stomach and the thighs, this is a result of the body shaping and the curvature of the stomach and top of the thighs unless it is tight like it will have lines, loose distortion

Tunic Block - Fitting Details

These image display the process of how the fittings occur, how areas are taken in and adjusted



Changing armhole shaping

Changing bust shaping/balance line

Changing underbust shaping/ balance line

Changing through side waist

Details of the pattern alterations needed when fitting one dress to 3 different body shapes

Changing shaping through armhole and back panelling

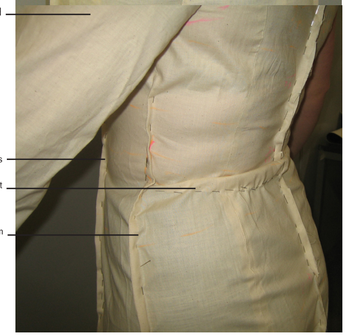
Taken in through back waist both horizontally and vertically

Shift armhole line/shaping

Taken in through back waist

Taken in through side seam

Details of how the fittings occur, how areas are taken in and adjusted



Taken in through front panels

Taken in through back waist

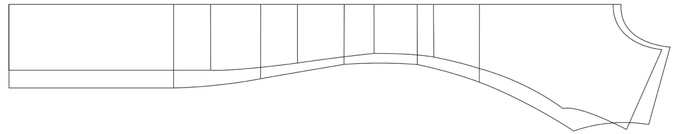
Taken in through side seam

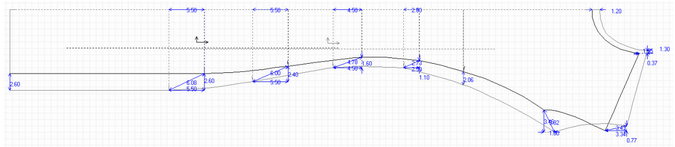
Fit Model 2 - Pink
Fit Model 3 - Orange
Fit Model 4 - Green

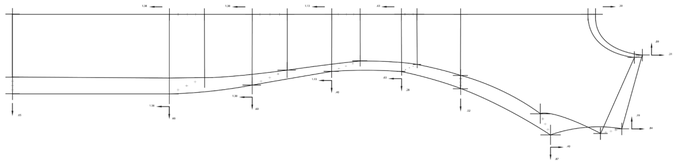
Once the adjustments to the patterns required by the underlying body had been decided, they were marked directly onto the fabric. To translate the marked changes to the pattern and change it accordingly, required me to work from a 3D form to a 2D representation of that shape, so I would often flatten the garment pieces to see the changes on a 2D plane. During this stage I have the toile on my lap so I can touch it, and feel the materiality and nature of the fabric, the give and take when I manipulate it to visually define the changes needed. This material sense allows me to connect with what I am seeing in the digital realm. I can visual the changes to the 2D digital pattern into a spatial realm, being aware of the effects that a millimetre shift will have on the 3D shape. The changes being implemented to the patterns in the 2D digital world is design that is informed by the information sourced during the fittings.

Shape Based Grading Development

Creating Grading Rules - Tunic Block Overlay

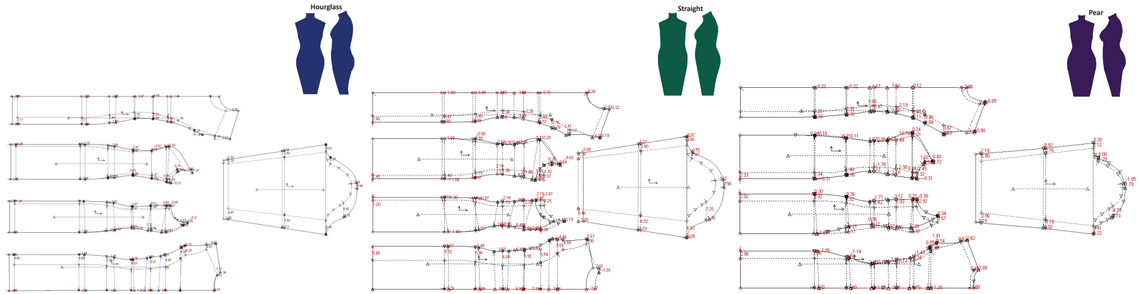






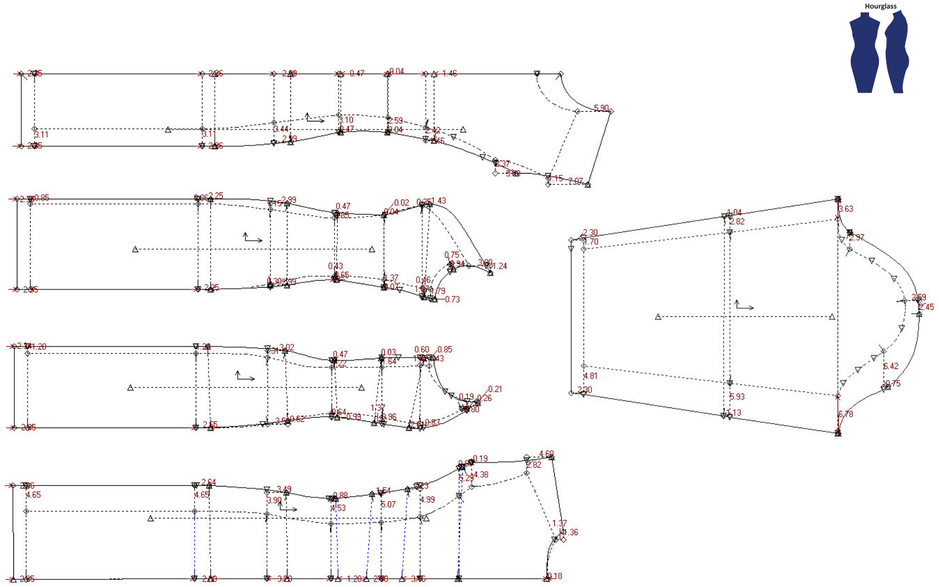
These images slow the process of developing the shape based grading created from the shape body block patterns. The patterns have been overlaid and the relationship determined. Once this stage is complete, the distances between the base size and the shape representative pattern are calculated on the x and y axis. From this the grade rules are determined.

Best-fit Shape Representative Relationship

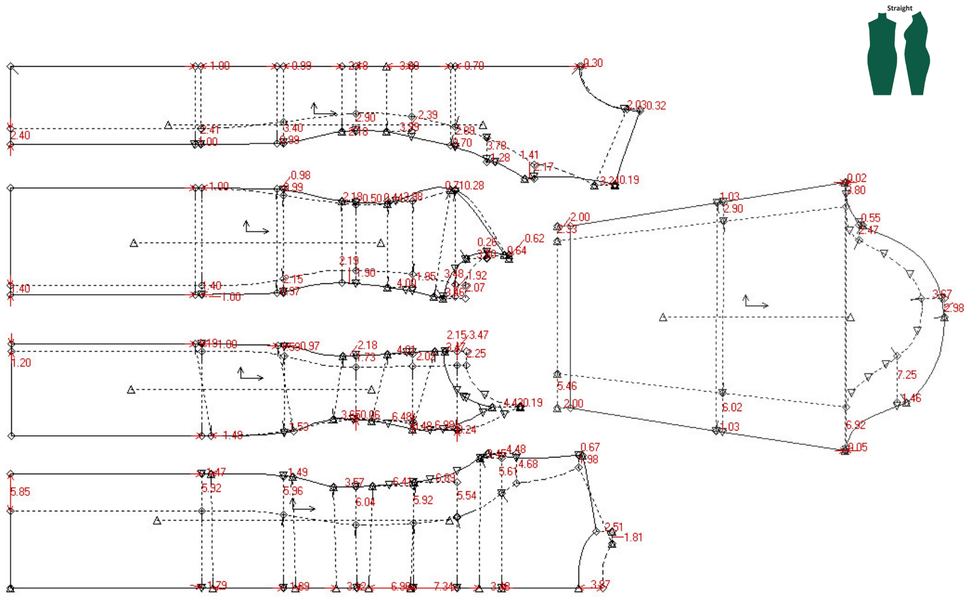


A lot of the work that I do during the designing and testing of the grading is through numbers. I see the patterns in numbers when I am working with them, being able to spatially realize the implications of each number, its relation to the proportions of the designs. Seeing the patterns and spatial implications of numbers gives me a unique view of the resulting design of the graded/morphed piece as well as the design of the patterns.

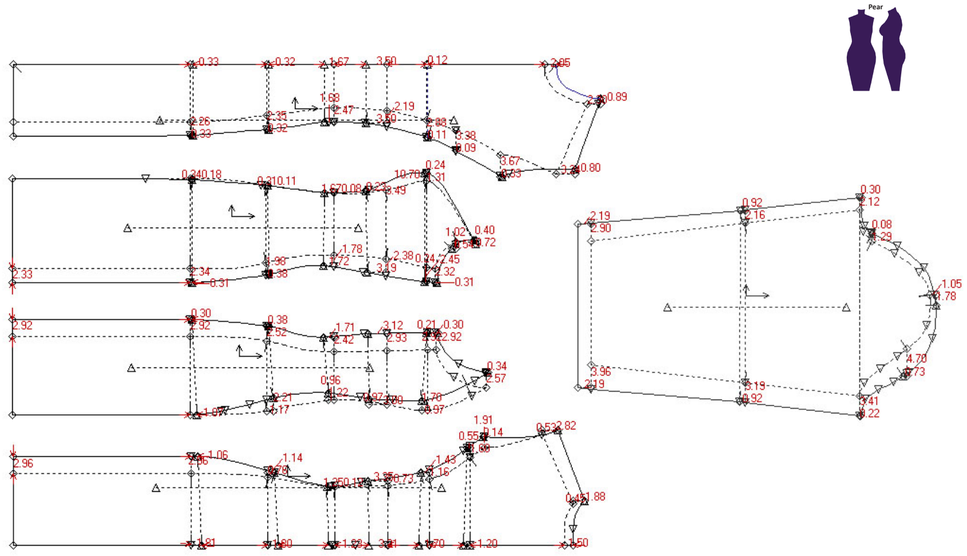
Best-fit Shape Representative Relationship



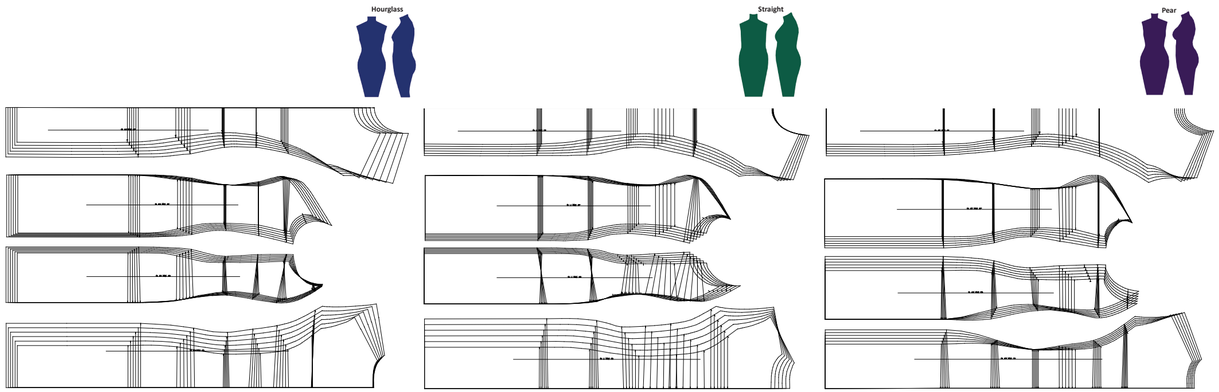
Best-fit Shape Representative Relationship



Best-fit Shape Representative Relationship



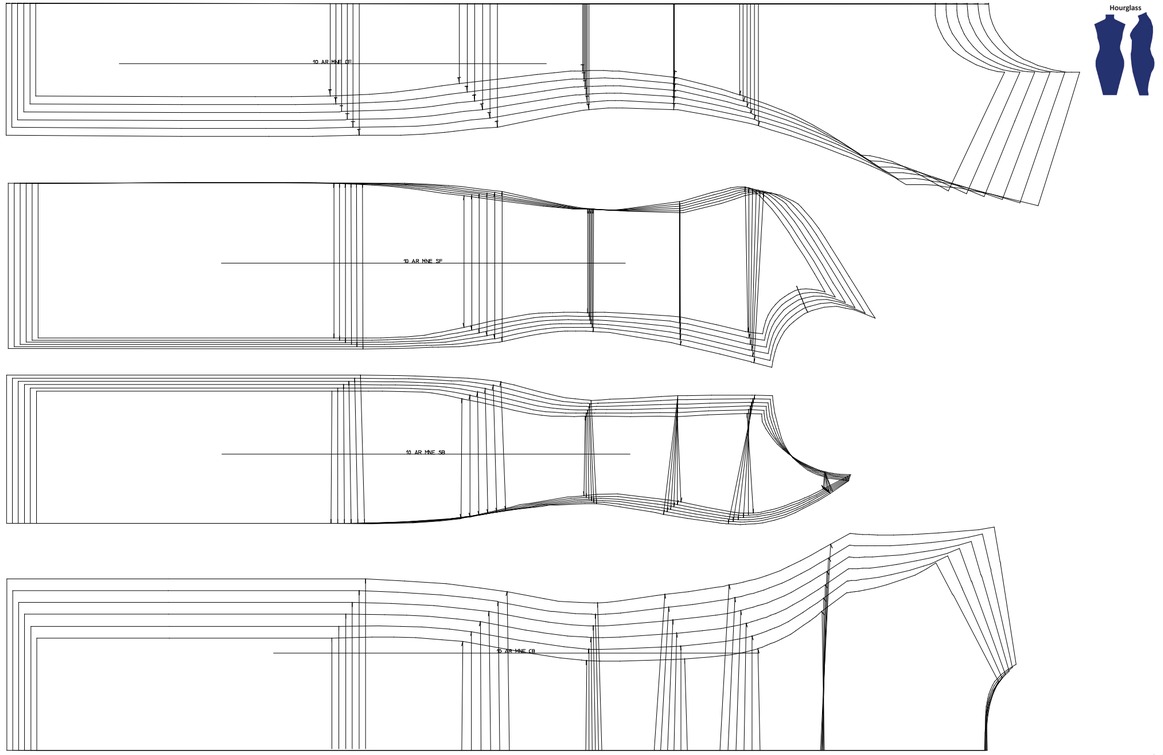
Shape Based Grading



The morphing of the base size tunic block allows a visual representation and analysis of the shape difference between the three fit models. The differences illustrate why such a large percentage of women have problems with clothing based on traditional sizing systems.

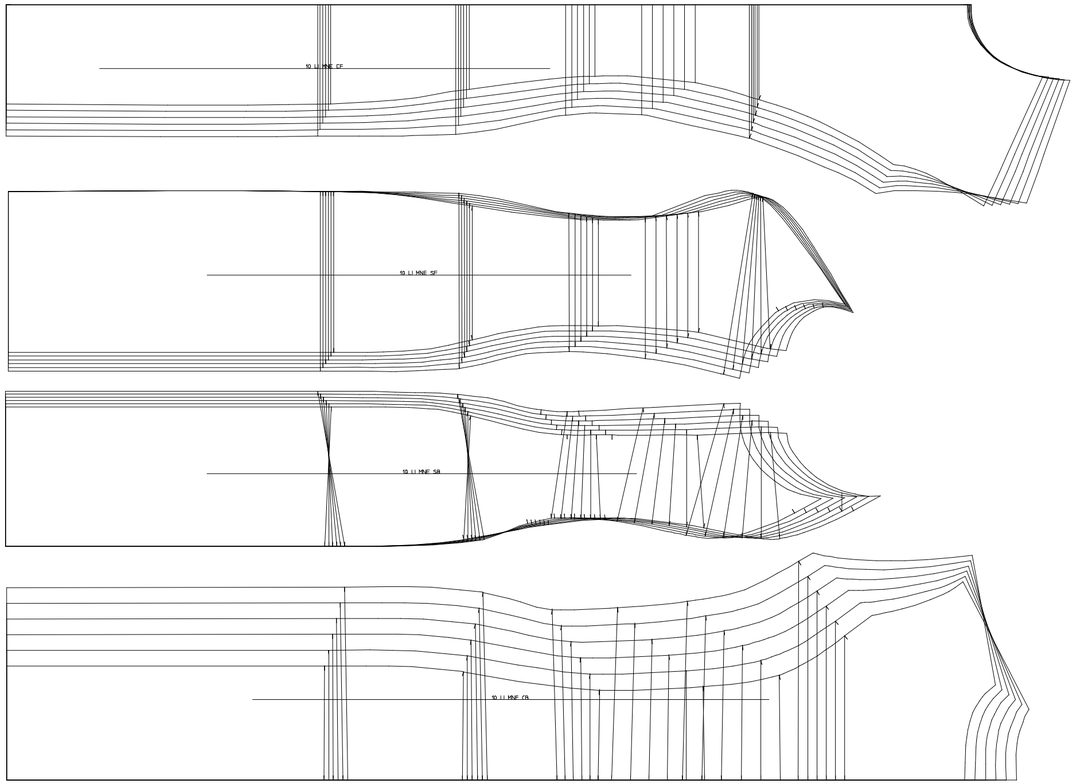
During the development and application of the graded morphing rules, I find the work very calming, I remove myself to a degree, allowing myself to work intuitively from the knowledge that I have without questioning myself at each point. This allows me to work smoothly, getting into a zone where I can work for hours, developing, and furthering the work I am designing.

Shape Based Grading



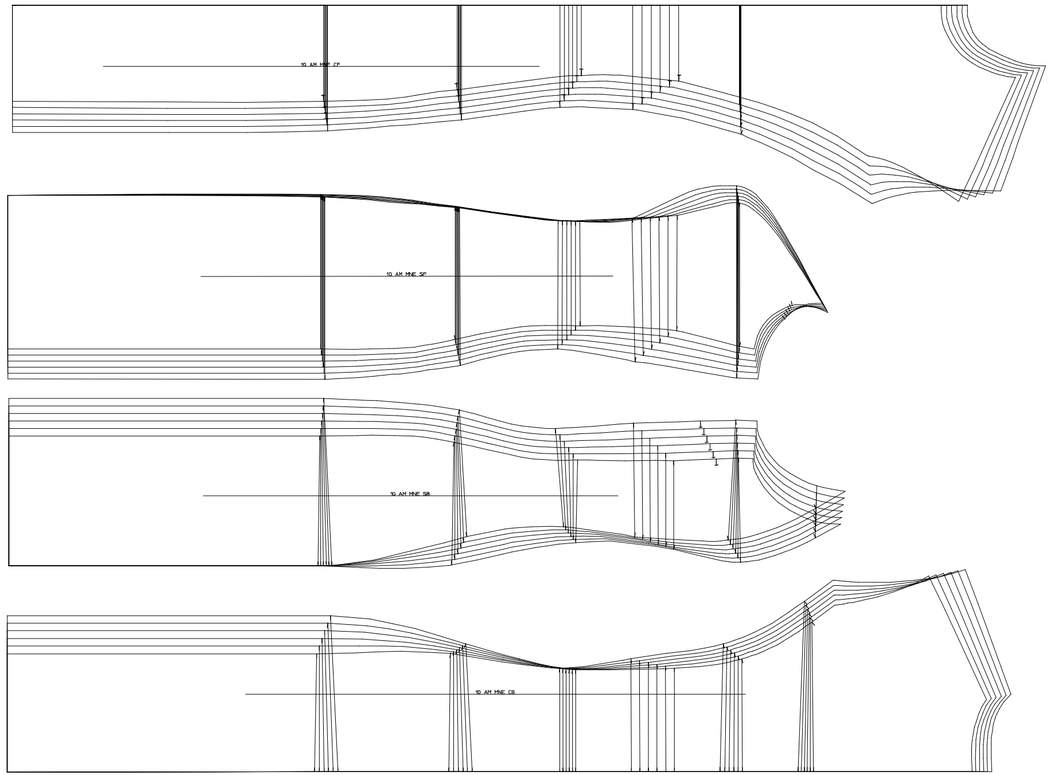
Shape Based Grading

Straight



Shape Based Grading

Pear

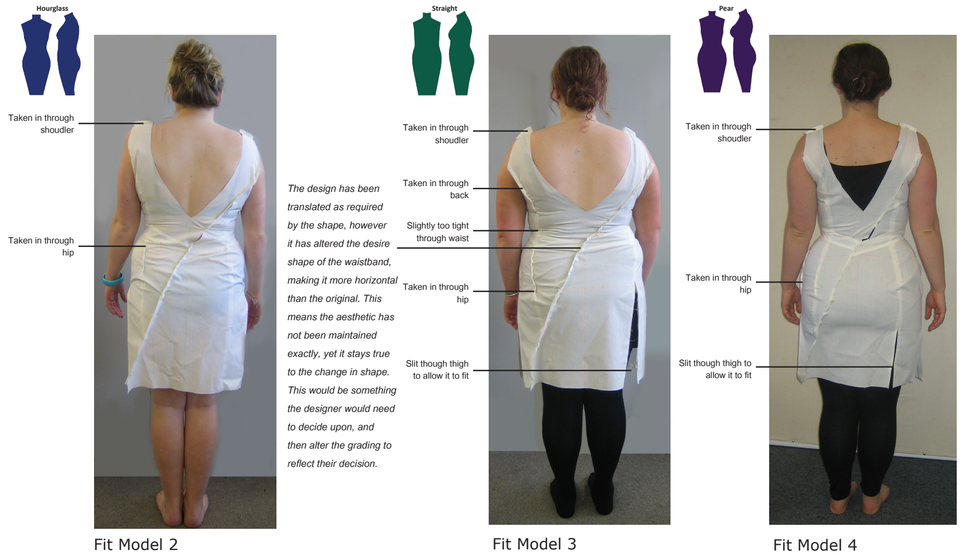


Appendix: C

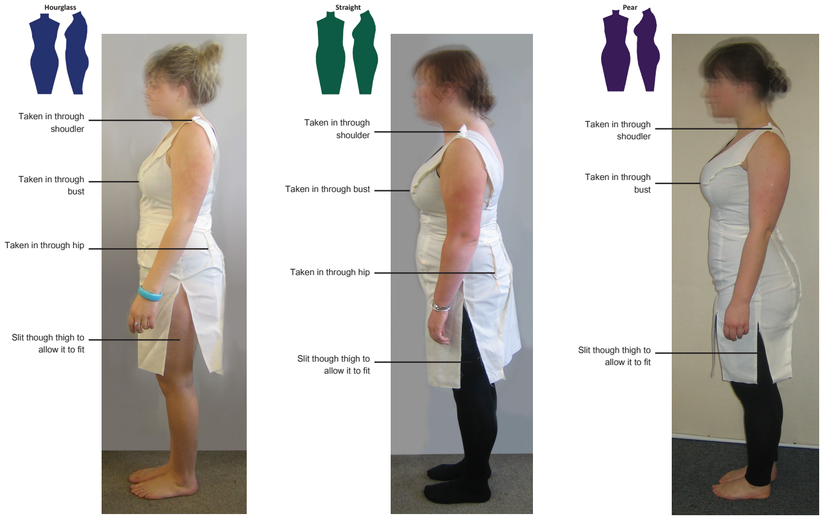
Design 3 Lining Visual Analysis

On all three shapes, the changes needed to the pattern/ grading are the same, which means that it is not an issue with the shape based grading, but the underlying base pattern. Therefore the adjustments could be made to the base pattern, solving most of the issues. From the image of the pattern itself you can see that the lining is tapered at the front seams as well as the side seams. This was done against standard practice, but it was required by the draped design. This affected shape over the thighs in the fuller figured sizes. To solve this problem, I needed to apply patternmaking skills and understanding during the implementation of the shape-based-grading.

Design 3 Lining Visual Analysis



Design 3 Lining Visual Analysis



Fit Model 2 | Fit Model 3 | Fit Model 4

These are slight anomalies in the fit thoughout this process that I have to acknowledge but ignore. This is the effect of possible weight/size/shape fluctuations, gain and loss during the year of the fit models. I can not let it affect the overall outome as this is not a made to measure process. These fit models are only indicative of shape. To adjust for these fluctuations would make this a MTM project, not a project to inform RTW grading.

Design 3 Lining Visual Analysis

Fit Model 2 | Fit Model 3 | Fit Model 4

Results: Design 1

Toile 1

The Design has been translated to the size relative to the fuller figured models by applying the shape based grading model to the patterns. As before the less complicated design details of the lining translates and maintains these design details well.

The draped design was more complicated to translate into other sizes while maintaining the aesthetic. This was because of the behaviour of the fabric and how it affects and impacts the drape and fall of the fabric. Therefore instead of just grading for size and shape, fabric behaviour needs to be calculated into the grading to allow the design to the translated into the other size.

Toile 2

Fit Model 2

Constantly analyzing the fit proportion and aesthetics occurs every time I view the garments, keeping each design detail in proportion to every other detail within the garment, adjusting the pattern if necessary. The aim is to maintain the aesthetics of the design when sizing it up to fit the fuller figure size and shape, thereby maintaining the aesthetics, so that the smaller and larger garments will be read the same.

Fit Model 2

Results: Design 1

Toile 2

compared to original drape on the mannequin

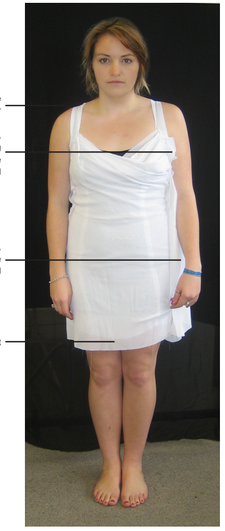
Results: Design 1

Details of the adjusted drape

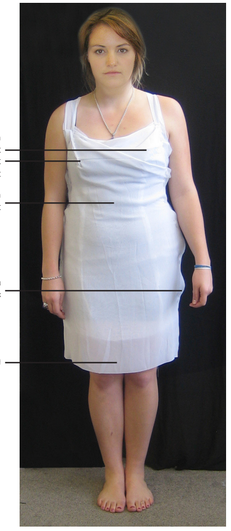
Design 1 Visual Analysis

Design 1: Fitting

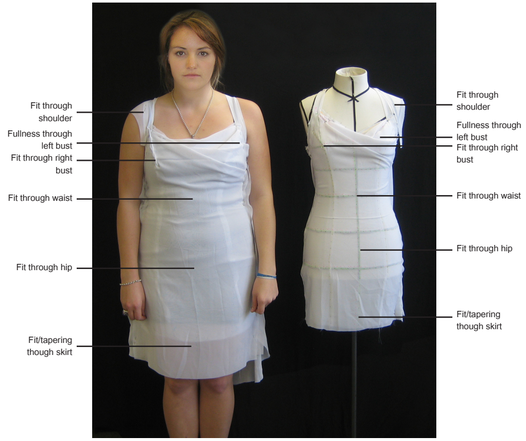
Fit Model 2



Toile 1



Toile 2



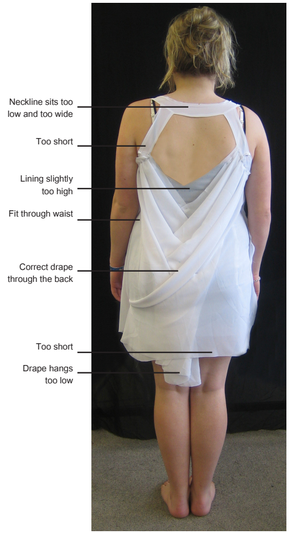
Toile 2 comparison

These images show the process of adjustments to work with the fabric drape, when the original shape was used to create the drape, the size was correct, as was the shape, it fit the fit model, but because the fabric drape behaviour was not draping correctly, the design aesthetic was not maintained. Therefore instead of just analysing the aesthetic, I adjusted the pattern to make the changes to work with the pattern as I was then able to vizualize the effect that the fabric drape behaviour has on shape based grading.

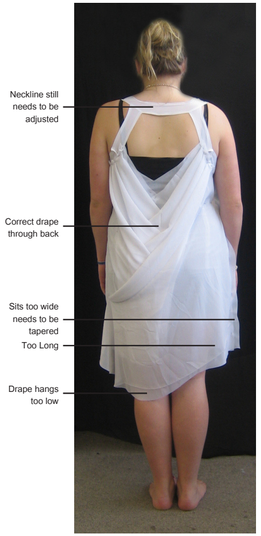
Design 1 Visual Analysis

Design 1: Fitting

Fit Model 2



Toile 1



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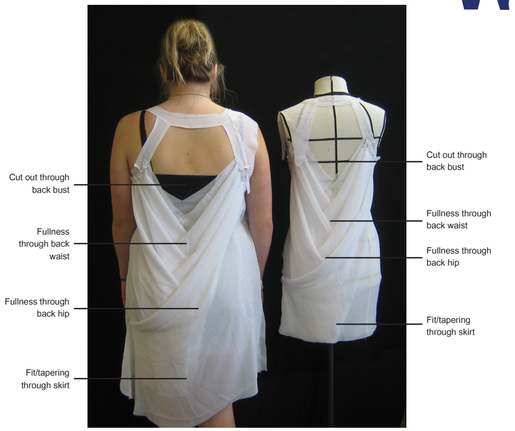


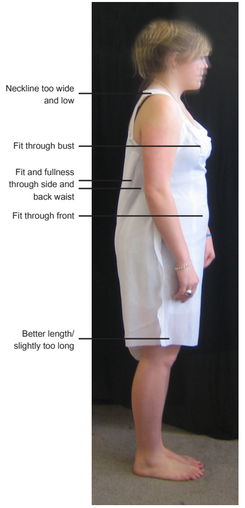
Toile 2 comparison

Design 1 Visual Analysis

Design 1: Fitting

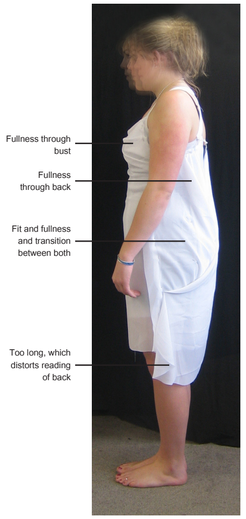
Fit Model 2

Toile 1



Toile 2

Toile 1



Toile 2

Results: Design 1

Toile 1

Toile 2

Fit Model 3

As with both of the other Fit Models the lining of the garment translated correctly and easily to the shape, size and fit of the original lining dress and the fit models size and shape. Again the draped design needed some adjustments. This body shape required more adjustments than the hourglass shape, but less than the pear body shape. As with the other two body shapes the extra adjustments were to work with the fabrics innate drape, rather than to fit the shape and size. The applied shape based grading allowed the draped design to fit the shape of the fit model, but because of the importance of the fabric in this draped design, maintaining the design aesthetic is impossible if the fabric is not behaving the same in both the original size and the shape based grading size. Therefore adjustments were required to allow fabric behaviour to be incorporated into the grading. This is not fed back into the grading rules in the grading model, because the developed grading is correct but the information/ knowledge learnt by incorporating fabric behaviour into shape based grading will allow more educated grading to be applied to draped designs.

Fit Model 3

Results: Design 1

Design 1 Toile 2 Comparison

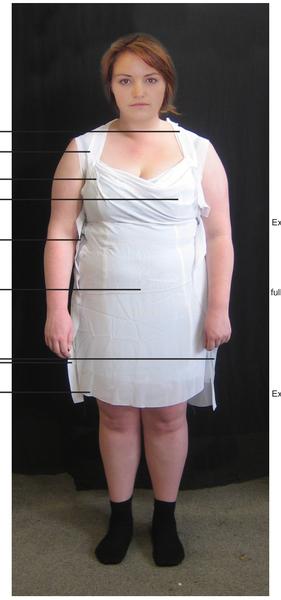
Results: Design 1

Design 1 Toile 2
Design Changes

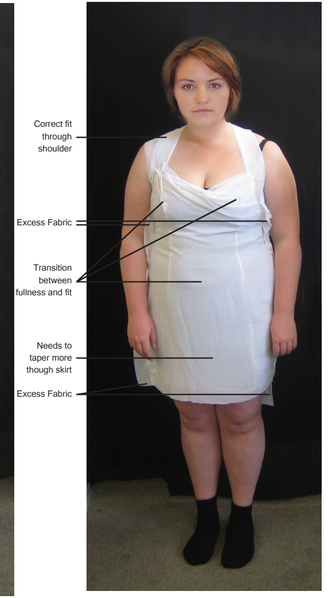
Design 1 Visual Analysis

Design 1: Fitting

Fit Model 3



Toile 1



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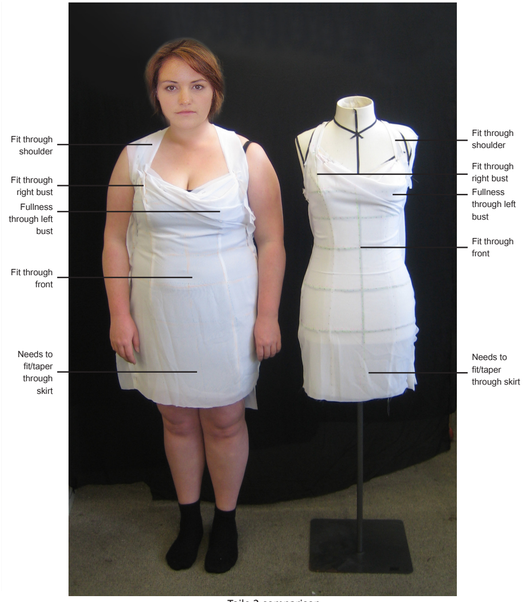
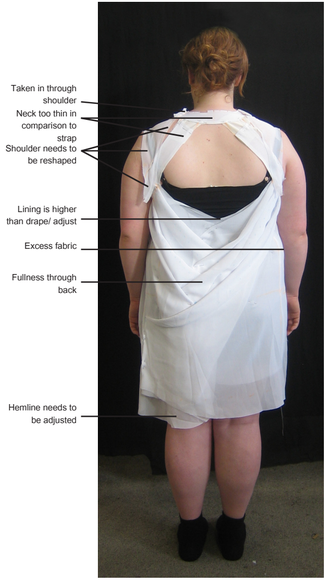


Toile 2 comparison

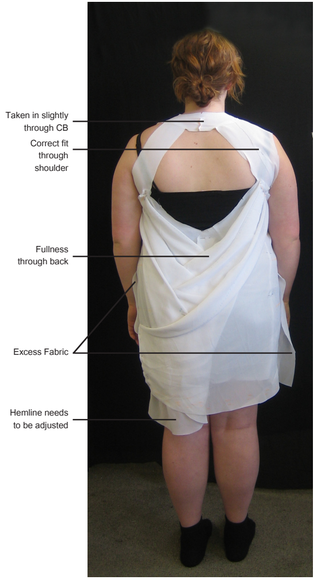
Design 1 Visual Analysis

Design 1: Fitting

Fit Model 3



Toile 1



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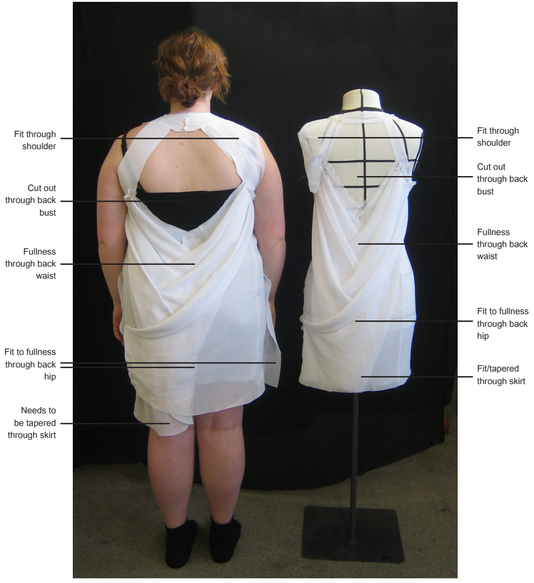


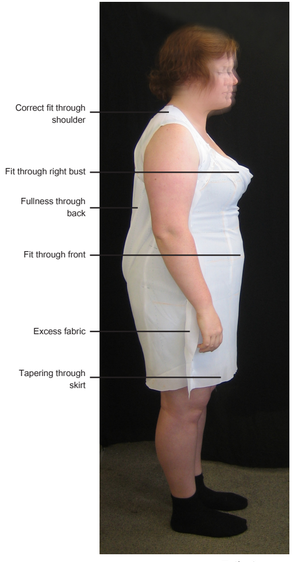
Toile 2 comparison

Design 1 Visual Analysis

Design 1: Fitting

Fit Model 3

Toile 1



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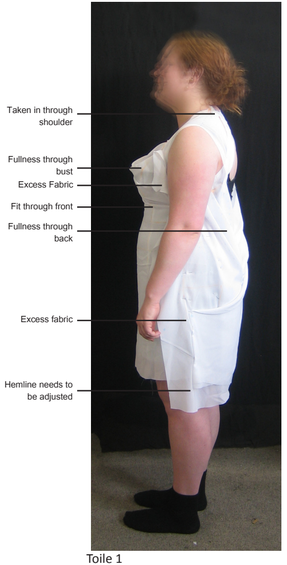
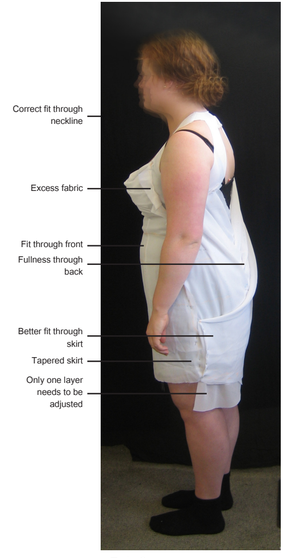


Toile 1



Toile 2

Results: Design 1

Toile 1

Toile 2

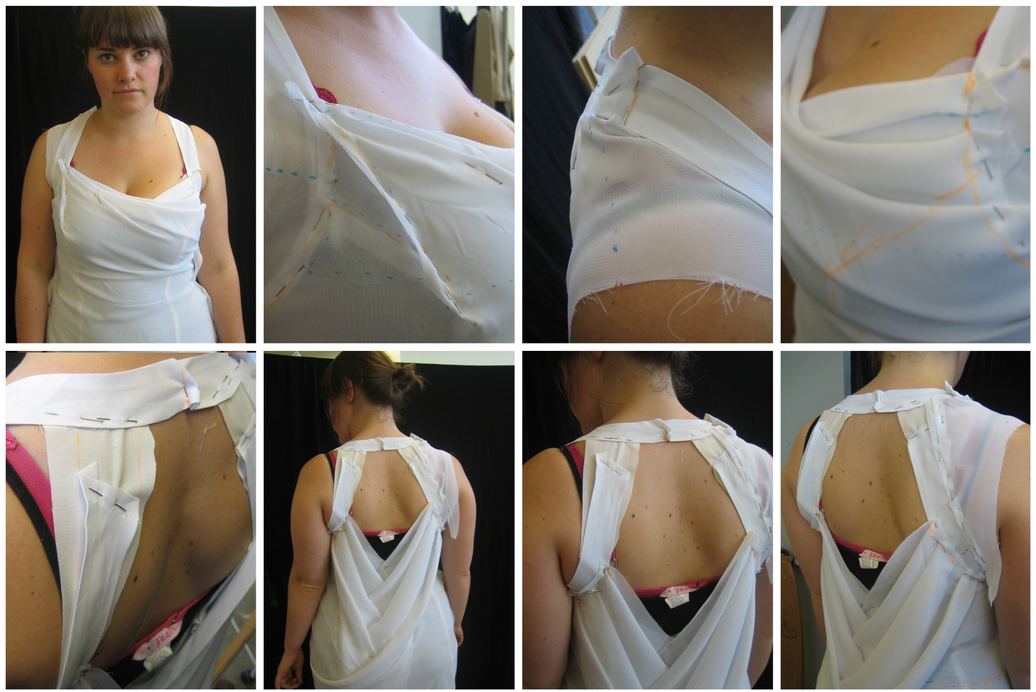
Fit Model 4

The drape process for the shapes that differ from the base shape, was more extreme than for Fit Model 2, the hourglass. As can be seen the changes needed to get this garment to maintain the same design aesthetic are more extreme and extensive than for the other two shapes. This is seen in both the first fitting photo's and the final grading. As with the other two body shapes, the original grading compensated for both size and shape, having applied the shape based grading, but did not have the correct changes to compensate for the fabric's drape behaviour.

Results: Design 1

Design 1 Toile 2 Comparison

Results: Design 1

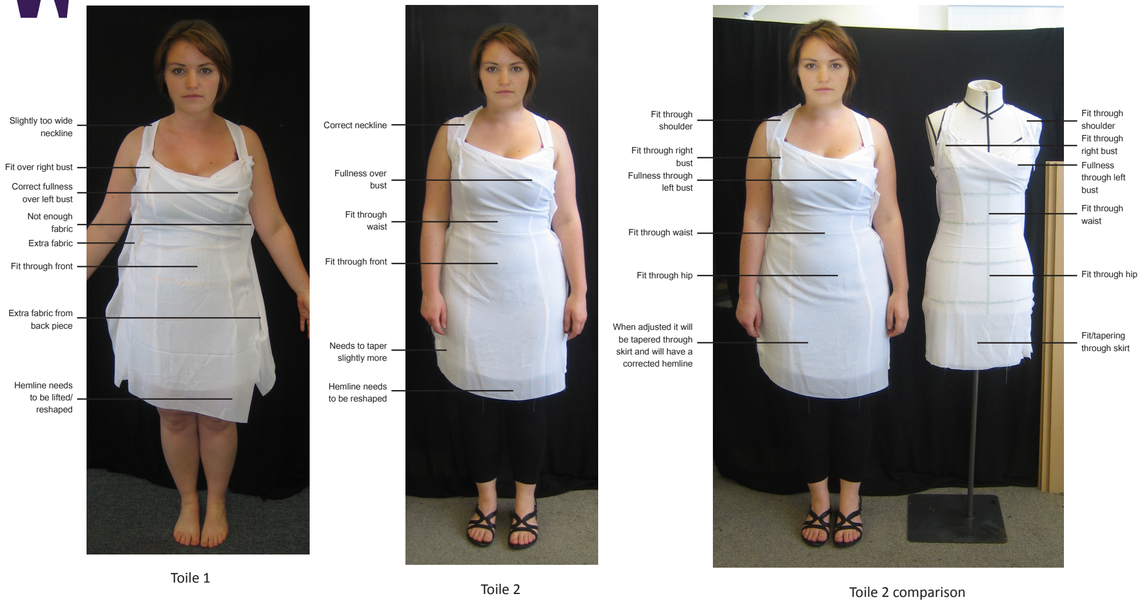


Design details of fitting changes

Design 1 Visual Analysis

Design 1: Fitting

Fit Model 4



Because of the way the drape is supposed to occur over the bust, the shape over the lower half of the body has shifted the grainline in relation to the side scam shape.

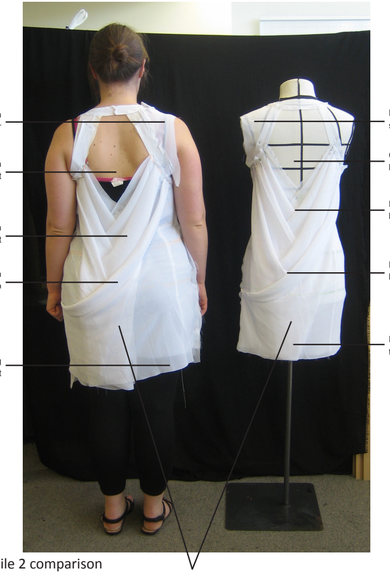
Design 1 Visual Analysis

Design 1: Fitting

Fit Model 4

Toile 1

Toile 2



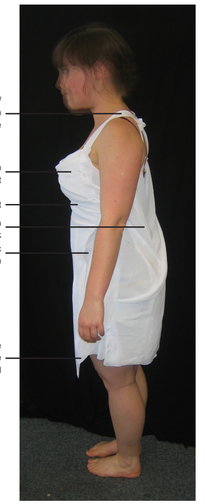
Toile 2 comparison

The pleat underlay and drape folds do not have the same proportions in compaison to the base size. This is related to the shape of the fit model. As the hips are wider, it makes the underlay seem smaller. The underlay cannot be enlarged to compensate, becasue of the relative width of the shoulders. This does not effect the aesthetic because it is part of the internals of the designs.

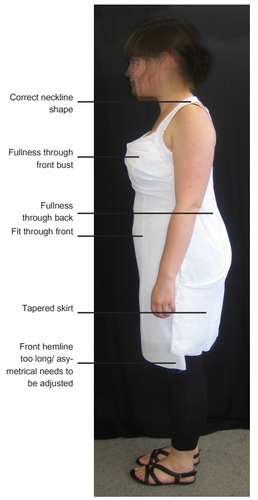
Design 1 Visual Analysis

Design 1: Fitting

Fit Model 4



Toile 1



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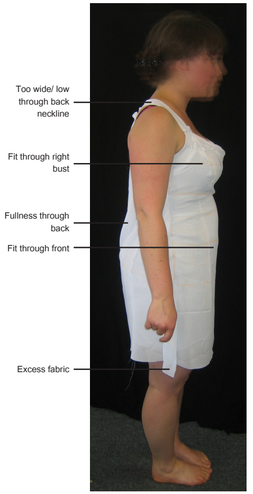
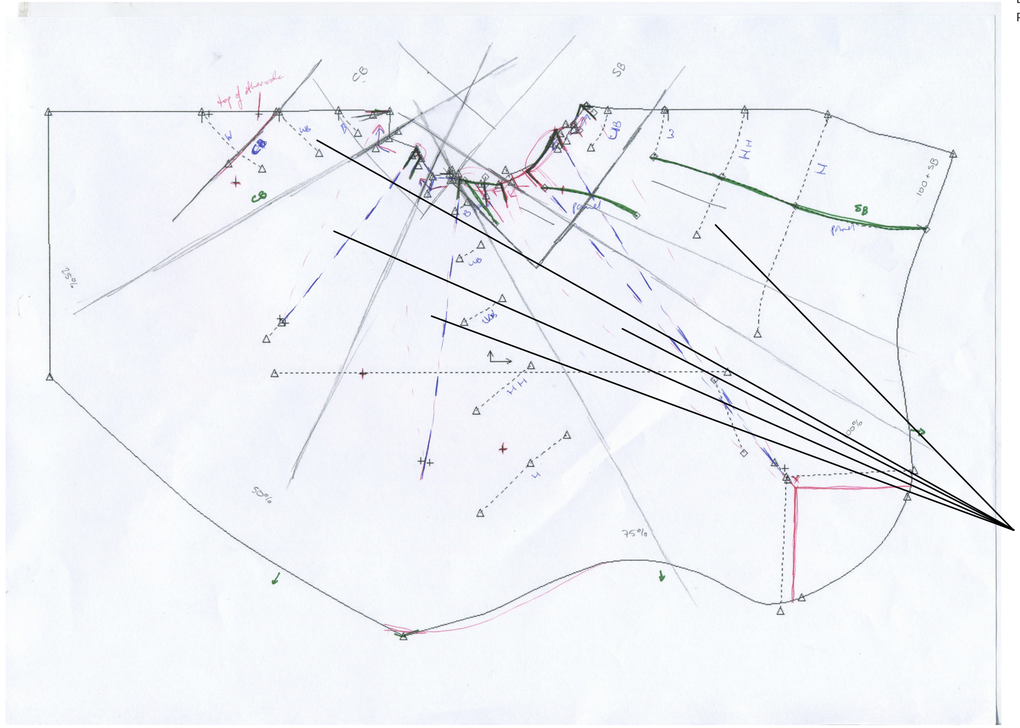


Toile 1

Toile 2

Fabric Behaviour: Design 1 Patterns

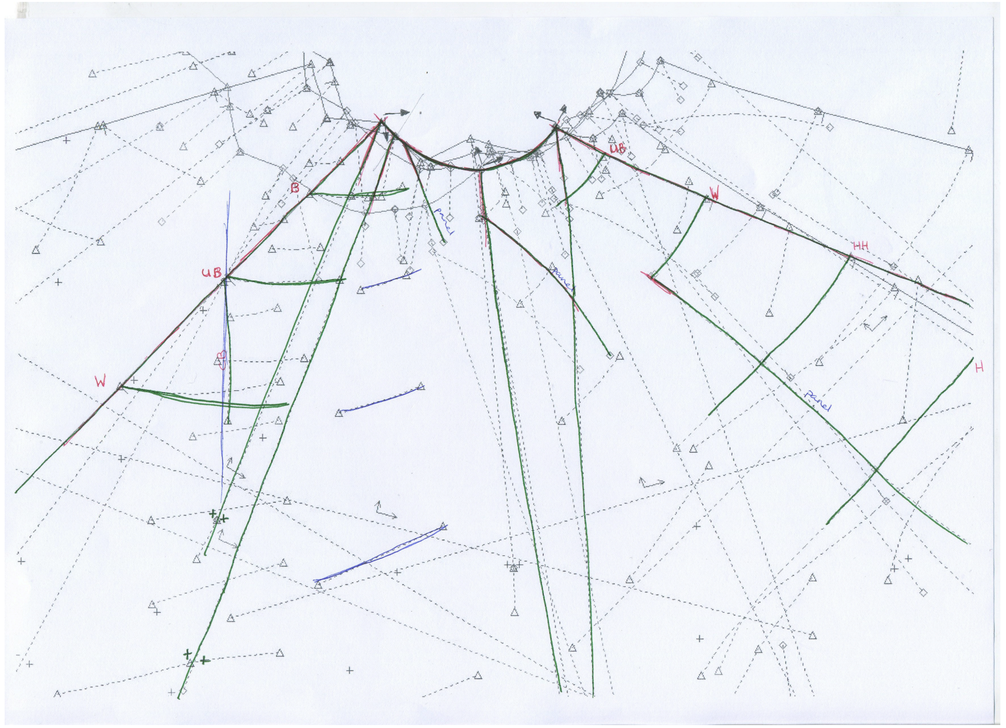


Back Right
Pattern Piece

Each area divided by the lines drawn on this pattern denotes an equivalent grainline effective area. While the fabric only has one straight grain, the fact that this pattern piece covers an entire 180° means that the draped areas each have their own respective grainlines, when sewn together into a complete garment.

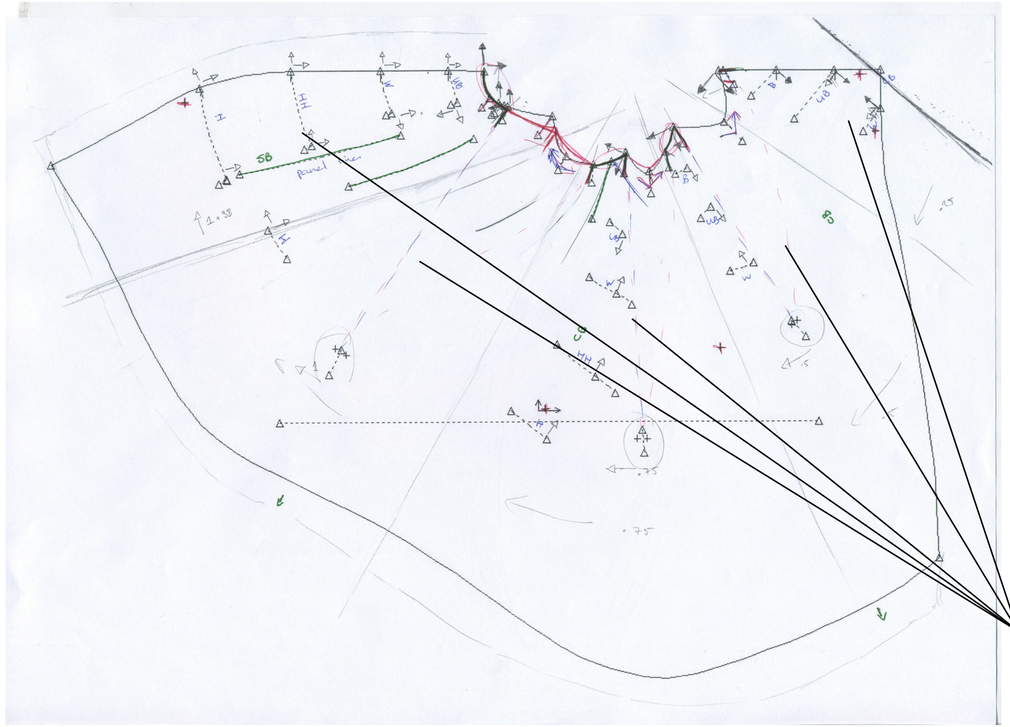
Fabric Behaviour: Design 1 Patterns

Back Right
Overlay to view multiple grainlines



This image shows the pattern, as it looks when the pleats are sewn. From the overlay of the pattern pieces multiple times you can see the shifting grainlines throughout the piece. This effects the grading of the pattern pieces, as this changing grainline in relation to the pleating caused the skewing effects of the fabric behaviour on the first application of the grading

Fabric Behaviour: Design 1 Patterns

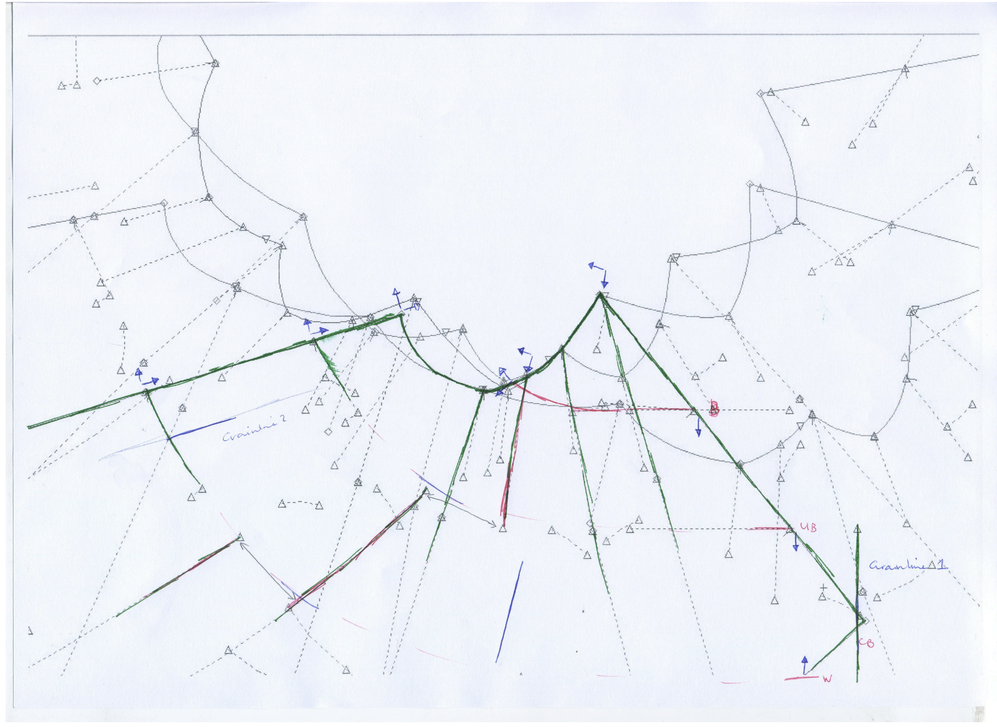


Back Left
Pattern Piece

Each area divided by the lines drawn on this pattern denotes an equivalent grainline effective area. While the fabric only has one straight grain, the fact that this pattern piece covers an entire 180° means that the draped areas each have their own respective grainlines, when sewn together into a complete garment.

Fabric Behaviour: Design 1 Patterns

Back Left
Overlay to view multiple grainlines

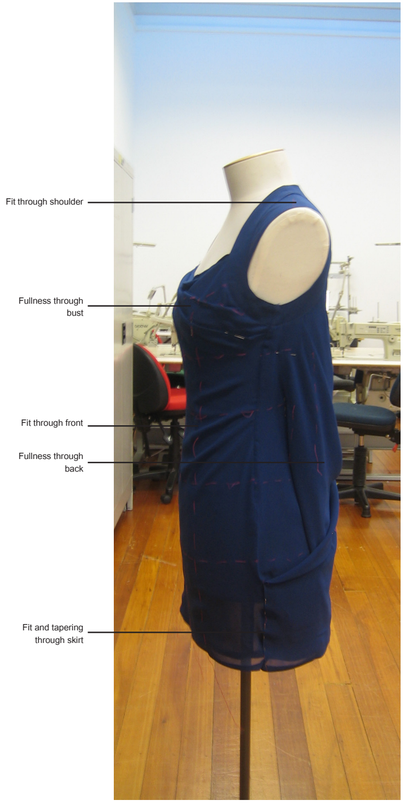


This image shows the pattern, as it looks when the pleats are sewn. From the overlay of the pattern pieces multiple times you can see the shifting grainlines throughout the piece. This effects the grading of the pattern pieces, as this changing grainline in relation to the pleating caused the skewing effects of the fabric behaviour on the first application of the grading

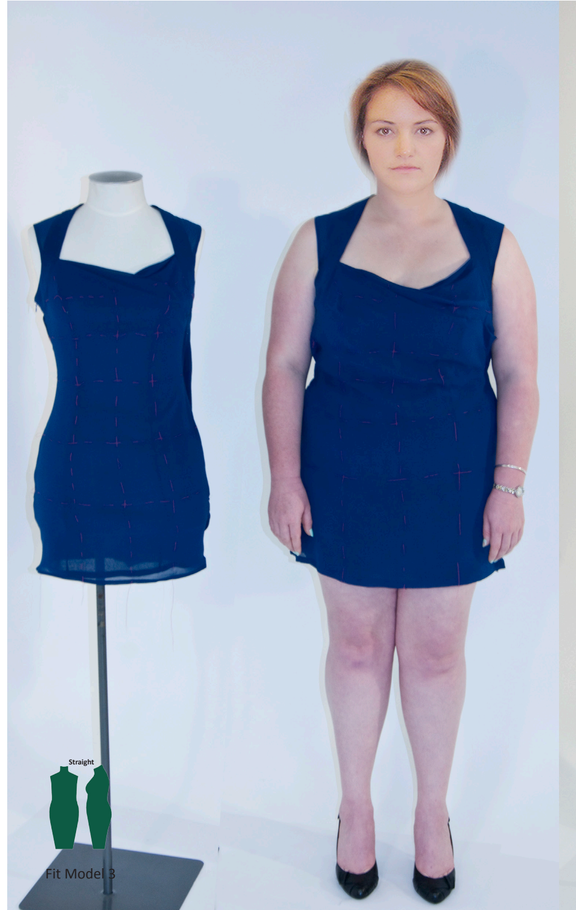
Prototypes: Design 1 Visual Analysis

Both front and back have a transition between fit and fullness

Prototypes: Design 1 Visual Analysis



Prototypes: Design 1 Comparisons



Prototypes: Design 1 Comparisons

Prototypes: Design 1 Comparisons

Fit Model 1

Fit Model 2

Fit Model 3

Fit Model 4

Prototypes: Design 1 Comparisons

Fit Model 1

Fit Model 2

Fit Model 3

Fit Model 4

Prototypes: Design 1 Comparisons

Base Size Hourglass

Fit Model 1

Hourglass

Fit Model 2

Prototypes: Design 1 Comparisons

Straight

Fit Model 3

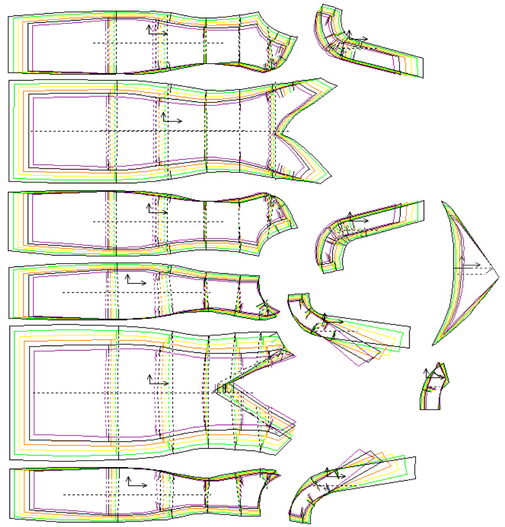
Pear

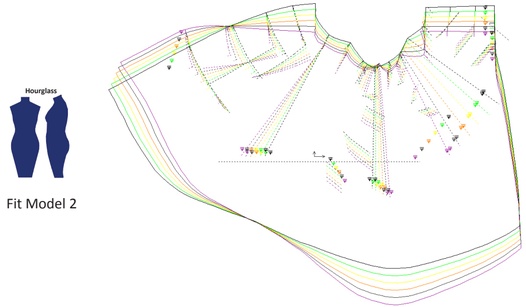
Fit Model 4

Design 1: Shape Based Grading

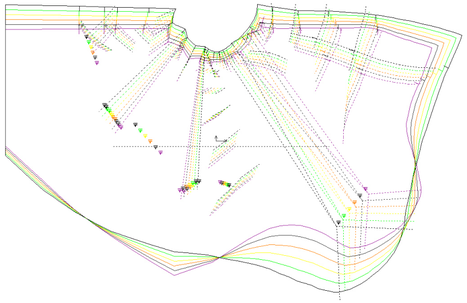
with Fabric Behaviour Calculated In

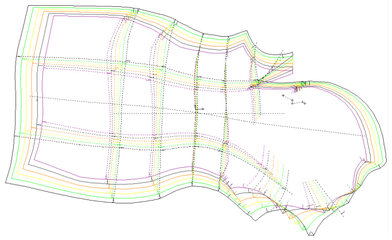
Hourglass to Hourglass





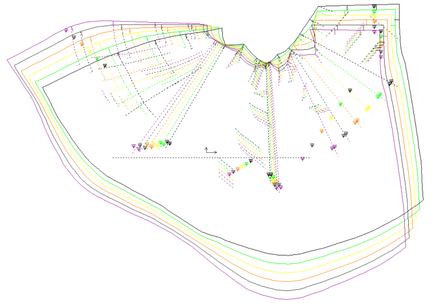
Fit Model 2



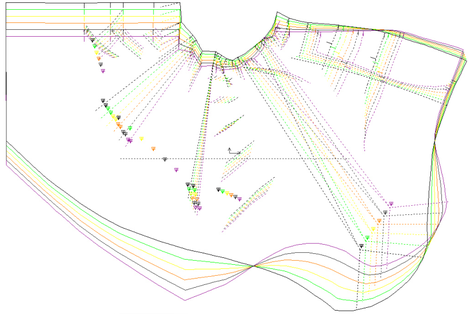


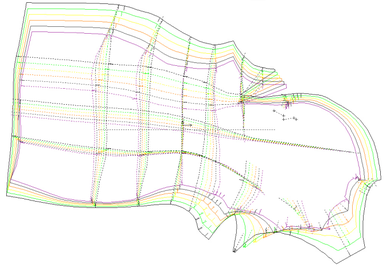
Design 1: Shape Based Grading

with Fabric Behaviour Calculated In

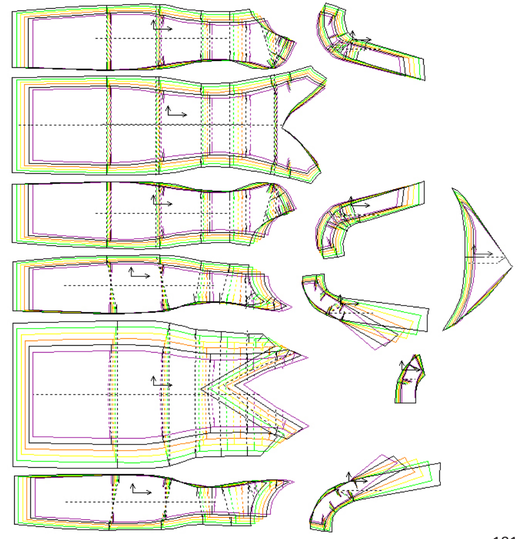


Fit Model 3





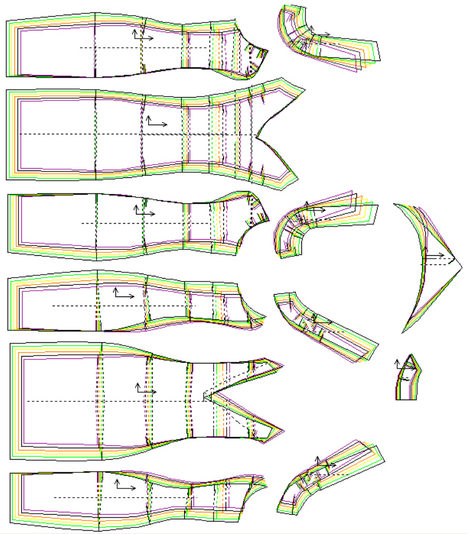
Hourglass to Straight

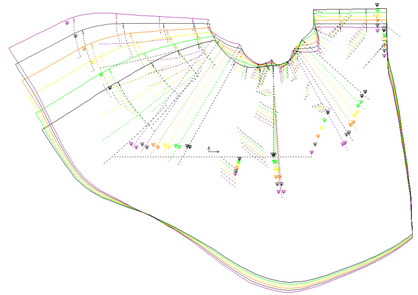


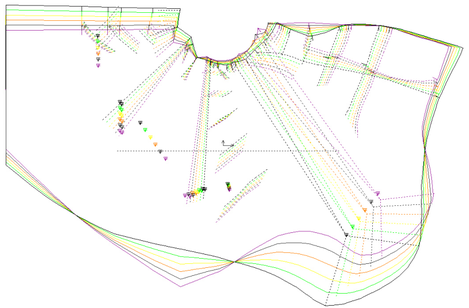
Design 1: Shape Based Grading with Fabric Behaviour Calculated In

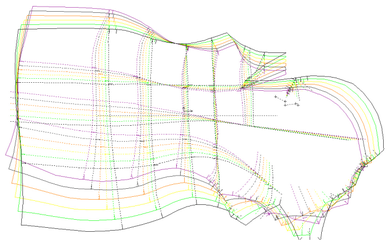
Fit Model 4

Hourglass to Pear









Materials: Prototype Fabric

Fabric Name:	Blue Polyester Chiffon
Fibre Content:	100% Polyester
Fibre Type:	Filament
Yarn Structure:	Single ply yarn, Z twist
	Smooth Filament Crepe Yarn
Weave:	1 x 1 Plain Weave

Benefit of plain weave, there is no right or wrong side, which was part of the decision making reasoning for using this fabric.

Thesis DECLARATION

Author's Name (student):	Michelle Freeth
Title of Thesis	**Maintaining Design Aesthetics** Case studies investigating grading for body shape variation; the translation of garment designs to fit fuller figured women.
Student number	03249646
Degree	Master of Design
Year	2011

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No other person's work (published or unpublished) has been used without due acknowledgment in the main text of the thesis.

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