Future Forms:

A methodological investigation for garment shape innovation in knitwear design

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I would like to thank Andreas Mikellis, Linda Jones and Mandy Smith for their support and encouragement throughout this project; I would also like to acknowledge the assistance of my supervisor Frances Joseph.

Abstract

Future Forms;

A methodological investigation for garment shape innovation in knitwear design

This practice based research project investigates the opportunities for invention and innovation within industrial fashion for the knitwear designer and focuses on experimental knitwear in which the fabric and the garment shape are created simultaneously, thereby integrating clothing and textile design into one process.

Following the development of seamless knitting technology, new possibilities have opened up for other ways of producing knitwear commercially. There is the potential for knitwear to have a different aesthetic to that which is currently based on a system of flat pattern cutting. This research investigates another way of developing knitwear by using a method of shape engineering as an alternative to the conventional flat pattern cutting approach to garment design. The current training and education options for knitwear designers are discussed, as are the working methods and processes of industrial knitwear production. The study also considers the importance of innovation in knitwear design and explores the opportunities for originality in industrial fashion knitwear through the adoption of non-standard working methods for the knitwear designer.

Keywords: knitwear, textiles, wholegarment, flechage, garment shaping, *design methods*.

Glossary of Technical Terms

Basque beret technique – see flechage.

Course –a row of knitting.

Cut and Sew – a garment manufacturing method whereby panels of knitted fabric are cut into the shapes of the required garment pieces and then overlocked together.

Feeder – Also called a yarn carrier, a feeder is a device which moves across the needle bed when knitting and through which yarn is fed to the needles.

Flat pattern cutting – Drafting a pattern on a 2-D plane using paper. The opposite of draping which is a 3-D method of pattern cutting using a dress stand (or a body) and fabric.

Flechage – This term comes from the French word for wedge and describes a method of shaping knitted fabric by increasing or decreasing the length of succeeding rows. This process can create both 2-D and 3-D shaping. It is also referred to as short row knitting, gore technique or the Basque beret technique.

Fully fashioned – Panels of fabric knitted to shape using a technique of transferring stitches.

Gauge (gge) – refers to the number of needles per inch on a machine. Finer fabrics e.g. 28 gge fabric have more needles per inch, whereas chunky fabrics e.g. 21/2 gge fabric, have less needles per inch.

Gore technique - see flechage.

Guernsey or Gansey – a traditional fisherman's sweater made of wool with a straight neck that can be worn reversed (useful for dressing quickly in a storm or darkness at sea).

Linking – the joining of two pieces of fabric with a knitted chain stitch (a linking machine is used for this process).

Needle transfer – needle transfer describes the process of transferring stitch loops onto different needles. It can be used for texture as in lace knitting or to increase or decrease the number of stitches in a fabric panel for garment shaping. This technique is used to shape fully-fashioned garment panels.

Overlocking – a method of joining fabric pieces using a type of sewing machine which incorporates the use of looper threads to encase the edge of the fabric within the seam and thereby prevent fraying.

Raglan sleeve sweater - a sweater with a sleeve that extends in one piece from the cuff to the neckline, with straight seams extending out from the neck to a point under the arm.

Saddle shoulder – a style of sleeve whereby the shoulder portion forms a straight band cut in the same piece as the rest of the sleeve. The saddle shoulder is a variation of the raglan sleeve, however the front and back are seamed parallel to the shoulder instead of at an angle as in a raglan.

Seamless knitting – a garment manufacturing method whereby a series of interconnected tubes are knitted to create an entire garment. These garments come off the machine complete and they have no seams.

Shape engineering – shape created within a knitted fabric by increasing or decreasing the quantity of yarn in selected areas of the fabric. This can be achieved by using a flechage (or short-row) knitting technique.

Short row knitting – see flechage.

Take down – refers to the application of pressure from below the knitting (using take down rollers) which pulls the knitting down to prevent the newly knitted stitches from rising up and becoming entangled in the ascending needles as the machine knits.

Tank top - a tight-fitting sleeveless knitted garment with wide shoulder straps and no front opening; often worn over a shirt or blouse.

Toile – a mock up or prototype of a garment or part of a garment.

Wales – the stitches in a row of knitting.

Warp knitting – a method of knitting whereby multiple yarns are fed vertically (warp-wise) to multiple needles, one end of yarn going to each needle.

Weft Knitting – a method of knitting in which one yarn is fed to one or more needles, moving back and forth horizontally to create a fabric.

Yoke cardigan - a cardigan that is fitted or shaped at the neck and shoulder area. Examples of yoke cardigans can be found in designs originating on the Shetland island of Fair Isle, Fair Isle yokes are traditionally hand knitted into seamless, hand-framed bodies.

Part 1. Introduction

The Research Enquiry

This research investigates an alternative way of developing knitwear by using a method of shape engineering as a substitute to the conventional flat pattern cutting approach to knitted garment design. The project addresses changes in the working methods of knitwear designers that are taking place as a consequence of recent developments in knitting production technology. Seamless knitting technology, which has the capacity to integrate 3 dimensional aspects of clothing design with textile development, is the inspiration behind this work. Now that it is possible to build shape into what could previously only be produced as flat fabric, there is huge potential for a change in the way that knitwear is designed.

There is an opportunity for new approaches to pattern cutting, or “shape engineering” as it could be more accurately called, where the fabric and the required shape of a garment are developed at the same time. This could also lead to the development of other areas of knitwear application and products. By breaking away from the woven “cut and sew” convention in mass produced knitwear and more fully exploring this form of integral knitting, there is great potential for the creation and commercial viability of new garment shapes enabled by this new technology. This, however, requires a paradigm shift in thinking and methodology by designers and manufacturers. It will also require the development of new teaching approaches to understand and adopt this new mindset and take us into an era of three-dimensional knitted products.

The area of enquiry also addresses ways that a designer could approach developing a garment shape. The research question framing this enquiry is: If a standard process, when applied to a conventional garment, creates a standard outcome; will a non-standard process, when applied to a conventional garment create a different outcome? As a knitwear designer trained in the conventional flat pattern method of cutting I am interested to see whether it would be more appropriate to use a different sequence of actions or calculations to achieve alternative outcomes, as this could be a consideration when training future knitwear designers. The project is inspired by (but not limited to) seamless knitting and its potential for shape engineering. The research has used Dubied handflats and Brother and Knitmaster machines to explore and develop new approaches to shape design through ¼ and ½ scale prototyping, and is focussed on the use of two techniques, needle transfer and short row knitting (or flechage) to explore the possibilities of three-dimensional garment design.

This research has relevance to companies who manufacture knitting machinery and design software because it examines the process of sample creation from a designer's perspective, concerned with fashion trends and aesthetics, rather than that of a knit technician, concerned with production. It has relevance to the knitwear manufacturing industry because it is concerned with the importance of innovation in knitted products. It is also relevant to fashion and textile students and design educators because it explores an alternative approach to knitwear design practice. It is hoped that this study will contribute to current debate around new knitwear technologies and the ways in which designers can work with them. The issues of working methods and processes in industrial fashion will be discussed, as will the current training and education options for knitwear designers. The lack of integration between the roles of knitwear designer and knitwear technician is also considered in this project. It addresses how better design communication can encourage greater synergy between these roles to the benefit of the knitwear industry from both a creative and commercial perspective.

The main focus and first part of the research, which is practice based, represents 80% of the thesis. It has involved the development of a range of sample garments in which a method of shape engineering through knitted fabric structure is explored. As part of this investigation the current working processes of industrial knitwear designers was assessed and an original design approach developed which disrupts traditional methods to accomplish a different approach to the development of garment shape. The second part of the research, the written dissertation, describes and analyses this practice and provides a contextual framework in which the project has been positioned. The first part of this exegesis gives an outline of the project and an analysis of current literature relevant to the research. The background and context of the study, an overview of current practice and the significance of seamless technology in knitwear design and production is provided in part two. In part three the focus is on the rationale behind the project. The importance of innovation in knitwear design is discussed along with the conflict that arises when limited training opportunities and restrictive traditional working methods impact on the designer's ability to perform innovatively. Part four concentrates on the methodology and design of the research project, whilst part five presents the documentation of project outcomes and the conclusions drawn from this research. A glossary of technical terms is provided on pages 9 to 12.

The Literature Review

In this section I have attempted to critically evaluate the current body of literature that is relevant to this project. There are four parts to the literature review undertaken for this study. The first looks at writing about seamless knitting technology, the second at the history of knitwear design and the third section covers design processes and methods used by both knitwear designers and in other areas of design. Finally the literature review also considered literature on design research methodology. While the first area of review is detailed in this chapter, a fuller overview about the history of knitwear design and technology development, and about the processes and approaches by designers, are presented in parts 3 and 4 of this exegesis.

A variety of academic papers, journal articles, internet reviews and online articles have been written about recent technological advances in knitting, but there is limited material written from a designers' perspective. There are a number of examples of papers written about quicker more cost effective production rather than design evolution. Peterson and Ekwall (2005), examine how new knitwear technology can be implemented to maximise business potential in a fast fashion production system. They state "it is not enough to invest in new machinery and then use the machines in the same production system as before"(p.264). However, their paper does not address the potential value in using new machines to create new types of garments. Lam (2005), documents the extent of the use of the new knitting technology and assesses the market share of seamless knitting. This paper is also focussed on manufacturing and traditional market oriented perspectives, whereas my research is concerned with ways that designers can engage with new approaches to developing knitwear products.

There are also several web articles similar to that by Choi and Powell (2005), detailing technical information such as how the new machines work, why they are different and what the benefits are from a production point of view. Anderson (2008), reviews the most recent developments in the technical functionality of knitting machines produced by Shima Seiki, Stoll and Santoni noting the advantages of seamless knitting as being a less labour intensive, less wasteful method of “quick response” production, but again there is no mention of the design innovation potential of this technology. Likewise Gupta (2006) reports on the prospective of new types of fashion retail in the form of mass customisation strategies for knitted garments enabled by combinations of seamless knitting technology and digital print. But this research is focussed on establishing a digital supply chain for customers rather than garment design and aesthetics.

In a series of three articles Hunter (2004), explains why complete garment technology is being adopted. He follows the evolution of technical developments in knitwear production and reports on the commercial availability of products made with complete garment knitting technology. The merits of comfort, fit and quick response manufacture are discussed, but the designs themselves are conventional.

Considerate Design, http://www.consideratedesign.com/projects/knit-for-fit/ is a London College of Fashion research project led by Professor Sandy Black and Dr. Penelope Watkins; it has been set up with the intention of challenging the traditional design process for knitwear. The objective is to combine the use of body scanning technology to gain precise body measurements, with CAD knitwear design systems to produce an individualised, made to measure, seam free, knitted product which can be further customised to the buyers personal request.

The Considerate Design project is also attempting to address issues of sustainability by using materials efficiently to minimise waste, to reduce overheads such as labour costs for garment production and to produce one off garments. Which, due to the customisation of fit will have superior comfort hopefully contributing to longer use of the product. ("Knit to Fit," n.d.) The project however is consumer and technology focussed and is not concerned with garment shape, silhouette or aesthetic innovation, nor does it engage with the development of new methods for designers.

From a history of knitwear design perspective, the online museum Knitting Together[1] has provided a rich resource of information and contextual understanding related to the development and industrialisation of the knitwear industry over the past four hundred years in the East Midlands of the U.K. David Spencer's definitive text on Knitting Technology (2001) has been useful in helping to verify the principles and evolution of electronic knitting and for clarification of knitwear terminology and definitions. This text has informed the development of the contextual framework presented in part 2.

In her paper "Functional to fashionable: knitwear's evolution through the last century and into the millennium" Power (2007) gives a concise history of the knitwear industry from Tudor times up to present day. The focus is on the development of technology for knit production, and the author acknowledges that especially over the last two decades, designers have struggled to keep up with technical innovation: "The millennium brought with it glamorous sights of commercially knitted complete garments, however it is worth noting that the styling was basic…Does this signify design or technological innovation?" (Power, 2007, p.15). However, the paper offers no insight as to why this may be, or what changes could be implemented to improve this situation. Power recognises a cyclical relationship between technological development and design development, "throughout history there appears to be periods of innovation where technology leads design, followed by periods of development where design exploits the technological capability and then the cycle repeats."(p15). This research project is located in this space between technological innovation and design perception that can lead to more innovative approaches and outcomes.

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[1] http://www.knittingtogether.org.uk.

This study has also involved a focus on design methods and processes. The work of Claudia Eckert and Martin Stacey has been particularly useful in this regard. They have written various papers about the ways that designers work and the systems and procedures that are used, both in the early stages of concept generation and in the subsequent development and manufacture of products. To this end I have also drawn on my own experience of working as a designer in the knitwear industry in the U.K. and in New Zealand. Many of Eckert and Stacey's papers make specific reference to knitwear design, based on the rationale that knitwear design is an area that encompasses many principles and issues also encountered in a wide variety of other design disciplines. For example in “Sources of inspiration: a language of design” they state that:

> Knitwear design shares many of the characteristics of complex engineering projects; many ubiquitous phenomena are especially salient and clear-cut in knitwear design. Complexity arises from the interactions between the inherent limitations of knitted structures, material properties, manufacturing constraints, market pressures and aesthetic considerations. Knitwear is created by multi-disciplinary teams, and problems arise from failures of communication between team members. The product is highly dependant on the context created by other designs and cultural and technological developments. (2000, p.525)

Eckert and Stacey carried out an empirical study of the knitwear industry over seven years in Britain, Italy and Germany and I have referred to a number of their papers in the course of this research. Distorting Design: Unevenness as a Cognitive Dimension of Design Tools (Stacey, 1995), Sketch Interpretation in Design Communication” (Stacey, Eckert & McFadzean, 1999) Sources of inspiration: A Language of Design (Eckert and Stacey, 2000) and Designing in the Context of Fashion: Designing the Fashion Context (Eckert and Stacey, 2001). These approaches are more fully explored in parts 4 and 5 of this exegesis.

Whilst reviewing the literature regarding knitting techniques and methods of working I have looked at sources dealing with both hand knitting and electronic machine knitting. Hand knitting (on needles) is a very distinct process from machine knitting - the challenges of a machine in all respects from basic yarn compatibility and feeder limitations to take down issues make it a very different medium, however I have used the books on hand knitting by Gladys Thompson and Elizabeth Zimmerman as sources of inspiration. Thompson (1955), has documented traditional hand knitting techniques from the coastal fishing towns of the British Isles. Her work contains many detailed photographs (dating as far back as 1850) of fishing crews wearing Guernseys. It also has graphs, diagrams and technical instructions relating to the construction of the garments. This was of interest to me because Guernseys have no seams and as I am working with minimal seaming, it is useful for me to utilise the techniques such as shoulder shaping, gussets, seam stitches and “drawing in” for garment shaping. Zimmerman’s work also includes detailed instructions for knitting in the round (a hand knitting technique for seamless garments), she also developed a mathematical formula to calculate sizing and fit for hand knitted garments.

Yang and Love (2009), have also taken a mathematical approach to the development of knitwear silhouettes by using a method called combinatorics[2] in an attempt to reduce the time involved in the design process and improve the efficiency of production. They have investigated how knit structure can be used to create changes in fabric shape without adjusting the number of needles in action during knitting. This system of knitting is both economical and fast compared with other methods of shaping such as the flechage or short row methods that I am using. The overall system of applying combinatorics to develop shape could certainly be cost effective, however this approach appears to reduce the design process to “listable, knowable”

[2] Combinatorics is a mathematically based approach that uses systems of finite sets whose intersections have specified numerical properties. These sets can be combined in various ways to produce variation. It is a computationally based design method, see Bezerra & Wakes (2005),

solutions. The authors regard this as a benefit of the system; “this new approach also offers the opportunity for knitwear designers to put more resources into other aspects of achieving better design outcomes and use their time in a more effective way” (2009, p. 545), but I have reservations about this approach as it works by recombining a range of conventional knit approaches. This issue is addressed further in part 3.

For this study I have endeavoured to review relevant literature encompassing areas of contextual, technical and methodological information related to industrial knitwear design and production. I’ve examined the sequential development of knitwear manufacture from an historical perspective and the knitwear industry’s response to seamless technology; this has helped to inform my understanding of current practice in knitwear design. I have also reviewed work on the subject of methods and design processes in an attempt to assess existing design practice and determine possible alternative approaches.

Part 2. Contextual Framework

An Overview of Current Practice in Knitwear Design and Production

Until the mid 1990's the limitations of knitting machines meant that, with the exception of socks and gloves, there was no ability to manufacture complete items of knitted clothing. Knitting machines were only used to produce knitted fabric, which was then made up into garments, (in the tradition of clothes made from woven cloth). This system is known as the "Cut, Make and Trim" (CMT) or "Cut and Sew" method (fig.1) and is still the convention for many knitwear companies today.

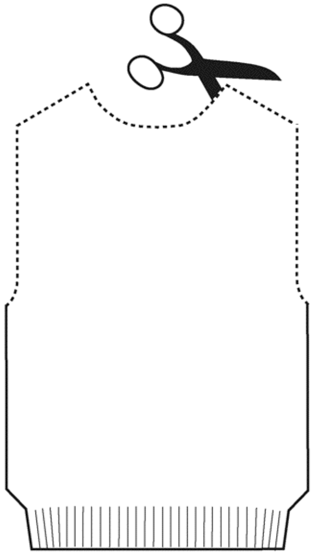

Fig.1

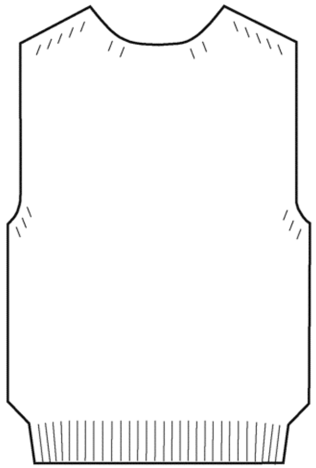

fig.2

Alternatively, the fabric is knitted into flat, shaped pieces (fig.2) and then made up. This is referred to as "fully fashioned" production, but the principle of the garment design is the same, and is based on flat pattern cutting. The only difference being that when clothes are made from woven cloth, features such as darts and ease are used to give the garments shape and fit, whereas in knitwear, the designer relies on the stretch properties of the fabric to provide garment fit. It can be argued that until now, knitwear production technologies have, in many ways limited design development in knitwear. Things have been gained, like production speed and low cost product, but the method of knitted garment design and the approach to the design development has barely changed since the end of the 19th century. Limitations of commercial knitting machines have led to a convention in knitwear design whereby knitted fabric and knitted garments are conceived as separate entities. The knitwear designer has to work first as a textile designer to develop fabric and then as a fashion designer to create a garment. This disaffiliation at the conceptual stage of design has resulted in a “two dimensional” design model which has become a standard method of developing knitwear. It is recognised that this is a historically contingent process, that is the result of technological limitations and that seamless knit offers what is potentially a more fluid approach to the design and production of artefacts to be worn on a 3 dimensional human body.

Another factor influencing this stasis in garment development is the perpetuation of the traditional roles of designer and technician (usually gender defined) within the knitwear industry, whereby the responsibility for the design of the product is separated from the process of its manufacture. While the issue of gender roles is not confined to knitwear production (areas of product and graphic design have historically faced similar issues) there are some unique dimensions to this problem in terms of current knitwear production systems. While the designer has responsibility for the colour, stitch structure and basic garment shape, the programming of the knitting machines and the manufacturing method of the product is the work of the technician. There is much speculation as to how this structure evolved and why it still exists but the general consensus is that it has emerged from traditional gender roles. Sonya Rose’s research on the factories in the hosiery and knitwear industry in the 19th century suggests, “job segregation among machine operatives was a direct outcome of gender conflict.” (Rose, 1986). She reveals that men earned twice the wages of women for the same work, prompting employers to attempt to hire female knitters in the place of men. One of the many ways that male workers resisted female employment is disclosed in union records of the 1860's as the creation of a workforce segregated by gender based on machines that were considered "a man's machine" (the more productive, newer machines) and those that were assigned as women's machines. Cynthia Cockburn (cited in Rose 1986) draws an interesting comparison when she analyses the effects of technological changes in the early 20th century printing industry:

> Attempts to introduce women as typesetters were strongly resisted. Male compositors were able to extend their control from manual typesetting to more automated processes by manipulating the definition of the skills required for their jobs to protect them from the threat posed by unskilled males and females. Workers were able to retain skilled status by restricting access to apprenticeships by which the skills of the trade might be learned. (Rose, 1986).

While digital processes have seen a shift in terms of print production methods and gender division of roles, little has changed over the decades in the knitwear sector. I can recall my own experience of working in a large knitwear factory in Nottingham in 1986. On asking why there were no female knitting mechanics or knitters, I was told by the division supervisor that knitting was a highly paid job and that in many instances the factory provided work for entire families. It would therefore upset the social balance of the town if wives or daughters were to earn as much money as their husbands or fathers. In their paper "CAD Systems and the Division of labour in Knitwear design" Eckert and Stacey (1994) also conclude that traditional gender roles are the background to the splitting of the knitwear design profession into two distinct areas. The predominantly female knitwear designer's role has grown out of that of the seamstress and the (male) role of the knitwear technician has evolved from that of the knitting mechanic. Before electronic machine programming, knitting patterns were cut into heavy metal punch cards (steels), which then had to be attached in rolls to the machines, this was done by the knitting mechanics and was a job which excluded women due to the hard physical nature of the work.

Today, the knitwear technician's job is one of computer programming and therefore not reliant on physical strength, nevertheless, there is still resistance to the idea of concurrency between these areas of work. This is an important factor because it dictates the way that knitted products are developed, disconnecting the areas of design and manufacture. This research also begins to question whether the roles and knowledges of designer and technician could or should be integrated in the future to facilitate superior development of more diverse knitwear products.

The separate roles of designer and technician were of limited consequence in terms of garment shape prior to the development of the presser foot[3] (which was patented in 1968 and came into widespread use in the late 1970's). Use of the presser foot enables knitting in selected parts of a row and this can create 3-dimensional fabrics. Prior to the presser foot, garment patterns had to be flat due to the lack of 3d shaping options when knitting fabric. The evolution of presser foot use, combined with other new knitwear technologies such as complete garment knitting, have created opportunities for not only faster, more economical product manufacture but also for new approaches to knitwear design and new aesthetics in knitted products, particularly in the area of pattern cutting and garment shape. This is an area that requires the input of someone trained in design with an understanding of garment functionality, silhouette and fashion trends. Yet knitwear designers, due to lack of training and or opportunity, do not have adequate understanding of the technology to be really innovative in this area.

[3] The presser foot is a device which holds the stitches low on the needle stems preventing them from riding up and becoming tangled as the carriage moves across the needle bed. Stitches can be held on inactive needles in this way because the presser foot does not create tension on the loops (in the way that standard takedown tension on the fabric below does).

The Introduction of New Knitting Technology

> At the 12th International Textile Machinery Exhibition (ITMA 95) held in Milan, Italy, Shima Seiki (the Japanese knitting machine company) made an historic presentation that dazzled the entire textile world. One-piece complete garment knitwear, the dream of the knitting industry, was finally a reality. Called WHOLEGARMENT™ it signalled the dawn of a whole new era of modern knitting…(Shima Seiki, n.d.)[4]

The Shima Seiki Wholegarment™ machine knits fabric in a series of tubes, which are interconnected (fig.3); this makes it possible (for the first time) to create an entire garment at the same time as the fabric is created. These garments come off the machine complete and they have no seams.

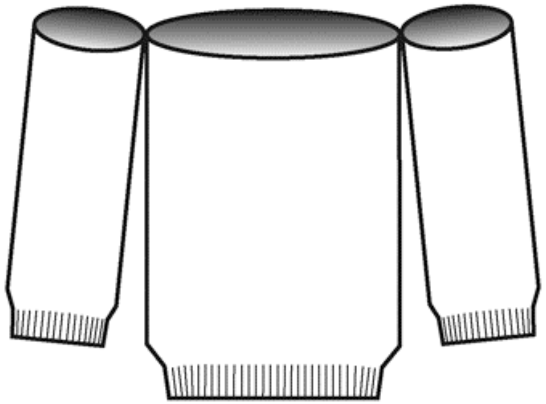

Fig.3

[4] Shima Seiki. (n.d.). Retrieved November 30, 2005, from http://www.shimaseiki.co.jp/wholegarment.html

This method of knitting has the potential to achieve a superior product. It offers the consumer more comfortable knitwear with better fit as a result of eliminating the seams. Different fabric structures can be incorporated into different parts of a garment, for example tighter structures can be added to create areas of compression, open mesh structures can provide ventilation and different yarns and fibres can be used in areas to provide moisture absorption and padding Lam (2005). The ability to achieve this without seams further improves comfort because seams that are too close to the body can cause chafing.

Complete garment knitting also eliminates all of the various cutting and sewing stages of garment manufacture, leading to savings in time and cost. Peterson and Ekwall (2005), state that “time to market” is a major element in cost effective production. They claim that complete garment technology is most beneficial when used in a fast fashion supply chain because the overall process allows a quick response to customers’ requirements:

> Processes are removed and non-value added time between processes is eliminated. If the whole business system and supply chain is designed to respond quickly to customer demand for new fashion products, the complete garment technology becomes an important part of the system. (Peterson and Ekwall, 2005, p. 273)

The world’s leading knitting machine manufacturers, including Shima Seiki (Japan) and Stoll (Germany) have developed machines that have the ability to knit complete garments. Although it is possible to knit tubular shapes very fast on conventional circular knitting machines and a degree of seamless knitting can be achieved, the versatility of these machines is limited by the fact that it is not possible to do partial knitting (also known as flechage, short-row knitting or the gore technique) within a course.[5] Knitting machines with seamless capabilities such as Shima Seiki’s Wholegarment™ and Stoll’s Knit&Wear™

[5] On conventional flat bed machines the main obstacle to knitting seamless garments was the inability to knit a tubular rib with only two needle beds.

machines use the gore technique as a method of seam free knitting. This technique involves reducing (or increasing) the length of successive courses to give shape or to narrow (or widen) the fabric. Fig. 4 shows a simple example of the gore technique.

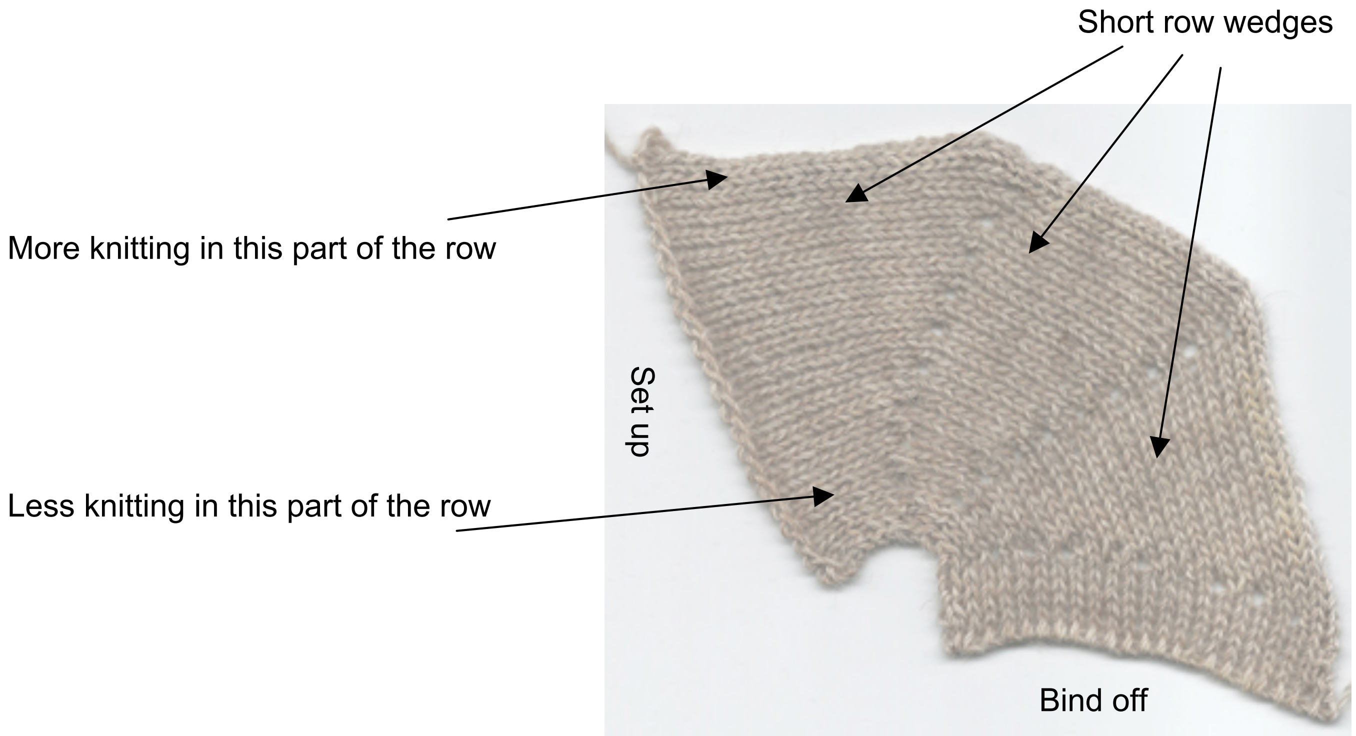

Fig.4

The Current Utilisation of Seamless Knitting Technology

When Shima Seiki first launched the Wholegarment™ machine it was hailed as the forerunner of an entirely new approach to knitwear design and production, however the first generation of Wholegarment™ machines did not have the initial impact on the industry that was originally predicted. The benefits of seam free knitwear were initially limited to ergonomic issues. The technology was assessed only in the context of improving production and the garments remained conventional. Even now the new technology is being mainly used for garments that require the comfort of being seam free, such as underwear and sportswear. Dr Olga Troynikov from RMIT University in Melbourne led a project funded by Australian Wool Innovation in 2007[6] that explored ergonomic seam free garments for active sportswear. The Journal for Asia on Textile and Apparel (ATA) has reported that companies such as Reebok, Nike, Adidas and Calvin Klein are all using seamless knitwear technology in the production of underwear and sportswear (Lam, 2005) and British knitwear company John Smedley uses its website[7] to promote the John Smedley ONE™ range which consists of classic simple knitwear pieces with an emphasis on seam free comfort.

Other companies are using the technology to cut manufacturing costs – no seams, no sewing machinists, no construction machines or buildings to house the garment construction machines etc. Despite the huge potential for design, knitted garment shapes produced through industrial manufacturing systems still adhere to the knitwear practice that responded to the limitations of the older machinery and is created following the principles of woven garment production, with the fabric giving only the colour and texture to the garment.[8]

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[6] Ergonomic Performance: Seam-free Apparel for Activewear, exhibited at IPSO(International Exhibition for Sports Equipment and Apparel) 2007, Munich.

[7] http://www.johnsmedley.com

[8] There are exceptions to this approach found in high end designer knitwear, such as the work of Sandra Backlund, http://www.sandrabacklund.com and Martin Margiela, http://www.maisonmartinmargiela.com

As stated previously, most current research seems to be investigating seam free knitwear from the perspective of comfort, fit and customisation of size, with little focus on design potential for new aesthetics and new products.

The CEO and president of Shima Seiki Manufacturing Ltd. Dr Masahiro Shima, acknowledges that Wholegarment™ technology is very much at a preliminary stage of development, “At the moment I estimate we only know around 1 percent of WHOLEGARMENT’s design potential, which means that our customers probably only use around 0.01 percent of the full capacity of the machine…”(Mowbray, 2002). This research project has set out to investigate and engage some of this unused capacity in relation to garment shaping process.

Part 3. The Rationale and Focus of the Project

Design is often understood as an evolutionary process, through the reinterpretation and improvement of a product; or it is seen as a process of invention or the visualisation and creation of something which did not exist before. At another level, designers interpret the dominant social ideas prevalent in a place or period into ideas for commercial merchandise or services. When design is observed across disciplines as a collective body of work we can acquire a greater understanding of our diverse cultures and sub-cultures.

Jack Schulze is the director of new product development at Berg in London and he also runs the creative design consultancy, Schulze and Webb. His definition of the role of a designer acknowledges the cultural importance of design and a role for design that goes beyond notions of functionalism:

> Some people (they are wrong) say design is about solving problems. Obviously designers do solve problems, but then so do dentists. Design is about cultural invention. There are some people who want to reduce the domain of design to listable, knowable stuff, so it's easy to talk about. …. This is damaging. It turns design into something terrified of invention. Design is about risk. (Schultze and Webb in Bove, 2009)

There are two elements of this quote that are significant to this research. One is the idea that design can be reduced to "listable, knowable stuff". In response to this I will discuss the training and education of knitwear designers and design mechanics (or design technicians) and how the lack of integration between these roles can lead to stasis in design innovation I have called this the "closed loop" problem.

The second element that is relevant to this research is identified in Schulze's comment about the role of design in cultural invention. The New Zealand Government's Design Task Force (2003) recognised the relationship between design and innovation and the place of design in economic development (p.8). Two key questions that are fundamental to this project are; what are the opportunities for invention and innovation within fashion for the knitwear designer? And why is innovation in knitwear design important?

The Closed Loop Problem in Knitwear Design.

Both Shima Seki and Stoll have now developed knit CAD packages aimed specifically at the designer, these systems tend to be focussed on making the design process simpler and faster by including various databases for stitch structures and garment shapes which the designer can then customise. In many ways they appear to have been developed for technicians rather than designers and whilst useful for mass market industrial fashion product, the "cookie cutter" approach comprising of the facility to select a garment shape from a database, then select a fabric from a database, then select a yarn from a data base etc. is not really conducive to interesting fashion design. Furthermore, the nature of the closed source[9] programmes used for high end digital knitting machines confirms the highly proprietary approach to the software ensuring that any attempt to explore the deeper programming layers of the technology is out of bounds and that the that the current method of developing knitwear based on pre-designated menu selection remains the standard practice.

In an interview with Fibre2fashion in 2010 Dr Shima discusses the problems of advanced knitwear technology, "At the same time we realise that the complexities associated with these advancements tend to overwhelm the user. If the user can't keep up, what good is the technology? So we've made the operation simpler, with more automated functions" (Face 2 Face, 2010). He goes on to list the features that simplify the programming and he mentions the variety of databases, from which stitch structures, patterns, yarns, etc. can be chosen. Whilst it is in some ways advantageous that a student with no knowledge of knitwear can spend an afternoon learning how to use the Shima Seiki Design system (SDS) and then produce a knitted

[9] The source code is a programming language that forms a set of instructions for the computer. Closed source software is a type of computer programme in which the source code is not available for the user to see or modify, this is the opposite to open source software where the source code can be viewed and altered by anyone.

garment, an opportunity for our future knitwear designers will have been missed if their knowledge of the machine capabilities is limited to style selection and simple data entry.

In the pursuit of innovative design, the process is often more important than the product. A process that is standardised will produce an expected outcome; a non-standard or unexpected process could lead to results that we can't imagine yet. It seems ironic that a new technology, so exciting to the textile industry, is being reduced to listable, knowable, automated functions because the potential capabilities are seen to be too complex for knitwear designers. Unless the training and role of the designer is reassessed, a closed loop situation will prevail, whereby the lack of technical understanding of the designer leads to a lack of experimentation with new technology, which in turn results in a lack of technological development, ultimately leading to a stasis in design innovation.

I have engaged with the closed loop problem in the practice element of this project, by making the decision to use different methods of working than would be the normal practice for an industrial knitwear designer. This has given me the freedom to try out unconventional methods of garment shape development without the restrictions of a role based design process that would be necessary if working with a design technician. This method has had drawbacks as well as advantages. These issues are more fully discussed in part 4 of this thesis.

The Importance of Innovation in Knitwear Design.

For the purpose of this study I am defining the word invention as “the creation of something new” and the word innovation as “a new way of doing things.” Jack Schultze has written that design is about “cultural invention”(2009), and this point raises questions about the current focus of much knit design: Firstly where do the opportunities for invention within fashion lie for the knitwear designer? It also raises the issue as to the importance for knitwear designers to be innovative?

Within the New Zealand context policy initiatives like “Better by Design” developed from the 2003 Design Task Force report Success by Design[10] have invested in innovation through design to create greater economic value. While the strategic direction of such design–led initiatives has been taken up by companies like Icebreaker (Jeremy Moon, CEO of Icebreaker is also the current chair of Better by Design) the focus has been on business innovation through design integration. While the “Future Forms” project is not focussed on business, it is concerned with innovation through design. It addresses the question: What is the potential for knitwear design to be innovative? In an interview for *Knitting International*, Dr Shima stressed the importance of innovative design in knitwear, “What we must remember is that fashion sells knitwear… if we do not keep knitwear fresh we will lose market share to other textile technologies such as weaving. Fashion must be allowed to drive the knitwear market” (Mowbray, 2004, p. 42). Dr Shima acknowledges that the consumer doesn’t differentiate between constructed textiles. Many people would not be able to identify the difference between a knit fabric and a woven one and do not have a preference when buying clothes. The primary driver in knitwear sales is the knitted garment’s relevance in the wider context of fashionable clothing. If knitwear does not constantly change and evolve in line with fashion it will become unfashionable, thereby reducing the market share for knitwear manufacturers. This change needs to be apparent in all aspects of the product including the

[10] The New Zealand Design Taskforce (2003) Success by Design. Ministry for Industry and Regional Development. Wellington.

method of production and in the garment shape as well as in the fabrication. Most commercial knitted garment shapes are very simple deriving their form from the effect of the fabric stretching over the body, a principle that has been used in industrial knitting since before the 1920's, whereas in woven fashion, garment shapes are constantly evolving.

For example in the woven fashion area, pattern cutting has developed in a number of directions since the 1980's. The influence of Japanese designers Issey Miyake, Rei Kawakubo and Yohji Yamamoto has led to a non-western form of cutting, which explores a sculptural silhouette that has a poetic response to the body but is not determined by human physiology. British designers such as Vivienne Westwood, John Flett, and Christopher Nemeth introduced a more irreverent approach that integrated multiple forms of experimentation combining pattern-cutting archetypes with geometric cutting, using simplistic fabric shapes to produce complex garment structures. In contrast, a strong sense of traditional craft led by John Galliano reintroduced and extended methods of cutting such as the bias cut that had been originally pioneered by designers like Madeleine Vionnet and Christobal Balenciaga. All of these developments have led to a clear distinction between modern fashion silhouettes and those of earlier decades. By comparison, silhouettes in mainstream industrial fashion knitwear[11] have changed very little (see figs 5 – 10), possibly because knitting machine development has been focussed on more efficient production rather than design.

[11] With the exception of some clothing made from jersey knit fabric using the cut and sew method of production.

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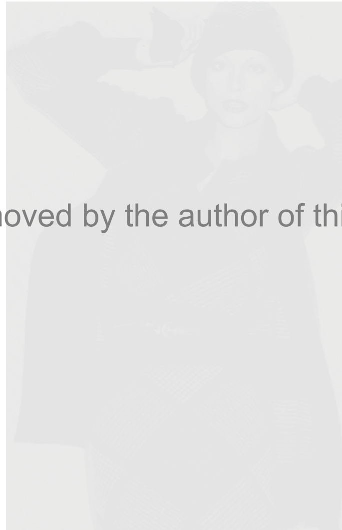
1933

fig.5

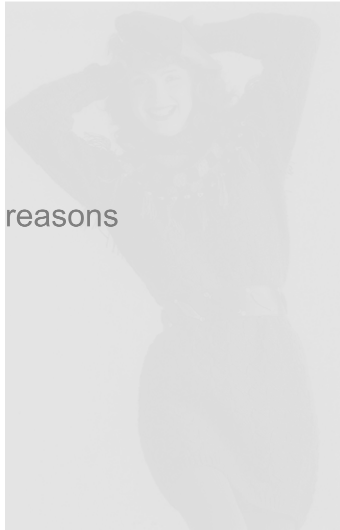
Wool knitted suit, maker unknown



1973

fig.6

Knitted suit by Missoni



1981

fig.7

Sweater dress by Artwork

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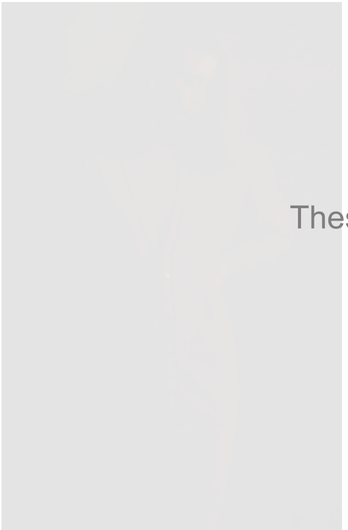
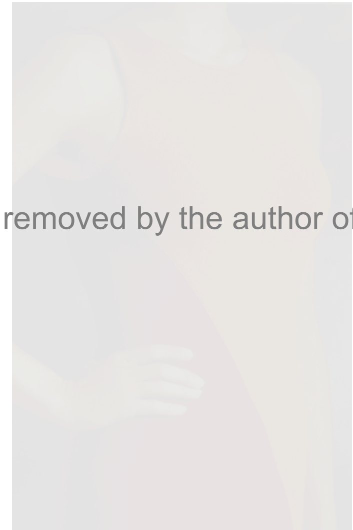


1987

fig.8

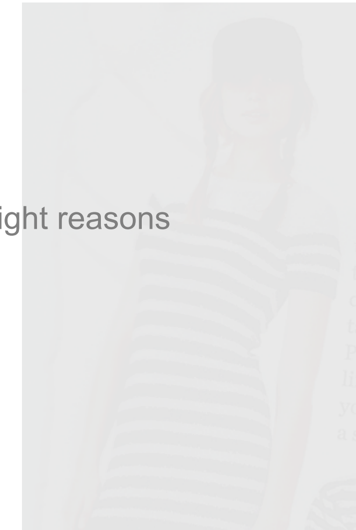
Knitwear by H&M



2001

fig.9

Seamless dress trend concept by Stoll knitting



2009

fig.10

Sequinned knitted dress by Paul and Joe

In Knitwear, more complex garment shapes have until recently, been difficult to manufacture to a high standard of quality. This is due to the delicate nature of knitted fabrics that can ladder easily especially when they are constructed with smooth yarns or in open stitch formations. Knitted garments are often constructed using manufacturing processes such as overlocking which is a technique that accommodates the stretch properties of the fabric. However it is a method that is better suited for medium to heavy weight fabrics because seams can be bulky or fraying can occur if the overlocking stitch is not tight enough. Seamless knitting has given designers the possibility of creating different garment shapes without the need to accommodate overlocking or linking as methods of joining garment pieces. Designers can work in more inventive ways with less of the previous restrictions imposed by garment construction, but they need to have a solid understanding of the technology in order to engage with this opportunity. This, in turn will provide the knitwear industry with greater creative flexibility and prescience.

Dr Shima also expressed his concern that the culture of knitwear fashion could be in jeopardy because of the move of manufacturing to countries offering cheap labour; “developed countries need to take back this industry at least in part, in order to keep knitwear fashion both new and dynamic.” (Mowbray, 2004, p.42). Countries like New Zealand that cannot compete with Asia on price of manufacture need to have a point of difference with their garments. It is becoming increasingly difficult for them to sustain their businesses with basic product. Design innovation can introduce a point of difference and help build or reinvigorate a brand. For example, Scottish knitwear company Pringle, re-established their brand by re-thinking their approach to the design of their products and repositioning the brand as synonymous with luxury fashion. Pringle no longer only produce golf sweaters, the brand now has four product categories and each includes complete collections as well as accessories. They have been innovative in developing luxury yarns such as new cashmeres; reconsidering the yarn preparation, the moisture level, the amount of oil, the twist and the relaxation time to produce yarn that creates a very soft fabric with excellent stitch clarity (Anderson, 2005). The head of manufacturing, Colin Anderson confirms “these days you can’t just churn out 15 gauge lambswool sweaters if you want to compete. It’s all about technical innovation during knitting and finishing to give a unique selling point.”(“Pringle,” 2005, p. 25).

Many knitwear companies such as English manufacturer Davenport Knitwear are finding a niche as fast response manufacturers, moving from being producers of high volume knitwear to that of quick turnaround, short run, high end, directional fashion knitwear (Hunter 2004). This is an area that is particularly suited to New Zealand manufacturers who, due to a small population base have a very limited home market and correspondingly cannot produce large volumes to meet cost targets for the export of basic knit products but could focus on selective markets for more exclusive merchandise.

The issue of the culture of knitwear fashion being in danger if manufacture is carried out overseas is not only a matter of price point. The way that much knitwear is manufactured offshore relies on technicians processing garments with very limited communication with the designer who is usually thousands of miles away. The standard methods of developing products by following specification sheets lead to problems with translation of language and sketches (this is an area which is discussed in more depth in the methodology section of this dissertation p.39). This difficulty is generally resolved by the provision of a sample garment for the technician to replicate. These sample garments have often been bought elsewhere in the previous season; the new garment is essentially a direct copy of an existing item with some minor changes in detail. Thus, problems created by the division between designer and technician in the development of knitwear are often detrimental to innovation when manufacturing takes place overseas because it can shift the role of designer to that of merchandiser or selector. If design is about cultural invention, how can knitwear designers - in New Zealand for example - invent and re-interpret their culture in the context of fashion when our working methods are not compatible with inventiveness? What might be the language of New Zealand knitwear design?

Underpinning the rationale for this project is the recognition of the need to rethink how knitted fashion garments are developed and what kinds of products can be manufactured with the new knitting technology, “Knitwear can now be much more than just a two-dimensional apparel item constructed from flat panels and sleeves” (Shima in Mowbray, 2004, p.43). Design innovation is not concerned solely with aesthetic variety, but also supports economic viability in the knitwear industry.

Part 4. Methodology

Research Through Practice

While the subject of this research is the development and understanding of new approaches to shape in knit design, the methodological approach taken is practice based, conducted through action research and reflective practice. It has involved experimentation leading to the prototyping of patterns and garments and simultaneous reflection on both the aesthetic value of the prototype samples and the process of developing the work. This iterative approach is summarised by Swann (2002) as “a spiral of cycles of action and research consisting of four major moments: plan, act, observe, and reflect.”

Action research is not concerned with first undertaking research and then applying the results, instead research is conducted through engagement with situations or practices. Schon (1995), describes action research as involving two phases, researching in action and reflection on action. This enables the researcher to achieve new understandings whilst working which will then inform the next stage of the work. Actions informing actions as a project unfolds.

The use of action research in the design research context has been criticised for being merely a record of professional practice that does not contribute new knowledge (Usher et al. 1997). In the context of this study action research provides a basic framework from which to explore and examine alternative methods of designing knitwear. As a knitwear designer this approach draws and builds up on prior or tacit knowledge[12] of knit design that I have developed over twenty-five years of practice. However practice based research is not the same as professional practice in that the outcome of such research is not just the end product, but the knowledge achieved through the development of, and embodied in, the designed outcome. The analysis of the process and outcomes and the communication and transmission of the knowledge gained through the research process is an important aspect of research. This project is concerned with exploring only one key element of the knitwear designer's role, that of garment shape. To this end the "final" garments are prototypes and not fully resolved in terms of other aspects of design (i.e. trend / market research, colour, yarn selection and so on.) The distinctions between the process of knitwear design as professional practice and the process of knitwear design as research for this project are illustrated in the following diagrams, fig.11 and fig.12.

[12] Explicit or declarative knowledge can be contrasted with implicit, tacit or procedural knowledge (Polyani, 1967) . Explicit knowledge is conscious and communicable, it can be taught knowledge, while tacit knowledge is unarticulated or intuitive, and is often developed over time through professional experience. (Rust, 2004)

Fig.11

The process of knitwear design as professional practice (the designer's role)

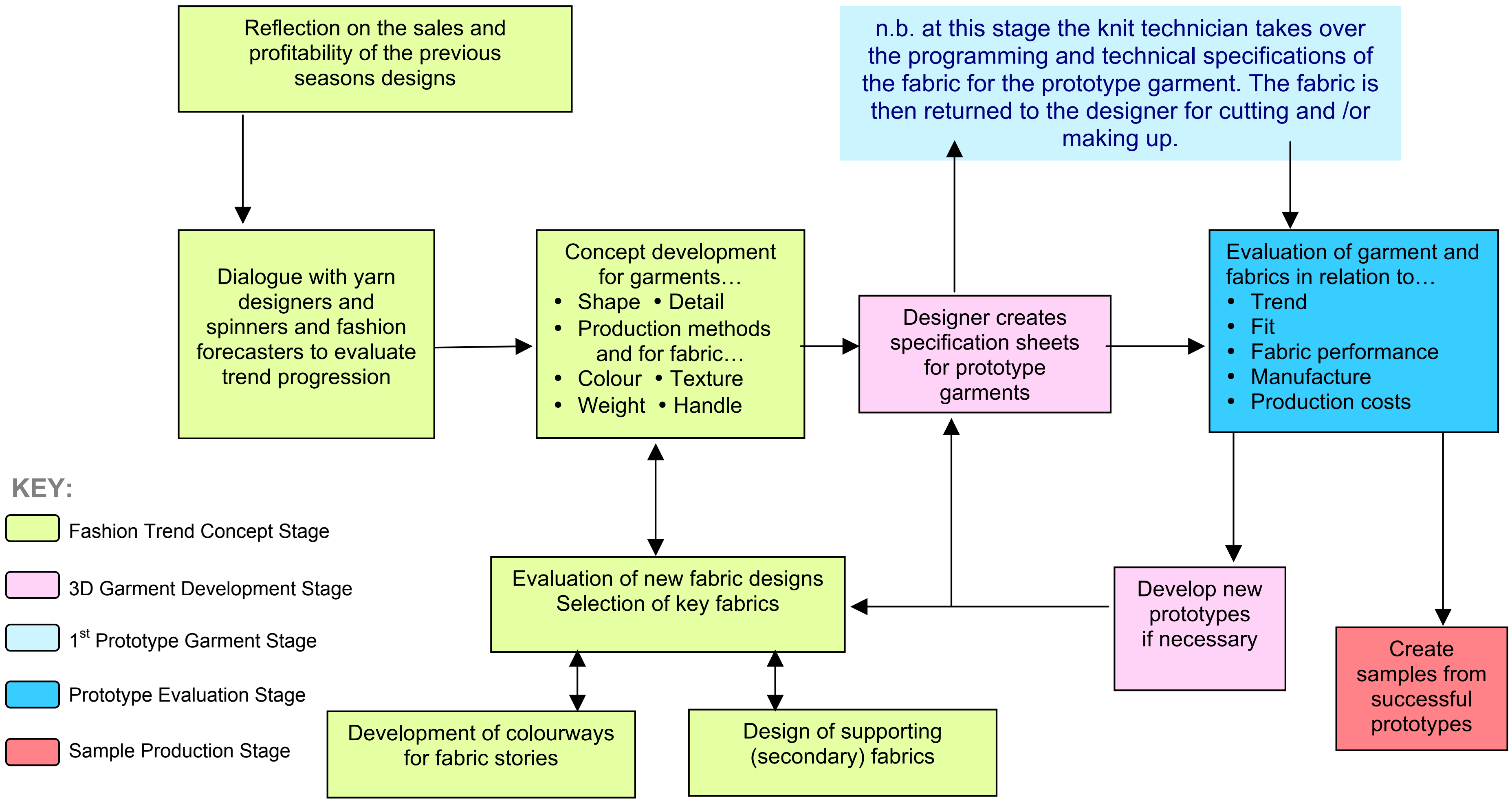
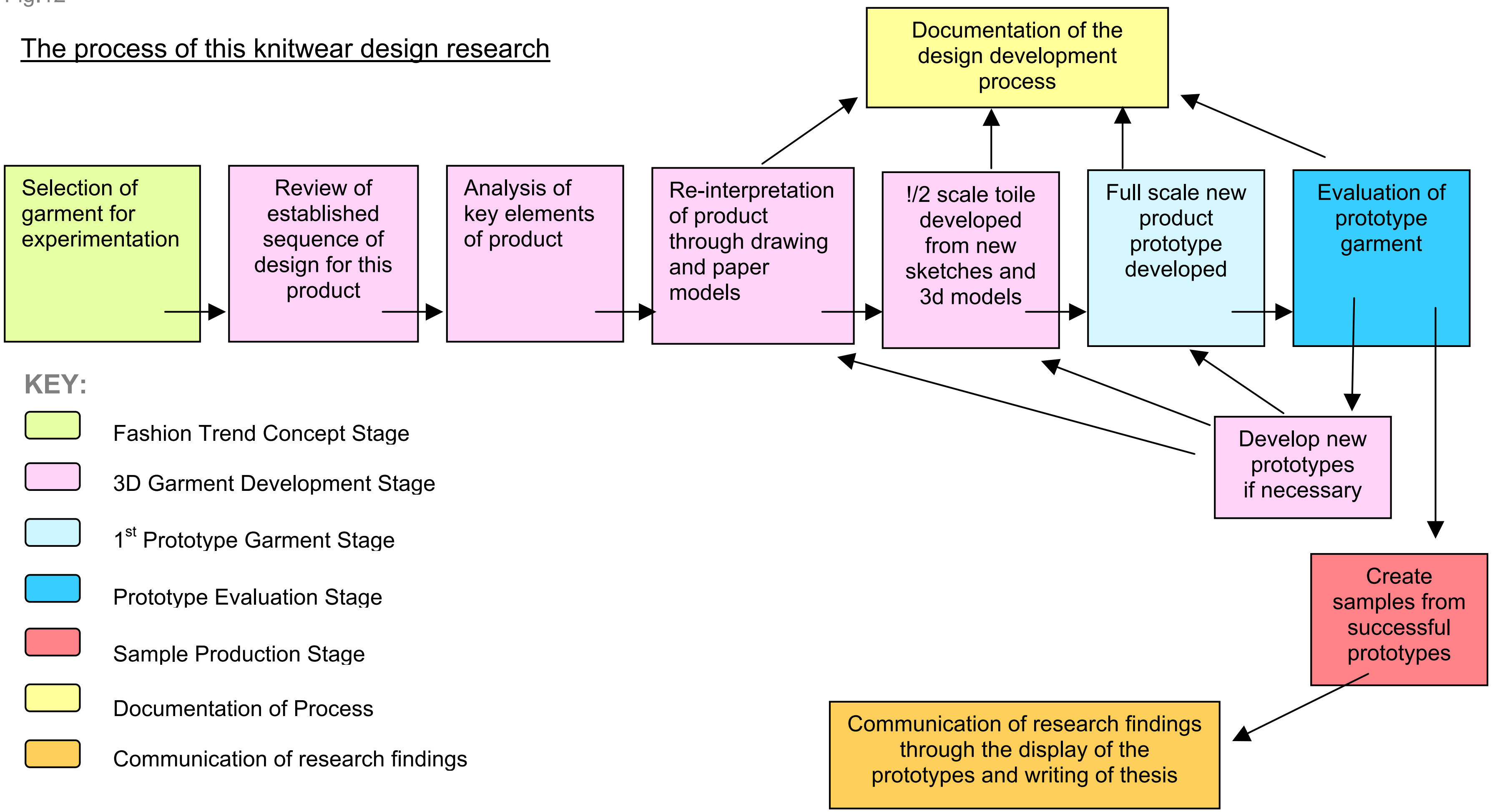


Fig.12

The process of this knitwear design research



The industrial knitwear designer is heavily occupied in the fashion concept stage of the process with much less input in the 3D garment development. This research project is engaged in the development of alternative methods of creating garment shape. The research plan emphasises experimentation into ways of developing garment shape through prototyping and analyzing and theorizing from the outcomes. The research focus is not primarily about seasonal trends or sales and profitability, instead a selection of classic knitwear garments have been re-worked using a different design process to the standard industry based model, and this process has been analysed and documented so that this processual knowledge is available to other knitwear designers and students.

The approach to experimentation is heuristic in that it attempts to find possible alternatives to developing garment shape in knitwear using a combination of tacit knowledge, intuition and trial and error. A break down of the research design and specific methods used in conducting this research are listed in the chart below (fig.13). This is followed by a more in depth discussion of the various stages of the project.

Research Design

Stage 1:	Stage 2:	Stage 3:
Literature review of techniques and working processes	Ideation/concept development	1/2 scale prototyping
Boundary establishment	Drawing	Reflection
¼ scale prototyping	Reflection	Documentation
Reflection	Model making	Analysis and synthesis of project findings
Garment toile making	Reflection	Communication of research findings through the writing of a thesis
Analysis of technique & documentation	Documentation	Garment sampling Communication of research findings through the display of prototype garments

Fig.13

Stage 1

1. Literature Review of Techniques and Methods

The fundamental essence of knitwear can be found in hand knitting. Hand knitting has never been about simply creating a stretchy version of woven clothes; the functionality and aesthetic qualities of hand-knits are intrinsically linked to the nature of a weft-constructed fabric. The ability to use tubular knitting and flecharge are important in the production of seam free garments and these processes have many close connections to the long-established methods used in hand knitting. Therefore a review of knitting techniques and methods of working in both hand and electronic machine knitting was undertaken for this study.

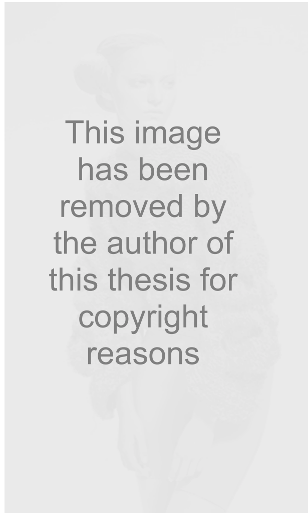


Fig.14 Sandra Backlund, 2011, Knitted sweater

I also examined the work of designers who are exploring alternative methods of knitwear production and shape development. Designers such as Sandra Backlund (fig.12) who uses a sculptural approach to creating silhouette and the Innovative warp knitting concept A-POC, a collaboration between Issey Miyake and Dai Fujiwara (fig.13) that attempts to maximise the use of a single piece of fabric with no waste, no seams and no finishing processes after knitting. Although this work is philosophically different in objective, the inventive approach of these designers provided inspiration for my research.

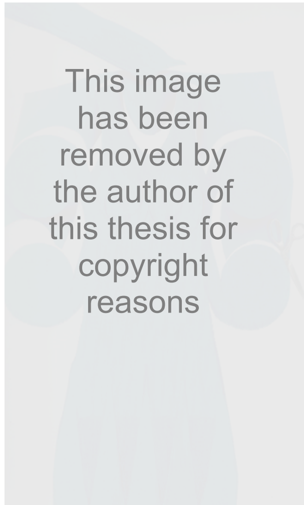


Fig.15 Issey Miyake, 2001, One piece, A-POC.

2. Establishing Boundaries for the Project

Knitwear design encompasses a wide diversity of technical and creative options through which a study such as this can be approached. In order to clarify the scope of this research, conceptual boundaries were defined in relation to the design of the project. This framing ensured that the work would be achievable within the allocated timeframe and budget and would also be appropriate to the research enquiry.

A key decision concerned which machinery to use. The choice of whether to work on the Shima Seki electronic machines or whether to develop fabrics and samples myself using hand flat machines was critical to the development of the project. I have worked in the knitwear industry as a designer since 1985, my professional experience has provided me with a comprehensive understanding of the capabilities and functions of many different types of knitting machines but I do not know how to write a full programme for a Shima Seiki Wholegarment™ machine. I am able to make amendments to existing programmes and to create basic garments using the Shima Seiki database but complex (or even unusual) programming is beyond my capabilities despite many years of experience as an industrial knitwear designer.

This gap in knowledge is typical for knitwear designers who tend to get very limited access to training in the programming of knitting machines, which is regarded as the tenure of mechanics. I therefore had to choose between working with a knitwear technician (as is standard industry practice), designing a project around creating better communication between designer and technician; or, I needed to develop a project based around utilising my skills as a designer and later evaluating that experience in the context of finding alternative methods of developing knitwear shape. To address the research enquiry more directly, I chose the latter option of developing the fabrics and samples myself using 8 gauge Dubied hand flats and 7gauge Brother and

Knitmaster (Silver Reed) domestic machines. The project has also been condensed to focus on the use of two knitting techniques, needle transfer and short row knitting or flechage to explore the possibilities of three-dimensional garment design. Short row knitting was pivotal in the development of seamless technology and as stated in part 2 p.23; older machines were limited in versatility because they did not have the capability to knit circular fabric using this technique. Because a domestic machine bridges the gap between hand knitting and electronic knitting, garments created using the flechage method can be made on them. Such garments would not be possible to knit electronically prior to seamless technology. Flechage and needle transfer were techniques that Kenneth MacQueen[13] experimented with in the 1960's but the technology at the time was too limited for successful industrial production. This research revisits these knitting methods now that it is feasible to use them in a much wider variety of ways on electronic machines. The domestic machines provided a useful tool that I could use, despite my lack of programming skills, to develop knitted shapes using techniques that could be transferred to the Shima Seiki Wholegarment™ machine.

The study is inspired by the potential of the technology that can produce seamless garments but the primary interest is not in the elimination of seams but rather in the exploration of alternative ways to create garment shape, therefore I will not restrict the experiments to producing entirely seam free pieces.

[13] MacQueen attempted to develop a revolutionary V-bed flat knitting machine in the early 1960's. His concept was to use a technique of knitting wedge shaped garment parts using partial knitting (flechage) and waste yarn to separate the individual panels and sections – this idea is also known as the Basque Beret knitting technique after the system of knitting for beret manufacture. However despite the fact that the machine was computer controlled, MacQueen's vision was far too ambitious for the time.

3. ¼ Scale Prototyping

The techniques of needle transfer and flechage were initially explored in a series of quarter scale prototypes of sleeves, armholes, neck holes and garments. Knitting small-scale pieces for the initial experiments enabled me to work quickly, creating a greater quantity of samples in a shorter time than it would take to make full size samples. The quarter scale pieces also helped with the economy of yarn at this early stage in the work. The disadvantage of making small samples was that the scale of the stitches within the panels was distorted. This process is documented more fully in Appendix 1.

4. Reflection

As I was completing the small prototypes I became aware of the role that scale was playing in the pieces. Smaller knitted panels give a distorted idea of the scale of the stitch within the fabric e.g. a 7 gauge knit fabric at ¼ scale (size 12), has a visual appearance that is closer to a 3 gauge fabric. This is more evident as the samples progress into prototype garments where the size of the transfer holes and markings are larger than would be achieved at full scale. The quality of the drape of the fabric is also different on small scale pieces due to the difference in fabric weight. A decision was made to trial some full scale pieces to test whether the aesthetic, though different, would still be acceptable.

5. Garment toile making

Full scale toiles and half toiles were made as test garments to ascertain the success or otherwise of a variety of procedures and components including yarn choice, technique, garment size, knitting specifications, stitch size, machine gauge, fabric handle etc. The details of this process are documented in Appendix 2.

6. Analysis of technique

The various processes, approaches and results were evaluated using four key criteria:

1. Is it employing shape engineering as a method of pattern development?
2. Does this technique add to the design / does it work aesthetically?
3. Is it possible to knit (theoretically) on an electronic knitting machine?
4. As a garment does it sit within a current fashion context?

The decision was then made to continue to the next stage of the work process.

7. Documentation

The work was photographed to provide a two-dimensional visual record of the process and resulting samples. Relevant information such as knitting instructions and salient points regarding evaluation of shapes, areas where seams may need to be incorporated, direction of needle transfer, orientation of wales (whether the knitting was vertical, diagonal or horizontal) and other observations were noted.

Stage 2

1. Ideation/concept development

The early experiments shown in Appendix 1 and 2 were an initial exploration into the use of flechage as a starting point for developing garments, as such there was no cohesive design concept for what those garments should be. The next stage of the project was to move away from random experimentation with the technique and to formulate a basis with which to evaluate whether engineering shape in this way could be an effective method of pattern development for all kinds of knitwear. While it would be relatively easy to create interesting idiosyncratic sculptural shapes using a shape engineering technique, I made an early decision that the initial design concept for my experiments would be that these garments would have some relationship to classic knitwear pieces. I used this approach for my work to ensure that focus remained on one of the underlying research questions: If a standard process, when applied to a conventional garment, creates a standard outcome; will a non-standard process, when applied to a conventional garment create a different outcome?

Using existing garments as a foundation from which new pieces can be developed is an approach that has been successfully used by many innovative designers. Hussein Chalayan's Echoform collection (A/W 2000), engaged with ideas of memory. It included a range of denim dresses that at first appear almost identical, however each garment has traces of a previous garment embedded in it, as if each one holds the memory of the one before. They also all make reference to other classic denim garments, denim jackets, jeans, overalls etc. (fig.16)

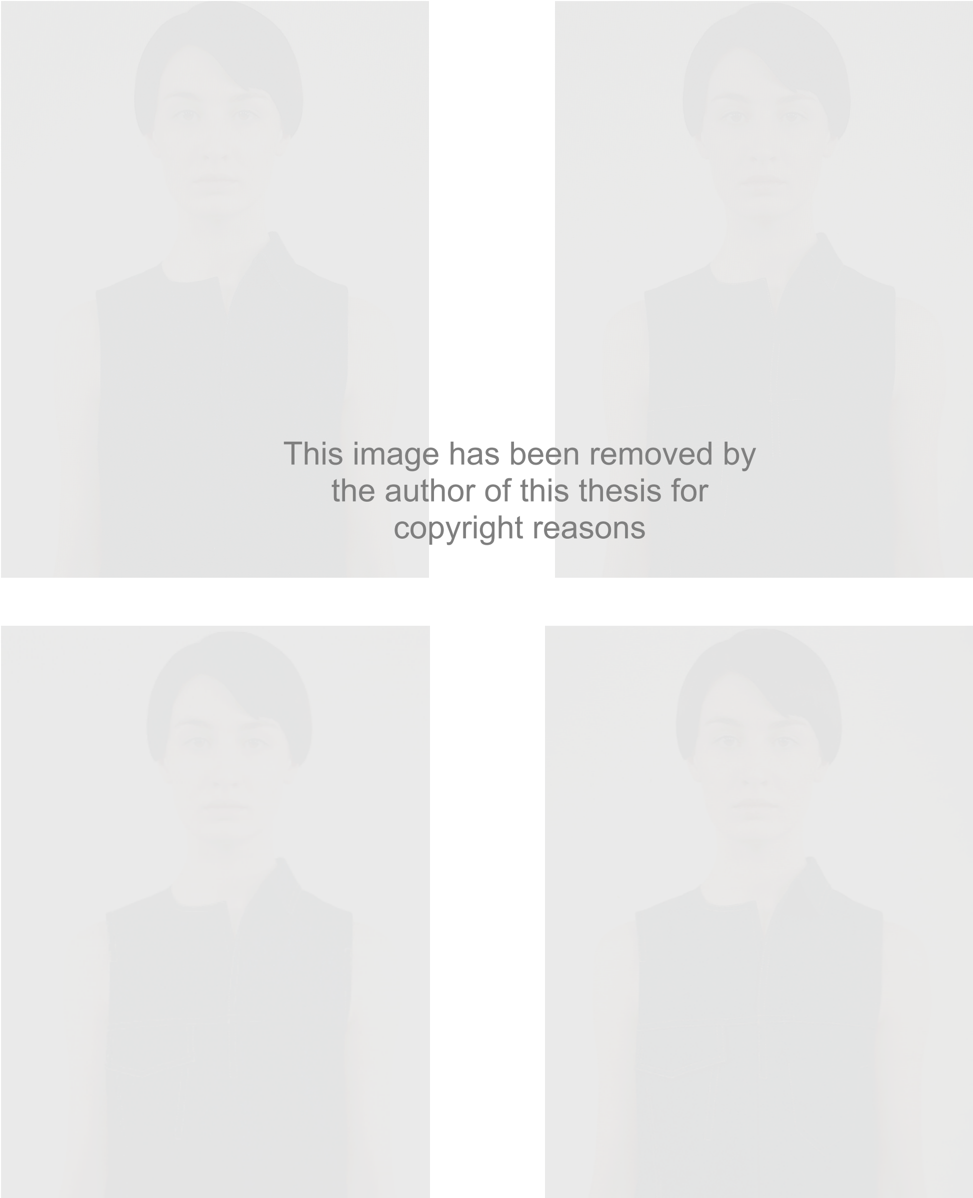


Fig.16 Hussein Chalayan,
Echoform dress, 2000

Belgian designer Martin Margiela also worked this way for his Spring 2001 collection in which the scale of existing garments was altered to achieve new proportions and silhouettes. (Fig.17)

Eckert and Stacey observe that designers have a type of visual vocabulary comprised of examples of existing designs and components of existing designs, which they use to create new ideas. “ Communication by reference to other designs and other sources of design elements is a powerful way to express complex ideas quickly, because the new design inherits both details and context from the object of inspiration.” (Eckert & Stacey, 2000, p. 537).

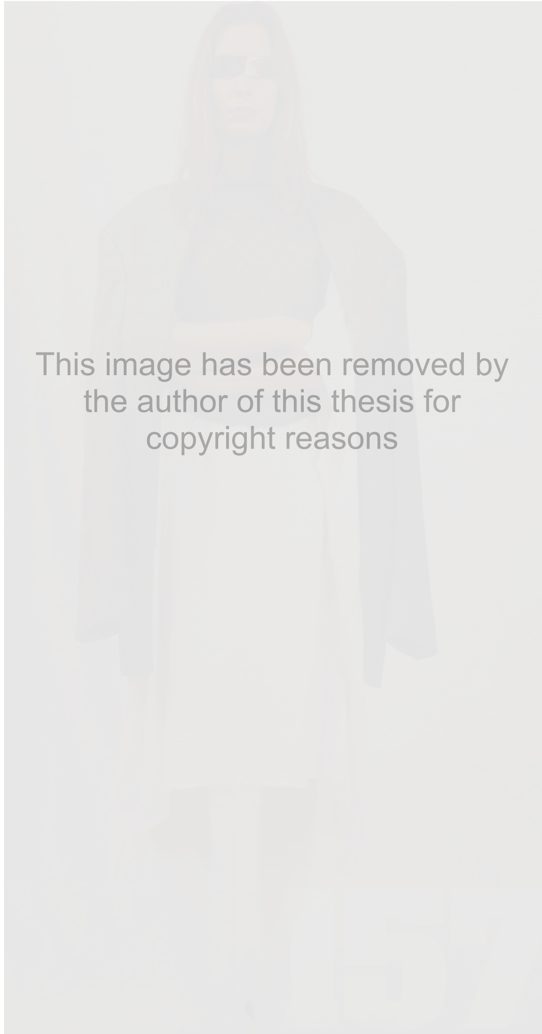


Fig.17 Martin Margiela, Prince of Wales check jacket enlarged 157%, S/S 2001,

The strong relationship between fashion trends and manufacturing capabilities is important. Fashion will direct manufacturing research and development and likewise production options will influence fashion trends. Access to the new knitwear technology and the concept behind the principle of seamless garment knitting is beginning to inspire many knitwear designers to re-think the traditional methods of garment shaping and pattern cutting for knitwear.

The re-emergence of traditional craft as inspiration for fashion product informed the decision to develop samples based on five definitive knitwear garments:

- A raglan sweater
- A saddle shoulder sweater
- A tank top
- A yoked cardigan
- A gansey (or Guernsey)

These styles were chosen because they are classic knitwear pieces and have an enduring presence in a fashion context. They have all been represented as seamless garments, as fully-fashioned items and as garments manufactured using the “cut and sew” process. They are conventional garments and they make reference to the tradition of the craft of hand knitting. They form a central part of knitwear vocabulary and have been reinterpreted many times in response to technical innovation. The familiarity of these garments makes them suitable to assess whether a non-standard development process will create new versions of them.

2. Drawing

During the concept development phase I began to make rough sketches of ideas for garments. In order to approach the project in a different way to my normal working practice, I was aware that these drawings should not take the form of standard working drawings (also called “flats”), these are technical drawings and are used to show the shape and the garment details. An example of a working drawing is shown in fig.18. It is important that working drawings are accurate as they are used as guides from which samples are produced.

Fig.18 Example of a working drawing

I took the basic forms of the garment and described them in sketches as a series of curves, circles and ovals. From this point I had a formative idea of how the fabrics could be shaped, where the weight should fall and which parts of the silhouette could be dominant. (figs.19 and 20).

Fig.19 Design sketches based on a tank top

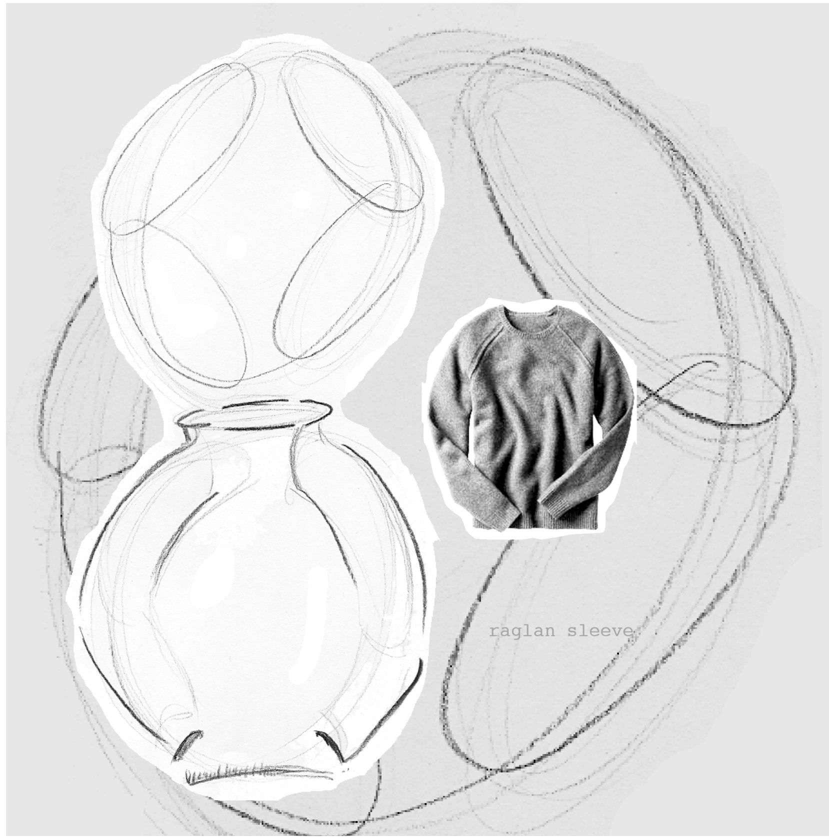


Fig.20 Design sketches based on a raglan sleeve garment

3. Reflection

An important observation was made at this point. In the standard industrial design process it is at this stage that the designer makes a specification sheet so that the technician can create a programme for the knitting machine. A specification sheet (an example is provided in appendix 3) will include all of the information, such as length, width, yarn type, fabric structure, sleeve lengths, welt and rib information etc. required to process the design. A specification sheet also includes a drawing of how the finished garment should look. My sketches gave me a sense of the shape of the fabric, but they would not provide enough information for a technician to work with. This was the first challenge; it immediately exposed one of the problems that a designer faces when she is working in a non-standard way. How can an idea that is still fairly abstract and only partially formed be communicated to a technician?

Stacey, Eckert and McFadzean (1999), also recognised that the design sketch is not always a useful tool for communication. In the early stage of design development when decisions about 3-dimensional shapes and specific spatial relationships between shapes are provisional, designers are not always able to produce accurate sketches of what they envisage. There is also a symbolic meaning of the elements of sketches. Designers tend to use recurring graphic symbols that are personal to them. “For example they would use the same curve to denote an arch, when they do not know the form of the arch.”(Stacey et al, 1999). These symbolic meanings are forms of personal notation and are not always understood by other people, including technicians who require more precise information for manufacture.

If the designer was to continue working with sketches this would not be a problem, but this early stage of drawing is being used as communication with the technician therefore it is important that the technician can recognise the designer’s drawing conventions in order to interpret an idea. It is also important that the technician can understand the designer’s context. Design elements change regularly in fashion knitwear and the technician's understanding of design sketches depends on awareness of these changes.

> Sketches drawn by knitwear designers, using design elements about to appear in coming fashion, are interpreted by knitwear technicians in terms of the elements of previously manufactured designs. Thus the garment designs and the technician's program end up far more conservative than the designers intend (Eckert & Stacey, 2000).

A decision was made to find another way of interpreting 3-dimensional ideas that would provide a better method of communication.

4. Model making

I began by looking for an existing garment design with which to experiment. The requirements for the design were that it had to be a shape that I understood would be possible to knit using a shape engineering technique; it needed to be a garment that would be difficult to describe as a specification drawing and it shouldn't be a complex form so that I could replicate it with relative ease. I consequently sourced a cape designed by Madeleine Vionnet in 1928 (Fig. 21)

Fig.21 Madeleine Vionnet, Anatomical Clutch Cape

The drawing gives a good idea of how the garment could be manufactured using traditional methods, so I had to ignore the image and imagine that the garment did not yet exist.

I began by using the flat pattern pieces as a reference to inform the shape that I was trying to achieve (fig.22). However, although I could clearly see how the pattern pieces worked together to create the shape, I found it difficult to work out a plan for knitting a 3-dimensional form by looking at a 2-dimensional shape. Despite my best efforts, my first experiments kept replicating the 2D pattern piece (figs.23 & 24)

This image has been removed by the author of this thesis for copyright reasons

Fig.22
Pattern pieces for cape by Vionnet

Figs. 23 & 24
Knitting swatches based on flat pattern

This would've been satisfactory if I was planning to use seams in the garment but my aim was to move away from flat pattern cutting. I needed to work from a 3-dimensional form, so I put the paper pattern together in the way that the fabric would be seamed, thereby creating a model which I could work from. (Figs 25, 26 & 27)

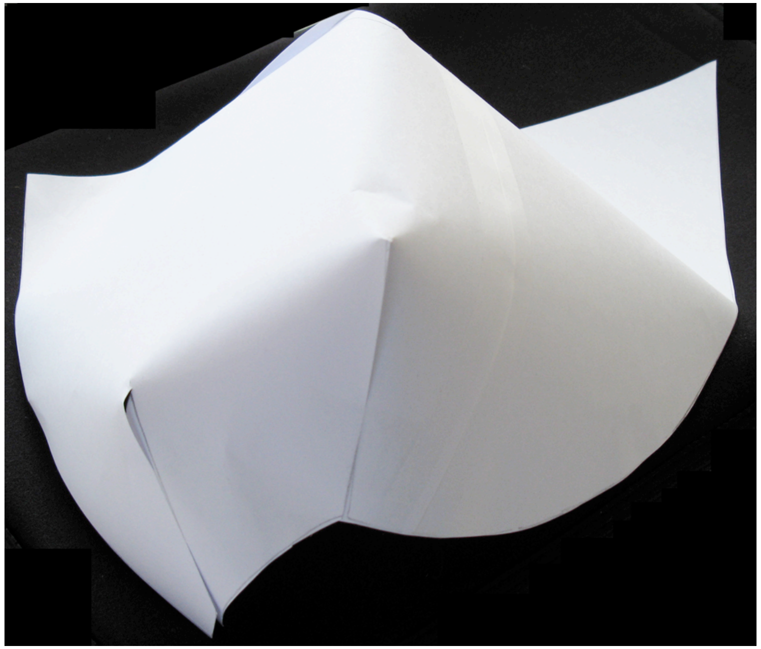


Fig. 25

Fig. 26

Fig. 27

5. Reflection

Working from a preparatory sketch, flat pattern or other 2-dimensional plan is not the best method of creating a 3-dimensional knitted product. (One in which the garment and the fabric are made in one process as opposed to making fabric and then sewing it up into 3D form).

Working with a model gave me a clear indication of how to create the test garment. The ability to visualise the 3-dimensional shape enabled me to also imagine how the fabric would be constructed and this helped me to write a pattern for the garment.

6. Documentation

The work was photographed to once again provide a two-dimensional visual record of the process that would contribute to the overall body of work communicating the research findings.

Stage 3

1. 1/2 scale prototyping

More small models based on the early sketches of responses to the classic knitwear garments were made. These were constructed out of paper and care was taken to approach making the models in a loose and informal way. This allowed for flexibility when creating the knitted prototypes, which were adapted and modified to suit the machinery, to ensure wearability and to satisfy aesthetic considerations. The models became sources of shape inspiration as opposed to templates from which the garment would be copied. Figs 28 to 32.

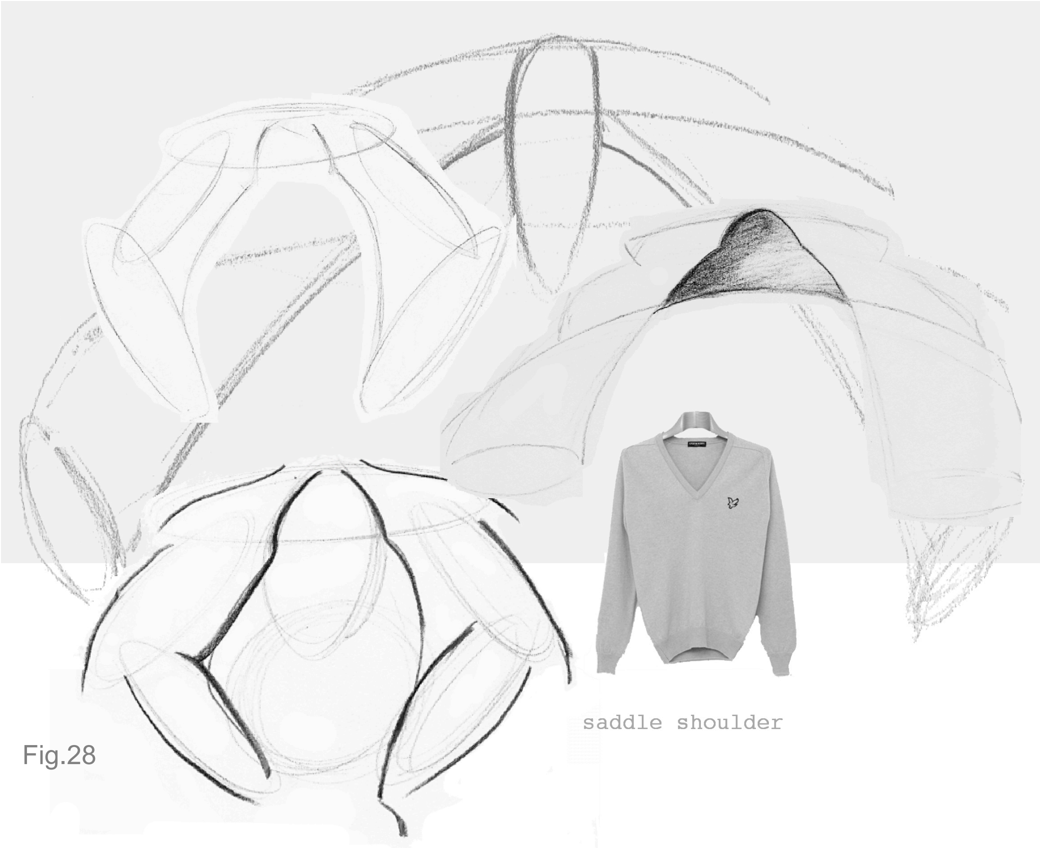


Fig.28

Figs.
29 & 30

Fig. 31

Fig. 32

At this stage I gave the sketch and the knitting instructions for one of the test garments to the knitting technician at the Textile and Design Laboratory at A.U.T. University. I asked for confirmation as to whether it was possible to knit the garment on the Wholegarment™ knitting machine. After some time the technician said that he had been unable to process the sample request so I then gave him the ½ scale prototype of the same garment, which he was quickly able to reproduce. Whilst a comprehensive study to determine the most satisfactory means of communication between designers and technicians when creating samples is beyond the scope of this study, this situation highlights the limitations of using 2-dimensional drawings to communicate 3-dimensional ideas.

2. Reflection and Documentation

Final reflections on the pieces taken through the prototyping stage and presented in the exhibition of practical work are presented in part five. Documentation of the exhibited work will be added to this section after the exhibition.

3. Communication of research findings through the writing of a thesis and the display of prototype garments.

The complete project was documented through notes, photographs, drawings, models and prototypes and I have attempted to condense these elements into a cohesive record suggesting an alternative method of designing and developing knitted garments. These prototypes could be used as samples from which a knit technician could create a programme.

Part 5. Project Outcomes and Conclusion

Some of the prototypes have been more successful than others. The pieces for which I actively tried to eliminate the side seams became more fluid and more 3-dimensional in shape, even though it was not an objective in this project to produce seamless garments, when I took a seamless approach and sought to eradicate or reposition the seams new forms emerged. Many of the ½ scale garments developed are successful as prototypes but they would need to be full scale to better ascertain fit and overall aesthetic appeal. I had assumed that once I'd made the ½ scale prototypes it would be easy to calculate the stitches for the full size garments, but to enlarge the samples was trickier than just doubling the rows and courses because of the 3-dimensional aspect of the shape. I assessed that the 3-D parts of the knitting (the flecharge areas) could be doubled in width and length but the plain fabric between the knitted panels and some of the areas of needle transfer needed to be scaled up in length 2.25 to 3 times the number of courses. A systematic analysis of stitch size ratios and the subsequent development of a system of calculation for this method of knitting is outside the parameters of this research, which is concerned with processes of shape innovation rather than the systematisation of these processes to scale. However it is recognised that this is a necessary aspect for future development. I therefore used my tacit knowledge of body shape and proportion and a process of trial and error to estimate the courses and wales in the knitting instructions for the full size samples.

The research questions that were embedded in this project were;

- Why is innovation in knitwear design important?
- What are the opportunities for invention and innovation within industrial fashion for the knitwear designer?
- If a standard process, when applied to a conventional garment, creates a standard outcome, will a non-standard process, when applied to a conventional garment create a different outcome?

This research has established that it is important for industrial knitwear designers to be innovative and to re-interpret their culture in the context of fashion (see part 3 pp 35-40) as this will not only create aesthetic variety, but will also support economic viability in the knitwear industry. Recent developments in knitting production technology have made it possible to create new types of garments and fabric structures. The Key areas that were explored in this project related to the evaluation of the education and working methods of knitwear designers to assess what aspects impede their ability to engage with this new knitwear technology.

As stated in part 3, the process of developing a knitted garment is separated into two areas, that of the designer and that of the technician. Commercial knitwear design is often reduced to a process of a seasonal selection of fabric structures, colours, yarns and basic shapes of garments. The knitting technician (sometimes called a “design” technician) is responsible for programming the knitting machines. There is often a lack of communication between these roles, a problem that is exacerbated by the current training and education in these areas.

In New Zealand, as elsewhere, design technicians are trained within knitwear manufacturing companies and through short courses offered by providers such as A.U.T. University in conjunction with organizations like A.T.I.T.O. (the Apparel and Textiles Industry Training Organisation). This training is largely operational and has limited creative or commercial elements in regards to the design of fashion product. In contrast the people who are trained in fashion product design tend to have limited technical training. In recent years the length of time spent studying for a degree in fashion has been significantly reduced. In New Zealand many undergraduate programmes have been cut back from four to three years with pre-degree certificate and diploma courses removed altogether, and the number of teaching weeks in a semester condensed from sixteen weeks to twelve weeks. Even those education providers who are very well equipped to offer more in depth training in knitwear, like AUT University, can only offer a student limited time to study in this as a specialist area. Elsewhere knitwear is often an elective subject or a short paper forming a very small part of a fashion design degree. The general view is that knitwear is a component of fashion design as opposed to a separate discipline. This approach perpetuates the “cut and sew” convention in knitwear design where knitwear is treated merely as a stretch fabric from which garments will be made in the same way as woven clothes are made. There are several reasons for the lack of training in machine programming for knitwear designers. Eckert & Stacey (1994) cite the economic factors; most manufacturers are unable to justify the expense of an extra CAD system for the use of the designer. Also many companies who employ graduates assume that their degree has incorporated all the necessary technical education and are unwilling (or financially unable) to sponsor further training. Many colleges and universities do not have the budgets to provide up to date knitwear CAD systems, nor the availability of trained staff. Addressing these sorts of institutional limitations is beyond the scope of this thesis, however these issues do form part of the context and motivation for the project. I have attempted to develop an approach to knitted shape design that would allow designers to work more intuitively and innovatively as a way of starting to bridge this divide between the technical and aesthetic domains of knitwear.

The lack of in-depth understanding of the technology and programming of these new knitting machines limits the ability of the knitwear designer to be experimental. Conversely, a lack of understanding of commercial design and awareness of fashion aesthetics limits the ability of the knitting technician to be experimental. The result is that there are two people employed to develop a product but neither is fully equipped to engage innovatively in the process, or to collaborate effectively to overcome the limitations of old production methods based on industrial divisions of labour from the 19th century.

It was determined that opportunities for invention and innovation within industrial knitwear fashion can be created when the segregation of the traditional roles of designer and technician and the resulting working methods and systems of sample development are challenged. Through analysing and experimenting with a different method of sample production it was also ascertained that even when working with conventional garments, a non-standard process could result in a variety of new outcomes.

A number of key issues were investigated and new insights developed through this research. These include the recognition that there is currently a lack of integration between the roles of knitwear designer and knit technician. This traditional segregation of job specifications within the knitwear industry has led to working processes in industrial knitwear design that is limiting design innovation. It is suggested that more synergy between the areas of design and sample production would be beneficial to the knitwear industry from a creative and commercial perspective. Design innovation is not concerned solely with aesthetic variety, but also supports economic viability in the knitwear industry. It is also acknowledged that the seamless approach to garment design offers an opportunity to re- think the evolution of garment forms and silhouette, whether the garment eventually has seams or not, by contrast the system of creating new products through the use of specification sheets with drawings can be an impediment to new or inventive garment development and is not necessarily a good method for communicating design ideas.

There are several paths that could be taken as an extension of this research into areas of design education, technical development and the knitwear industry. For example from an education perspective it would be exciting to experiment with the teaching of knitwear design based on a 3-dimensional approach to garment development using 3-D models instead of sketches and drawings to develop ideas. From a technical angle, the development of a system of calculation for resizing small-scale prototypes into full-scale garments would be useful and this would also be important for size grading of full-scale samples. A study to determine a more satisfactory means of communication between designers and technicians when creating samples could also be of practical use in the knitwear industry.

This research project set out to investigate the opportunities for invention and innovation within industrial fashion for the knitwear designer. Current working methods and processes of designing knitwear were examined and an alternative system was developed to create new ways for designers to communicate ideas for more experimental knitted garment shapes with technicians.

Appendix 1 – ¼ Scale Prototypes

First Experiments

Sample Size

- The initial experiments were done at a ¼ scale of a standard size 12 garment.

  Advantages – 1. Speed, knitting small size pieces enables a greater quantity of samples in a shorter time.
  2. Economy of yarn.

  Disadvantages – Stitch scale, smaller knitted panels give a distorted idea of the scale of the stitch within the fabric e.g. A 7 gauge knit fabric at ¼ scale size 12 has a visual appearance that is closer to a 3 gauge fabric. This is more evident as the samples progress into prototype garments where the size of the transfer holes and markings are larger than would be achieved at full scale, also the drape quality of the fabric is different on small scale pieces due to the difference in faric weight.

Machinery

- The initial experiments were created on a 7gauge Brother and Knitmaster (Silver Reed) domestic knitting machines, the reason for this was again speed, it was important to be able to quickly try out lots of ideas without having to make a computer program each time as would be required if using an electronic machine for prototypes. Using a domestic machine also helped to economise on yarn usage. Once the experimental stage was completed some of the sucessful pieces could be trialled using a Shima Seiki machine.

Yarn

- The yarn used for the first experiments was 100% wool, 2/18's NM (new metric count). This yarn was a good thickness for the type of fabric required to be knitted on the machines chosen, it also offered good stitch clarity which was important to analyse the shaping techniques and asses the next stage of the sampling.

Summary of early prototypes

- The weight of a garment hangs from the shoulders. The areas of the back neck and the top of the chest support the garment. The neck opening is where the wearer emerges from the garment, this is a logical place to begin working - growing the garment down from the neck and shoulders.
- 3 conventional crew necks were created to establish stitch size, fabric tension and accuracy of garment scale. They also helped to give some visual inspiration as to the next stage of experimentation.

Fig.1

Classic crew neck shape/vertical wales/shoulder shaping.

Fig. 2

Crew neck/vertical wales/shoulder shaping/dropped back

Note - excess stitches in the front spill over into a roll.

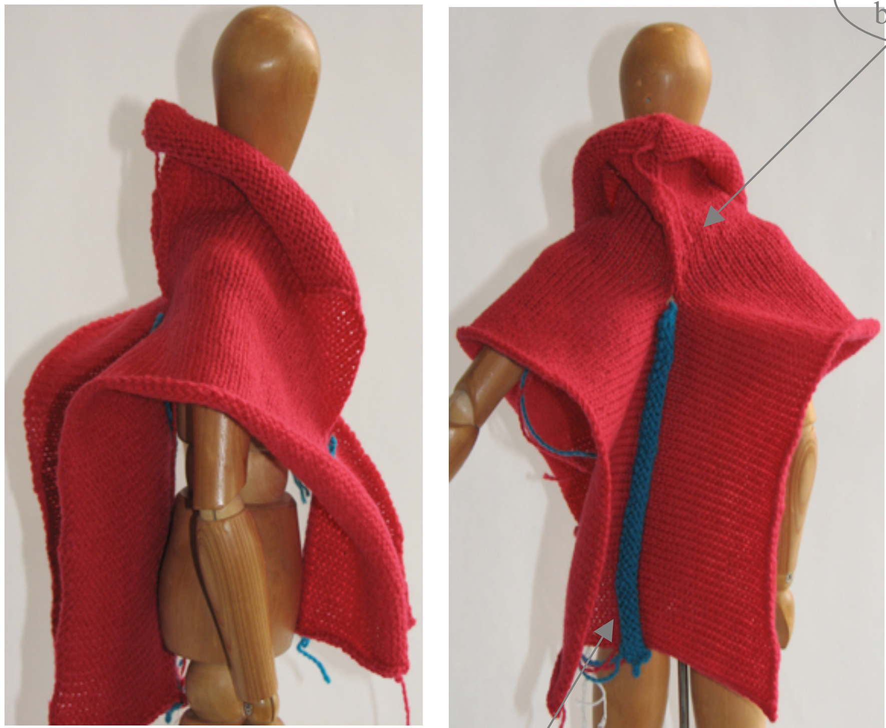
Fig. 3.

Crew shape/vertical wales/split back neck and shoulder shaping.

Note - very conventional, flat shapes, try knitting the fabric with the wales running horizontally.

Prototypes Experimenting with Neck Openings

Seam joining back neck



1.

Waste yarn still attached (blue)

Wales running horizontally

Waste yarn removed

2.

Note - Shoulder shape unsatisfactory - explore creating "angles" for shaping here.

Prototypes Experimenting with Shoulder Seams

a

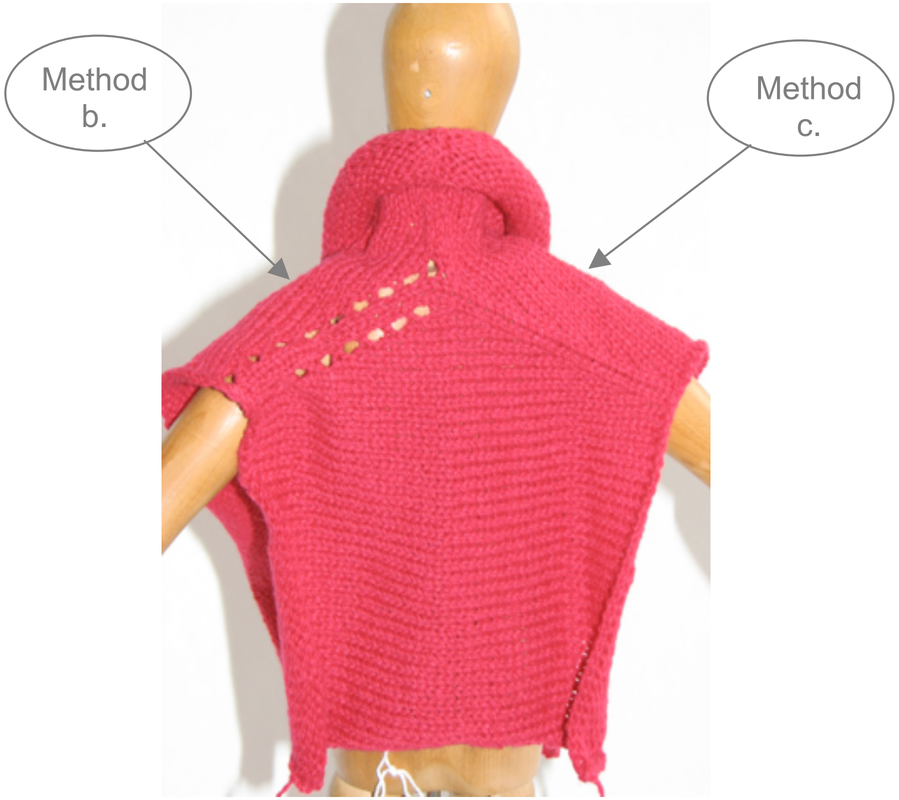
a. Reducing needles creates a shoulder raise.

b.

b. Increase needles right across the bed for
a left hand side shoulder drop.

c.

c. Decrease needles right across the bed for a RHS shoulder drop.



Shawl collar/horizontal wales and shoulder shaping

Note – is the back neck angle too steep now?

Prototypes exploring alternative “holes”/neck shapes

Fig. 4.

4. Wide crew neck/horizontal wales/shaped shoulders

Fig. 4a.

4a. Same sample has potential if the wales are vertical to be a v neck shape

Fig. 5

5. Slash neck/horizontal wales,
alternative fashioning marks/shoulder shaping

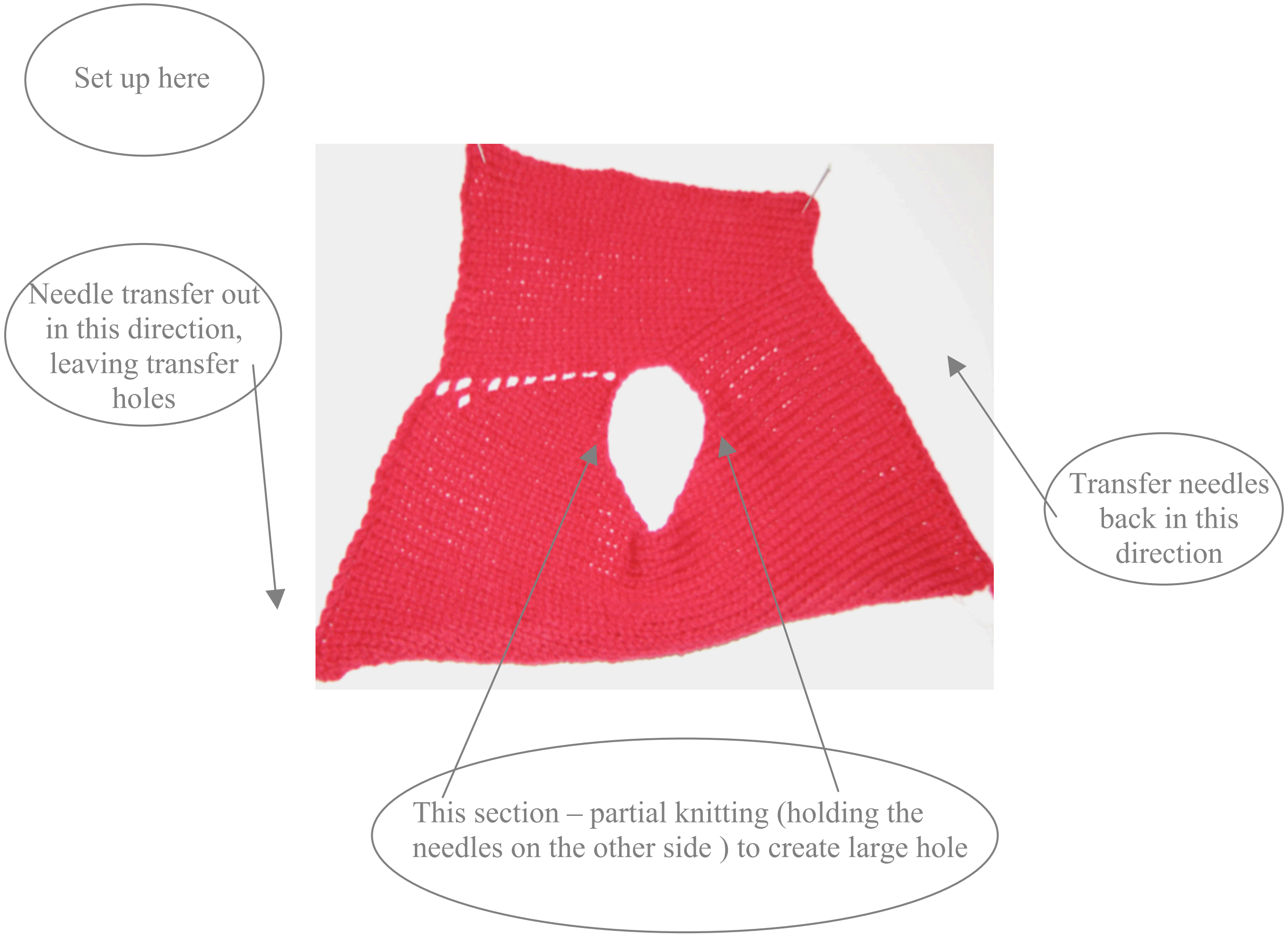
Fig. 5a.

5a. Same sample also has potential as a v-neck if the wales are vertical.

Develop - swatches are looking too balanced and flat, work on making a difference between the fabric on one side of the panel and the other, try to change the fabric disproportionately - add more stitches into one side etc. Also continue exploring holes that could be used for other purposes e.g. sleeves etc.

Altering the Proportions and Balance of the Fabric.

Fig. 6. Crew neck/shoulder shaping - extra fabric in the front - to create distortion – wales used horizontally.



Altering the Proportions and Balance of the Fabric.

centre back

7. Crew neck as before - more extreme distortion, could also work with wales running vertically as armhole.

7a. Wales running vertically as an “armhole”

7b. Panel mirrored from the centre back to form ¼ scale prototype jacket with no seams – Jkt A

Note - starting to give a more organic “rounded” shape, similar to those achieved in traditional hand knitting

- Try back neck shaping
- Slit shaped armhole
- Less distortion at centre front

Also Note - Back shape – unlikely to have evolved using a flat pattern cutting method

Prototype - Jkt A/modification 1

- B.N. shaping
- Slit shape A/hole
- Less distortion at C/F

Prototype - Jkt A/modification 2

- Armholes further forward

Next - try moving the Armholes forward

Note - What's the benefit of the shaping at the bottom?

Continuation of prototype of 1/4 scale jacket shape with no seams

Prototype - Jkt A/mod.3

Notes -
- Try shaping the Back neck by transferring needles on 1 course only
- Armhole to be deeper
- Shoulder shaping to begin sooner

Prototype - Jkt A/mod.4

Notes -
Alternative B.N. - I like both, this sits in closer though
Next -
Take shaping up through the shoulder blade (raglan line) to define the shoulder

Prototype – ½ toile 1/4 scale jacket shape with no seams

Prototype - Jkt A/mod.5

Notes -

- More pronounced sleeve achieved
- Extra shaping here causes shoulder blade area to collapse - could be good or bad
- Collar needs more work, it's too high and front neck requires some shaping.

Next -
Grow the sleeve

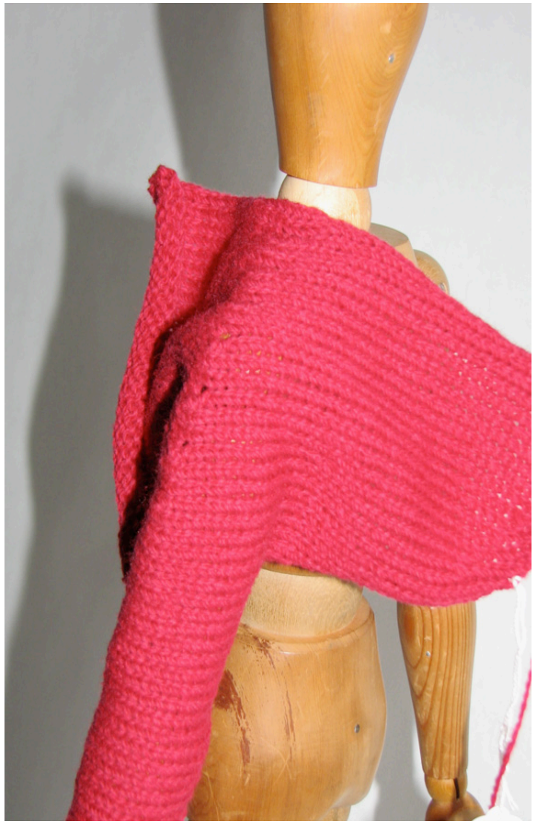
Prototype - 1/4 scale “jacket” shape with sleeves

a.

Notes - Horrible flat shape - sleeves too geometric - rethink this

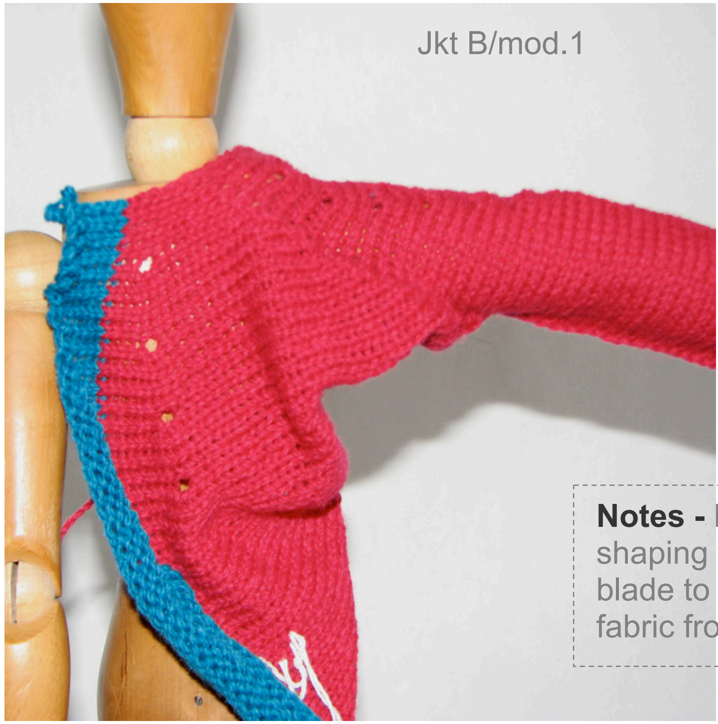
- Return to horizontal wale idea again
- Try sleeves as tubular knit

b



Notes – Still very flat and lifeless, also the width of needle bed required for a full scale piece would limit the design options if using this method.

Prototype - 1/4 scale “jacket” shape with sleeves



Notes - Move centre back shaping to the shoulder blade to remove excess fabric from the underarm.

Notes -
- Increase shoulder depth
- Decrease sleeve width at elbow
- Lengthen body
- Trial with both sleeves

Jkt B/mod. 2

Notes - Top of the shoulder too narrow

The Knitting instructions for these are quite complicated, so to make the process easier I am making 3 copies - the first a handwritten draft (fig.a) which is then typed and printed out twice, the first copy as a record of the previous sample (fig. b) and the second to make notes on for the next sample (fig. c). The reason that the first copy is very roughly hand written is because I basically make it up as I go along, I have a rough idea of measurements, but I decide what to do as I'm sitting at the machine and I write it down as I go along. I was concerned that this method wasn't scientific enough, but I have been pleased to find out that other people also do this when developing garments, not least Saville Row Tailors! For example…

Rock of Eye. - This is the system I specialise in. This is where the second system, the above Drafting Formula is calculated mentally in my head, however I just cut the pattern freehand, using only my tape measure and chalk to guide me. This method is used for the jacket only- to draught trousers without a square and stick would be folly. This method does sound slightly vague, because it is. However as Mr Halbury told me, on my first encounter in the Anderson & Sheppard cutting room, "Show me a right angle on a man and I'll let you use that square".

Thomas Mahon bespoke Saville Row Tailor. http://www.englishcut.com/archives/000030.html. retrieved September 2007

Set up 60 needles (30 either side of centre) JKT A MOD 4
closed edge cast on ten 10 2 courses to set up.
Ten 9.
*inc 1 needle ~~either~~ either side moving all of the needles over from needle 1.

K2c

Repeat from * for 20c. (10 Times.)

Hold 24 stitches on the RHS. & K 6 courses of waste yarn on the rest & remove from the bed

- with the Remaining 24 Stitches Knit 4c Plain
then inc 1 needle on RHS. towards centre of knitting every 2c x 5 (10c)
Knit 6c waste yarn & remove ~~stitches~~ Knitting from M/C

- Re-introduce 24 stitches to the LHS of M/C &
Knit 4c plain.
then inc 1 needle on RHS (towards the centre of knitting) every 2c x 5 (10c).
Knit 6c waste yarn & remove Knitting from M/C.

- Re-introduce central 32 stitches.
K. 4c Plain
then inc 1 needle on ~~either side on~~ opposite side to the carriage every course for 10c
1c to secure last stitch.

Re-introduce the earlier 2 sides of the Knitting (100 needles).

K2c

- Dec 1 needle either side of the centre of the whole.
~~K2 x 5 (10c)~~
At the same time dec 1 needle on the outside of the sideseam (needle 11 from the centre - mark this on the M/C). *but remember it moves in each time

Jkt B – 3rd modification.

½ toile

Set up 52 needles with waste yarn
Ten 9 – main yarn
K11

(partial knitting) Hold 4 needles at centre of knitting K1
Hold 4 needles at cuff edge of knitting K1

Hold another 4 needles at centre of knitting K1
Hold another 4 needles at cuff edge of knitting K1
Hold another 4 needles at centre of knitting K1
Hold another 4 needles at cuff edge of knitting K1
Hold another 4 needles at centre of knitting K1
Hold another 4 needles at cuff edge of knitting K1
(16 needles held in total)

Then reverse the process by putting 4 needles back into action k1, repeat each side until all of the needles are knitting again.

K10 c

Join 38 sleeve stitches together and cast them off.

Then add 2 extra needles on to the edge that still has stitches left to attach by moving stitches over by 3 needle transfer k1, and picking up 1 stitch from the waste yarn k1 until all of the stitches are on the needles.

Using partial knitting hold the stitches on the edge of the fabric and increase the knitting in the centre to balance out the length of the back (not sure of exact calculations here - I did it by eye.

Jkt B – 3rd modification. ½ toile

Set up 52 needles with waste yarn
Ten 9 – main yarn
K11

for mod 4.
(partial knitting) Hold 4 needles at centre of knitting K1 2
~~Hold 4 needles at cuff edge of knitting K1~~

10 needles in centre of each side. to go out & then in. 42 needles set up. out to 52 back to 42

Hold another 4 needles at centre of knitting K1 2
~~Hold another 4 needles at cuff edge of knitting K1~~
Hold another 4 needles at centre of knitting K1
Hold ~~another~~ 4 needles at cuff edge of knitting K1
Hold another 4 needles at centre of knitting K1
Hold another 4 needles at cuff edge of knitting K1
(16 needles held in total) on inside edge

Then reverse the process by putting 4 needles back into action k1, repeat each side until all of the needles are knitting again.
missed this out. K10 → for MOD 4. K5.
Join 38 sleeve stitches together and cast them off.

Then add 2 extra needles on to the edge that still has stitches left to attach by moving stitches over by 3 needle transfer k1, and picking up 1 stitch from the waste yarn k1 until all of the stitches are on the needles.

Using partial knitting hold the stitches on the edge of the fabric and increase the knitting in the centre to balance out the length of the back (not sure of exact calculations here - I did it by eye.

For MOD 4 this is different.

for Mod 4.
with remaining ~~stitches~~ Needles left on bed.
Dec 1 N on RHS. + move 3 needles in to leave a transfer hole on LHS. + Add one stitch from knitting held on waste yarn.
xxxoxxx
K2.
Repeat until ½ of the stitches from the knitting held on the waste yarn are attached.

in too far perhaps stop at 5 needles before centre

Then ~~hold~~ castoff ½ the needles on the RHS & K. 4c on LHS. ~~In~~ Decreasing 1 needle on RHS each time so that there is not a large ~~hole~~ gap.

Prototype - 1/4 scale "jacket" shape with sleeves

Jkt B/mod. 3

Notes -
• Not working - too "smock" - like
• Too symmetrical
• Return to the idea of asymmetrically knitted left and right sides
• Interesting that when adding the sleeves, the body shape becomes conventional again – try starting with the sleeve and build the body on.

Prototype - a different knitting method for a sleeve to increase the possibility of a less conventional body shape

Sleeve using a construction idea based on a tubular welt. Fabric is twisted as it is knitted, to create a pouch for the body area - n.b. waste yarn is turquoise colour

Prototype - Trial a 1/4 scale “jacket” shape using tubular welt based sleeve from last prototype

Note - fashioning marks and holes such as the hole in the centre back can remain the same size when the garment is full scale. - The hole is left by one or two needles out of action in the knitting process which at this scale looks quite large, one or two needles missing in a full size garment will only create a very small hole.

Jkt B/mod.4

Prototype - Jacket 4B/mod. 4 - no seams

Note - this little jacket works, in that it has the qualities of old garments that are “body shaped”, or hold the memory of the body that wore them. There’s a sense of something inside it even though it is empty, the sleeves bend in the way that an arm naturally bends.

Appendix 2 – Garment Toiles

Second Experiments

Sample Size

- These experiments were done as a ½ toile of a standard size 12 garment.

  Advantages – 1. Speed, knitting ½ toiles enables a greater quantity of samples in a shorter time.
  2. Economy of yarn.

  Disadvantages – There are still areas of the garment that cannot be evaluated, such as how the centre back area will work. This is particularly evident when making toiles with a degree of assymetry.

Machinery

- These experiments were created on a 7gauge Brother and Knitmaster (Silver Reed) domestic knitting machines, the reason for this was again speed, it was important to be able to quickly try out lots of ideas without having to make a computer program each time as would be required if using an electronic machine for prototypes. Using a domestic machine also helped to economise on yarn usage. Once the experimental stage was completed some of the sucessful pieces could be trialled using a Shima Seiki machine.

Yarn

- The yarn used for the first experiments was 100% wool, 2/18's NM (new metric count). This yarn was a good thickness for the type of fabric required to be knitted on the machines chosen, it also offered good stitch clarity which was important to analyse the shaping techniques and asses the next stage of the sampling.

Prototype – Jacket B Version 1 Aim – to achieve curved sleeve shape(an arm shaped sleeve) in a full garment.

1/2 toile size 12

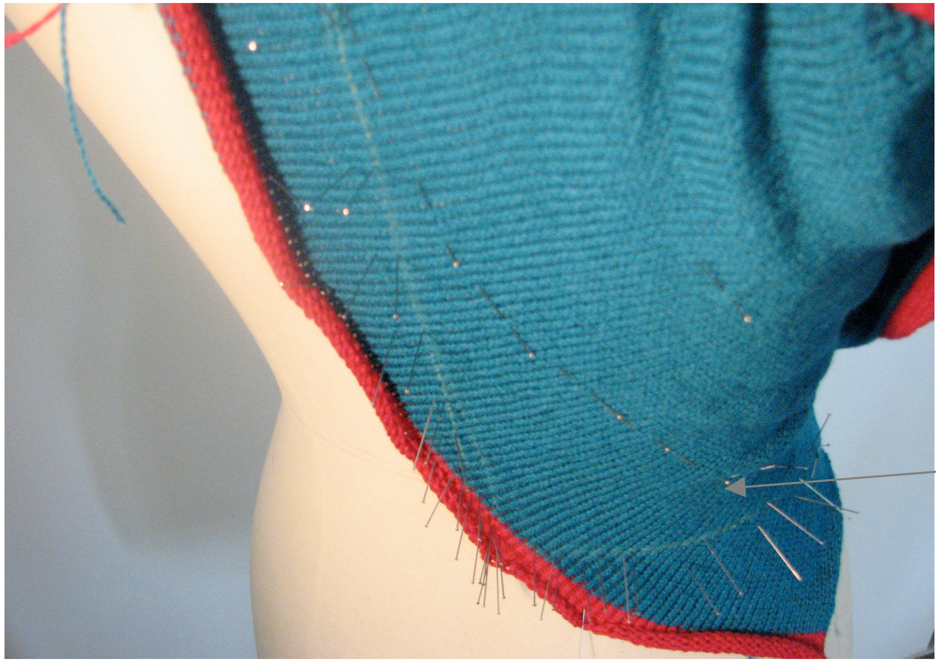
waste yarn still attached (pink)

Jkt B Version 1

Note -

- Armhole not quite deep enough, drop underarm slightly.
  Knit an extra 40c at a/hole point and join less stitches to form sleeve approx.100
- Back neck much too shallow, but this can be resolved to any shape.
  Try making it 170 needle cast on to see if this is enough to improve it.
- The back underarm section looks a bit clumsy - too much fabric gathering in, the shape is too curved, the b/n is too low.
  As the underarm is going to be modified I will make a new pattern for this section.

Prototype - Jacket B Version 2 – ½ toile size 12



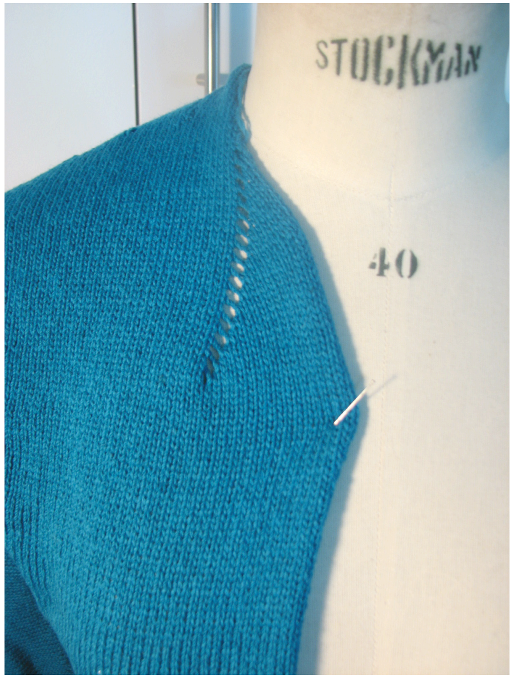
Jkt B Version 2

Note -

- Armhole is a much better shape.
- Back neck is improved but could still be lifted higher.
- Still too much gathering on to the waste yarn.
 Try 2c,1c,2c,1c etc instead of 2c each time - n.b. this will also reduce the width of the back panel though, so more shape needs to be added into the back to compensate for this.**
- Side goes to a strange "point" shape.
- Sleeve, elbow shaping a bit too high up - drop this down a bit, approx 5 ins
- Cuff too wide
- Try twisting the underarm so that the elbow shaping sits more fully to the back.

Photo showing wax markings and pins to calculate flecharge for version 3

Prototype - **Jacket B Version 3 – ½ toile size 12**



Jkt B Version 3

Note -

- Underarm twisted but not nearly enough, needs to come right around to the middle of the wrist.
- Back neck - disaster - miscalculated and now extra fabric has come out at the front of the garment.
- Still not happy with the gathering at the back under the shoulder blade (although it is slightly better)
- Try knitting this part vertically i.e. re-attach all of the stitches at the same time in one course.
- Elbow shaping perfect height
- Cuff still too wide

Prototype - Jacket B Version 4 – ½ toile size 12

Jkt B Version 4

Note -

- Sleeve sits well now that the elbow is moved around to the back.
- Back neck can still be adjusted a bit but this method is definitely working.
- Back panel has lost all of the excess gathering now that it is knitted vertically, however it's quite flat and more conventional now.

Prototype - Second garment shape, using the back panel as a starting point.

"Grey Jacket" version 1 / long

Note -

- Shaping the shoulders from the centre back out is similar to bias cutting on a woven garment - gives a smooth shoulder and a nice high back neck
- Shapes are quite interesting but seem naive/ undisciplined, is it the length? Proportion control needed!
- I think that I should make this garment shorter so that the distortion is less dramatic. The distortion would occur higher up the back across the shoulders if the piece were shorter.

Test panel of facing to determine facing depth and if needle transfer shaping is working

Prototype - Shorter Version of Grey Jacket

a.

b.

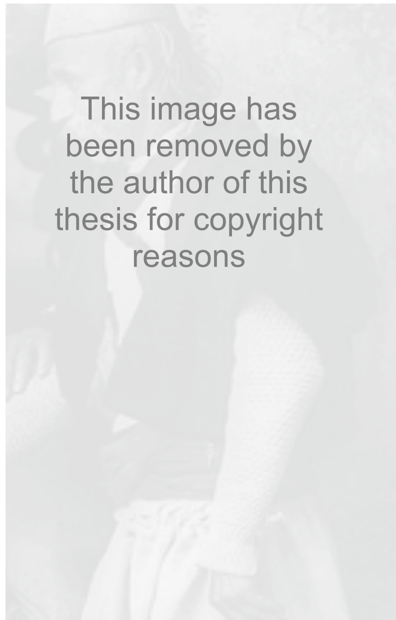
"GreyJacket" version 2 / short

Note -

- This jacket has "the memory of a hood"
- What to do with the armholes? Maybe they will have sleeves.
- Armhole in fig.c has more fabric in the back, armhole in fig.d. has more fabric in the side at the underarm - neither of these is looking right yet.
- Maybe the sleeve and armhole should be combined as in the handknit garment in fig. e?

c.

d.



e.

Appendix 3 – Example of a Specification Sheet

SPECIFICATION SHEET

SEASON:	STYLE NUMBER/NAME:
DATE:	
DESCRIPTION:	

GENERAL INFORMATION:	DIAGRAM: (ATTACH SWATCH TO REVERSE OF SHEET)
Machine & gauge:	
Knit structure body:	
Knit structure sleeves:	
Welt:	
Yarn 1:	
Composition:	
Colour code:	
Yarn 2:	
Composition:	
Colour code:	
Yarn 3:	
Composition:	
Colour code:	

SPECIFICATIONS	
O/LOCK	
LINK	
CUPSEAM	
COVERSEAM	
THREAD COLOUR:	
THREAD COUNT:	
STITCH LENGTH:	
BUTTONHOLES:	
WET FINISHING:	
PRESSING/FINISHING:	

COMMENTS:

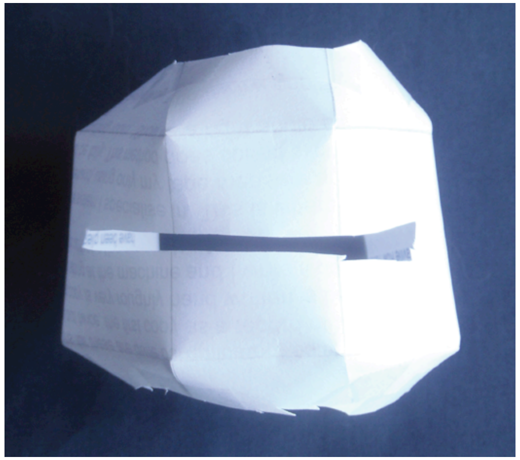
TRIMS	CLR	SIZE	QTY	PLACEMENT		
					BRAND LABEL:	
					SIZE & CARE LABEL:	
					SWING TAG:	
					PACKAGING:	

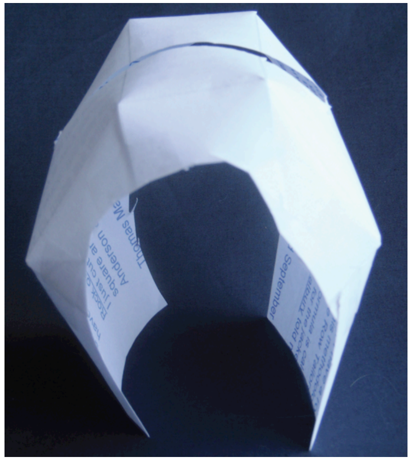
Appendix 4 – The Sample Development Process

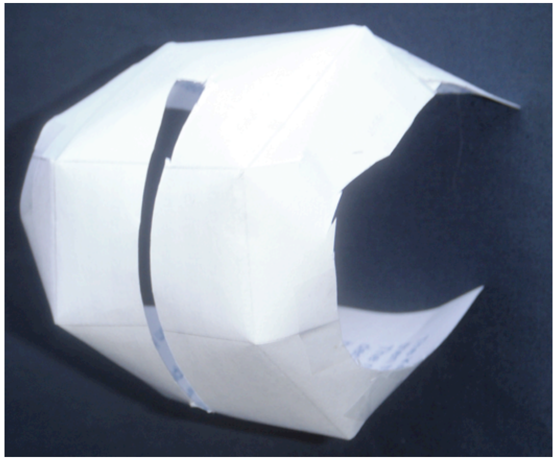
a. The Gansey

Guernsey or Gansey – a traditional fisherman's sweater made of wool with a straight neck that can be worn reversed (useful for dressing quickly in a storm or darkness at sea).

A paper model is made in response to the elements of a classic Gansey. This model was then used to inform the shape of the knitted panels

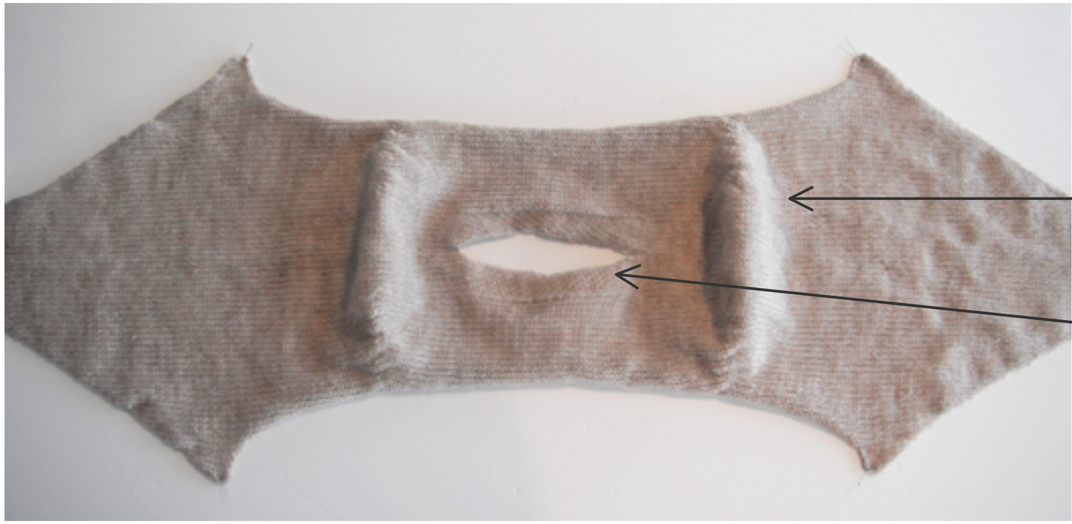






The fabric was set up here and knitted vertically

Fabric panel showing shaping



shoulder

neck

n.b. Needle transfer has been used along the neck area to strengthen and give extra support at the neck opening

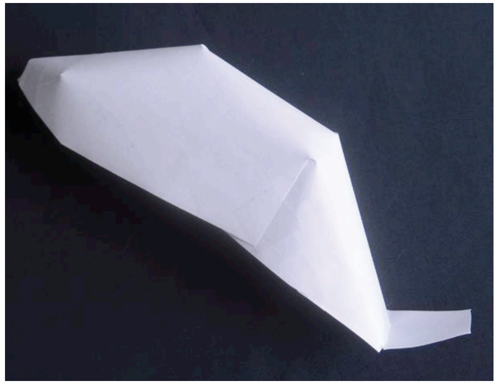
The width of the panel was extended to produce a ½ scale garment

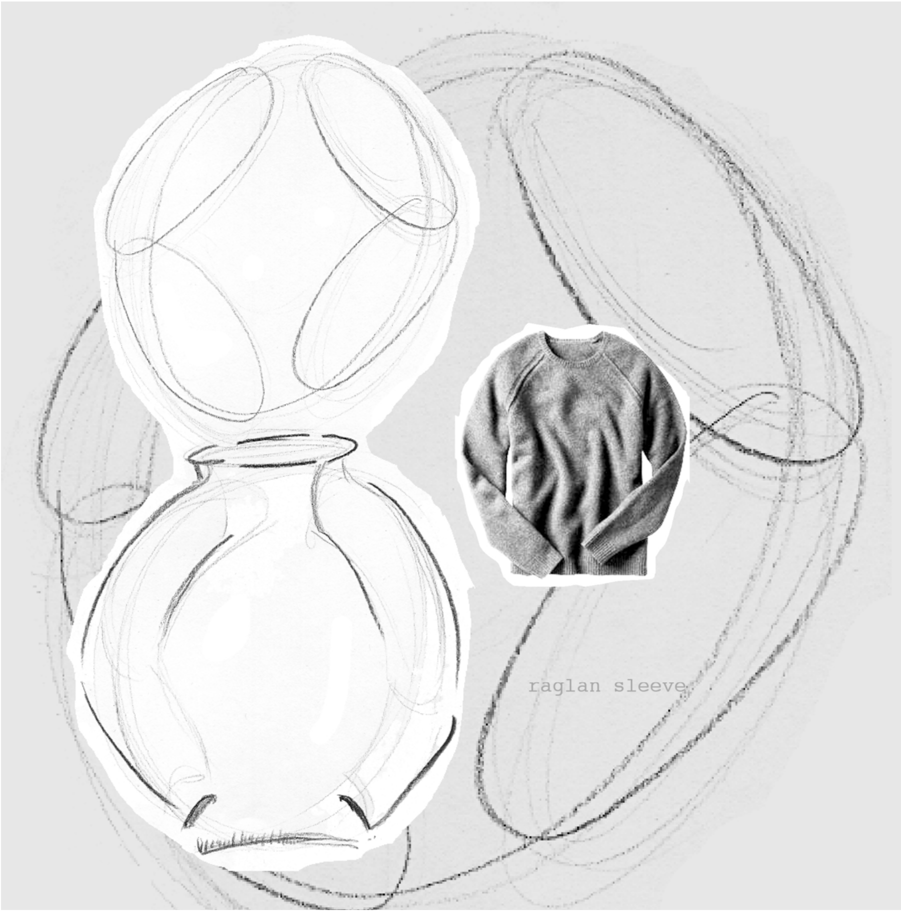
Photographs of prototype garment showing details of the neck area

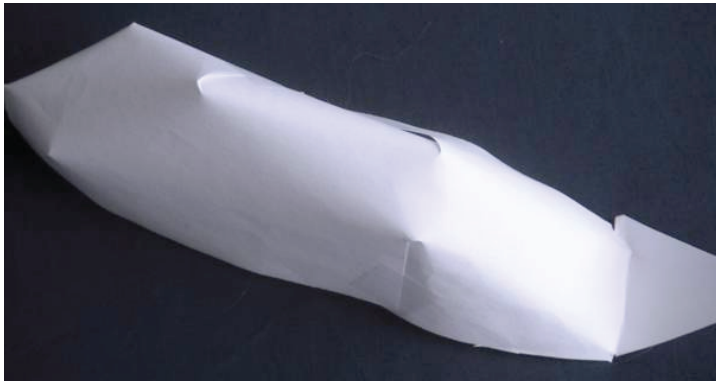
Gansey - Sample Garment

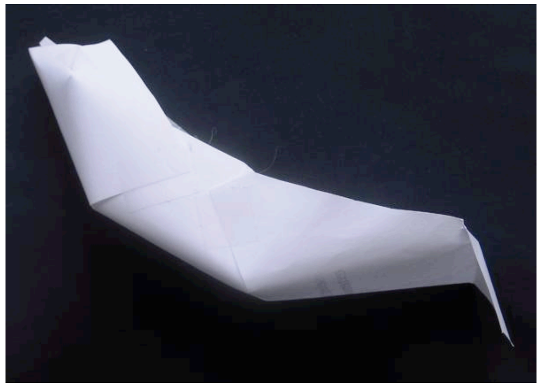
b. The Raglan

Loose sketches and paper models are made in response to the elements of a classic Raglan.
The models were then used to inform the shape of the knitted panels









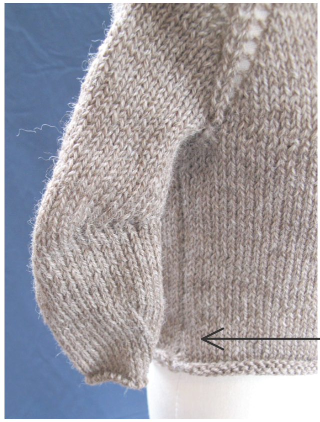
Raglan sleeve sweater - a sweater with a sleeve that extends in one piece from the cuff to the neckline, with straight seams extending out from the neck to a point under the arm.





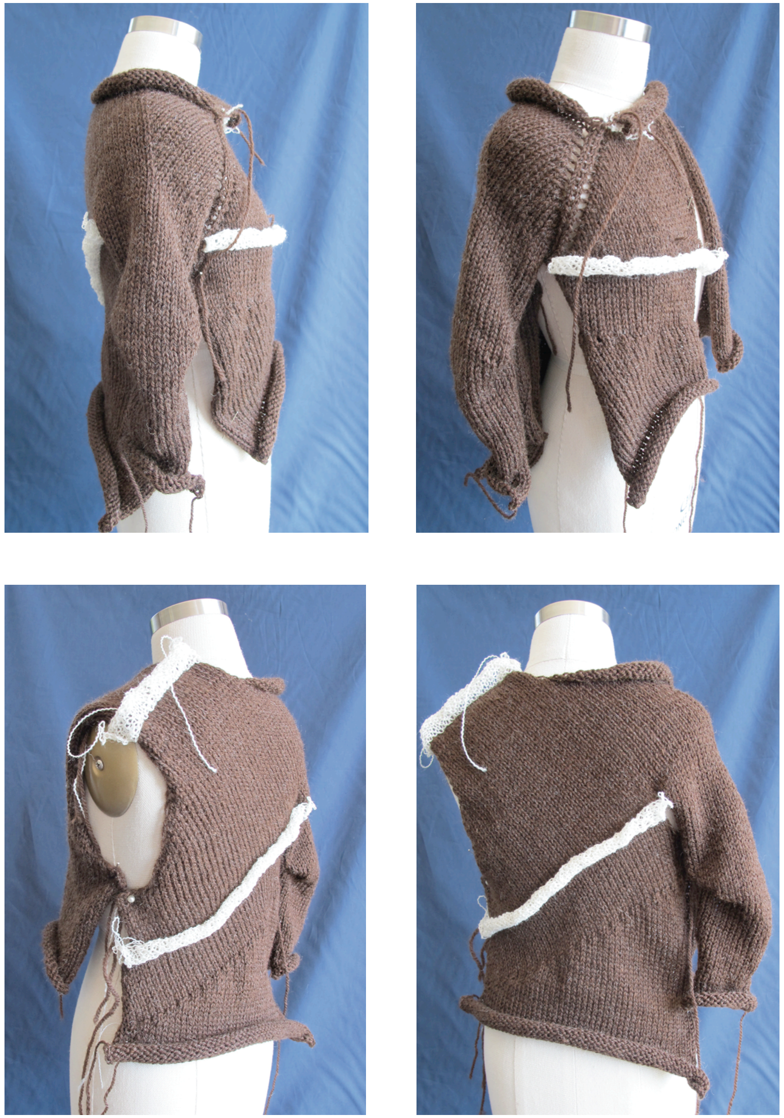






½ scale prototypes exploring different versions of the raglan sweater

Detail of sleeve shaping



Final prototype for raglan sweater (n.b. waste yarn is in white)

Fabric for raglan showing shaping

Raglan - Sample Garment

c. The Saddle Shoulder Sweater

Saddle shoulder – a style of sleeve whereby the shoulder portion forms a straight band cut in the same piece as the rest of the sleeve. The saddle shoulder is a variation of the raglan sleeve, however the front and back are seamed parallel to the shoulder instead of at an angle as in a raglan.

Loose sketches and paper models are made in response to the elements of a classic saddle shoulder sweater.
The models were then used to inform the shape of the knitted panels



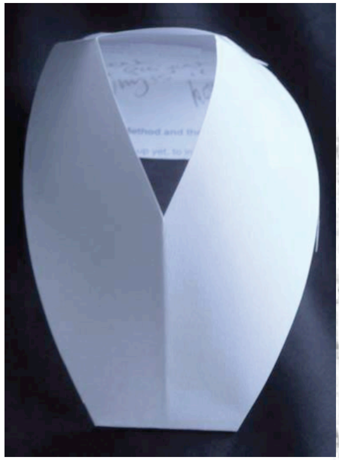

Prototypes of saddle shoulder garment


Alternative versions
of back neck shaping

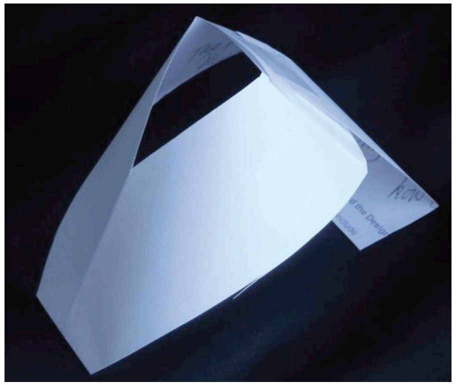
Saddle shoulder - Sample Garment

d. The Tank Top

Tank top - a tight-fitting sleeveless knitted garment with wide shoulder straps and no front opening; often worn over a shirt or blouse.



Loose sketches and paper models are made in response to the elements of a classic tank top. The models were then used to inform the shape of the knitted panels.



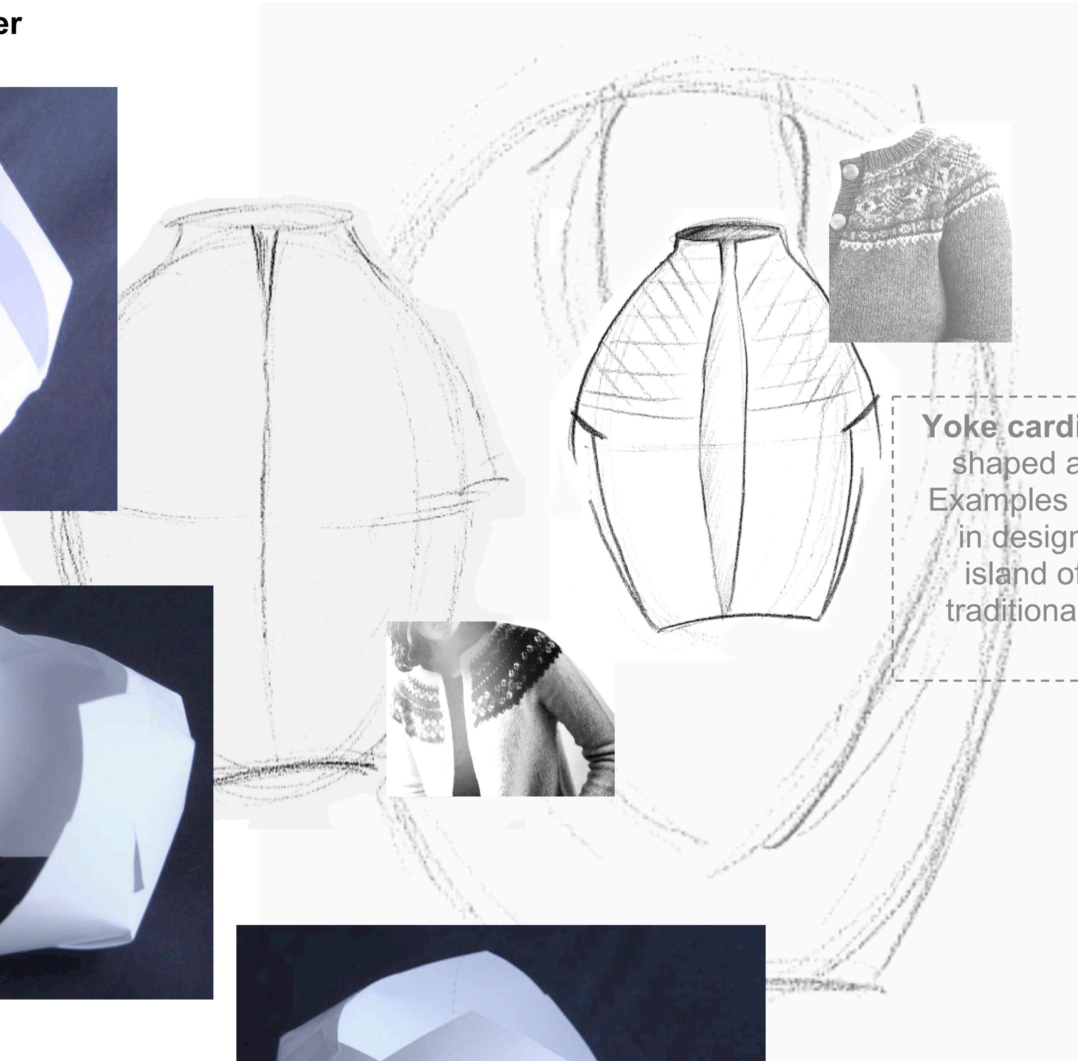
The 3D models suggest a re-evaluation of the neck and shoulder area and of the position of the side seams.

Fabric panel for tank top showing detail of neck and shoulder shaping

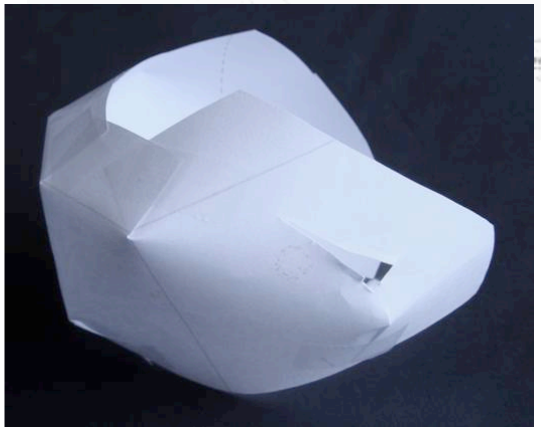
½ scale prototype of tank top

Tank top - Sample Garment

e. The Yoke Sweater



Yoke cardigan - a cardigan that is fitted or shaped at the neck and shoulder area. Examples of yoke cardigans can be found in designs originating on the Shetland island of Fair Isle, Fair Isle yokes are traditionally hand knitted into seamless, hand-framed bodies.



Loose sketches and paper models are made in response to the elements of a classic yoke sweater.
The models were then used to inform the shape of the knitted panels.

Shoulder shaping

Neck shaping

Armhole

1st version of yoke garment
- 1/2 toile, 1/2 scale

2nd version of yoke garment - cap sleeve

Welt flipping up due to small scale of sample

Detail of shoulder showing shaping

3rd version of yoke

Needs more shaping at the bottom

Centre back is bulky





4th version of yoke garment - 1/2 scale prototype

Yoke Cardigan - Sample Garment

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