



# University of HUDDERSFIELD

## University of Huddersfield Repository

Power, Jess and Oteino, R.

Investigating the Relationship Between Anthropometrical Data and Fully Shaped Knitted Garments in UK Manufacturing

### Original Citation

Power, Jess and Oteino, R. (2008) Investigating the Relationship Between Anthropometrical Data and Fully Shaped Knitted Garments in UK Manufacturing. In: Proceedings of the 86th Textile Institute World Conference. The Textile Institute, Hong Kong, China. ISBN 1870372700

This version is available at <http://eprints.hud.ac.uk/id/eprint/13837/>

The University Repository is a digital collection of the research output of the University, available on Open Access. Copyright and Moral Rights for the items on this site are retained by the individual author and/or other copyright owners. Users may access full items free of charge; copies of full text items generally can be reproduced, displayed or performed and given to third parties in any format or medium for personal research or study, educational or not-for-profit purposes without prior permission or charge, provided:

- The authors, title and full bibliographic details is credited in any copy;
- A hyperlink and/or URL is included for the original metadata page; and
- The content is not changed in any way.

For more information, including our policy and submission procedure, please contact the Repository Team at: [E.mailbox@hud.ac.uk](mailto:E.mailbox@hud.ac.uk).

<http://eprints.hud.ac.uk/>

## INVESTIGATING THE RELATIONSHIP BETWEEN ANTHROPOMETRICAL DATA AND FULLY SHAPED KNITTED GARMENTS IN UK MANUFACTURING

Power, E. J. and Otieno, R

Manchester Metropolitan University, UK.

### ABSTRACT

In the area of woven garment manufacture the use of anthropometrical data to generate size charts is well documented and is generally accepted as standard procedure in the clothing industry. A previous publication (Power & Otieno, 2007) outlined that despite the high level of understanding which has been established between body dimensions and woven clothing sizing, there has been little study into weft knitted garment sizing and its relationship with anthropometrics. Since the properties of weft knitted fabric differs extensively from woven materials it is not possible to relate data obtained in past studies directly to knitted outerwear. Unfortunately the UK industry has diminished in size in favour of a move to offshore production. Many Authors have identified that the remaining companies need to diversify into niche markets to continue to hold any market share, focusing directly on garment quality and fit. This paper presents the findings of an investigation into the methods and practices used in a sample of UK weft knitwear manufacturers to determine how knitted sizing specification are derived and used to produce shaped knitwear. The study establishes important knowledge gaps in relation to size charts and knitted garment fit, and outlines the requirement for further study in this area.

### 1. INTRODUCTION

For many years we have become accustomed to the study of anthropometry, comparing and contrasting sizes and proportions of the human body. Roebuck, (1995) acknowledged that physical anthropology has a strong grounding in disciplines such as criminology and medical practice. However, it was not until the mid 20<sup>th</sup> century that researchers began to create relationships between anthropometrical data and clothing size charts. A pioneer in this area was Kemsley (1957) who was attributed to conducting the first UK national size survey and has influenced clothing sizing systems since. Today the use of anthropometrical data as a basis of clothing size charts is an accepted reality for most woven clothing manufacturers (Bougourd et al., 2000; Pechoux and Ghosh, 2002; Power and Otieno, 2007) and it is the foundation for determining accurate national and international standards (BSI 2001; Kemsley 1957, Newcomb & Istook, 2004). Many studies have been conducted that identify anthropometrics as a valued contributor to the fit and sizing of clothing worldwide, linking its use directly to consumer satisfaction (Pechoux and Ghosh, 2002; Bougourd et al, 2000; Otieno et al 2005; Tamburrino, 1992). The largest UK anthropometrical study to date concerning the civilian population was sponsored by the UK government in 2001. SizeUK used state-of-the-art 3-D body scanners to compile data on the civilian population, bring together academics and retailers within the industry together in a large scale for the first time (Bougourd et al., 2000; Stylios, 2001). The UK sizing survey involved scanning 11,000 subjects and it is reported that some major retailers modified their sizes as a direct result of the findings (Derbyshire, 2004 and Carvel, 2002). Despite the first major civilian anthropometrical study being conducted in the UK there is still limited information available in the public domain regarding how this has been translated directly into clothing size charts. Various academic studies have been conducted that utilise anthropometrical information to inform size charts, however, all of these have a direct

focus on clothing intended to be manufactured from woven fabrics (Beazley, 1998, Kemsley, 1957).

## **2. JUSTIFICATION OF THE STUDY**

It was concluded in previous research that the use of anthropometric data to generate garment size charts was an established practise for woven clothing manufacture (Power and Otieno, 2007) and is well documented in literature. The same study identified that there was limited knowledge available in the public domain regarding the relationship between anthropometrics and weft knitted goods (Power and Otieno, 2007). Since the material properties are vastly different between woven and weft knitted goods it is not appropriate to relate the data obtained from past studied directly to knitted outerwear. Weft knitted material is less stable than woven fabrics due to its method of production (Spencer, 2001). The weft knitted structure is produced from a series of intertwining loops, which may modify significantly in dimension, with the application of force, thus providing a high degree of two way stretch, that we commonly associate with knitwear. The fit of knitwear over the body contours is largely dependent on the elastic deformation of the fabric (Brackenbury, 1992), which can be varied by introducing different structure types (from ribs that stretch and contract, to stable interlocks with limited drape properties) and a combination of three different stitches (changing the formation of the loop, which affects the stretch properties). It is this versatility within the material that enables knitted stylelines to conform to the body in a manner in which woven fabrics are not able. In addition to the distinctive structural properties of weft knitted fabrics, the modern electronic knitting machine enables garments to be produced in a variety of forms (cut and sew, fully fashioned, integral and 3-D complete garments) using advanced technology. The latest technological developments in weft knitting are supreme in terms of programming software, electronic needle selection and takedown control enabling ever-more complex 3-D shapes to be developed into garment forms. Despite these breakthroughs in patterning and shaping capabilities, it is unknown how the garment sizing data, which is so critical to accurate shaping and garment fit, is derived. No publications have been identified which examine the relationship between the usage of anthropometrical data in knitted goods and the resultant garment fit or studies concerning knitwear shape development. Therefore, it was concluded in a previous study (Power and Otieno, 2007) that it was reasonable to assume that knitted garment development in terms of size and fit was heavily reliant on empirical data and the skill of the knitting machine programmer or designer to devise new shapes and manipulate this advanced technology into innovative knitwear styles. It appears that there is no sound theoretical framework grounded in anthropometrical studies. In the UK, Mintel acknowledged that premium knitwear production remains important particularly in the Scottish borders and East Midlands (Mintel, 2008). In order to compete with offshore production in terms of manufacturing, it has been identified that developed countries need to focus on the niche markets, providing new and dynamic knitwear styles with exceptional attention to quality and fit (Hunter, 2004 and Mowbray 2004). Previous unpublished research found that many new knitwear developments are based on empirical knowledge utilising the trial and error approach to develop styles with good fit which conform to the human figure and the theoretical application is very much lacking. This suggests that there is a void caused by the lack of theoretical data and a knowledge gap between the relationship of anthropometrics and knitwear sizing (Power and Otieno, 2007).

### **3. THE PROJECT AIMS**

This purpose of this project was to assist the UK knitwear industry by providing a sound theoretical understanding of knitwear sizing and fit. The justification of the work and the development of the project aims were based upon the following 6 extracts.

- Anthropometrics is accepted to be a valued contributor to size and fit of clothing worldwide and promotes consumer satisfaction.
- UK clothing size charts are available in the public domain that relate to the production of woven garments, but there appears to be a knowledge gap in relation to size charts suitable for knitted materials.
- Material properties are vastly different between woven and weft knitted goods and it is not appropriate to relate the data obtained from past studied (focusing on woven clothing) directly to knitted outerwear.
- Knitwear is considered a high fashion item not an accessory and UK manufacturing has historic links to high quality fully shaped knitwear for the luxury sector (Power, 2007).
- In order to compete with offshore production in terms of manufacturing, it has been identified that developed countries need to focus on the niche markets. In knitwear one market is the luxury sector, where a strong focus can be placed on innovative stylelines, produced in quality yarns, which conform well to the human form.
- UK knitwear manufacturing therefore needs to streamline the product development process and focus on producing innovative quality knitwear based on a sound theoretical understanding of size and fit. Therefore, academic research is required to fill the knowledge gap identified above.

The study proposed, focuses on contributing to the knowledge gap in relation to knitwear sizing and fit by developing a database of anthropometrical information related to knitwear styles and sizing procedures. To inform the development of the database a three phase approach was adopted. Phase one was the investigation to determine the knowledge gap in relation to knitwear sizing and fit, the findings have been presented and summarised in the early section of this paper. Phase two established current UK industry standards in relation to knitwear sizing and the use of anthropometrical data. This was achieved by interviewing four UK fully fashioned knitwear manufacturers, from an initial sampling frame of 346 companies. The final phase of the project examined grading procedures utilised in fully fashioned knitted garment production to determine current industry practices. This paper presents the methodology and findings from the second phase of the project.

### **4. IDENTIFYING THE SAMPLING FRAME**

In order to determine the initial sampling frame for UK weft knitwear manufacturers, a specialist financial survey report was consulted which listed 346 UK related knitwear industries (Prospect Swetenham, 2004). The listings included demographic data categorised by 51 UK postcodes and 11 different sectors of knitwear related products. Initially a basic mapping process was conducted to collate this information. It was found that the locations with at least 10 associated knitwear industries were: Leicester

(139), Manchester (53), Nottingham (30), Galashiels (15) and Derby (13). These 5 locations thus formed the initial sampling frame for further purposive sampling. In addition, five of the 11 product sectors were identified to contain possible references to weft knitwear manufacturers (These sectors are shaded grey in Table 1), the six remaining sectors were grouped together and categorised as “other sectors”. Table 1 presents the results of the initial sampling frame, which consists of 250 related industries.

**Table 1: Locations with Principal Knitwear Industries in the UK**

		PRODUCT SECTORS					
Location	No. of knitwear related industries	Sale of knitwear	Manufacture of pullovers & cardigans	Knitted & crocheted fabrics	Knitted & crocheted hosiery	Apparel products	Other Sectors
Derby	13	2	0	2	6	0	3
Galashiels	15	5	5	0	3	0	2
Leicester	139	27	7	18	65	11	11
Manchester	53	11	11	7	12	12	0
Nottingham	30	8	1	3	14	3	1

#### 4.1 Mapping the Weft Knitting Industry

In order to determine the final sampling frame, each of the 250 UK industries summarised in Table 1 was individually mapped using three key criteria a) knitting technology - only weft knitting manufacturers were selected (all warp knitting manufacturers were excluded), b) knitting machine type – only flat-bed technology and the traditional straight bar frame were selected (all manufacturers using circular machinery were excluded) and finally c) manufacturing method – garment production was required to be fully fashioned, integral or complete production (any cut and sew manufacturers were excluded). The final sampling frame is presented in Table 2 and amounts to 10 UK manufacturers; these were thus defined as the key players in UK shaped knitwear production. Each company was contacted by a formal letter explaining the research and inviting them to participate, followed by a telephone call to provide further information. Four companies agreed to participate in the study by contributing knowledge through an interview process.

**Table 2: Selection Criteria for the Final Sampling Frame**

		Initial sampling frame	No of UK industries
			250
Key Criteria	Selected criteria		
a) Knitting Technology	Weft knitters		127
b) Machine Type	Flat-bed Straight bar frame		11
c) Manufacturing method	Fully fashioned Integral Complete garment		10
		Final sampling frame	10

## 5. PHASE TWO PRIMARY INVESTIGATION

The purpose of the interviews was to establish UK industry standards in relation to knitwear sizing and the use of anthropometrical data. Four UK weft shaped knitwear manufacturers participated in this phase of the study from an initial sampling frame of 346 related industries. The interview was semi-structured to enable as much information as possible to be gathered. A series of 43 questions were asked relating to five different categories (The company, The products and manufacturing methods, The shaping techniques, The sizing procedures and finally, Consumer issues related to size and fit). Three interviews were conducted using the face to face interview method and were recorded and transcribed at a later date; one manufacturer opted to complete the interview questions electronically. The results of the main findings are presented for each category in the following paragraphs.

### 5.1 The Participants

The participants that were interviewed were all currently employed in general management or sales at a senior level. However, during all the interviews technical personnel and representatives of the design teams were made available as appropriate. Three of the knitwear manufacturers could be described as having a long history (over 100 years) in the production of fully shaped knitwear. The remaining manufacturer had less than 10 years trading; however the company was formed on a management buyout of various companies each with long histories (over 100 years) in textile production. It was found that not all the manufacturers had mission statements, but of those which did there was some reference to ethical trading. The 3 traditional fully shaped manufacturers had long histories of producing in the UK and had no intention of producing any garments offshore, mainly due to their heritage. The newest company was part of a larger group that had other production factories in Cambodia, Sri-lanka, and Bangladesh. The UK knitwear operation had been set up to provide a near to market facility for a large selection of high street retailers. All four manufacturers at the time of the interviews employed more than 100 personnel (one company employed over 400). However, it was noted that the two companies that had completely modernised their production plant (with all or the majority of machinery having complete garment capability) employed significantly less personnel than those that had retained the more traditional manufacturing techniques. In terms of production capacity two manufacturers were producing in excess of 450,000 garments per year (over 9,500

garments per week). The remaining two had a lower level of production (168,000 and 60,000 per year) predominantly specialised in cashmere.

## **5.2 Products and Manufacturing Methods**

Three of the manufacturers produced fine gauge luxury knitted outerwear which retailed in either flag ship stores, designer ranges, luxury export worldwide, quality independents, department stores or golfing ranges. The remaining manufacturer supplied high street fashion retailers. Two manufacturers stated that in recent years they have introduced design innovation aimed at the younger customer into their classic ranges. Three of the manufacturers that were interviewed used the latest technology (complete garment technology) in terms of garment production. The manufacturer that supplied the high street had a production plant made up entirely of 12 gauge Shima SWG X. One of the traditional fully fashion luxury manufacturers was in the process of changing its entire plant over to Shima SWG X machines, in potentially three gauges (5, 8, 12). The manufacturer that had the widest variety in machinery also employed the largest number of personnel and had some complete knitwear production capacity (Shima SWG X) in 15 gauge. The final luxury manufacturer was the only manufacturers that was interviewed that had not invested in the complete garment knitting technology. The main reason for the two traditional manufacturer's hesitance to utilise the complete garment production method was they required assurance of quality within the product they produced. Prior to using the machinery in production it was fully trialled on site by company personnel. The fashion supplier made the change to complete garment production relatively quickly, investing heavily in this production method. When the manufacturers were asked to comment on why they had selected their current technology. The traditional manufacturer with the heaviest investment in complete garment technology acknowledged they had made the move to have a competitive edge over low cost countries, claiming that the Chinese had now reached the level of quality that UK manufacturing were always seeking in fully fashion production. The traditional manufacturer with the most varied machinery plant had a plan for continual investment whilst retaining the core business and some traditional manufacturing methods. The final traditional manufacturer regard their old plant as industry standard, again relying on historical links to quality and branding to sell their products worldwide.

Two manufacturers agreed that knitwear has become more than just a pullover or a sweater (hence, an accessory) it was acknowledged to be a fashion item with innovation being highly important. Knitwear was declared to have grown (in terms of market share) in fashion ranges, with ladies garments being the biggest department in many autumn ranges, retailers are now managing growth, and with that growth, comes originality and innovation. Three manufacturers commented that in the last 20 years, knitwear fit and shape, has become more varied primarily driven by technology.

## **5.3 Analysis of Shaping Technologies**

The general opinion of the manufacturers who had invested in complete garment production was that this production method produced better fitting garments especially in fine gauge knitwear and opened up more innovation in styling than traditional fully fashioning. Ultimately, seamless was declared to produce a natural fitting superior shape which moulded to the bodies contours. It was recognised that the US market had

been quicker in appreciating the benefit of no seams, but it was acknowledged that the UK market was slowly adapting to this production method (however, it was pointed out that consumer didn't really fully understand the technology yet). Three of the manufacturers commented that in shaped knitwear (fully fashioning or complete garment) they were more subject to the vagaries of how the yarn & raw material performs. It was considered that mathematical calculations ultimately determined the knitting specifications, but the performance of the raw materials did change things drastically. This is where it differs from cut and sew and woven fabric production. All of the traditional manufacturers when developing knitwear shapes used empirical knowledge in the main, occasionally supplementing this from the machine builder's library. Only one manufacturer had purchased specialised software which preformed the shaping calculations (knitting specifications) automatically. It was confirmed by all the manufacturers that manual techniques are still used in some capacity. Interestingly the fashion manufacturer with the latest technology used a manual technique, including trial and error more than the traditional fully fashion knitters. Producing each new style shape from scratch, using a total product development approach involving a designer, a technologist, a knitting technician, and a commercial person from a costing point of view, they felt that this provided a more flexible approach to new product development.

#### **5.4 Procedures for the Sizing of the Knitted Garments**

It was found when examining ladies size coding that there was no standard method, all four manufacturers that participated in the survey used different approaches (10, 12, 14 etc; S, M, L etc.; 1, 2, 3, 4 etc. ; and 32, 34, 36 etc.). When asked about the development of size charts the three traditional fully shaped manufacturers all attempted to keep regular increments between grades, but ultimately revealed that they relied heavily on a trial and error approach based on the empirical knowledge of the development teams. Interestingly the manufacturer that supplied the high street appeared to have the best working knowledge regarding the effects of the structural properties on the grading procedure. Although the size charts were governed by the retailer these were negotiable depending on the structure (the manufacturer commented that this was a relatively new way of working, previously retailers would dictate the block). Surprisingly the high street supplier was the only manufacturer that expressed total satisfaction in relation to size charts; all the other manufacturers (which exported) had some issues with sizing or styling in one or more countries.

It was concluded from the interviews that all of the manufacturers were using empirical knowledge to develop size charts, shaping and stylelines and predominantly adopting a trial and error approach. None of the manufacturers stated that they based their size chart development on the information contained in the British Standards; most commented that they were developed empirically grounded on historical knowledge. The common procedure to produce knitting specifications was to calculate the stitch densities manually, then derive the length and width of the garment in terms of courses and wales, prior to developing the shaping frequencies. Most of the manufacturers produced one garment (size 12) based on empirical experience and to some extent trial and error. Once the prototype garment had been produced they had a fit session on an actual body. The grading increments were then calculated by hand, or computer (depending on the manufacturer). Interestingly only one of the manufacturers had purchased specific software for calculating knitting specifications. The reasons for adopting the software to assist with the fully fashioned shaping specifications and

knitting programme development were twofold, either historic (the companies had adapted software that was already tried and tested) or convenience (the new knitting technology came with the software). One manufacturer claimed that they found the automatic program restricting when using cutting edge technology, however, if using a manual method it can take three to four days to grade for production, but they found this method more accurate. The only manufacturer to identify their shaping calculation method as very successful was the company that used a specific shaping calculation package. The manufacturers which used the machine builder's software still calculated many aspect of the grades manually, due to limitations in the software. Despite not being totally happy with the shaping calculation software the three manufacturers felt that they were using the correct size charts to allow garments adequate fit. Only one of the traditional manufacturers commented that some of their size charts need to re-develop. However, they were quick to acknowledge that there was no tangible evidence at the moment, apart from what everybody feels or thinks the average knitwear size should be. Each company responded differently when asked about future investment in knitwear sizing. The high street manufacturer was retailer based – so any changes to its garment sizing would be initiated by the retailer (but they did comment that the retailer should be looking at this area carefully). Two of the traditional manufacturers were more concerned with controlling the variations in the yarn quality between the different batches. The final manufacturer, who had not experienced complete garment production, was very much of the view that historically its sizing systems had always worked well, but would be prepared to look at investment dependant on cost. All four manufacturers acknowledged that they had previously compared styles for fit informally to those produce by other manufacturers. Two of the manufacturers commented that there was a knowledge gap in relation to sizing and grading and a great reliance on empirical knowledge. They commented that there is no exact science in knitwear sizing, there are so many variables involved, machine tensions, yarn colours, yarn batches, therefore most knitwear companies will have size tolerances.

Surprisingly none of the four manufacturers used sizing and fit as a direct marketing tool, but yet they were all aware that good fit is paramount in consumer satisfaction. One of the traditional fully fashioned knitwear manufacturers did use the complete garment production method as a marketing tool, because they gave it a separate branding. Two manufacturers believed that complete garment production was superior to fully fashioned production because it was sculptured to the body as a 3-D form; but one manufacturer stated that the average consumer did not understand the technology and had made a decision not to use this as a marketing tool. None of the manufacturers supplied sizing data directly to the general consumer, however, two companies stated that if a consumer requested the information they would be happy to provide it, the other two manufacturers passed on sizing information to the retail teams. One of the manufacturers who sold on-line had an innovative idea for web based sales (however, this had not been launched yet), were the customer would input their height, or suit size and the correct knitwear size would be suggested. This was to try and give people more information, as they can not see the garment.

### **5.5 Consumer Issues Related to Size and Fit**

It was reported by the manufacturers that there were no direct problems relating to consumer sizing or fit, this was accredited to their understanding of specific market requirements. However, two of the manufacturers commented that they had some issues

with variance in sizes (particularly between colours) and consumers washing garments incorrectly, resulting in the overall shape changing. In terms of identifying a knowledge gap in relation to fit and styling within UK manufacturing, it was acknowledged that there is a problem with size standardisation and the fact that consumers don't really understand the different knitted structures (and how they effect shape) or the different methods of shaping (difference between cut and sew, fully fashioned and 3-D manufacture). One manufacturer acknowledged that it is important to share knowledge in the Western environment and use resources efficiently. In relation to complete garment production the high street manufacturer commented that garments fit better when there are a reduced number of variables (human error- cut and sew). The disciplines have also got better in their approach to product development; adhering to size charts, fitting sessions and grading session. It was also reported that there has been significant development in relation to 3D mannequins and its systems of using models more. Although it was acknowledged that every complete garment size has to be fitted before it is released to production. The fit of a knitted garment has to be right; it was considered that after attracting someone to the garment, the fit is the most important characteristic.

## **6. SUMMARY OF KEY FINDINGS**

The study confirmed that UK knitwear manufacturers currently considered knitwear as fashion item (in its own right) rather than a garment accessory (as it was historically grouped). It was also suggested that knitwear has become the dominate item of fashion in autumn/winter high street ladies ranges rather than woven manufactured goods. Three manufacturers commented that in the last 20 years, knitwear fit and shape had improved dramatically which had been driven by technological advancement. This research also found that traditional UK fully fashioned knitwear manufacturers have been slow to utilise the latest knitting technology, primarily due to issues related to quality. The companies needed reassurance that the technology was tried and tested prior to substantial investment. The one traditional manufacturer with the largest investment in complete garment technology made the move to gain a competitive edge over low cost countries, and as a result made significant reductions in labour expenses. The general opinion of the manufacturers who had invested in complete garment production was that this method of garment manufacture produced superior garment fit (especially in fine gauge knitwear) and opened up more innovation in styling than traditional fully fashioning methods.

It was found when examining ladies size coding that there was no standard method. This was supported by the findings of a previous study (Power and Otieno, 2007). All of the manufacturers predominantly developed knitwear size charts based on a trial and error approach using empirical knowledge. An interesting finding of the study was that the manufacturer supplying the high street retailers negotiated the size charts based on the knitted structure, (the manufacturer commented that this was a relatively new way of working, previously retailers would dictate the block, thus suggesting that there is a lack of confidence from the retailers were knitwear sizing is concerned). Surprisingly the high street supplier was the only manufacturer that expressed total satisfaction in relation to size charts; all the other manufacturers (which exported) all had some issues with sizing or styling in one or more country. Thus, suggesting that garment sizing should be related to the national population. Only one of the manufacturers had purchased specific software for calculating shaped knitting specifications. The reasons

for adopting the software to assist with the shaping specification development and knitting programme development were twofold, either historic, the companies had adapted software that was already tried and tested, or convenience, the new knitting technology came with the software. However, it was acknowledged that quite often the automatic program restricting innovation when using cutting edge technology and the manual method of calculating shapes was much preferred. The only manufacturer to identify their shaping calculation method as very successful was the company that used a specific shaping calculation package. Despite not being totally happy with the calculation software most of the manufacturers felt that they were using the correct size charts to allow them to provide adequate fit? Only one of the traditional manufacturers commented that some of their size charts needed to be re-developed. Interestingly however there did not appear to be any tangible evidence that any company was providing a correctly fitting garment due to there being no standard for comparison. All the manufacturers have previously compared styles for fit informally to those produce by other manufacturers, but there was no formal study which provided a detailed set of data. It was widely acknowledged that there was a knowledge gap in relation to sizing and grading and too great a reliance on empirical knowledge.

Surprisingly none of the four manufacturers used sizing and fit as a direct marketing tool. But yet they were all aware that good fit is paramount in consumer satisfaction. Although one of the traditional fully fashioned knitwear manufacturers did use the whole garment more as a marketing tool, because they gave it a separate branding. Not all manufacturers agreed that the consumers understood the complete garment concept. When asked about consumer sizing or fit issues none of the manufactures reported any direct problems and stated it was understanding specific consumer needs that was important, this was surprising since earlier the manufacturers had acknowledged that there were no studies relating to sizing and fit of knitwear and none of the manufacturers had formal records of consumer comments, in fact most were reliant on information being fed back though sales teams. Two manufacturers commented that they had more issues with variance in sizes and consumers washing garments incorrectly resulting in the overall shape changing.

In terms of identifying a knowledge gap in relation to fit and styling in the UK it was concluded that there is a problem with size standardisation and the fact that consumers don't really understand the different knitted structures and how they effect shape or the method of shaping (difference between cut and sew, fully fashioned and 3-D manufacturer). One manufacturer commented that the fit of garments produced using complete garment manufacture was better because it reduces a number of variables (human error in make-up).

## **7. CONCLUSION**

Despite the limitations of the current study (only interviewing a limited number of UK knitwear manufacturers), each company had a long established history with the fully fashioned knitwear trade and therefore it was reasonable to conclude that the findings were representative of the sector as a whole. It was clear that the findings supported the previous phase of this project, in confirming that there had been limited studies into weft knitted garment sizing and its relationship with anthropometric data; Since none of the manufacturers utilised any British Standard publications in this area, all the

manufacturers utilised a trial and error approach to size chart development and had previously compared goods to those produced by other manufacturers. Interestingly all of the manufacturers understood the value of producing superior fitting garments, but none of them had conducted any formal enquiries relating to their customer or had kept a record of consumer feedback filtered through the retail outlets. When developing size and shaping specifications prior to the knitting process all of the four manufacturers interviewed utilised experimental investigation grounded in empirical knowledge. Only one of the manufacturers had purchased specific shaping calculation software to assist them in the task, interestingly this was the only manufacture that reported satisfaction with their shaping methods. It was found that the high street manufacturer who had utilised the complete method of garment production for the longest period of time had the most appreciation of how the structural properties of knitwear influenced garment fit and as a result of this knowledge was able to influence the retailer to amend sizing specification and grading increments appropriately, perhaps signifying a change in the product development process. However, this particular manufacturer always engaged in producing a full set of graded garments prior to production (A very expensive practice and a long winded product development process). The manufacturers reinforced claims that knitwear was no longer seen as a fashion accessory, it was a discipline of fashion in its own right, showing significant growth in the market share of autumn and winter ranges. It was widely accepted that in recent year's knitwear fit and shape had improved dramatically which had been driven by technological advancement and most manufacturers were of the view that complete garment production particularity in fine gauge knitwear produced a better fitting garment than traditional fully fashioned methods. It was concluded from the findings of phase two of the research project that there were significant knowledge gaps in relation to knitted size chart developments and knitted garment fit, resulting in no industry standards in relation to knitwear coding, sizing and use of anthropometrical data. It can therefore be quantified that the final phase of the project which focuses on examining grading procedures utilised in fully fashioned knitted garment production with the intension of producing a database, will be of benefit to UK manufacturers and will contribute to the development of a theoretical sizing framework based on sound anthropometrical principles.

## 8. REFERENCES

Beazley, A. (1998) Size and Fit: Formulation of Body Measurements Tables and Sizing Systems – Part 2. Journal of Fashion marketing and Management. 2 (3) 260-284.

Black, S. (2002) Knitwear in Fashion. Thames and Hudson Ltd, UK.

Bougourd, J.P., Decker, L., Grant Ross, P. and Ward, J.P. (2000) A Comparison of Women's Sizing by 3D Electronic Scanning and Traditional Anthropometry, The Journal of the Textile Institute, 91 Part 2, (2)163-73.

Brackenbury, T. (1992) Knitted Clothing Technology. Blackwell Science, UK.

British Standards Institute (2001) BS EN 13402-1:2001 Size designation of clothes – Part 1: Terms, definitions and body measurement procedure.

Carvel, J (2002) Britons stand tall but heavy in Europe, The Guardian, 28<sup>th</sup> August 2002, p. 11.

Derbyshire, D. (2004) Women lose their curves in the age of exploding waists, The Daily Telegraph, 2<sup>nd</sup> September 2004, p. 11.

Financial Survey Report (2004) Knitwear Manufacturers 35<sup>th</sup> Ed, Prospect Swetenhams.

Hunter, B. (Dec 2004) Complete garment – evolution or Revolution? Part 3. Knitting International. 111 (1320) 20-22.

Kemsley, W.F.F (ed) (1957) Women's Measurements and Sizes, HMSO, London.

Mintel (2008) Womenswear Report: UK March 2008: Production and Trade, Premium Production. Mintel Oxygen. <<http://academic.mintel.com>> [accessed July 2007].

Mowbray, J. (Feb 2004) Complete Knitwear Solutions. Knitting International. 111 (1310) 42-43.

Newcomb, B. & Istook, C. (2004) A case for the revision of U.S sizing standards. Journal of Textile and Apparel, Technology and Management. 4 (1)1-6.

Otieno. R., Harrow, C. & Lea-Greenwood, G. (2005) The unhappy shopper, a retail experience: exploring fashion, fit and affordability. International Journal of Retail & Distribution Management, 33 (4) 298-309.

Pechoux, B. L. and Ghosh, T. K. (2002) Standard Sizing and Fit Testing Applied to Women's hosiery.

Power, E. J. and Otieno, R. (2007) Study of Anthropometrical Data in Knitted Garments. Conference Proceedings: 85<sup>th</sup> Textile Institute Annual World Conference, Sri Lanka.

Power, J. (2007) Functional to Fashionable; Knitwear's evolution throughout the Last Century and into the Millennium. Journal of Textile Apparel, Technology and Management. 5 (4) 1-16

Roebuck, J. A. (1995) Anthropometrical Methods: Designing to fit the human body, Human Factors and Ergonomics Society, USA.

Spencer, D. J. (2001) Knitting Technology 3<sup>rd</sup> Ed. Woodhead Publishing Ltd. UK

Stylios, G. K. (ed) (2001) The UK is to start a national sizing survey in partnership with academe and industry, International Journal of Clothing Science & Technology, International Journal of Clothing Science & Technology, 13 (5).

Tamburrino, N. (1992) Apparel sizing issues Part 1. Bobbin, April 1992, 44-46.

## **ACKNOWLEDGEMENT**

The Authors would like to thank Denish Karwal (research assistant) for her contribution to this work (transcribing and collating the interview data).

**CORRESPONDANT ADDRESS**

Dr. Jess Power ATI CText ILTM  
Senior Lecturer in Fashion Technology  
Manchester Metropolitan University  
Department of Clothing Design and Technology  
Faculty of Food, Clothing and Hospitality Management  
Hollings Campus  
Old Hall Lane  
Manchester  
M14 6HR

Tel: 0161 247 2676

**E-mail:** [j.power@mmu.ac.uk](mailto:j.power@mmu.ac.uk)