

Re-Shaping the Process of Design & Making: Shifting the relationship between designer and client in the context of digital knitwear design and production systems

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Abstract

New technologies have created a gap in designer knowledge and understanding of the design capabilities and production potential of new CAD software driven equipment. Significantly, within some sectors of the fashion industry, there is an assumption that CAD software run production technologies can eliminate the need for a designer, with production-based technologies “driven” by a technician.

Our work with the garment industry supports the emergence of an assumption amongst production machinery manufacturers that CAD software systems can eliminate design input and associated costs (Mohammed, May, & Alavi, 2008; Eckert, Cross, & Johnson, 2000; Eckert, Kelly, & Stacey, 1999). CAD driven production technologies such as the Shima Seiki WholeGarment® knitting system have “predefined garment templates” (preregistered garment shapes in Shima Seiki’s terms) embedded in the software. The manufacturer of this machine claims that these preregistered garment shapes can minimize the creativity gap between the designer and technician. However it is our experience that the system is too complex for cost effective implementation of design innovation.

Recent developments in CAD driven knitwear production systems have resulted in changes to the conventional relationships between the client, the designer and the technician. In this context, we have identified a new role, the “designer-interpreter”. Designer-interpreter denotes a professional knitwear designer with additional training in managing computerized seamless knitting machines. Research carried out at Curtin University has identified this as a creative role that is required to optimize design and production using computerized flat V-bed seamless knitting systems.

Within current applications of computerised V-bed seamless knitting systems, the textile and garment design processes are fully integrated and cannot be effectively manipulated in isolation. There is a current assumption that a knitwear technician can be a design-interpreter. However the designer-interpreter is required to facilitate the creative integration of textile and garment design. This is achieved through the application of their specialist knowledge of knit design, CAD driven software and machine operation. The designer-interpreter can work with either another designer or the end user to develop fully customized garments. With the creative support of the designer-interpreter, a consumer without any design background effectively becomes a “designer”. This system repositions the relationship between designer, manufacturer and consumer.

This paper presents research carried out by the Fashion Design & Research HUB at Curtin University into the creative potential of the design process using computerized flat V-bed seamless knitting technology for the client with little or no garment design experience. It reflects on observations made during workshops, of the changing nature in the relationships between designer-interpreter, client, design process and technology.

Keywords: Computer Aided Design (CAD), fashion, design process, garment technology

Introduction

The introduction of computer aided design systems has generated significant changes in the consumer designer dynamic. According to Fischer (1998), the introduction of CAD systems should have increased “[t]he possibility for humans to be and to act as designers (in cases in which they desire to do so)” and “should be accessible not only to a small group of ‘high tech scribes’, but rather to all interested individuals and groups.”

The reality is that the many new technologies have created a gap in designer knowledge and understanding of the design capabilities and production potential of

new CAD software driven equipment. Most significant is the assumption that CAD software run production technologies can eliminate the need for a designer with production based technologies simply “driven” by a technician, with increases in efficiency and a reduction in costs. Knitwear design and production using CAD systems have become far more complex than in the past. In the case of the CAD V-bed seamless knitting system, there has emerged a need for the division of tasks between three different roles, the knitwear designer, the knitting machine technician, and the knitting machine operator, which has increased both the complexity and cost associated with the development and production of designer garments.

This paper provides an overview of the research that we have been doing over the past nine years to engage designers and consumers in the use of CAD driven knit technology, and our observations of the reshaping of the processes of design and making.



Figure 1. Project: Bodyworx Collaboration 1999; Photographer: Ashley da Prazer; Dancers: WA Ballet. Image Source: Anne Farren.

As researchers we have the experience of applied research and knowledge gained through reflective practice gained through our creative investigation into the use of knitted tube forms. Anne Farren came to fashion design from a practice in textiles

and a focus on the investigation into the relationship between simple tube forms and the body. Her experience of knit is embedded in the application of hand knitted cloth and commercial knit materials. These practice-based investigations resulted in interdisciplinary creative projects such as “Bodyworx”, a collaboration with photographer Ashley da Prazer and dancers from the Western Australian Ballet (Figure 1). For many years Farren’s practice was based in the craft of making and the application of what could essentially be described as the “low tech”¹ techniques to the design and construction of cloth. This interest led to a closer investigation of the relationship between technology and fashion.



Figure 2. (Left) Designer: Sooyung Yang, Curtin 10 Year Fashion Retrospective Showcase 2013; Photographer: David Cowe; Image Source: Curtin Fashion HUB. (Right) Designer: Sooyung Yang, “a touch of wool II” Project showcase 2010; Photographer: Cameron Etchelles; Image Source: Curtin Fashion HUB.

Dr Sooyung Yang has been working with 3D knitwear design using the computerized knitting systems since 2006. Dr Yang completed a series of training programmes in Japan using the Shima Seiki WholeGarment® knitting system and went on to

¹ The significance of the use of the term “low tech” to this paper is illustrated in the research model presented in Figure 5.

complete her PhD investigating the application of knit based CAD systems in fashion. Yang's investigations into the creative use of the computerized knitting system led to the development of the unique 3D cloth structure, which she has been able to integrate into the seamless garment system. Garments illustrating this work are shown in Figure 2.

Yang and Farren have been working together since 2006 investigating the creative application of the CAD driven Shima Seiki WholeGarment® design and production system. Farren was working with the Department of Agriculture and Food, Western Australia (DAFWA), on the development of a wool design project when they decided to purchase a Shima Seiki knitting system and invited Dr Yang to become involved because of her interest in working with the system.

Experimental Procedure

Creating potential for the application of seamless garment production has become a research focus for Farren and Yang over the past nine years. Seamless knit technology provides an opportunity for the design and production of minimal waste, customized fashion items. However the CAD programs are complicated and do not easily accommodate creative design applications.



Figure 3. Seamless garment emerging from the knitting beds of a Shima Seiki WholeGarment® machine. Image Credit: Curtin Fashion HUB

Figure 3 shows the arms and body of a garment being produced and “dropping” down from the knitting bed. The system applies the traditional principles of circular knitting to produce a seamless garment which requires only a small amount of finishing in the form of tying off of some of the end threads. CAD driven production technologies such as the Shima Seiki WholeGarment® knitting system have “predefined garment templates” (preregistered garment shapes in Shima Seiki’s terms) embedded into the software. It is a system that is marketed on the basis of its potential for customized production, however in reality it is a complicated process to make changes to these basic structures.

The designer- interpreter

There is an assumption amongst production machinery manufacturers that CAD software systems can eliminate design input and associated costs (Mohammed, May, & Alavi, 2008; Eckert, Cross, & Johnson, 2000; Eckert, Kelly, & Stacey, 1999). The manufacturers of this machine claim that these preregistered garment shapes can minimize the creativity gap between the designers and technicians. We identified very early in our experience of working with computerized seamless knitting systems, the need for someone with knowledge beyond that of the technician. The reality is that in order for designers to work with this technology there is a need for a new role, one that Yang described in her PhD as the “designer-interpreter” (Yang, 2011).

Shifts in the design and making process

Table 1. Historical shifts in the Design and Production processes. Source: (Wallbank et al., 1992)

TRADITIONAL PRACTICE	→	PRESENT CAD ENVIRONMENT	→	FUTURE DIRECTION
<ul style="list-style-type: none"> – Artisan – Artisan Guilds 	→	<ul style="list-style-type: none"> – Designers working with Specialists – Multi-professional teams 	→	<ul style="list-style-type: none"> – Consumer integrated design systems – Local-based making – Integrated

	– Designer-Interpreter	Specialists
– Quality workmanship	– Division of labour & establishment of specialism.	– Moving towards more Sustainable practices in design & production.
– Directed toward group welfare	– Identification of sustainability issues	– Community benefit.

CAD systems have definitely led to changes in design and production practices, however not always in the manner that was necessarily predicted by the system manufacturers. There is often an assumption that the latest technology will provide better and/or more cost effective design and production, but this is not often the case. Our interest is in the critical review of technology and how to best utilize the technology in order to achieve both creative and sustainable outputs. We see that there is a place for CAD based knit technologies in a new more sustainable system, but it should be noted that it is an expensive system and requires a change in thinking about the roles and relationships between designer, client and customer. It is a system best suited to those who prioritize a broader and more holistic approach to sustainable design; a concept described as design for sustainability (D4S). D4S philosophy and thinking goes beyond meeting the challenge of how to make a “green” product.

According to organizations such as Design for Sustainability (DfS), it is critical that we look at the relationships within the whole production system rather than individual components. They include in this the examination of the relationship between consumer, designer and product and embrace how best to meet social, economic and environmental consumer needs on a systematic level. These three key elements of sustainability that surround the product are also referred to as *people*, *planet* and *profit* (<http://www.d4s-de.org/manual/d4sChapter02.pdf>). The trend towards a more comprehensive understanding of sustainable thinking and action is reflected in the predictions made by Eddie Norman in his paper “Time to Move On?”

There can be no doubt, that current design and technology curricula are going to come under increasing pressure from the requirements of sustainability in a general sense – environmental, economic, and social dilemmas – and in the particular economic drive for a knowledge-based economy. (Norman, 2008)

The CAD systems fit well into this model, with low waste, the ability to accommodate customization and profit and, we hope, quality product with the support of the designer-interpreter. However, this does assume some rethinking around the nature of the fashion object by both designers and consumers. In her TED talk, *Paper beats plastic? How to rethink environmental folklore*, Leyla Acaroglu² challenged the audience to design products that changed consumer behavior (Acaroglu, 2013). It is a worthy challenge and one that we believe that our work with the customer-designer is addressing in a small way by addressing how we value a garment and the lifecycle of the object.

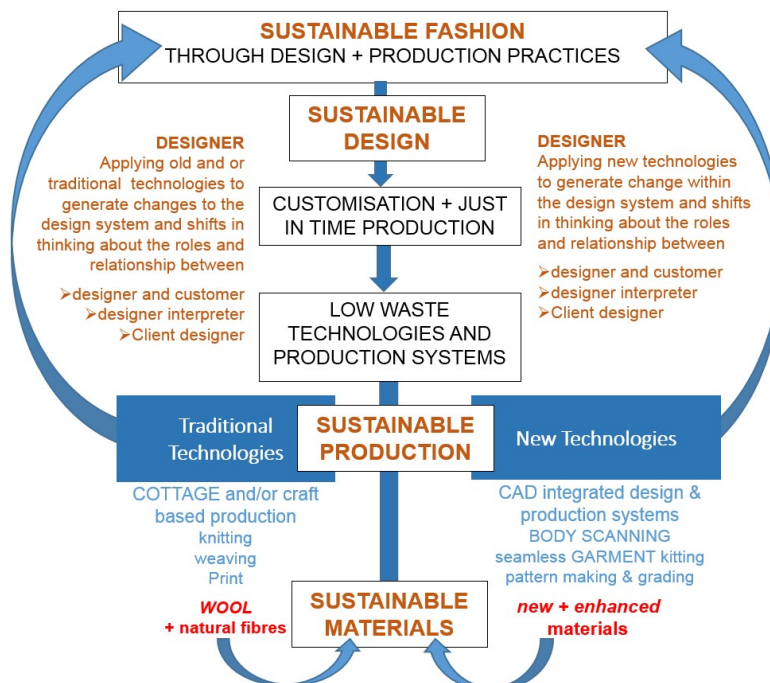


Figure 4: Curtin Fashion Design & Research HUB research model. Source: Anne Farren

² Laler Acaroglu is an award winning Melbourne based sustainability strategist who is Director of Eco Innovators and runs a creative agency that specializes in sustainability-led creative practice.

The concept of sustainability is not new to fashion and is discussed by many authors. Of particular note is the work of Sandy Black, presented in *The Sustainable Fashion Handbook* lecture at the 2013 Hay Festival. The Curtin University Fashion Design & Research HUB research model (Figure 4) illustrates our rethinking of the relationship between the designer and the object. In this model the designers are more aware of the materials that they use and of the selection of appropriate technology to both design and production processes with a view to increasing sustainability.

The research that we are focused on at Curtin's Fashion Design & Research HUB is working towards the establishment of a more sustainable fashion industry through the integration of technologies. This includes not just new technologies, but the recognition of the value of those that have gone before, taking the best of both worlds. (Farren, 2012)

The primary focus of this model is to increase understanding of how sustainability can be enhanced through a more integrated approach to design and production practices.

This model requires a re-examination of how as designers we engage with and apply technologies. The new technology that we are working with is the V-bed seamless garment knitting system, specifically Shima Seiki's WholeGarment® knitting system. This system has eliminated waste and allowed for recycling of yarn used in prototypes³. We also recognized the place for the integration of hand crafted elements into the design and production process. This enhances the creative potential of using the new technologies. This is illustrated in our discussion about "the tube project" in the next session.

Foundations and Investigations

Current research has its foundations in the Design for Comfort project, a collaboration with the Department of Agriculture and Food, Western Australia (DAFWA). While the focus of this project was primarily on the application of wool for comfort, it also engaged researchers in the examination of sustainable practices in garment design and production. The first design project, "a touch of wool", was

³ Limitations exist.

initiated by Curtin researcher, Anne Farren and engaged local fashion designers. The project brought together the scientific research being carried out by DAFWA and design process investigations to test the creative potential and the next-to-skin comfort of fabrics developed from Western Australian yarn. Bill and Vikki Webb of Kojonup (WA) are breeders of Merino wool from Merinotech WA bloodlines. Bill and Vikki allowed DAFWA researchers to hand pick wool with particular comfort attributes from their flock. DAFWA then processed this fibre into yarn. Sooyung Yang worked with local fashion designers to interpret and translate their ideas into customized fabrics that were knitted on the Shima Seiki knitting machine. Ray Costarella, Rebecca Paterson, Megan Salmon, Louise Snook and Melissa Yap fashioned these knitted wool fabrics, and fabrics sourced from Premiere Vision in France, into garments designed with next-to-skin comfort in mind. The project was also very focused on showcasing the sustainable application of wool in fashion. As part of this project, Curtin and DAFWA published “a touch of wool” (2006) documenting this research and other research carried out by DAFWA as part of the Design for Comfort project.

Following on from “a touch of wool” DAFWA established a link with young emerging Italian designer Bianca Gercasio. Sooyung Yang worked with Gervasio and the DAFWA team as a designer-interpreter on the development of fabrics for a collection presented in Europe at the 2008 Alta Roma/Alta. Farren identified the potential for students to engage with seamless knit technology and developed the “tube project” which was introduced to the Curtin Fashion Design curriculum in 2007.

The Tube Project

The objective behind the tube project was to introduce students to the application of “new tech” seamless garment design and production systems that are supported by Computer Aided Design (CAD). Also significant to this project was developing the students’ understanding of the “old/low tech” origins of circular knitting that form the conceptual foundations for the application of the new/high tech design and production systems. The project was designed to encourage creative investigations into the application of the 3D garment system, stretching the design applications of the system which in many respects has been limited by the complexity involved in making changes to the embedded predefined garment shapes. The tube project

engaged students in design development, applying the basic principles of seamless tubular garments that have minimal waste in production. Multiple tube forms were applied to the creative investigation of garment structure and design.

Because of the complexity of digitizing a complex new garment form, students were asked to specify details for seamless tubular forms that could be joined by hand post production and provide creative thinking around the application of predetermined tubular shapes. Within the teaching/learning environment we only had three hours contact a week with students and so it was not possible to provide large groups of students numbering approximately 30, the designer-interpreter and production support that would be required for full seamless design and production.

Following an introductory design workshop, students began work on the creation of garments using a range of tube forms. They then had to select and specify the stitch patterns and their position or placement on the tubes. The first year of the project students were directed to work with a single tube inserting a combination of knit stitch patterns to form a next-to-skin garment with the application of slits, slashes and holes created via the insertion of small slashes in the tube structure. In following years the insertion of slashes was applied to create “holes” to accommodate the attachment of other tubes and the creation of more complex 3D forms for the body.

The following describes the students’ engagement in the design process.

Step 1 – Initiation

Introduction of group tube project brief and parameters and key design strategies: The use of slits and slashes

- Manipulating tube components
- Specification of knit structure
- Design for comfort and fit.

Step 2 – Engagement

Individual visual diary and group garment development diary

- Student designers engage in a series of 2D and 3D investigations into the potential for joining of tubular shapes to create a garment

- Following individual investigations, we formed small teams to work on the development of a joint work for production.

Toiling is carried out to test ideas

- Investigation into flexible forms that can be worn in different ways on the body.

Specification sheets completed for the production of garment components

Step 3 – Outcomes

Production

- Tubes produced using the seamless knitting system with inserted knit structures as specified
- Designers join tubes to create final garment forms
- Some further manipulation of tubes is sometimes applied
- Further experimentation with flexibility in the orientation of garments on the body.

Through the programme students learn to work with a simple set of tubes and to create forms that are flexible in the ways that they could be worn. The premise for this component within the brief has been to increase the potential life of the garments through versatility and the ability for the wearer to personalize and change the way that it is worn. It is hoped that this will decrease the potential for garments to be discarded after a short life. In 2008 the project was distinguished by the students being provided with the access to long thin tubes as a design element. This process has resulted in creative investigations into joining of the tubes and culminated in a very complex and creative form created by student designers Taylor Ainley and Emma Young, illustrated in Figure 5. This outfit also illustrates the development of a garment, in this case the top, which can be worn in a number of orientations on the body.



Figure 5: Tube Project, sample work illustrating top being worn in different ways on the body; Designers: Taylor Ainley & Emma Young, 2010; Photographer: Penny Lane; Image Source: Curtin Fashion HUB.

In 2014 a decision was made to investigate the design potential with a more limited range of tube components. It was believed that this would provide a means for measuring the design potential and variation that could be achieved through application of the same set of simple elements. A new set of design parameters was set for the students to work with: three basic cream wool tubes each of different scale and knit structure were provided to the students (see Figure 6).

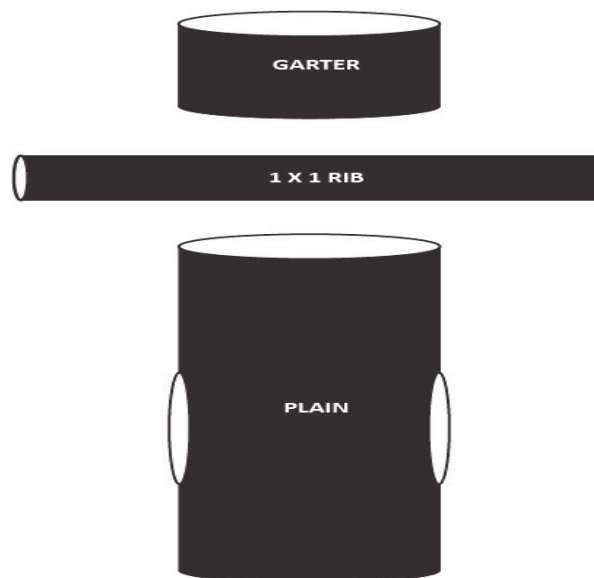


Figure 6: 2014 Tube Project design units. Source: Dr Sooyung Yang

Students are still working on the development of these forms, however what has so far been observed is a diverse range of design outcomes. The restriction in the range of design elements does not appear to be restricting the final garment outcomes. This simple set of components can be customized to create a diverse range of individualized forms. These simple forms also increase efficiencies in production and in the demand on the designer-interpreter's time for the production of components.

Based on our experience and observations of the design students' outputs working with simple tubular forms, we suggest that templates for simple tube forms could function more effectively as a component of CAD driven knit systems rather than the standardized conventional garment forms currently within such systems.

This simplification reduced the extent of the input and support required of the designer-interpreter while still providing opportunities for a customized design process and output.

Changing relationships

There is a rising demand for consumer customization that has resulted in a new role in the product design and development process, the consumer-designer. The evidence of this demand is found in the existence of major brand engagement in the provision of a unique range of customization options, such as those presented by adidas through their paint your own sneaker product kit (<http://www.adidas.com/>), the ijeans (<http://www.ijeans.com.au/>), and construct (<http://www.constrvct.com/>) on-line customer-designer services.

The historical precedent for this model within fashion is based on the "traditional practices" described in the table illustrated in Figure 5, where the consumer accessed the skilled "artisan" in the form of a dressmaker or tailor who would liaise with the customer closely on the design features required for their garment. This model really only now survives in the wedding market where demand for customized garments that have high consumer input is still prevalent. The distinct difference with

CAD systems is that they need the designer-interpreter who facilitates the realization of the consumer-designer.

In 2013 the Fashion HUB commenced working with clients and found that there was a demand from consumers to directly engage in the creation of their own customized garments. The first of these workshops, “Winter Woolly”, was run in 2013 (Figure 4). While running the workshop, a need for a change to the workshop content and design process were identified. The changes made included combining week one and week two activities and instruction of 3D body scanning⁴. These were immediately taken into consideration for better outcomes and presented as “Winter Woolly Workshop II” (Figure 5). By doing so, we also found a greater potential for a quick turnover, i.e., more condensed workshop delivery.

Table 2 below describes the final revised workshop content and process which is proposed for future workshops. It is a more efficient model for both the workshop organizer and the consumer. The reduction of time from one and a half months to one month in the workshops provides faster turnover for the workshop organizer and quicker access for participants to their garments.

Table 2: Finalized Winter Woolley Workshop content and process. Source: Dr Sooyung Yang

DESIGN PERIOD	DESIGN DEVELOPMENT PROCESS
26 th of October	<ul style="list-style-type: none"> • Orientation to clarify design process for WG garment. • Introduction to Garment shapes, Stitch patterns and Yarn colours for selection. • 3D body scanning.
2 nd of November	<ul style="list-style-type: none"> • Selection of Garment shapes, Stitch pattern(s) and Yarn colour(s). • Experience of developing design specification sheet(s).

⁴ Other researchers, such as Sandy Black, are also engaged in the development of “personalized” knitwear through the integration of body scanning and seamless knitting systems (*Design for the 21st century*, n.d).

9 th of November	<ul style="list-style-type: none"> No session for production.
16th of November	<ul style="list-style-type: none"> Distribution of garment and discussion.

Our reflection on participants was that we identified them as a unique set of people engaging in the design and making process. Table 3 describes the characteristics of four participants in the Winter Woolly Workshop, the nature of their engagement in the design process, and the level of support required.

Table 3. Characteristics of four participants. Source: Dr Sooyung Yang

TYPE OF PARTICIPANT	DISTINCTIVE / INTEREST OF ENGAGEMENT IN THE DESIGN PROCESS	LEVEL OF DESIGN SUPPORT
Craft-based hands on hobby knitter	Appreciated intricacy of machine-produced lace, but chose the plain stitch in a superb colour combination for her final garment.	Swatched her choice of lace stitch pattern and yarn colour combination to meet her expectations. Picked an actual sample for her final garment design.
Pure theory-based designer	Verbally expressive about her ideas, but never showed any physical evidence, focused on silhouette of garment.	Chose one from “Predefined garment shapes” which had never been tried out before.
Internet shopaholic	Engaging in every process, after the body flattering garment shapes.	Picked an actual sample for her final garment design. Had neither back- ground in design nor in art, but did her best to complete the design specs when asked.
Artisan practitioner	Organized & persistent with her own ideas. Had her own thoughts about body flattering garment shapes.	After failing her own tubular shape sweater design, presented one of the most intricate design specs on the

		stitch pattern placement on a simple sweater shape. Skilful in stitch pattern combination.
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Participants were engaged in the design process through:

1. Examination and handling of stitch pattern samples to assist in the selection of the knit structure for their garment customization.
2. Collaborative design process – consumer-designers tried on actual samples and discussed the suitability of the design in relation to fit and the general aesthetics of the garment. This process resulted in the development and resolution of an appropriate design selection.
3. Development of design specifications sheet/s.
4. Garment collection, review and discussion.

Responses from the consumer based workshops participants indicated that the concept of the tube project, that had been so successful with design students, was too complex and/or innovative than was required. Predefined garment shapes were much more accessible for this set of consumer-designers because the templates provided a basic form for simple design modifications and customization. Participant engagement in the design of customized garments resulted in high levels of satisfaction in both the process and outcomes of the workshop.

It is important to note that while the consumer-designer participants are interested in the design process, they have a primary focus on securing the outcome – a customized garment. We believe that the consumer-designer will value the garment to a higher level than the ready-to-wear item resulting in a longer life cycle and as such is a more sustainable product.

Conclusion

This paper investigated shifts in the relationship between designer and client in the context of digital knitwear design and production systems through student projects and consumer workshops. The case studies presented verified the potential for a new level of consumer engagement directly in the design process and a need to find

new ways of engaging with the complexities of new technologies. The solutions to some of these challenges can be found in an understanding of historical relationships that have existed between the consumer, the designer and the technology. The complexities of new technologies such as the computerized knitting system and 3D body scanning have generated the need for the designer-interpreter. Shifts in the relationship between the designer and client, and more recently the emergence of on-line customer-designer services in designer brands are only possible because of the existence of specialists who understand both the clients' needs and the technical demands of the new technologies. It is crucial that the collaborative nature of the relationship between the designer-interpreter, or the "specialist" in the case of on-line design services, is recognized in these new design and production environments. These customer-need-focused design and production processes are however very time intensive and more suited to high end, or high value, markets that also value design for sustainability.

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