PLYMOUTH COLLEGE of ART

Making Futures

The Transference of Craft to Digital Knowledge through the Medium of Knitted Textiles

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Current knit design methodology has evolved incorporating a blend of craft and the digital. This has resulted in a need for deeper collaborative networks from a variety of knowledge perspectives. Paramount to this shift is the impact on the relationship and skill sets required between designer, maker and technician. During a practice-led collaboration between a craft-maker and technical designer; this paper acknowledges the unique skills that each participant contributes illustrating the need for a shared knowledge base. The collective skills ensure that the complex technology of seamless knit is understood from multiple viewpoints, extending design outputs beyond perceived technical boundaries. This model of collaborative practice and production incorporates traditional knitwear knowledge and techniques, to rethink possibilities of knitwear artefacts produced via mass-production methods. Drawing inspiration from a historical perspective within a New Zealand context, this project explores the process involved and the shift in knowledge required when interpreting traditional craft elements using advanced digital knit practices. A series of seamless knitted artefacts are developed to identify the perceived possibilities, boundaries and limitations of digital knitting methods when interpreting traditional knitting techniques.

Keywords

Digital, Craft, Knowledge sharing, Knitted textiles.

Introduction

The potential of whole garment knitting is concealed amongst technical jargon and lack of understanding of technology applications in an innovative design context. To extend usage from mass production into the creative design process a practice-based collaborative approach has been applied, interpreting traditional knit techniques into non-traditional silhouettes exploring structure and colour within seamless knit boundaries. The ever increasing gap between knit designer and digital knit technology has been shown to require increased collaboration between skill sets and knowledge to initiate more ingenious knit outputs (Eckert and Stacey 2003; Sayer et al. 2006; Smith 2013).

This paper approaches this research from two perspectives; craft in a digital knit environment and the collaborative skills required between a craftsman designer and technical designer. These combined directives are applied to the project to investigate the potential and limitations within the whole garment knitting technology, Shima Seiki NSES 183-SWG; available to the research team. The relationship of craft and technology is explored through a series of case studies that inform an iterative design process where 'the process of making becomes as significant as the made object' (Turney 2009: 137). This project also identifies with the premise that knitted digital technology remains linked to its craft roots and as Lee (2007) states 'Technology is nothing without craft' in a similar manner this project illustrates that craft can be extended through technology.

Throughout this research craft is interpreted as the act of making rather than a movement or field (Adamson 2011) with craft practice defined not by the material but rather by the intensive expert engagement with materials used during creation (Shiner 2012). Through the perception of technology utilised as a tool, the technology is applied as a medium and the yarn as a material during the design process. Shiner (2012) suggests we add the 'idea of a process' of making to Adamson's definition of craft, 'by using the idea of a process embedded in various practices, we can bring together the concept of craft as a way of making with aspects of the concept of craft as a category of disciplines and the name of a general area of practices parallel in scope to art and design' (Shiner 2012: 234). In addition, this project explores the argument proposed by McCullough (1996) that expert usage of the computer to create is comparative to the use of hands in traditional craft practice and similar to a 'designer-maker' (Tanner 2010).

The use of digital knit technology for the production of case study artefacts such as in this research could be argued as not operating within a craft context because of the use of a linear and predictable computer interface, but if viewed within the same technology/ craft framework as discussed by Dormer (1997), the outcomes, become less predictable and more responsive when using shared knowledge bases. Dormer discusses craft being able to provide variety and unexpected outcomes whereas technology produces more predictable uniform outputs; in conjunction with this idea Dormer argues these can still be considered craft outputs:

Craftspeople can be defined generally as people engaged in a practical activity where they are seen to be in control of their work. They are in control by virtue of possessing personal know-how that allows them to be masters or mistresses of the available technology, irrespective of whether it is a mould, a hand tool, an electrically driven machine or a computer. It is not craft as a 'handcraft' that defines contemporary craftsmanship: it is craft as knowledge that empowers a maker to take charge of technology (Dormer 1997: 140).

During a practice-led collaboration between a craft-maker and technical designer this paper explores the unique skills that each participant contributes. Collective skills ensure that the multifaceted technology of seamless knit is understood from multiple viewpoints to extend design outputs beyond perceived technical boundaries. Drawing inspiration from a historical perspective within a New Zealand context, this project explores the process involved in the collaborative shift of knowledge required when interpreting traditional craft elements using advanced digital knit practices.

Technology and craft links to knitting

When Shima Seiki Manufacturing in Japan established the development of seamless knitting technology in 1995, its original intent was to reduce production, make-up time and labour costs (Smith 2013; Underwood 2009; Yang 2010). It was a model developed following production processes of a cut and sew lineage and this continues to be the way that knitwear manufacturers apply and understand the technology (Finn and Smith 2015). The technical programming outside of these pre-set parameters is time consuming, complex and often reduces a designer's use of multiple colour or pattern within seamless knit outputs (Smith 2013).

Kalyani and Joseph (2013) argue that knit designers need to utilise the potential of the knit technology by 'taking a more craftsman-like approach, engaging with both the technical and design dimensions of the technology and distributing this knowledge to enable further innovation, accessibility and change.' By using historical hand-knitted garments as starting points for translation into seamless knitted artefacts, this research sees the transference of knit knowledge from one discipline, that of craft to the new domain of digital. Such a 'domain shift' (Sennett 2008) references the past and begins to challenge the perception of 'craft' knitting as it moves into a potential future digital-craft self.

background and research

Currently, most garments produced using seamless knit technologies are limited to one or two colours and rely heavily on links-links textures to add a point of differentiation. This is in part due to a linear interface between the computer and technicians that encourages designers to work within the boundaries of the CAD formats when creating within the sample and production pressures of an established manufacturing company.

In technology, knowledge is distributed between people and hardware (Dormer 1997) this means collaboration is required to achieve a design potential. Dormer discusses how this collaboration encourages new ways of doing things and new applications for the things made. This research investigates one potential avenue of new knowledge application by referencing knitting's craft past in addition to merging two knowledge bases, a craft practitioner and a technical designer, with seamless knit technology.

Previous research into seamless knitwear technologies have cited lack of understanding and communication between designers and technical operators being contributing factors preventing an innovative digital knit design process (Eckert and Stacey 2003; Kalyanji and Joseph 2013; Smith 2013). To navigate the complex digital environment innovatively requires collaboration between several sources and the creation of an alternative design process ensuring collective involvement at all development stages. This was recognised during the progression of this research project with both researchers gaining further knowledge as the research moved into new design territories.

A greater understanding of technical possibilities extends designers creativity during the development of structures and silhouettes; partially through 'errors creating the new' which incorporates a stronger linkage with 'hands on inspiration' of a type that designers are more used too. Power (2007) recognised that as far as advancement in knitwear design was concerned 'that design leads technology then technology leads design'. With seamless knitwear technologies it has become apparent through research such as this; that design and technology development needs to be contributed to by both technicians and designers simultaneously for its potential to be fully understood, implemented and grown.
This research project investigates the current limits of design and possibilities for replication of traditional knitted garments while investigating ways the traditional could be used to extend the current production variants of pattern and texture when using seamless technologies. This has been achieved through the development of a series of knitted garments focusing on particular craft based knitting techniques.

Overview

The use of digital technologies to produce artefacts which can be traced to have relationships to craft roots has triggered the debated positioning of the digital output and modes of making: do they still remain as craft artefacts? Are digitally programmed outputs still considered a crafted output created by crafts persons? Seamless knitting technology can be seen to have such craft roots and also triggers many of the same questions as found in other digital environments.

When analysing data from this research in a retrospective manner it was found that there were many crossovers and parallels with other digital practices and uses as outlined in Dormer (1997). Dormer references Prof Stanley Lechtzin using CAD /CAM design software to create virtual samples for the lathe, to trial ideas that were not previously possible to imagine, however, he still creates some samples in physical materials to progress ideas and design development. During this project virtual imagery was utilised to trial the stitch codes, testing the visual accuracy to see if the stitch aesthetic required was produced. The actual knitting of these virtual programmes then produced trial samples in a physical swatch format for closer review and design development.

Furthermore according to Dormer technology for craft production appears to use the following components: ‘Simplicity; the pooling of skills means no one person fully comprehends the whole, there is a need to simplify to communicate. However, the idea is to use the simplification to create complicated outputs’ (Dormer 1997). Until recently, the simplification of knit technologies to communicate ideas between divided knitwear knowledge bases had resulted in simplified or expected outputs.

Knitted textile design is considered a complex process. As a constructed textile, visual and textural elements emerge from its fabrication. Knit design often involves designing the construction of the fabric and the form of the end product in parallel. This process requires simultaneous consideration of aesthetic, functional, two-dimensional and three-dimensional characteristics. Seamless knit technology introduces further complexity, via its programming interface; there is an abstracted translation between two-dimensional knitting programs and three-dimensional fabrications, requiring a high level of technical expertise to design and operate.

The joint craft/digital knowledge of the researchers enabled craft to expand through the use of technology, as Nitsche et al. (2014) stated ‘a driving factor of digital craft is its combination of new technology with physical hands on experience’ and that ‘the tacit knowledge of handwork meets digital creation’ through which the maker becomes empowered by technology. This research required new design processes to be negotiated through an iterative design development practice; feeling our way through issues as they arose. This relates to the discussion by Woolley (2011) referencing Niedderer’s (2009) view of ways that technologies can offer opportunities for mass production and new methods of experimentation to produce ‘unique work’.

Craft based work relies heavily on the physical materials and connections made between the craft-maker, their knowledge bases and the materiality informing the final artefacts produced while digitally produced textiles generally remain disconnected from the maker.

The maker in the digital environment interacts with a computer screen, codes, colours and grids. There were similarities between the hand and digital throughout this project when craft and computer integrated. As Dormer (1997) highlighted the connections between weaving, mathematics and the loom with digital computer processes, so there are connections found between hand knit pattern grids and codes with the digital equivalent on the CAD knit programme. Negotiating between one to the other became a new form of language, translation requiring the combined researchers’ knowledge bases and inherent understanding of material relationships and coded reactions. This reflected the discussion by Nitsche et al. on how ‘craft requires proximity and skill with physical materials, whilst digital inaugurates a completely new spatial logic.’ (Nitsche et al. 2014).

Our approach also has linkages with Woolley’s (2011) suggestion of using hybrid manufacturing approaches to connect and shift craft practices on three levels of interaction being: ‘influence, intervention and integration.’ This refers to the craft practices being shifted through technology connections; however we found that the digital can also be moved forward from its isolated position of production model replication by recognising that craft practices can be used as a driver for production change and new design perspectives.
McCullough (1996) discusses using technology as a tool to create within the digital environment allowing development of a visual prototype before the physical. However the seamless knit technology CAD interface does not work in this manner; what is shown on the screen is not what is finally created due to the diverse materiality and physical responses caused by factors of knit such as integration of the nature of yarn, stitch structure, shape, and form. The realities of the three-dimensional knitted garments and the flat two-dimensional screen images of a front and a back are incompatible and therefore not true representations of each other. It is only through the experiential experience that makers are able to adapt and grow knowledge of the digital imagery and the physical object developing an understanding of the relationship between the two representations.

Overview and methology

This research is part of an on-going study into the role that craft plays in promoting further design advancements for digital knit technologies; both authors have collective knitted textile design knowledge gleaned from their individual design practices before undertaking this research. An iterative design methodology combined with a mixed methods approach, linking literature, contextual review, local and global industry scoping, artefact analysis and reflective practice have all been utilised to underpin this research as methods of knowledge gathering and analysis. Background knowledge of both the handcraft knitting industry and the digital seamless knitwear industries grounds this research as a means to develop new approaches to making for the digital knit production industry. Additionally, this methodology informs how craft influences remain continuous even in a digital environment and how the digital/craft nexus connections revolve around one another. The research is practice-based leading to new perspectives in the development of both traditional and digitally knitted artefacts, the discovery of which could be transferable to other craft/digital maker arenas.

This research project involved the selection of historical hand knitted garments for the inspiration of techniques and shapes to trial replication and interpretation using seamless knitwear technologies. Historical pieces were selected due to the use of traditional hand knit practices, such as multicolour fair-isle and complex textures. To date, these techniques are seldom used on seamless knitted garments therefore by referencing historical garments for new design ideas currently perceived boundaries of machine use were extended.

Using the past to create a new understanding of a design materiality is not a new idea and it is definitely not a new idea within the realms of knitwear design. Domestic hand knitting has continued to run in parallel with knitwear's machined industrial production developments and as such have often influenced it. Turney (2009) looked at the history of knitting in relation to design and stated 'knitting frequently refers to its own history and can, therefore, be understood as self-reflective.' Knitting uses its own past to recreate and innovate, frequently using historical artefacts, stitch structures or techniques as references for the new. Turney goes on to say: 'The past is a reference, a sign amongst many others, which is sourced as inspiration but developed rather than copied, or revived into a new form.' (Turney 2009: 61).

However unlike with hand knitting which is flexible in its form building, working on each stitch individually; seamless knitwear's mechanised functionality is limited in machine movements by its linear design and manufacturing system. The premise of this paper's design approach was to access the stitch by stitch capacity of hand knitting and interrogate how much subtly of design detail and unique elements of structural techniques have to be compromised when working in a seamless knit technology arena.

Case study 1

This research was conducted in New Zealand and is influenced by the researcher's observations of the local craft and commercial knitwear industries design outputs. New Zealand has had a knitwear industry since the 1840s, established along with the first European settlers (Finn and Smith 2015). The knitwear manufacturing industry is one of the few industries which have remained predominately producing onshore in New Zealand and have continued to update machinery and manufacturing processes; heavily investing in seamless knitwear technology (Smith 2013). Seamless designs in New Zealand (as also seen globally) remain two-dimensionally configured and few three-dimensionally designed outputs are seen being produced commercially (Smith 2013; Yang 2010).

This research was two-fold in its aims: to establish if craft practices could be used to promote design development movements away from seamless knitwear design norms, and to establish to what degree a hand knitted garment could be replicated via seamless technologies, and at what point and why changes needed to be made.

Due to the national importance placed on New Zealand's reputation as a wool producer and the longevity of a knitted craft history it would be thought that there would be many documents and books that reflected this both within local libraries, historical archives and museums; however initial research into historical knitwear samples within New Zealand yielded minimal results. The Loving Stitch by Heather Nicolson (1998) remains one of the main sources of compiled information on the histories of knitted craft in a New Zealand context.

In conjunction with the limited resources was a surprising lack of documented histories with knitted garments in museums throughout New Zealand. Matkovic (2015) states that from a historical viewpoint knitting has been overlooked 'Knitting has been underestimated to such an extent that richly illustrated histories of clothing often do not contain even one example of a knitted garment, arguably with the exception of stockings'. Reflecting on the prominent role wool has played in the New Zealand economy and the social fabric of the country the researchers can only conclude that as Turney (2009) and Black (2002) argued knitwear is so commonplace within society that it lacks the element required to be considered remarkable in the stories and histories of the locality and, therefore, is not 'saved' as its woven counterparts are.

Two local museums were used for this study: Museum of Transport and Technology (MOTAT) and The Auckland War Memorial Museum. Under supervision both museums allowed the researchers to search through archived knitted artefacts; one garment from each was chosen to develop into the digital realm.

Three samples were selected for the project; the first example from MOTAT a child's undergarment (figure 1), the second from Auckland War Memorial Museum a ladies fair-isle sweater (figure 2), and the third garment a shawl (figure 3) from a New Zealand based designer/ pattern writer, Margaret Stove, who designed and published hand knit patterns based on New Zealand flora and fauna in the book Wrapped in Lace (2010).

Fig 1. Child's Lace Undergarment from MOTAT. (Moore and Smith 2015)

Fig 2. Ladies Fair Isle Vest. Auckland War Memorial Museum. (Moore and Smith 2015)

Fig 3. Granny Chenye's Lace Shawl knitted by Margaret Stove. (Stove 2010)

One of the aims of this research was to see how literally a hand knit garment could be translated into a seamless knitted garment. The first garment we looked at replicating was the child's lace undergarment from MOTAT. This appeared to be a simple garment with no shaping throughout the body, sleeves or armholes giving a false hope that translation through into the digital would be an easy task (figure 4). Our initial findings were: due to seamless programming occurring continuously row by row from a right sided view as opposed to hand knitting which works from the front then the back of a piece, a row by row translation from craft based structures to the digital did not translate readily. This garment's basic 'tee' shape also caused issues: starting with the wholegarment pre-programmed basic shape with the required stitch structure added to the program, the first samples trialled resulted in tension issues at the sleeve head of each garment, causing yarn bursting and creating holes due to machine shaping restrictions.

One of the main challenges was the translation between hand knit instructions into a language understood by the machine based designer-programmer and the hand knitter leading to the development of an adapted bi-lingual language (figure 5). This is not a new finding, knitters working with various hand knit patterns discover differences between symbols and charts.

Fig. 4. Final Seamless Knitted Child's Undergarment as sourced from MOTAT. (Moore and Smith 2015).

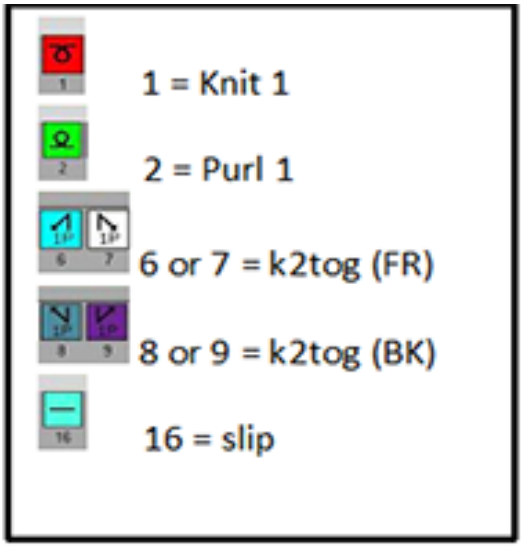

Fig. 5. Translation from Shima Code to Hand Knit Stitch Instructions. (Moore and Smith 2015).

The second garment chosen to adapt into a seamless style was Granny Cheyne's heirloom lace shawl re-interpreted by Stove (2010). Translation of the complex lace movements stitch by stitch was especially difficult without analysing a physical garment. The hand stitch chart was converted into machine knit codes, however hand knitting has the capacity to manipulate the individual stitch to a greater degree than the machine, leading to compromises on stitch replication accuracy. Distinct advantages of the digital were the ability to trial individual design motifs allowing ease of modification and rapid replication with controlled placement of the motifs into a larger design. However, the original shawl had been knit using four directional changes to the knitting which made it impossible to knit in the same way on the seamless knitting machine. Having proved that we could replicate the motifs, it was decided to push the seamless garment programme further applying these to an innovative seamless silhouette. Oates in discussion with Hanus about digital technologies for creative ceramic craft making stated; 'I believe this can only be achieved by altering the machines and software past its current state. This involves me becoming a computer programmer and a tool-maker in addition to an artist/maker/designer' (Hanus 2015). By using the hand knitted shawl as a starting point, the research developed iteratively as boundaries between the handmade and the digital blurred: the craft of hand knitting moved digital seamless modes of make into new design arenas.

In reference to the shawl shape a pre-programmed parachute garment was selected; for sample one the lace motifs were aligned along the bottom of the garment body (figure 6) and for the second sample the lace was positioned within the parachute area (figure 7).

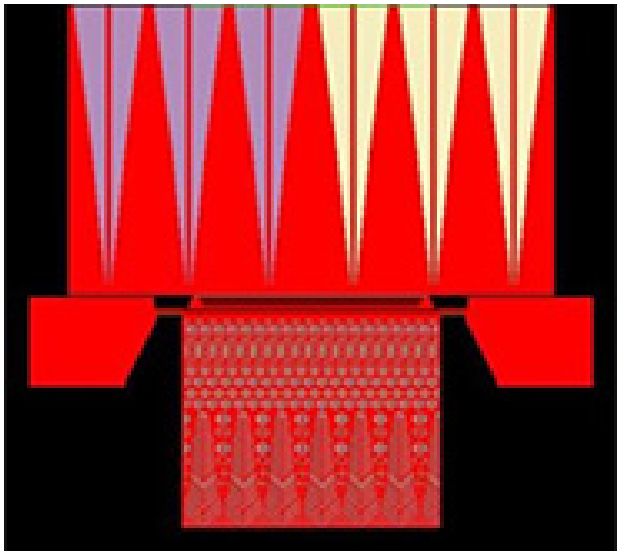

Fig 6. CAD Programme for Lace Placement on Bottom of Seamless Garment. (Moore and Smith 2015)

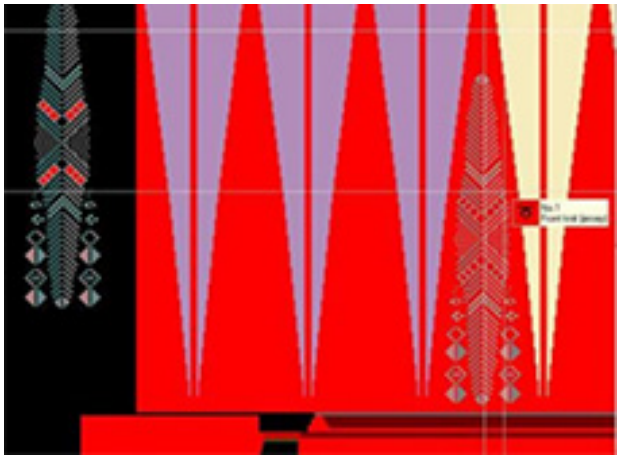

Fig 7. CAD Programme for Lace Motif Placement on Seamless garment. (Moore and Smith 2015)

Key findings

The complexity of multiple machine movements across each row to create the lace in conjunction with the ten simultaneous shaping decreases in the parachute area initially resulted in areas of dropped stitches. A simple mirroring of the fern motif structure codes caused the machine movements to knit the structure inside out therefore certain lace transfer movements needed to occur in the opposite direction to the original to produce a correct mirror image.

The first garment, with the lace placed in the lower half where no shaping occurred, knitted flawlessly except interpretation of the machine movements in relation to the front and back knitting were difficult to view on screen leading to several errors in stitch movements. After analysis of the first sample garment it was found that applying logic and mirroring the program for the back had produced an incorrect result because the computer was programmed to adjust automatically. Visually these on screen programming issues are difficult to identify until after production of the artefact unlike when working by hand on a piece. McCullough (1996) states ‘In traditional craft, the eye constantly monitors the effect of the hand to guide the work towards some abstract vision.’ suggesting that this ability to ‘see’ the pattern emerging is intrinsic to traditional craft techniques.

Throughout the design development process of the lace garments it was recognised that programming stitch codes was not dissimilar to reading or writing a knitting pattern in conjunction with the need to; ‘regularly materialise the digital, to create the physical manifest of the actual during the design process’ (Oakley 2013). This research found that during the transference of the two-dimensional digital virtual visuals into actual three-dimensional stitches and forms, what emerges is entirely different to the screen version because stitch structures have raised forms. Additionally the shapes trialled were too far outside the parameters of the pre-programmed shapes for the computer visualisation software to attempt, therefore what was finally knit out was unknown until actualised in a physical material way.

Fig 8 and 9. Final Seamless Lace Garments Interpreted from Margaret Stove's Lace Shawl. Moore and Smith (2015).

Case study 2

McCullough (1996) discusses digital artefacts and building them one step at a time 'Like a traditionally made form, it represents the results of many simple repetitive actions, where one move enables the next. We build up digital artefacts one step at a time, one piece on top of another with what is already there affecting what is to come' (McCullough 1996: 155). It was found that this was also the case when working with seamless knitwear design, each iteration builds on the last, adding new knowledge to older understandings. This process of digital knowledge growth pushes beyond known boundaries and can only be added to through attempts to develop new concepts.

Replication can be viewed as a way of learning a skill or a tool which once mastered can then be adapted and improved upon. The final garment for translation was a ladies Fair Isle vest from Auckland War Memorial Museum. To date the researchers had only evidenced two colour patterns in seamless knitted product's, therefore this garment was selected for its multiple colour combinations. Acknowledging the limited carriers available on the seamless knitting machine used during this research, it was recognised that a full replication of this garment would be difficult.

The initial findings during replication of the vest were that machine carriers and rail allocations limited machine movement and dictated design possibilities. Machine movements were dictated by the carrier direction being set up to be used from a left start or right start, with limited yarn carriers it dictated how many colour combinations could occur in a garment. Another design limitation was that the jacquard pattern needed to be developed in two row units, Shima packages are designed for use of two row knitting when programming two colour floating jacquard. Hand knit fair-isle often works in units of two rows or multiples of two but because it is flexible the hand knitter can change yarns and colour every row just as easily, as evidenced in the original vest. With only ten carriers available on the machine used the vest could only truly be replicated to the mid area of the body as seen in figure 10.
Part of multi-colour seamless knitting limitation is due to the 'C' knitting machine movement, as seen in figure11, this is what enables a seamless garment to be knit across two knitting beds seemingly simultaneously in areas with openings. With the ten carriers available for knitting on the machine used seven varying two colour jacquard combinations were achieved.

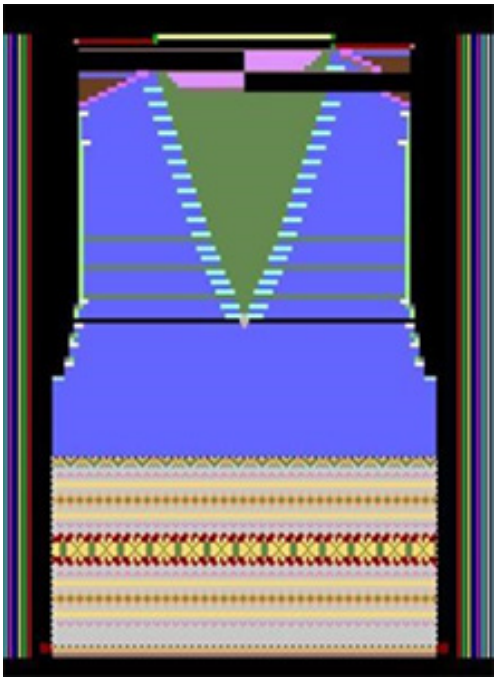

Fig 10. CAD Visualisation of the Multi-Coloured Fair Isle Vest. (Moore and Smith 2015)

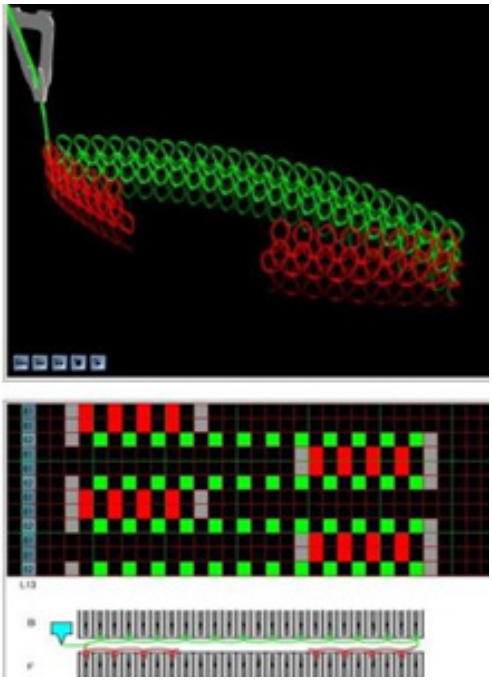

Fig 11. 'C' Knitting sourced from Shima Seiki Manufacturing Help. (Shima 2015)

Revised design plan

Reflection of the findings from the vest replication trial highlighted restrictions for future multiple colours developments; design was controlled by the limitations imposed by machine movement in conjunction with the available number of yarn carriers. This caused the research focus to shift into new design territories using the knowledge gained from the replication exercise: to apply multi-coloured jacquard in a seamless garment in a creative manner. Using a shape previously created by one of the researchers (Smith 2013) the jacquard was placed through points of the garment with minimal machine movement for shaping, introducing multiple colours into a seamless garment achieving a curved colour movement effect.

An understanding of packages is essential when developing multiple colour combination jacquards for seamless knitting. This process had to be worked through logically by the technical designer because no 'HELP' exists for this package development process. The computer has information for a sleeved seamless sweater shape with packages provided for the use of just a single two coloured jacquard, through a non-shaped area of a garment. The garment created through this research was a sleeveless garment using four colours and was therefore outside of known design parameters within the available information provided by the manufacturer CAD programmers.

Development of the compressed file has no step by step instructions for processing; this led to multiple trials to work through errors and issues to complete this process. Though time consuming this was achieved via the computer interface and checked visually. However this visual is not a direct translation of the final textile and requires expert knowledge to interpret, a little like a hand knitter knows how to read stitch instructions from a graph or code

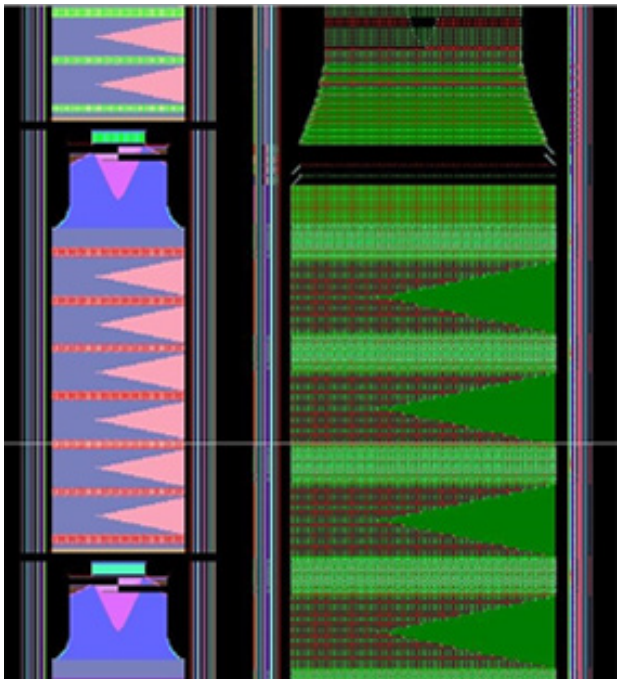

Fig 12. CAD Compressed Visualisation of Multiple Colour Jacquard Garment. (Moore and Smith 2015)

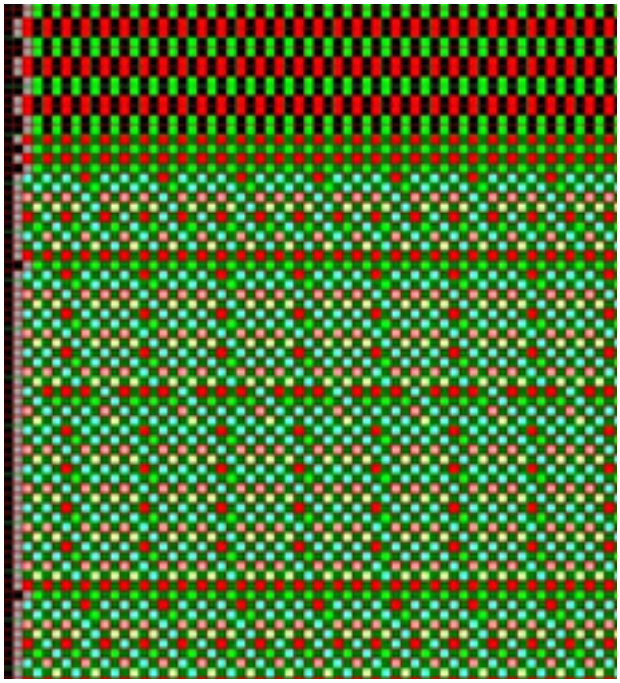

Fig 13. Detail of CAD Programme for Multiple Colour Jacquard Stripe. (Moore and Smith 2015)

The final garment, though created using a traditional fair-isle hand knitted vest as its original source of inspiration, has been iteratively moved into a design output which becomes unique to its digital mode of making. This shift provides a counter perspective to that of Pagoldh as cited by Turney in The Culture of Knitting; 'machines can't copy human handwork or create one-of-a-kind colours and patterns. Machines form stitches evenly and monotonously, with no trace of feeling. Every stitch in a hand knitted sweater bears the traces of a time, a trip, a landscape; of persons, events and thoughts.' (Turney 2009: 42) During this research, although the machine follows a linear programming and machine movement process the blending of digital and hand knowledge allows a machined garment to embody a uniqueness of its own. The seamless knit allows the curvature of the jacquard to move uninterrupted around the garment and body. The garment identifiers of the traditional fair-isle seeped in historical meaning have been shifted into a new manner of identification; that of the digital creating its own unique meaning.

Fig 14. Final Two garments using the Multiple Colour Jacquard Techniques. (Moore and Smith 2015)

Fig 15. Close up of Multiple Colour Jacquard Curvatures around Seamless Garments. (Moore and Smith 2015)

Conclusion and further research

Though in many areas where craft making has directly moved into a digital environment, the merging of the hand and digital knowledge is still acknowledged and in many cases the artefacts of the one or the other are still being held up as being superior to the other. Knitted artefacts have been industrially produced in parallel to the domestically produced for hundreds of years, each mode of making following its own path and rarely crossing. This research purposely set out to create an overlap of these two modes of making through collaboration between the two researchers and the aims of the research. By using traditional hand knit garments as starting points, the researchers were able to exploit craft-based knowledge whilst utilising the seamless knit knowledge of the researchers for translation of both onto a digital platform. The starting point pushed both researchers into new bi-lingual arenas, which in turn prompted new ways of approaching seamless knitted outputs which moved into new territories of craft/digital exploration. Collaborative experiences of the research project were; that understanding of the hand to machine required multiple sets of knit knowledge to enable an accurate knit translation, this resulted in extended technical boundaries and knowledge for the collaborators. This research moves beyond working with either the hand or the digital within a prescribed or pre-scripted way, merging the two into a new medium where technology can be seen as a new form of material and not just a making tool (Armitage 2011).

This research contained some predetermined rules such as needle selection possibilities, machine constraints, but became blended through the iterative creative design process. It was found that it is possible to introduce multiple colour, texture and shape to the seamless knit environment in an innovative way: when boundaries of machine limitations are observed and worked within, in a creative way which can result in unexpected garment outcomes. This shows that technology and design can and do inform and influence one another and through this process that the digital starts to create its own life or design force through the iterative design cycle which it feeds on.

Transference of knowledge into the digital environment 'creates' something new in its own right (unexpected outputs) it is not just about the use of the technology as a tool. McCullough (1996) defines 'affordances' as a term used to describe the usable capabilities or potential of a medium and how the affordances of a material may not be obvious that they need to be discovered, McCullough applies this to wood as an example but this could just as easily be applied to knitting technology. Visual cues worked differently for both researchers when viewing technical issues during the programming of the garments; the hand knitter worked more intuitively with a zoomed out view of the overall digital programme, responding to issues such as repetition and symmetry whilst; the digital researcher was prompted by more zoomed in visuals such as colour code programme information. Through this combinatory approach of the researchers and their combined knowledge bases the final garment outcomes became more dramatic and pushed into new ways of achieving seamless knitted outcomes. Adding a craft perspective into the seamless knit design process changed the potential outputs from the norm or those prescribed by a linear digital environment: for technology to move forward such knowledge transference is required. Finally this research illustrates how the machined or digital knit environment still has much that it can gain from integration of knowledge from craft-based practices.

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