Translating the Creative Process of Knitwear Design: from Manual to Digital Practices in a Material-driven Approach

Martina Motta[1]

[1] Politecnico di Milano
Milan, Italy

ABSTRACT

For ages associated with manual work, in the paradigm shift through the Industry 4.0 knitwear is nowadays one of the industrial sectors that is most experiencing the dualism between craftsmanship and technological innovation. The article investigates the relationship between the creative process of knitwear and its tools, in a comparison between a traditional manual expertise and a constantly evolving technological knowledge. Through a case study, the article analyses the nodes that connect the creative and manual process to the production and technological ones, stressing the translation effort that a de-signer faces when switching from manual to electronic machines. A translation that requires a structured dialogue between designers and technicians, and that consists in evolutions that explore the possibilities and limits of the most up-to-date technologies, of traditional and innovative yarns and materials, of the processing techniques.

Keywords: Knitwear Design, Technologies, Manual Techniques

INTRODUCTION

In the paradigm shift through the Industry 4.0, where the industrial production processes are changing in favor of rapid and mutable design practice, knitwear is nowadays one of the industries that is most experiencing the dualism between craftsmanship and digital-technological innovation. For ages associated with manual work, the complexity of a knitted product has always required to designers not just creativity, but specific technical knowledge and manual skills in the constant analysis of materials and processes for the creation of something new (Motta, 2018). Knit designers find themselves in a constant search for balance between the knowledge belonging to the traditional manual work and the codified industrial processes supported by technologies. In the framework that outlines the knit design process and the knowledge needed by knit designers (Fig. 1), one of the three pillars is dedicated to hands-on practice, where designers explore the technological possibilities (whether they are manual techniques and tools or more digital and evolved ones). In knit design, indeed, the making of samples and prototypes is a fundamental moment that is non consequent but inter-related with the generative creative phase and with all the stages of the project, and together they concur to the development of a knitwear project (Motta, 2019).

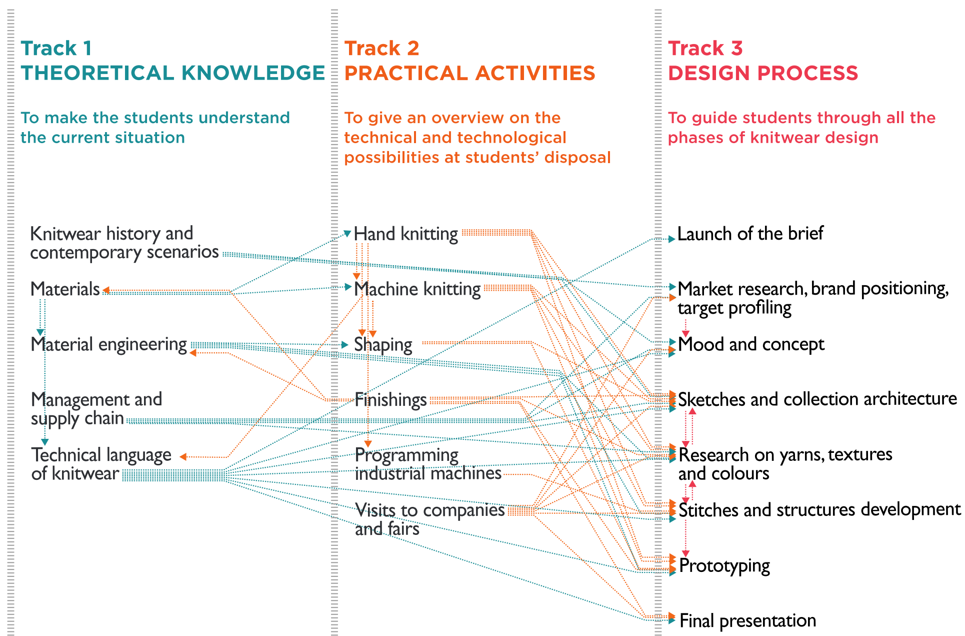

Figure 1. The framework for the ideal knowledge of knit designers. (Motta, 2019)

The present article aims to focus on the importance of the tools, on their role in the design development of a knitted product and in the definition of the materials that can be used, the structures that can be realized and the shapes that can be designed. The framework outlines how approaching knit design means to learn manual techniques: hand-knitting and manual machine knitting. A designer needs "the ability to examine the different technical means to achieve more or less different results; this leads to a research method essentially based on experimentation: observation, analysis, deduction" (Tellier-Loumagne, 2005, p.12). With regard to industrial machines, a basic knowledge of their functioning and of CAD programming adds value to the expertise of designers, as it makes them aware of many critical aspects: they learn which process a programmer goes through when he/she receives the technical sheets to be coded into a program; they understand what is industrially feasible and sustainable in terms of time and costs; they learn the basic technicalities which make them able to dialogue with the programmer, to better explain what they want and to more easily reach solutions. In contemporary times the two areas of knowledge, manual and technological, have become two fundamental aspects of the research work at Politecnico di Milano, that deepens the comparison between manual and electronic processes to generate updated methods and perspectives for future designers in the sector, questioning the role that the two play in the important moments of teaching and learning.

THE CHALLENGE OF DIGITAL AND ELECTRONIC TOOLS

Electronic knitting machines are among the most complex machines in the world, made up of over 100,000 parts, with a price ranging from € 55,000 to € 120,000. The two main manufacturers are the Japanese Shima Seiki and the German Stoll. The first invented the WHOLEGARMENT® machines, which knit 3D finished garments without seams, eliminating the assembly steps, while the second has released the Knitelligence® software, which optimizes the productivity of all phases of the work. The machines are controlled by CAD software supplied by the manufacturers themselves (Eckert, 1999), and used by specialized technicians: M1plus® by Stoll and Apex by Shima Seiki. In their latest versions they include assisted programming tools which makes them more intuitive for those who know knitwear even if they are not a professional programmers. However, to master its use independently, working on complex garments and with all the stitches, it takes at least two years of full-time experience (Motta, 2019). In other words, it is necessary to be a specialized technician, as it is particularly difficult to know how to set up the work and a little negligence can cause considerable damage to the machines. According to Mashiro Seiki [5], the founder of Shima Seiki knitting machines, the world of knitwear is experiencing a cultural renaissance where the tools and methods of the past are constantly changing. The machines will change, and the technology with them: the purpose for designers should not be to learn and master a software, but rather to creatively respond with skills that adapt and update with ease and agility over time. Technologies are expanding the boundaries for designers' intervention, but also the domains of knowledge they need to control. Given that the expertise of designers cannot overlap with the one of programmer-technicians, there is the need to define the features and boundaries of this knowledge. How can it be transferred effectively?

How specific and deep does it have to be, and in what measure it can be manageable by a designer alone? How far can designers push their intervention?

MANUAL KNOWLEDGE. IS IT STILL USEFUL?

It is natural to wonder whether today it still makes sense to use manual machines, when they have been completely replaced at the industrial production level by electronic ones. What contribution can a tool that seems obsolete give to the training of designers and their professional life? How could such different tools coexist and relate?

If it’s true that Knitwear is learned by doing (Conti, 2019), using the same tacit knowledge used by craftsman which is learned throughout the experience (Ray, 2009) and transferred through action (Polanyi, 1967; Schön, 1983), the direct experiments on manual machines are still useful for designers as they are allowed to manipulate the knit and to suddenly change the design parameters, while the programming phase prior to electronic knitting requires a very de-fined design intention and the mediation of a technician. The value of manual machines is recognized also by companies: if the production is entirely entrusted to electronic ma-chines, in many design and development labs the manual machines are still used in the early stages of prototyping, for samples on large gauges, for the knitting of small com-ponents, and as a support for the programming phase, to practically understand how to make complex stitches when difficulties happen in programming them on the computer. It is clear, however, that the future of knitwear is increasingly heading towards automation, and therefore the designer's experience cannot stop at manual machines: moving from making by hand to comparing it with electronic machines is the key point in the creation of a real, industrial, knitwear project (Affinito, Conti & Motta, 2017). Through a research project taken as a case study, the article analyses the nodes that connect the creative and manual stages of knitwear design to the production and techno-logical ones, stressing the translation effort that a designer faces when switching from manual to electronic machines. A translation that requires a structured dialogue between designers and technicians, and that consists not just in the simple recreation of the same structure with a different tool but in evolutions and developments that explore limits and possibilities of the most up-to-date technologies, of traditional and innovative yarns and materials, of the knitting techniques.

FROM MANUAL TO DIGITAL: A CASE STUDY

These pages show the results of Giulia Squellati's Master's thesis entitled “Designer and knitwear industry. A path from manual work to electronic development”. The design process described is divided in two phases. First, the development of a knitwear collection, created according to the phases of the design process (see fig. 1) in conjunction with the work on manual machines. Second, the translation of the samples developed manually into CAD programs and then in samples made with electronic machines. Here, all the moments that connect the creative and manual process to the production and technological one are relevant: selection of samples developed on a manual machine, discussion with the technician on possible developments, check of the feasibility with the technician, CAD programming, prototyping, production of the final piece.

The research is structured on three tracks: flowers, that shows the diversity of jacquard structures between manual and electronic machines; shaded, that shows the possible interpretation of the same stitch through different programs; embossed, that shows the limits of electronic machines with manual structures that cannot be replicated.

1. Flowers

First sample (Fig. 2):

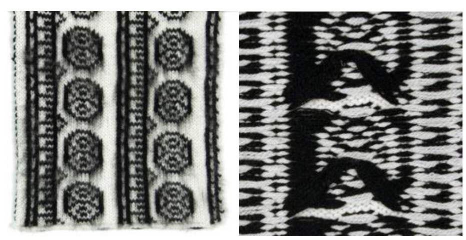

Fig. 2. Single-knit jacquard with floating yarns and final combing, front and back side. Made with punch card on Brother gauge 5 linear machine.

Aim: explore the different types of jacquard processing that can be obtained with electronic machines to overcome the two-color limit imposed by jacquard punch cards and eliminate the long floating yarns on the back that limit the wearability of a garment and therefore its marketability.

Development (fig. 3):

Fig. 3. The samples of group 1 “Flowers” developed with electronic machines.

1A: tubular jacquard on double needle bed, with same design on front and back, but in negative. This makes both sides of the fabric usable and is suitable for garments where the inside is very visible, such as scarves. The black wool has been replaced by angora that, due to long fibers, facilitates the achievement of the "washed out" effect.
1B: piquè jacquard with floral motif knitted on gauge 16 to make the flowers as realistic as possible, increasing the number of colors and the definition of the design.
1C: floral motif in tubular jacquard. The front and back work independently, the result is more compact, colors are cleaner. More precision here means a higher consumption of yarn and a longer knitting time, therefore a higher production cost.
1D: same of the 1C, but different yarns to obtain a different aesthetic result. The elastic opaque black viscose shrinks, making the other colors emerge. The white is a slightly over-titled chenille which gives volume, one of the two grays is a shiny lurex.
1E: floral motif in piquè jacquard on machine gauge 5 instead of 16. If compared with sample 1C, the scale is clearly larger, the design is more fragmented and less realistic.

2. Shaded

First sample (fig. 4):

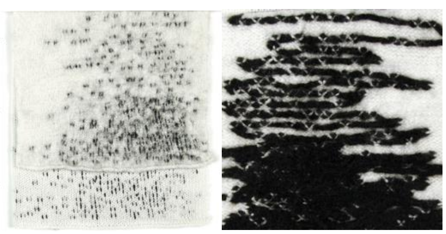

Fig. 4. Single jersey stitch with manual intervention (e-wrap technique) on the back of the cloth with a different color, on needles chosen randomly with a degradé pattern from the bottom to the top.

Aim: The manual intervention gives intentional blurring on the right side, while on the reverse it generates very long black floating threads that are an obstacle to the development of any marketable garment. The e-wrap technique, in which a yarn is manually wound on the needles to put it to work, is not feasible on electronic machines. The goal is to find one or more techniques that produce the same type of visual and tactile effect on the front side, with due attention to eliminating the problems on the reverse.

Development (fig. 5):

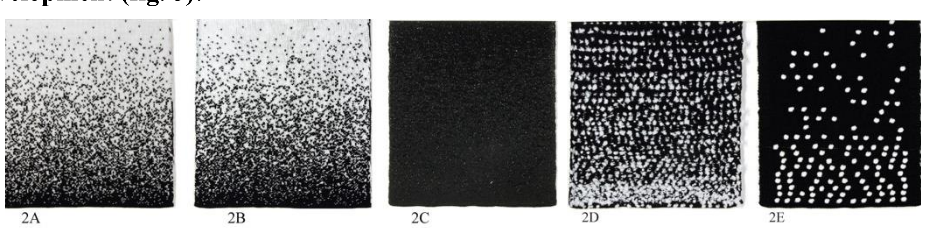

Fig. 5. The samples of group 2 “Shaded” developed with electronic machines.

2A, 2B and 2C. Subsequent interpretation of the original fabric, made with a more traditional and intuitive process: the jacquard. It easily recreates any type of graphic motif, visualizing the stitches as if they were pixels. The samples have been knitted on a gauge 16 but differ in the yarns used and have very different final effects.
2D: single jersey with degradé stripes from bottom to top. The effect was obtained thanks to a white knop yarn with a black core, which blends easily with the background, letting out only the soft white buttons. Knitted quickly in 2’45’’, inexpensive although of great effect.
2E: bobble stitch with white yarn on a background of black single jersey. The bobbles are visually very similar to the white dots of sample 2E, but this one has a very complex processing module and takes 29’41’’ to be knitted.

3. Embossed

First sample (fig. 6):

Fig. 6. Single jersey with manual manipulations that create 3D effects depending on frequency and position. Done by taking stitches already knitted back into work following a precise pattern.

Aim: to reproduce with electronic machines the same volume effects that simulate large cables, not being able to intervene manually.

Development (fig. 7):

Fig. 7. The samples of group 3 “Embossed” developed with electronic machines.

3A. The sample reproduces as faithfully as possible the technique used for the original manual sample. Despite the scheme is the same, the design appears much less voluminous as the use of two needle beds causes slackening in the work that cannot be avoided.
3B: same pattern as the 3A but with an elastic yarn to avoid yarn breakage and enhance the 3D effect. The result improves while not reaching the original compactness.
3C: 12x12 cable that produces a volume like that of the original sample.
3D: untied tubular jacquard with parts in 1x1 floating jacquard. Normal yarn coupled with an elastic one that, once steamed, shrinks giving the embossing.
3E: links-links, namely the alternation of knit and purl stitches that produces 3D effects by exploiting the opposite directional tensions of the two stitches. Very laborious with manual machines, it is achieved in a short time with electronic machines.

CONCLUSIONS

As shown in these pages, electronic machines can carry out in a short time an infinite number of processes that are difficult and laborious to do by hand, especially when it comes to stitches that involve a multitude of steps (transport, needle movements and selections) and of combined processes such as inlays, textures, jacquards, more than two colors in the same row or numerous changes of yarn (Group 1). At the same time, how-ever, it is impossible to satisfactorily replicate some stitches (Group 3) with the same technique used by hand. The transposition of these processes from the manual machine to the electronic one requires great effort in the search for alternative solutions, and therefore several hours of programming and many tests. To be noted how, in the translation, the centrality of materials and of any feature that fibers and yarns have (Cassidy, 2017) does not get lost, but is enhanced. The design activity keeps its aspect of being material-driven and every design decision stands as regulated by the choice of yarns, the limits they have, their performative features, the tactile and the visual properties, the matching of different compositions, the subsequent interventions on responsive materials. It is the designer's ability to move between these limits and opportunities by recognizing craftsmanship as the fundamental support for the creative phase and technology as the essential tool for the production phase, to direct work towards the best solution. This process is observed as regulated by a triangulation of skills: (1) the designer’s ability to have a general and methodological vision of the project; (2) the specific technical knowledge of the knit product, from the stitches to the characteristics of the yarns, to the modeling, common to the designer and the programmer; (3) advanced skills in the use of IT and technological tools, typical of the programmer.

The research highlights the importance for designers to rely on the programmers’ support even in the initial design stages, and helps to define the role of the designer along-side the figure of the technician, that is to direct the project and make aesthetic and technical decisions to achieve the intended final result. A clear and precise communication of these intentions is essential for the programmer to respond with his technical and IT skills on what is feasible, what are the alternatives or the possible solutions that had not been considered. If the dialogue is reciprocal, the designer is actively involved in the production phase and can make all the necessary decisions, from the most important to the most subtle, having complete control of the final result. The man of industry 4.0 takes on an active, collaborative role of mediator between different knowledge, within the production system (Lotti & Trivellin, 2017). The interaction between designers and technicians leads to a continuous exchange of information on the definition of mate-rials and colors, the study of details, the development of stitches and structures. This information all together constitutes a sort of "innovation platform" on which, every time a specialist interacts on the project, technical and product-specific values are aggregated. This contribution is what Bettiol (Bettiol & Micelli, 2005) affirms as an engine of innovation, necessary to access new knowledge.

REFERENCES

Affinito, L., Conti G.M., Motta, M. (2017). New vision on knitwear design. How the traditional craft methodologies are evolving into fashion international scenarios. The Design Journal, Volume 20 sup.1, pp. S2760-S2770

Bettiol, M., Micelli, S. (2005). Design e creatività nel made in Italy. Proposte per i distretti industriali. Milan, IT: Mondadori Bruno

Cassidy, T. (2017). "Knitwear design technology", in: Textile and Clothing Design Technology, T. Cassidy, T., Goswami, P. (eds.). CRC Press, Boca Raton. pp. 441-461.

Conti, G. M. (2019). Design della Maglieria 2. Milan, IT: Lupetti

Eckert, C. M. (1999). Managing Effective Communication in Knitwear Design. The Design Journal, 2, pp. 29-42.

Lotti, G., Trivellin, E. (2017) Una possibile strategia per il prodotto italiano. Design & Industry 4.0 Revolution, MD Journal, Volume 4, pp. 60-73.

Motta, M. (2018) "Who makes Italian knitwear? The great companies behind the fashion brands", in: Maglia, punto. Forty years of hidden treasures from MF1 archive, Conti, G. M. (ed.). pp. 43-49. Cinisello Balsamo, IT: Silvana Editoriale.

Motta, M. (2019). Designing knnit designers. Milan, IT: FrancoAngeli.

Interview to Mashiro Seiki. Retrieved from https://www.shimaseiki.com/company/dna/founder/ accessed September 1st, 2021

Polanyi, M. (1967) The tacit dimension. Garden City, NY: Doubleday.

Ray, T. (2009). Rethinking Polanyi's concept of tacit knowledge: from personal knowing to imagined institutions. Minerva, Volume 47 n. 1, pp. 75–92.

Schön, D.A. (1983). The Reflective Practitioner: How Professionals Think in Action. Aldershot, UK: Ashgate Arena.

Tellier-Loumagne, F. (2005). The art of knitting: inspirational stitches, textures, and surfaces. London, UK: Thames & Hudson.