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KNITWEAR DESIGN NEW VISIONS: SMART-K PROJECT. how the traditional craft methodologies are evolving into new scenarios thanks to technological innovation.

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Abstract

The following paper aims to show some of the results of the SMART - K research whose purpose was to create a software for 3D modelling to be applied within the production chain of the industrial sector of Italian knitwear.

Today, the market offers software for knitwear designers that can represent the product concept in 2D and still remain purely descriptive, without providing any kind of information useful for the end producer in terms, for example, of yarn quality or size and placement of working to be used for a given item of clothing.

While technology must improve production efficiency, in Italy, the knitwear sector in particular needs this intervention as it is characterised by a long, complex and highly fragmented production chain. SMART-K, or new System for the creation of design innovation processes and for the integration of the production chain, by Means of the Application and Research of new Tools for virtual prototyping and rendering in immersive environment in the Knitwear sector, tries to offer companies in the sector a series of new digital tools in order to improve the various design phases of clothing items. The following are some of the operational phases (those not covered by an industrial patent) of the software the objective of which, within the companies of the specific sector, is to increase the efficiency of the stylistic, creative and production skills of all operators involved thus optimising costs and production times.

Keywords: new technologies, 3D visualisation, knitwear design, innovation, crafts

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Technology and knitwear: the contemporary

In the contemporary context of the Fashion System, technology is playing an increasingly important role: it improves efficiency in the production phase, provides designers with new tools during design, revolutionises traditional prototyping techniques.

The introduction of new technologies in the Italian Fashion System meets the special reality of Made in Italy, which has always been synonymous of excellent products designed by integrating craft know-how with innovation of materials proposed by small and medium-sized enterprises.

In the current socio-economic context, where precisely small and medium-sized enterprises that make up the production core of our country suffer most, even where craftsmanship and tradition have a dominant role, integration with high technology is deemed necessary. This integration, and its subsequent implementation, must be able to improve production effectiveness, reduce waste and at the same time, enhance the creative process in its deep connection to craft know-how; all this so local realities of Made in Italy districts can compete with global companies both in terms of project "value", and efficiency and innovation.

A sector that particularly requires this type of intervention is the knitwear sector which, in Italy, is a reality of excellent companies recognised all over the world but that reflects, more than others, the economic difficulties due to the long, complex and fragmented production chain. It is precisely in this case that technology can support creative and production processes increasing business performance, preserving the quality of products. Knitwear products have always been the essence of manual labour. However, in Italy, it is an integral part of the industrial System divided into spinning and knitwear companies and brands of specialised products. Technology, in Made in Italy intended as clothing, intervenes at the level of materials or finishes applied on them. The software is only available in the translation of stitches in "machine language", i.e. specific stitches and working that the needles of the machine must use to obtain a sweater or a cardigan, leaving to the eye and hand of man the subsequent phases prototyping, defect removal, quality control for the finished garment.

The software currently existing are 2D, in support of the graphic representation by the creative team, while remaining at purely descriptive and with the need for frequent additions from the point of view of the programming of machines: for the latter in fact, there is specific software that, in most cases, is developed in collaboration with the manufacturers of industrial machines (Stiger, Stoll, Shima Seiky) and cultural heritage of the various internal programmers of companies which manage to translate a design into what, is colloquially called "machine language".

The disconnect between various software, the difference in the management of the automation languages, as well as the need to shorten the supply chain in some of the burdensome steps currently planned, generated the idea of the SMART-K Project, a research project aimed at developing applied technology (software) that can improve production efficiency, reduce waste and losses and at the same time enhance the creative process in its deep connection between workers. Started in April 2014, in particular the research project aimed to integrate and analyse project skills in new technologies applied to the design of knitwear patterns and expand the skills from the operating point of view of software, and their integration, for the realisation of a unique machine file, which can be easily shared by the various players in the production chain and immediately understandable.

THE Smart – K RESEARCH

Work group. Players involved

The work group of the SMART- K project involved various stakeholders; initially, the collaboration of professionals of the knitwear sector with researchers from Politecnico di Milano, together with knitwear design experts, aimed at identifying the strengths and weaknesses of the sector. Subsequently, some professionals were involved for 3D modelling and visualisation, fast prototyping, as well as the Steiger for the realisation of a common software language for design and manufacture of industrial knitwear machines. More specifically:

- Maglificio Ghidotti and “Cose di Maglia”; the first, an industrial knitwear producer and, the second, a brand of knitwear design. The role of these two players was very important in order to have a sampling of garments suitable for the study and analysis of garment development.
- Two knitwear designers and two researchers from the Politecnico di Milano that favoured knowledge on the state of the art of the production chain in the knitwear industrial sector, in addition to acting as intermediaries between traditional production and innovation, with the role of translating prototypes into patterns to be used during programming of the industrial machine.
- Three experts in the creation of software related to the company Mw Power lab.
- Three operators of Signal, an Italian company active in many areas of electrical engineering and automation, whose core business is the development of technologies for industrial textile machinery, and particularly in the knitwear sector, with applications on flat, circular knitwear machines, for hosiery and for the realisation of seamless garments.
- Three operators of Steiger, a Swiss company worldwide leader in the production of machines for industrial knitwear that verified the Smart - K software, applying it.

Research phases

Creation of a library of stitches, the models, the software.

From an initial preparatory phase of analysis on the state of art of the production chain of the industrial knitwear sector, a second one was necessary, of field research with companies, which could describe the various phases of the production chain, identifying the weak points, and those with greater expenditure of time and/or economic resources. Smart - K was developed to compress and shorten the various production phases, especially in the preparation of samples; for textile and knitwear companies, this is a real collection of clothing, which is intended only to be presented to buyers for orders of garments. No one may ever wear the sample because, for example, the sizes are only indicative and do not comply with the law of each country. The garments indicate only the placement, or position, of processing, the purpose of which is to perceive “the touch”of the yarn, its size in terms of tensions used.

In parallel with the early phases of research, researchers from Politecnico di Milano and those of Mw Power lab integrated and analysed design skills in new technologies applicable to the design of knitwear patterns through Lectra's 2D software, specifically Kaleido Knit, in order to understand the extent to which design could be digital as opposed to manual prototyping. In fact, Smart - K starts from a base of existing data: for example, from Lectra Knit derived the library that catalogues the physical and morphological characteristics of the yarn along with the types of stitches in order to obtain a programming and virtual design tool as complete as possible.

The virtual “library” elaborated on the Lectra model was integrated with information until then absent through dismantling and reconstruction of some existing knitwear garments. At this stage, it was very important to physically

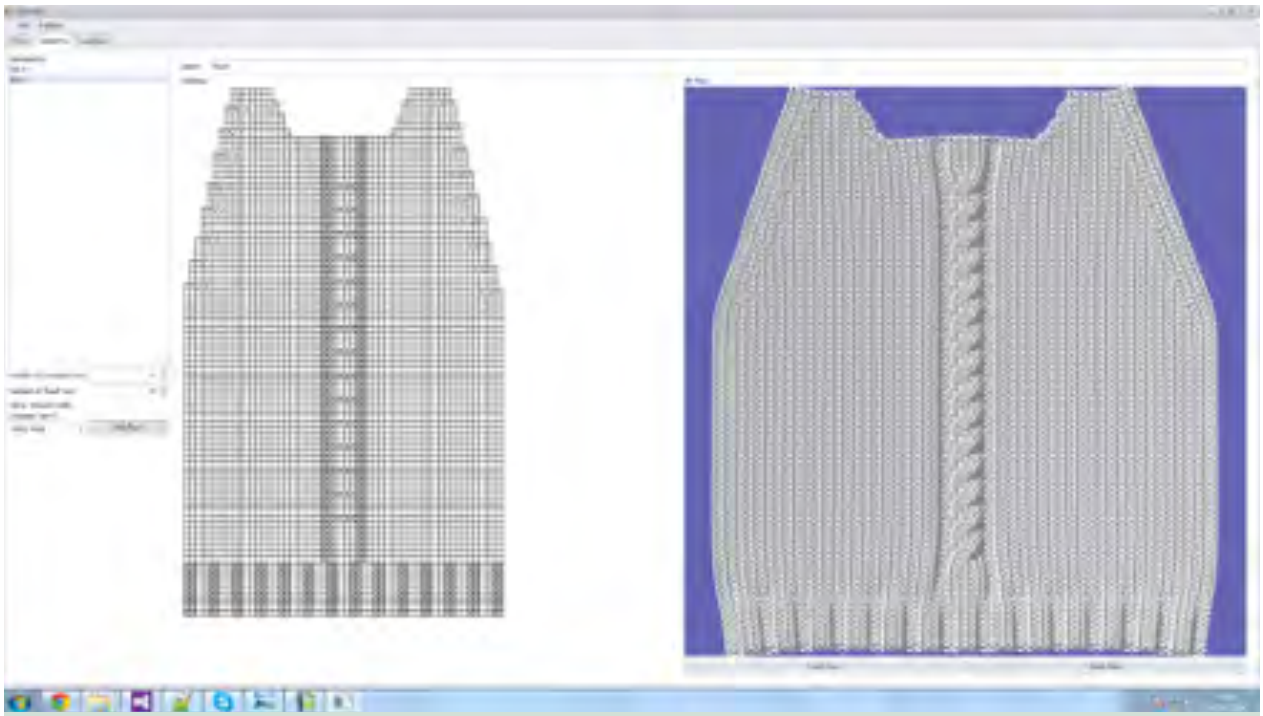

Figure 1: To the left, the pattern of the various stitches to be realised. To the right, the flat view of 3D.

experiment so that the software was not just another virtual reality tool but had a real application value. In this phase, most of the specific information was collected about the construction of the garments, yarn quality, type of stitch used by the knitwear industry for the realisation of articles of clothing. "Cose di Maglia" and Maglificio Ghidotti provided basic articles of clothing that were analysed and from which the pattern was derived to develop an abacus of collection-type for Smart-K. The intent of this part of the project was to create the basis for a collection providing for all the possible types of basic clothes able to implement the software "library" as much as possible.

25 items were chosen and for each of these there were four photographic sequences (azimuth, lookbook, hardLight, softLight) and two video sequences (hardLight, softLight). Moreover, from the same article of clothing two photographic sequences were also made with still model, for a possible 3D reconstruction of the human figure.

At the conclusion of this graphic, visual and physical reconnaissance of the articles, a shared language (CSV) scheme was elaborated to create the pattern, and the relative working to appear thereon, for the programming of the industrial machine.

At the same time, within Maglificio Ghidotti, the programming method currently in use was studied: in fact, the programmer interprets the design provided by the style office and manually completes Excel files, in which in enters, stitch by stitch, all the movements that the machine will have to make. Manufacturers of industrial knitwear machines such as Steiger provide their own software, such as Model, which translates the information of the Excel files into machine language.

From the Model software and having developed a shared language (CSV), the final tables and procedures to complete a pattern-type were elaborated so that both the company and the knitwear producer, or Knit designer, may have the necessary and shared tools for the design of the garments.

For the representation of the pattern-type, there were several design tests both for redesign of the garment and modelling; each garment was deconstructed into its original parts (sleeves, front, back, neck, pockets) and once the basic pattern was defined (number of needles/ranks, yarn titration, type of stitches), two separate cards were created for each model: the first, which provided information on the type of garment (colour, yarn titre, fineness of the machine, measured in cm of the pattern), the second, an Excel file in which each cell corresponded to a stitch, and each sheet , represented a part of the garment (neck, sleeve, front, back, pocket, etc...).

Above we see one of the tables completed through the CSV language: all information on the yarn (titration, density, fineness, composition, twist, colour, elasticity, resistance), garments (length and width as well as extension, resistance of seams,

Figure 2: Some of the screens of the Model software, in which the programmer enters stitch by stitch the commands related to the product to be realised.

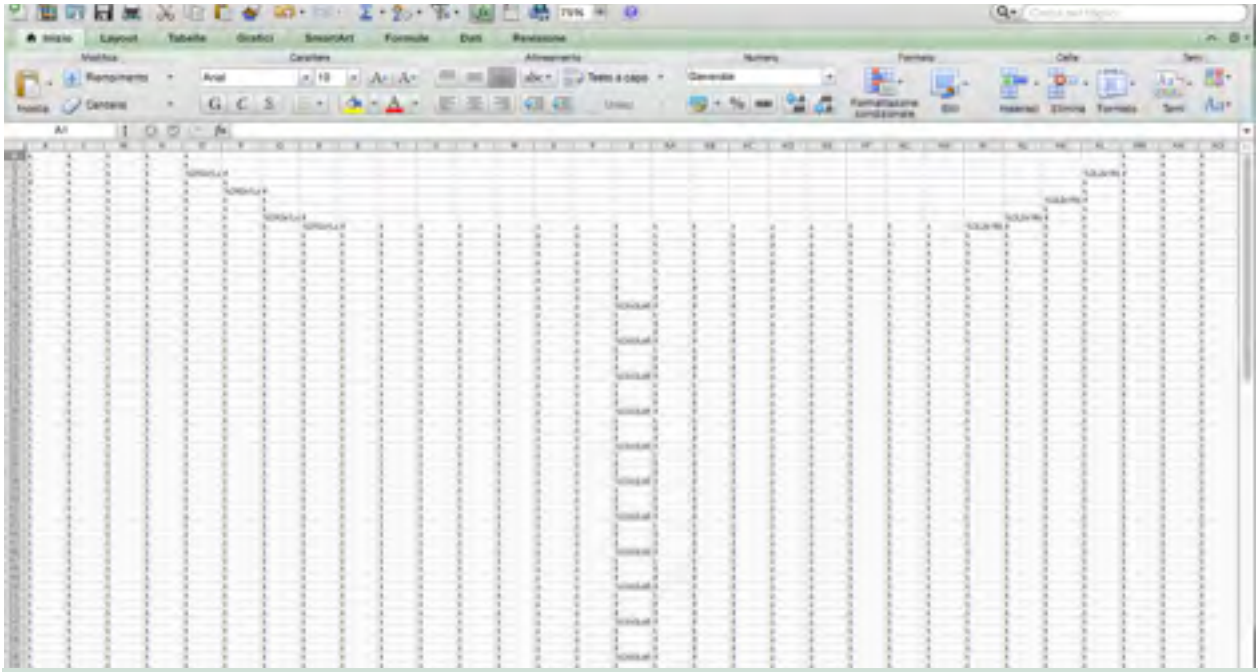

Figure 3: Screenshot of the excel file with the CSV language: in the table you can see the straight and reverse stitches (respectively encoded as P and K), and the code for the intersection of 4 knitting on the left to form a braid (%C4x3Left2)

etc.,), stitches (straight, reverse, detained, cross, increases and decreases) has an own code so SMART - K will be capable of combining data and elaborating the simulation of the finished product. This type of language, combined with the Model software dedicated to the programming of Steiger industrial machines, can encode codes so that the industrial knitwear garment can be easily designed and thus realised.

Objectives achieved

Several objectives were achieved during the two years of research and there was intensive exchange of information and methods between the partners. As regards modelling, the guidelines were created for the achievement of a collection of basic items in knitwear studied in order to obtain a palette of specific patterns. In addition, through the interface model belonging to the application for 2D design of the knitwear producer Lectra Kaledo Knit, characterisation parameters of yarn were included in the Smart-K software: titration, density, fineness, composition, twist and colour. As for the area of Virtual Prototyping, during the project, design skills in new technologies applied to the design of the pattern of a knitwear garment were integrated and reinforced. Also, competencies in terms of operating software, and their integration, were enhanced for the realisation of a shared file. The shared file is a file that uses CSV language that is then inserted directly in the Smart-K display system.

The photos and videos were entered in the Smart-K software to integrate and return a 3D display as realistic as possible. In particular, the behaviour of the various materials and various models worn in motion was studied at physical level and helped ensure that the software, once the characteristics of the yarn and pattern were inserted, returned a rendering of the knit fabric as realistic as possible. This meant that through Smart-K real-time simulations could be obtained and it was possible to intervene immediately with the related corrections in order to avoid the production of test sheets, or sometimes test articles, which are now produced by knitwear producers to understand how to turn a design into wearable garment.

In industrial production, the last phase of the research involved the creation of a test item produced with the industrial machine by Maglificio Ghidotti and designed in full only virtually with the new Smart-K software. Specifically, it was possible to computer program the knit sheet, using the CVS language of the Smart-K software making it interact with the hardware part of the Steiger industrial machine and producing directly, with fewer steps on the part of the Model programmer, the sheet itself. Therefore, from the idea to the machine in a single step: the designer can intervene by giving the Smart-K software aesthetic and creative information on the desired garment. The software in real time simulation simulates the final product and passes the information directly to Model, which, in turn, transforms the 3D garment in technical language of working for the industrial machine. SMART - K is definitely one of the first integration projects of the entire production chain of the sector of the Italian knitwear industry.

Figure 4: Screenshot of the simulation of a garment worn: tests of wearability, colour, working stitch, yarn quality.

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