DESIGNING KNIT DESIGNERS

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Knitwear design. A design discipline between manual tradition and advanced technology
by *Giovanni Maria Conti*

Knitwear design. A design discipline between manual tradition and advanced technology

by *Giovanni Maria Conti*[1]

In the following pages, the reader will be able to understand how today knitting, typical manual practice of the Italian tradition, is a young discipline with a great need for scientific and technological deepening.

Since 2008, at the School of Design of Politecnico di Milano, we deal with knitwear design and deepen its dynamics of innovation within Italian companies. Knitwear is, indeed, one of the founding sectors of that Made in Italy that has made the Italian products famous all over the world. It's no coincidence that spinning, weaving, embellishing were the ways in which women mainly worked threads, yarns, various materials; some of the most futuristic uppers, created by Salvatore Ferragamo in the 1930s, are preciously weaved and knitted. The SNIA Viscosa was created in Italy to experiment towards the creation of yarns that could mimic the sheen of silk used, especially during the 30s and the 40s, for parachutes. The popular tradition of the peninsula, from Lombardy to Sicily, from the technique of *chiacchierino* to the *sfilato*, sees a manual richness in working natural fibres and yarns for the realization of unique traditional products.

Today knitwear is an articulated and complex industrial sector that includes different kinds of stakeholders with which the University constantly dialogues to facilitate and promote product and process innovation. We can say that in Italy we have various fashion brands, many of which strongly specialized in knitwear; some among the most specialized yarn manufacturers, with high rate of innovation, that range from the processing of animal and plant fibres in very fine and high-quality yarns to the creation, transformation and production of artificial fibres. Italy also boasts the presence of the international locations of

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some of the most authoritative certifiers and promoters of natural fibres such as Woolmark Company Italy and the Consortium of Linen and Hemp - CELC, as well as having the commercial and production headquarters of the most important companies for electronic knitting.

Still, in Italy, meta industrial districts have evolved with a high rate of specialization, which makes the products unique in terms of recognition, quality and research. Surely if we search for the best Merino wool or cashmere, we will take a tour around the cities of Biella, Vercelli and Novara, and we will look for fancy yarns around Prato. We will find silk in Como and cotton in the provinces of Bergamo and Brescia, together with the best machines to make a pair of socks.

Despite being synthetic, these considerations describe in broad terms what we find in each territory, and clarifies the fact that, at the production level, in that specific territory has grown the best value chain that Italian companies have been able to structure and for which, day after day, they work.

We then asked ourselves what the University could do for these companies, and how the discipline of fashion design could respond in terms of training to make the professionals of the future ready to work within such a highly specialized sector.

Through project activities directly developed with some companies of the territories described above, participating in the international competitions offered by some of these companies to students, sometimes forcing the disciplinary practice itself, we have, in recent years, worked on several training activities, always keeping the aim to make available to the company the human and intellectual capital represented by students, to generate innovation in terms of product/service/process. On the other hand, we involved the companies within the University in an active and factual way so that they could interact, directly and immediately, with those who will probably be their future designers, consultants, managers.

Finding the methodology for teaching design within such a context was, and is, the theme covered in this volume, the main academic challenge. Agreeing with what Schön (1983) wrote

It is our capacity to see unfamiliar situations as familiar ones, and to do in the former as we have done in the latter, that enables us to bring our past experience to bear on the unique case. It is our capacity to see-as and do-as that allow us to have a feel for problems that do not fit existing rules.

During these years, and within some of the activities described below, the educational goal that we have pursued has always been to go beyond the

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practice to find unexpected solutions for the assigned design themes. Hybridize processes and production methods to understand how to give new features to knitwear, compared to those that by its nature characterize it in terms of hand, fit, usability: students have stiffen it, print it, make it waterproof, or three-dimensional, during the thesis carried out in collaboration directly with the partner companies involved.

Another element that characterized the structuring of the training course in knitting design was that of how to learn techniques and technologies. The first phase of learning sees students starting to work with knitting needles, to understand the movement of the yarn and the time it takes to realize a product; this purely manual activity is hybridized with the learning of how to knit with double-bed domestic machines. At this stage, students acquire awareness and independence over what can be achieved and what can't, and it is here that the university education model has focused. If a garment is nothing more than the assembly of previously cut pieces, knitwear is made by the designer on the machine, starting from a yarn and ending with a finished garment.

The training model finds here its characterization, bringing within the university design discipline approach typical of the knitting factory. Here the synthesis between the design method and the operational practice of the industry has also shown that students are able to deal with the last step of learning, namely the programming of power machines.

In all the project activities carried out in recent years, and in the collaboration with the companies, this methodological approach has proven to be very useful in bringing the university methodology closer to the operation of the company, understanding the constraints and stimulating students to find design solutions that exceeded the limits imposed by the techniques. On the other hand, it has shown the company that considering the practical operation a routine restricts the activity and does not generate research for new design solutions, as it relegates everything to the mere compliance with the constraints. A prime example was the participation of two students of Knitwear Design in the international Knit Game competition promoted by Loro Piana. Winning the first phase and being in the company to develop the stitches that they had designed and realized with the domestic machines, the students, together with the technicians of the company, verified that one of those samples was not feasible with the electronic machines present, or rather with the technologies until then available to the company. This particular was a further design challenge for the designers because they had to adapt their idea to what technology could offer. It has demonstrated to the company that research is a source of continuous innovation, even by adapting the existing technology to the encountered design need.

The relationship between technique and technology, and the cross-fertilization between tools and methods in use at the Universities as well as in the companies, are therefore the real "place of research" for all the activities outlined within this book.

Design is a living discipline and fashion is such a diverse and complex sector that, specifically in Italy, it requires great knowledge and skills. Knitting is a very interesting area of research, where the methodological rigor of design combined with the know-how of the industrial sector today feeds a rich area of experimentation and innovation.

1. Introduction

1. Knitwear design as a scientific discipline: a complexity to be addressed

Traditionally associated with craftmanship and manual work, knitwear could seem a quite unusual subject of investigation for scientific research in design, as it also pays the price to be part of the fashion practices, which are still often treated with an artistic approach.

The work presented here had the aim to demonstrate the validity of the topic as an area of inquiry among the industrial design disciplines, and to give it structure from an academic point of view.

As part of the industrial design culture, the fashion system has developed in its areas a high degree of specialization of the creative and productive chain (Dell'Acqua, 2007), and the academic discourse is now moving towards these specific realities, focusing on jewellery design, artisanal techniques, technology and interaction. With these premises comes this work with a focus on a specific area of fashion design, knitwear design, that is often left as a simple variation on the theme of fashion but is a peculiar ground of new industrial and technological experimentation while being at the same time one of the most traditional sectors of Made in Italy (Conti, 2016).

From the industrial standpoint, indeed, knitwear is a very interesting field to be addressed, as it is one of the most complex realities between the excellences of Made in Italy, with a long and fragmented production chain made of many different stakeholders. This complexity leads to high waste of time, resources and materials and leaves low budget for the training of new designers and for knowledge transfer inside companies. Nonetheless, in an industrial scenario that is continuously renewing itself, it is increasingly urgent the concrete need to train new professionals, able not only to innovate the processes of the whole production chain of knitwear, but also to keep the eye on the craftsmanship and on the traditional work from where this industry

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originated (Affinito, Conti and Motta 2017), to act therefore in between tradition and innovation, creativity and technique. Doesn't such a discipline require a cultural background and specific competences that are different from to those of the more generic clothing designer (Traini, 2004) and, therefore, a specific set of teaching tools and methods and a peculiar university research?

Despite being so specific, the reality of knitwear includes all the four substantive challenges that, to Friedman and Stolterman (2014) are driving the ongoing convergence in design practice and research, happening in all the fields: it has increasingly ambiguous boundaries between artefacts, structure, and process; it faces increasingly large-scale economic and industrial frames; it is an increasingly complex environment of needs, requirements, and constraints; it contains information that often exceeds the physical substance, as it deals with material products charged with immaterial values.

If fresh eyes can foster innovation, it is also true that these «eyes must be educated and knowledgeable» (ibid.) in understanding this kind of complexity.

In the contemporary scenario, whoever deals with the training of knitwear designers inside higher education institutions (HEIs) has the duty to understand, and return, how the methodological and educational boundaries of this design discipline are expanding and what are the tools and the design methodologies at designers' disposal for them to be successfully placed in the contemporary production and consumption scenarios, which means to make design that «is not industrial design in the sense of designing products, but industry-related design, design as thought and action for solving problems and imagining new futures» (ibid.).

As a researcher who also works into design didactics, the author addressed the complexity of knitwear industry from this educational perspective, investigating what kind of competences should a well prepared professional figure own to respond to the needs of the industrial context, whether or not knitwear design education needs specific design tools and methods and how these tools can deliver the proper technical and cultural knowledge, different from the generic one of fashion design. The recognized industrial vocation of knitwear therefore represents the key point of a discipline that is set in the academic context of Politecnico di Milano, where the fashion design program is the youngest among the other industrial design disciplines, but like them is deeply connected with the project-oriented mind-set and so mainly detached from the common thought that sees fashion as the product of an artist.

2. Experimental actions to teach knitwear design: a research strategy towards innovation

Due to the presence of very few literature and scientific research about the topic, the present work had to frame the state-of-the-art and to build new knowledge useful to then intervene with impacting experimental actions.

A preliminary qualitative investigation has been conducted on two parallel tracks, to acquire knowledge on the two macro-areas of research interest: knitwear design as a part of the industrial Italian fabric, and knitwear design as a discipline taught inside design universities. The aim was to identify, especially in the overlapping boundaries between the two areas, fertile spots to intervene with experimental actions towards innovation.

For the first macro-area of research, knitwear as an industry, the investigation had multiple aims: to obtain a clearer picture of the sector on the Italian context, identifying the best practices between the stakeholders and framing the productive process in all its steps, also understanding the role of each stakeholder inside it, the relations between all of them, and the role that a designer could undertake when immersed in the supply chain.

Information were collected through observation during visits to companies, shops and trade fairs, combined with desk research and semi-structured interviews to professionals. The investigation focused on the Italian context, as Italy is still today the only country with a complete industrial system specialized in knitwear, from the raw material processing to the production of the finished product. As said earlier, it is a fragmented and complex system grown with the interaction between different stakeholders highly rooted on the territory, especially in the areas around Biella, in Piedmont, Carpi, in Emilia Romagna, and Prato, in Tuscany which are the actual industrial districts of knitwear, plus the areas of Bergamo, Brescia, Padova and Treviso, where another part of this production of excellence is located due to the work of small and rarely medium manufacturers.

Studying Italian knitwear means also to take in consideration the rich relations between local SMEs and the international context, which represents the major market for the sector: the research thus involved international fairs, as FILO and Pitti Filati; the most important certificatory bodies operating on a global scale, as The Woolmark Company for wool and CELC for linen and hemp; the most important producers of industrial knitting machines, as Shima Seiki and Stoll. The analysis of these last three categories of stakeholders turned out to be very important for the study, being them facilitators in creating networks, contacts and collaborations, among the companies

certainly, but also between companies and universities, which are among the final objective of this work.

This analysis highlighted the needs of the industry in terms of young designers, that delivers to the main necessity of specifically trained professionals in the field and, by outlining all the steps of the productive process, answered the important question 'who needs a knitwear designer?' with 'almost everyone': the strong contribution of the competences of a specialized knitwear designer indeed emerged not just within the style departments of fashion brands but in many steps of the chain and with all the stakeholders.

The second macro-area of research deepened the existing training offers for future knitwear designers and the teaching methods used, with the aim to identify what are the more effective methods and the patterns of knowledge transfer, understanding their strengths and possible weaknesses.

Here the methodology combined participative observation, made during diverse didactic activities at Politecnico di Milano (BA curricular courses and workshops, Post Graduate courses, BA thesis development) to understand knitwear design activities in their natural context, with the mapping of other Italian and international universities that deliver knit design courses, built mainly through desk research plus semi-structured interviews to teachers and students.

The participative observation has been important to understand how, around the same discipline, teaching tools and methods are different depending on the students' background, on their previous skills, on the available time and facilities to develop a given project. Alongside this, the mapping of the educational offer in knitwear design in ten national and international universities –selected among the excellent fashion design schools with specialist courses in KD– mainly aimed to investigate the structure of their programme and, useful in equal measure for this study, to understand if they have a pattern of connection with the industrial context of the territory. Given the identified needs and desiderata of the knitwear industry, this second track of preliminary research led to assume hypotheses of intervention for HEIs to address them. This twofold investigation led to set the following experimental phase of the work, based on the research approach through design theorized by Frayling (1993) and subsequently classified by Findeli *et al.* (2008) who sees design activity as a tool for the inductive generation of knowledge. In this phase, research through design met the applied research approach, putting the previous findings into practice, to generate new knowledge about their application.

The experimental phase was guided by two main pillars outlined by the preliminary research.

First, in this field there can be no creation without a technical background: knitwear is not just a creative exercise but a technique, a tool for creation that has to gather the ancient technical knowledge of the manual tradition and the ability to experiment with design and technological innovation. The knowledge of designers has to contain both creativity and technical knowledge, to make them able to interact in the most effective way with the various actors of a so articulated industrial structure. With these premises, first step to be done was to build a tool to orient and structure the envisioned experimental activities: a methodological framework for knitwear design teaching was set, to be better defined, applied and evaluated during the field experiences with didactic activities conducted on a national and international scale.

The second pillar was the constant tendency from people –professionals as well as academics and young designers– to believe that industry and university should be more deeply connected. The experimental pilot activities here reported were just intended to push the boundaries of the existing relationship between the two environments, to understand how the exchange of knowledge between them could be built and systematized to be beneficial for students, researchers, and professors as well as for professionals, managers, and the business environment as a whole. Didactic activities –diversified for number of participants, participants' background, setting, duration and applied solutions– were the tool used for the purpose, to create connections between the academic realities and the industrial territory and to work towards a synergic system of multi-level relationships companies-universities.

The analysis on successes and shortcomings of this phase made this study able to codify those that were initially just experimental assumptions in a set of guidelines to be transferred to further teaching/learning activities, even in different contexts. The integration of the guidelines with the designed framework reaches a comprehensive approach to the teaching of knitwear design which involves all the aspects of the industrial reality; a system of "knowledge alliances" among the partners involved designed to get a scalable pattern that could be applied on international contexts but always takes into account the territory and the industrial know-how in contact with which each university operates.

2. Knitwear, really?

1. The academic discourse

1.1. Scientific research in design: the roots

«Industrial design has a relatively recent history: as a somehow codified and explicit praxis it has no more than two hundred years, while as a discipline object of studies and academic research it is even younger» (Bertola, 2006, p. 25).

In *Design Multiverso* (2006) Ezio Manzini and Paola Bertola collect what they call "notes on design phenomenology", to give an overview on the status of academic research in design, with a particular focus on the different kind of design research pursued at that time –and still ongoing and evolving– at Politecnico di Milano. Introducing the issue of scientific thinking in the field of design, Bertola (ivi, pp. 25-26) recalls its history as an activity practiced for a long time in a natural way and learnt through direct experience, which did not feel the need of a specific education, neither of academic research. Then, since design entered schools, all of its disciplines –i.e. product design, graphic, fashion and textile design– have traditionally been included among the Arts and Crafts, with, again, no need of a theoretical and critical debate which could involve the academic world. Bertola continues reporting the attempts made in the Anglo-Saxon world in the mid-Nineties to codify a rational "design science" moving from the positivist paradigm, that, coming from positivism as a philosophy, adheres to the view that only factual knowledge gained through human experience is reliable and gives observable and quantifiable findings. This atomistic, ontological view of the world that comprises «discrete, observable elements and events that interact in an observable, determined and regular manner» (Collins, 2010, p. 38) was strongly jeopardised by the subsequent development of a new thinking about design research. In 1982 prof. Nigel Cross, one of the key figures in the birth of the modern design research community, presented design as the new "third" domain of human knowledge, placed halfway between science and humanities. As an independent domain, he wrote, design has particular ways of exploring the surrounding reality, addressed by Cross as *designerly* ways of knowing. To Cross, both design research and design education had a common concern with these fundamental "ways of knowing", and together they were contributing to the development of design as a discipline. In the same years Donald Schön (1983) redefined the activities of the project as a combination of theory and praxis and started to think about scientific research in design as a reflection in and on action, an ability to observe the design action and to learn and produce new knowledge from this observation. This view

opened new perspectives for scientific research in design, which suddenly found itself practice-oriented. In his book, Schön observed also that the ability to learn from the practice and to gather new knowledge to be applied to subsequent processes was already owned and used by some working professionals in the field of the project. When this common attitude, nearly spontaneous, had to change to a scientific cognitive approach it has been necessary to rigorously rebuild its features and the circumstances in which it manifests itself. It has been necessary to «carry out specific research with the aim of broadening the information available, taking into account the reality of the social and territorial environments in which the phenomenon occurs» (Simonelli in Colombi and Simonelli, 2005, p. 1).

To Bertola (ivi, p. 28) this perspective was particularly suitable to shed light on the distinctive knowledge processes of Italian design, in which tacit knowledge has always been gathered from experience, exchange, cultural values and know-how, collectively shared inside industrial districts and deserved to be codified through scientific thinking. In such a context scientific research on design followed a reverse process, not preceding practice but being consequent to it, taking for once the moves from the fertile debate on design spontaneously ongoing inside industrial and entrepreneurial communities. (Bertola, 2006; Seassaro, 2004).

Naturally placed between arts and scientific disciplines, including aspects of both the domains, the research approach developed by the research communities in Italy –Politecnico di Milano came first followed by many other universities– took two fundamental features. On the one hand, due to the above-mentioned historical attitude to reflection on practice, there is a kind of research primarily oriented towards the codification of professional practices in a specific field, as a source of new knowledge on the "object of the project"; on the other, there is multidisciplinary research which explores the operative potential of design as an investigation tool of reality (Bertola, ivi, p. 38).

1.2. The discussion about fashion design

Both of the mentioned kinds of research find, at a contemporary glance, application in the field of fashion design. But fashion has waited for a long time to be included among the disciplines of industrial design and to be the object of attention from the academics. Ruppert-Stroescu and Hawley (2014) recalling Kawamura (2005), Vinken (2005) and Wilson (2003), note how the practice of researching in fashion industry has been traditionally marginalized in academic communities where fashion has always been perceived as

a too ephemeral artistic world with no reason to be addressed by scientific thinking, as it already possesses its own innovative processes guided by the designer's creative genius and, therefore, not attributable to the codified processes of academic research (Colombi, in Colombi and Simonelli, 2005, p. 4). On the other hand, there was also someone looking at fashion from the perspective of a mass-productive industry, where market impositions could affect the disciplinary integrity of university research.

Within the past fifteen years something has changed (Ruppert-Stroescu and Hawley, 2014) on the international scene as well as on the Italian one. A part of the scientific circles related to industrial design has drawn attention to fashion products, recognizing the correspondence between industrial and fashion design: if industrial design is thus the discipline that deals with the design and development of industrial products by integrating cultural knowledge with artistic, technological and managerial operative skills (Dell'Acqua Bellavitis, 2007, p. 13), fashion accentuates this dichotomy being on one side a cultural product, an identitary and collective language, on the other a consumption good of mass-production. (Bertola, 2007; Ricchetti and Cietta, 2006). Traini (2004, p. 239) outlines the parallelism between the design process in fashion and furniture –here intended as the most widely recognized form of Italian product design– saying that «if design is an action of figurative transformation that leads from concept to a finished product, then fashion is obviously related to it». Making fashion is, in this sense, a design process which includes «design, textile and textile decoration research; the invention, the creative process; expression through words and drawings; ergonomic checks; feasibility checks. Even the relationship between concept, planning and production is exactly the same» (ibid.).

From the moment fashion received its acknowledgement, scientific research in the field has been progressively structured as one of the most recently established areas of inquiry among the ones of industrial design. It took the features of action-research, because it gathered continuous feedback from the teaching activity in higher education institutions, which was young yet already ongoing and oriented towards the training of figures responding to the needs of the different sectors of the fashion production system (Dell'Acqua Bellavitis, op. cit., p. 13). In Italy this process has been even further fostered by the strong orientation of the Italian fashion towards an industrial and product dimension and towards an idea of designer far from the ephemeral image inherited from French *couturiers*. Here the whole fashion process is permeated by the culture of the project, namely the work ethic typical of the enlightened industrial designer who, working in close collaboration with manufacturers, and continually dealing with these almost

artisanal realities, knows how to combine techniques, materials and production, while remaining constantly in search of innovation and creativity (Mazzucotelli Salice and Mora 2013; Bertola in Bertola and Conti, 2007).

1.3. A role for knitwear design among academic research

The first doctoral researches conducted at Politecnico di Milano in the field of fashion (Conti, 2007; Colombi, 2007) helped to set the methodological groundworks of the Fashion Design study path for the training of this new kind of figure and took at the same time a founding role for the related academic research (Conti, 2007, p. 9).

Once defined the boundaries of the academic discourse, research in fashion started to move towards studies able to foster innovation on a regional or national scale (see Vacca, 2009; Zanolla Mancini, 2012), using design-oriented practice as a driver to gather new knowledge and innovation to then transmit territorial values on the international projects with which university research is used to deal (Dell'Acqua Bellavitis, 2007). Although they kept the multidisciplinary approach of design research, it has been spontaneous for this kind of investigations to search for correspondence among the diverse realities with high degree of specialization, which constitute the excellences of Italian fashion system and to narrow attention on them focusing on jewellery design, artisanal techniques, technology and interaction. This specialization, as Dell'Acqua Bellavitis (2013) notes, is due to the duty of a Fashion Design study path to train designers-technicians able to operate in a specific industrial sector and at the same time to represent and communicate the system as a whole. For this reason, knitwear design has been introduced as a specialism in the study program of Fashion Design at Politecnico di Milano since 2011. This specific area is often left as a simple variation on the theme of general fashion education, and even where –in Italy or abroad– it has dedicated university courses, still no mention is made to it among academic research. To open a line of research on knitwear inside a design university means to have the opportunity to study one of the most traditional sectors of Made in Italy, peculiar ground of new industrial and technological experimentation (Traini, 2004; Conti, 2016), but more importantly to deal with an integrated way of designing, concerning materials, representation, sampling, prototyping, techniques and so forth (Sissons, 2010; Conti, 2013).

With the exception of the investigation work carried out by Claudia Eckert and her research group and concluded in the early years of the century, there is no other reference to systematic academic research on the knitwear

design process and on the role of knitwear designers. Some other scientific literature in the field does exist, but it is out of focus for the present study as it is mainly concentrated on the latest technologies which use knitwear as a technique comparable to 3D printing and other additive production methods.

In her investigation Eckert (1997) explored knitwear design as a complex industrial process which had never been previously studied in detail, to find solutions to its inefficiency through the use of new software and technology. Even if she identified as one of the main problems the lack of technical knowledge owned by designers, her work did not touch knitwear design education and considered knitwear products more as the result of a mass-production process rather than as garments charged with cultural values of which the designer is a promoter.

Framed on the Italian academic and industrial scenario, the present study intends to represent a bridge between scientific research and education in the field of knitwear design, to find an effective response to the needs of this sector, made of extremely specialized excellences that require designers to have a cultural background and specific competences different from to those suitable to the more generic clothing designer (Traini, 2004). It is in light of these premises and observing the ever-greater correspondence of fashion design disciplines with their respective specialized production areas, that this research promotes for knitwear design a specific set of teaching tools and methods and a peculiar university research.

2. Knitwear as an Italian industrial reality

2.1. Introduction

Knitwear usually reminds to an ancient craft art, but it is also one of the oldest fields of Italian fashion industry and still one of its most important on a commercial point of view. With a total invoice of about 6 billion Euros (data 2014), there must be something a long way from people knitting scarves with two needles in the warmth of their houses.

That "something" is a working industry with a structured and articulated supply chain, rooted on the territory, which is part in its own right of the textile-clothing sector that Fortis (2015) includes among the "4A", the four areas of excellence of Italian manufacture, together with home furnishing, automation-mechanics, food and beverages[1]. The recorded exports of 4.28 billion Euros (2015), increased of 6.5% compared to 2014, show how Italian knitwear represents the high-quality values of Made in Italy in the world and contributes to its success. The prevalence of European and northern America countries –the first market is France, which accounts for almost 14% of sector revenues, following Germany and the United States, Hong Kong and United Kingdom– is a consequence of the high quality products that Italian fashion exports, mainly intended for high-end *prêt-à-porter* signed by international brands, the market segment of the so-called "affordable luxury" that is re-emerging in the latest years (Pieraccini, 2017).

In knitwear, as well as in many other sectors of Italian manufacture, the merely industrial aspect and the artisanal one, that might seem so far apart, are not really divided but interweaved together in constituting the fundamental pillars of Made in Italy. This section deepens these aspects with an overview on the literature about Made in Italy and the Italian fashion system, with the aim to verify how Italian knitwear is deeply embedded in this reference context as a productive reality with high degree of specialization, peculiar ground of new industrial and technological experimentation while being at the same time one of the most traditional sectors of fashion.

The background outlined here also intends to explain why this study has been framed into the Italian context and the reasons why it represents a privileged area of inquiry for the related experimental actions of research.

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[1] The "4A" refers to the Italian words *Abbigliamento, Alimentare, Automazione, Arredamento* (Apparel, Food, Automation, Furniture). A similar and common categorization is the one of the 3F, for Fashion, Food and Furniture.

Country of origin	Mil. €	Var. %	% Share	Country of destination	Mil. €	Var. %	% Share
TOTAL	4569	1,3	100,0	**TOTAL**	7995	3,9	100,0
inter EU 28s	2062	-1,5	45,1	inter EU 28s	4239	6,0	53,0
extra EU 28s	2507	3,7	54,9	extra EU 28s	3756	1,7	47,0
First 15 suppliers				**First 15 clients**			
China	1011	-0,5	22,1	France	913	3,3	11,4
France	502	6,5	11,0	Germany	855	4,9	10,7
Bangladesh	347	6,1	7,6	United States	601	-2,9	7,5
Romania	297	-6,7	6,5	Hong Kong	560	-3,2	7,0
Germany	247	5,5	5,4	United Kingdom	547	7,4	6,8
Spain	180	-5,4	3,9	Switzerland	544	11,6	6,8
Belgium	178	-18,2	3,9	Russia	458	9,0	5,7
Turkey	159	-9,0	3,5	Spain	443	6,7	5,5
Tunisia	147	-3,4	3,2	Japan	328	-4,1	4,1
Netherlands	143	33,5	3,1	China	275	4,3	3,4
India	125	-2,1	2,7	Austria	200	13,0	2,5
Bulgaria	95	-13,0	2,1	Belgium	197	2,6	2,5
Cambodia	88	2,6	1,9	Netherlands	187	11,4	2,3
United Kingdom	88	-21,7	1,9	South Korea	155	9,4	1,9
Croatia	83	-3,7	1,8	Poland	139	15,3	1,7

Fig. 1 - Analysis of the import-export of Italian fashion (womenswear) towards and from other countries. Source: Confindustria Moda on ISTAT data.
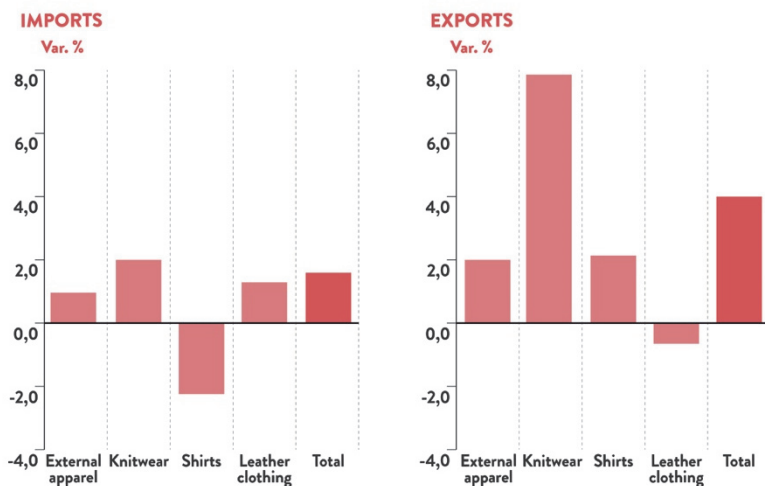
Fig. 2 - Analysis of the trade of Italian womenswear with foreign countries per product category (Jan-Nov 2017). Source: Economic note "La moda femminile italiana nel 2017-2018", edited by Confindustria Moda - Centro Studi per SMI Sistema Moda Italia, Milan, February 24th, 2018.

The following paragraphs retrace what the production of several authors–both scholars and professionals in the fields of design, sociology or economy–presents as the added values which make the Italian industry and fashion system a unique case of interest, and analyse their specific declination on the knitwear sector, highlighting correspondences, peculiarities and diversities.

These values, or specific features, extensively treated in the literature as deeply integrated between each other, are here resumed and furtherly discussed along this chapter as the elements which constitute the complexity of Italian fashion system.

- **Culture**. The double-sided orientation of the fashion system towards cultural products as well as towards mass-produced items.
- **Product-oriented creativity**. A fashion made of well-designed products, feasible, saleable on the market.
- **Territory and knowledge**. The collective creativity which pervades the industrial districts.
- **Small and specialized**. A whole supply chain made up by the smallest realities and the highest expertise.

2.2. Culture

The double-sided orientation of the fashion system towards cultural products as well as towards mass-produced items.

The pair culture-production has been recognized by many authors in the different fields of design, sociology and economy as a peculiar feature of the whole Italian fashion industry: Bertola (Bertola and Conti, 2007), Kawamura (2005) and Ricchetti (2006) frame the cultural component of fashion as an instrument of definition and communication of the individual, social and collective identity, and state that the distinctive trait of fashion is indeed to be, on the one hand a cultural product, and on the other to be comparable with industrially and mass-manufactured consumption goods.

While this is a viable definition for fashion in general, when talking about Italian fashion it is worthwhile to introduce other facets of the concept of culture: to Malossi, Traverso and Di Pasqua (in Ricchetti and Cietta, 2006, p. 10) Italian fashion it is not just industry, but also culture, intended as the tacit know-how handed down through generations. In this view, they introduce the concept of a "capital intensive" culture, namely of an industry with high use of the cultural capital as it was raw material within the production process, considering it as productive investment. Again, to Bertola (2008)

and Zanolla Mancini (2011) Italian fashion products are to all intents and purposes industrial products, but they are deeply rooted in our culture and represent the history of local areas and a typical idea of beauty. They are the product of an all-Italian creative process on the one hand, and of a painstaking production process on the other (Zanolla Mancini, ibid.).

Can be said that in Italy the fashion field accepts and integrates different facets of culture, and always takes them into account in their dualism with industrial-productive processes. Starting from this perspective on the fashion field in general, it is important for this study to define which are the values that contain the "culture of knitwear": when Giuliano Marelli[2] says "*La maglia è cultura*", "knitting is culture", he refers to the heritage and to the ensemble of materials, shapes, techniques, and stitches that does not bring just to the ancient allure of a handmade sweater but evolves with the Zeitgeist and becomes integral part of a productive industrial sector (Marelli, 2018).

From these words, given that this research addresses knitwear from the perspective of an industrial designer conducting design studies, and so it aims to be focused on the contemporary productive reality, the strong bond with the handcraft has to be taken into account while defining the boundaries of the topic, and a clearer framework of what manual work should represent and of how it should be considered along an industrial supply chain, especially from a designer's perspective, must be given.

Knitwear, as a product of the action to knit, is often considered more as a craft art than as an industrial system. In the personal experience of the author, any dialogue which happened more or less accidentally with friends or acquaintances –people outside the academic world but not always stranger to the fashion system–, in the most diverse situations, about knitwear as the specific focus of her professional activity and of her doctoral research, led to the so dreaded question: **Oh, would you knit me a sweater?**

This, so common, naïve reaction indeed opens many reflections on the actual perception on knitwear, which too often still recalls to an ancient manual work, barely homemade.

Knitwear certainly has a centuries-old tradition related to the manual techniques of hand-knitting. Its origins date back to when human beings started to make craft objects with the ability of their hands, weaving yarns only with the fingers, as long ago as 1000 BC (Sissons, 2010). The oldest knitted artefact, likely made with four or five needles with the circular

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[2] Giuliano Marelli is the founder, with his wife Giusy, of Studio Marelli, a private design studio where the couple designs hand and machine-knitting. Giuliano and Giusy deal with knitwear since the Eighties, when they used to design entire collections for national and international brands.

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knitting technique, is a pair of seamless red socks with divided toes made to be worn with sandals; it has been found in Egyptian tombs and belong to the Romano-Egyptian period. Lately, over the centuries, hand-knitting successfully produced any kind of accessory and garment as caps, gloves and socks, sweaters and underwear, until the more recent examples of traditional knits such as ganseys sweaters, popular from the 17th century among English fishermen, Fair Isle or Aran, which still return every winter on contemporary catwalks.

Hand-knitting so evolved as human society did, being part of it, perpetuated through generations and charged with symbolisms. Stitches have been used as a language to tell stories or as a mark of identity and of belonging to different tribes, materials have been processed and developed in many diverse ways around the world, techniques have become more and more sophisticated, and all of these elements articulated the rich cultural heritage of manual knitting (Sissons, 2010; Black, 2012).

Returning to Giuliano Marelli's words, such a strong manual cultural heritage is also integral part of a productive industrial sector: historical records from the late fifteenth century report clear evidence of the spread of hand knitting not just as a domestic practice, but also as a profitable commercial activity throughout the British Isles, Europe, Scandinavia and United States. From then on, knitting has evolved from a hobby into a modern industry: starting from 1589, when the English Reverend William Lee invented the stocking knitting frame, created to be used with British sheep's wool. Lee, unsuccessful in promoting his invention to Queen Elizabeth, who feared it as a threat for the flourishing hand-knitting industry, adapted the frame to be used with silk: twenty needles per inch instead of the previous eight, the frame could work the expensive thin silk yarns and proved to be a great success among the French silk manufacturers. Not anymore one stitch at a time, as whole rows were now knitted at once, knitting became faster and faster, opening the path –with the operation of hand-frames and the development of powered knitting machines and advanced technology– to knitwear industry to develop and grow as mass-production (Sissons, 2010).

On the Italian scenario knitwear industry followed a slightly different path in its development, managing to preserve the craft aspect as an intrinsic value in all the processes that happen inside industrial districts. This somehow uncompleted transition from craft into mass-production introduces today, from a designer's perspective, a very up-to-date issue: do manual techniques, charged of cultural values, still have a role in a contemporary designer's work?

To Annichiarico, the transition from hobby into project is the implementation of

a purely manual process, an apparently simple gesture that can be understood as a metaphor of the human creativity itself, that brings together craftsmanship and design, aesthetic sensibility combined with today's technological developments, by placing the knitwear designer's work halfway between tradition and modernity (Annichiarico, 2009, p. 10).

This view completely includes knitwear in the contemporary debate on design and future craft, where, as Micelli (2011) writes, the enhancement of manual work does not refer to any nostalgia for the past. Micelli sees craftsmanship in Italy as an essential ingredient for the success of businesses, when it manages to know how to project itself into a new economic and cultural dimension. Moving from these statements, the craft aspect must be considered still today, especially when dealing with an industrial system, as an essential part of the cultural value of knitwear and is the duty of designers to enhance this peculiarity. This introduces what Conti (2016) defines as the basis of the industrial excellences of Made in Italy as a whole: the modus operandi of Italian design, namely the integration of traditional knowledge with technological innovation and experimentation throughout the supply chain, while condensing design, know-how and craftsmanship. This modus operandi, Conti continues, finds «its perfect soil in knitwear, expression of an ancient local tradition with a strong distinctive style and production quality», and places it in its own right among the recognized culture of Made in Italy.

2.3. Product-oriented creativity

A fashion made of well-designed products, feasible, saleable on the market

What are the peculiarities of Italian industry? How does this country produce products recognized all over the world for their beauty and their quality? Can these qualities be found in knitwear products as well?

Made in Italy has been defined in the literature as a set of high-quality products and services of a compound of sectors, recognized by the collective imagination around the world, characterized with cultural content, based on small and medium enterprises and connected to the values and heritage of the territory where they belong (Bertola and Colombi 2014; Bertola and Maffei 2007; Fortis 1998; Beccattini 2007).

Fortis (1998) continues saying that the strengths of Italian economy are the so called and already mentioned "traditional" sectors, the ones that evolved from an ancient artisanal know-how that Italy has owned for centuries and that is often due to the expertise in the processing of raw materials. Fashion with wool, silk, leathers, gold and other precious metals; furniture with wood, marble, brass; automation and mechanics with the high-level specialized machinery developed to process those materials. Knitwear, «describable as an activity that transforms a single yarn, or more yarns, in a fabric with the aim to generate a shape which then can assume a specific function» (Motta and Conti, 2014) is one of these traditional sectors and, furthermore, it still keeps a strong bond with the processing of raw materials, since spinning mills –mainly wool spinners, but also cotton, linen and fancy yarns– represent a large part of the entire system (data 2018).
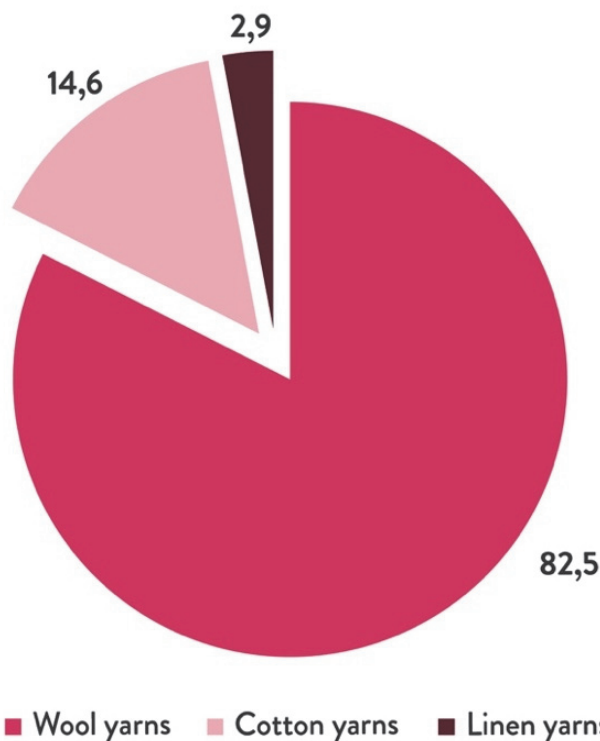
Fig. 3 - Italian spinning industry (2013-2016). Source: SMI on ISTAT data.

	2013	2014	2015	2016
Income	2979	2918	2917	2837
Var. %		-2,0	-0,0	-2,7
Production value	1885	1834	1820	1759
Var. %		-2,7	-0,8	-3,3
Exports	898	871	871	828
Var. %		-3,0	-0,0	-4,9
Imports	831	833	849	881
Var. %		0,3	1,9	3,8
Consumption	1819	1797	1798	1813
Var. %		-1,2	0,1	0,8
Structural indic. (%)				
Exports/Income	30,1	29,8	29,8	29,2
Inports/Cons.	45,7	46,4	47,2	48,6

Fig. 4 – Incoming of the Italian spinning industry in 2016. Source: SMI on ISTAT data.

It must be considered that this particular kind of know-how about materials led to products that are today far from being artistic craftworks, and rather engender «an essential bond with the world of production» (Bertola and Colombi, 2014, p. 181). Bertola and Colombi (ibid.) also observe how the strong bonding between the creative-cultural and industrial systems in Italy that definitely occurred in the 1960s and 1970s, brought the final emancipation of Italian fashion from the French one, just a decade after the first fashion show held by Giovanni Battista Giorgini in Florence, in February 1951.

Since that first presentation, Italian fashion had to search for its own way to be different from the French one: a big help came from Italian knitwear, that has never had nothing to do with haute couture or with art as an end but was born as a proper industrial sector that has always been oriented toward a well-designed product, feasible and saleable on the market.

Consequently, it is no surprise that knitwear had a decisive role in placing itself alongside the Italian *alta moda* made by expert tailors and dressmakers for special occasions and gave a strong contribution to define the distinctive character of Italian fashion (White, 2013). Side-lined until then mostly to sportswear and woollen underwear, knitwear was proposed, by Giorgini's intuition, as daily informal clothing: easy to be worn, suitable for the everyday active life, sold at reasonable prices, yet elegant, it was the perfect

product to differentiate the Italian way of creating fashion from the established artistic mode of French *couturiers* (Motta, 2018a).

Back in those days, it was rather brave and ingenious to go with the idea of opening the fashion show with that seemingly informal and minor fashion item, one that could be created in a small shop in Capri. Placing knitwear in the limelight [...] was like desecrating a tradition, the custom of haute couture. Giorgini did it, and as a mark of his talent, did so with flair. He knew that those garments on show were in line with [...] the American way of life. (Elisa Massai cited in Vergani, 1992, p. 48)

As can be found out from the words by Elisa Massai, the only foreign journalist –from Woman Wear's Daily– invited to attend the baptism of Italian fashion in February 1951, the clientele at that time was predominantly American, because the European market was still reeling from the aftermath of the Second World War. It wasn't too long before Europe regained its purchasing power, contributing to the fortune and growth of our fashion industry. Anyway, United States remained one of the most important export markets for this sector thanks to the affordable prices of knitwear products and to the flexibility of Italian manufacturers in answering American requests (White, 2013). As White (ibid.) assumes, can be said that United States' demand of Italian knitwear, exponentially grown in terms of volume during the Fifties, guided the Italian production in the evolution from artisanal small series to machine-made mass-production. Again, knitwear led the success of boutique fashion, which integrates the serious collections of tailor-made *alta moda* with casual yet sophisticated clothes in knitwear or more traditional fabrics, perfect for the American city life or for the spare time of weekends (Massai and Lombardi, 1985).

During the Seventies the typical informality and comfort of knitwear reinforce its success, at a time when fashion moved, in Europe as well as overseas, towards leisure clothing in the refusal of the more traditional set look.

Again, knitwear found a way to be appreciated also during the Eighties, with the explosion of any kind of decorative technique like jacquards, stripes, sparkling yarns, tartans, squared motifs and patchworks, and renewed itself in the Nineties, when luxury was no longer ostentatious and the comfort of the individual body became more important than appearance, with high quality fibres as cashmere and silk used in natural tones.

Along its evolution, in every part of the world, whoever talks about high quality knitwear makes direct reference to Made in Italy products. This success is based on a series of economic and technical facts that, combined with the creative abilities and with the cultural traditions diffused among the manufacturers, allowed to expand the productive capability, incomes and exports.

Once highlighted the cultural aspects of knitwear and the unique features of a product that is designed for the industry rather than being a fashion artwork, it is the moment now to underline what is the typical structure of Italian industry and how knitwear has evolved inside it during the last century as one of the excellences of Made in Italy, becoming part of the district system that has established itself over the years as a unique and distinguishing element of this territory.

2.4. Territory and knowledge

The collective creativity which pervades the industrial districts

Numerous studies conducted in the last decades concentrate on the particular organization of Italian economy into districts, a phenomenon that is subject of interest almost everywhere in the world for scholars, politicians and mass media. The most common definition of industrial district is that of a productive specialization concentrated in a specific limited geographical area, marked by a special historical and cultural identity and by important social relationships (Fortis, 1998; Testa, 2003). Later, Corò and Micelli (2007a, p. 42) defined the district model as «an organization of production by small and medium-sized enterprises in which the local territory performs the function of infrastructure for economic, institutional and knowledge integration». According to them, although the Italian idea of the industrial district has been often associated just with traditional manufactures, the most important aspect of district economies is their being pools of specialized know-how, with a marked division of labour between firms and a dynamic competition between them.

From this view comes the third essential condition for Italian fashion system to be what it actually is. To create the above-mentioned products with cultural content, and to design them with an industrial and technical perspective a high expertise is surely required, but with a special feature: knowledge must be anything but punctual, secret or kept inside a company. According to the original intuition of the literature, what matters in industrial districts is not the single company, apparently too small and weak to survive on the fashion market, but the efficiency of the local division of labour, supported by the mentioned network of relationships, values, institutions, cultural codes and behaviour: Signorini (2014) argues that these are clearly very evanescent elements for economists. It is no coincidence that studies and literature on districts soon became multidisciplinary, engaging sociology first,

and later design, which study the phenomenon applied on creative industries and address the ways in which the creative process is spread and articulated along a whole supply chain.

A district is thus a structure of combined elements where the bonding between industry, territory and community keeps «the learning process alive and thus encourages innovation» (Corò and Micelli, 2007a, p. 43). The knowledge exchange happens spontaneously and often informally without any rule or procedure, thanks to the system built by the community since the beginning. Born as family businesses based on active collaboration towards efficiency and creativity, most districts in Italy still maintain the same matrix they had twenty or thirty years ago (Rapporto osservatorio distretti, 2014, p. 52) and knowledge networks still play a decisive role inside them, despite the profound changes induced by the economic crisis and the relocation of production in foreign countries, where the labour costs are lower and looser the environmental rules (Sassatelli, 2006).

The fashion industry is one of what many authors in the literature widely treated and defined as creative industries (Henry, 2007; Pratt and Jeffcutt, 2009), generally framed as knowledge-intensive and labour-intensive industries which use creativity to generate wealth. It follows that, in the fashion system, the knowledge to be shared is not just technical or productive but also precisely creative, namely the "**design know-how**" that creates new products with a peculiar kind of innovation that is both technical and cultural, and subsequently generates new knowledge.

This particular condition transforms the active collaboration and the informal networks typical of the district economy and common to all districts in any kind of sector in structures pervaded by this distinctive creativity, that Bertola (2009, p. 24) defines as «creativity of the project, namely that synthesis between the individual creativity and the collective one, from places, local cultures, industries». **Collective creativity** is therefore the keyword of Italian fashion system: here, creativity has always been linked and exchanged with a myriad of productive realities, in a close relationship that goes far from the veneration of the one-of-a-kind or from the excess of the catwalks; we go back to the well-made, wearable, and productively sustainable clothes that do not come just from the creative abilities of the style department but see the contribution of a team of actors working along the entire production chain, from product development to production, to deliveries and logistics (Bertola and Colombi, 2010).

The idea of collective creativity is furthermore addressed by Volonté (2012b), where the author explains that in contemporary fashion a creation is very rarely the work of a single individual, but rather the outcome of

actions by many subjects who contribute to the creative process with their skills and expertise.

The product would not be that particular product without the contributions of the pattern-maker, the product manager, the visual merchandiser, the photographer, the stylist, the catwalk manager, and the many other figures whose work leaves personal imprints on the product's tangible and intangible characteristics (ivi, p. 426).

Mora and Volonté (2014) in an interview to Alessandro Fumagalli[3], detect among all the people collaborating in the creation and production of a fashion item three key figures: the designer, that is usually labelled as the creative one; the product manager, who has a grounded role, more oriented towards the feasibility of a product in terms of costs, materials, and market demand; and the pattern-maker, the more technical one, «who is both a barrier and a bridge between the designer and production» (ivi, p. 265).

Although this division of labours is true and complete for fashion production in general, when focusing on knitwear some differences must be pointed out: knitted clothes are indeed a fully-fledged fashion product and as such, they are charged with all the intangible characteristics concerning the brand immaterial values, their communication, their presentation on the market. Being often part of broader collections made of fabric apparel, leather accessories, jewels, and many other products, knitwear talks the common language of that particular season and carries the messages communicated by the brand. But alongside the intangible aspects, the specifically technical nature of a knitted product makes the development of its tangible characteristics the complex result of the collective work of much many more figures next to the above-mentioned three, each one of great importance. It is a common practice for these figures not to work in the same place: in the typical structure of district economy, small and medium enterprises (SMEs) hire highly specialized employees and with them handle just small steps of the production chain.

Apparently dispersive and expensive, the fragmented structure of the districts and of the whole knitwear chain still represents today the best opportunity to exchange and share know-how and a unique lever for innovation. SMEs survived the years of economic crisis thanks to the ability to be flexible and responsive, especially in a sector like fashion where the

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[3] Alessandro Fumagalli is a young freelance fashion designer of leather accessories (especially bags and footwear) who has been working for ten years for Italian brands within the luxury, ready-to-wear, and fast fashion sectors.

complexity of the market is affected by tight deadlines, demand fluctuation and to seasonal workflows. According to Rullani (2004), the firms that are part of a district are more likely able to turn uncertainty into opportunities, because they can count on a dense network of social, economic and professional relations.

The beginning of this system can be traced back once again to the early 1950s: before that period, tells Traini (2004) reporting some records from Maglieria magazine of the early 1930s, Italian firms were chiefly specialized in the industrial manufacture of underwear and hosiery which was produced for the domestic marked and partially exported. Outer knitwear was barely ignored, produced by small firms which generally supply the town or region where they were based; this production, mainly functional, aimed at meeting family needs and budgets, which did not allow for frequent or expensive purchases. In the 1930s, however, angora knitwear for women by Luisa Spagnoli, from Perugia, and men's luxury knitwear by Avon Celli, Milan, were making a name for themselves in overseas markets (ibid.).

It was from its first public debut in 1951 that Italian knitwear evolved and articulated itself in the contemporary district structure, which stands today as unique, distinctive and typical of its country. From the intuition of Renato Crotti, owner of Silan, founded in 1948, who sensed the industrial potential of a production system that already existed and worked well at a domestic level: he supplied the first domestic knitting machines to the ladies of Carpi, who worked at home in between their household chores. The making of knitted garments for the family members was nothing new, the ladies knew the technique, but what was new was the idea of gathering together all the know-how in a small territory and turning it into a work force for the company. This «upstream and downstream organization virtually anticipated the structure of the future industry: buying and supplies, outsourcing, production, quality control and shipping» (ivi, p. 21). As a result, in Carpi and in the surrounding areas of the Po Valley and the Apennines, the Italian knitwear system was born; in little more than ten years it went from strength to strength thanks to its unique structure. The same happened for the Umbrian district, which has its roots in the culture of subcontracting. Here, where the 70% of knitwear enterprises counts between 6 and 20 employees, the birth of this galaxy of SMEs started at the beginning of the Seventies from the entrepreneurial spirit of Luisa Spagnoli. When her angora-knitwear business grew, she began to outsource production by creating small artisanal workshops, specialized in the different stages of product processing, that worked just for her. Over time, within a couple of generations, many activities have evolved and have created their own labels –one among the big names is

Brunello Cucinelli– becoming leaders in the production with fine yarns like cashmere, many others have become suppliers for bigger brands.

From the 1960s and 1970s, the collaboration between fashion houses, designers, spinning mills and knitting machine manufacturers became increasingly strong due to the growth of the sector and an increase in exports; even later, during the 1980s of the undisputed realms of Armani, Ferrè, Versace and Krizia, the importance of specialisation in the knitwear sector remained unchanged, and the creations of the designers were the successful result of long-standing and trusting relationships with the best knitwear producers.

Manufacturing firms are places where creative orders are not simply executed by rote but where designs are interpreted, solutions are sought, and innovation is created thanks to the design contributions that come from the outside, from customers and suppliers, along with the style departments of brands, but also from spinners, packagers, other small experimental workshops or freelance designers. Knitwear companies are not factories, but rather "places of the project", privileged locations for the district theorized as a cognitive space (Conti, 2007).

The complexity of a knitted product makes it

crucial to have the specific technical knowledge, to carry out a constant analysis of the limits of the materials and processes and to always be trying to create something new. In this sense, the skill of those who design and those who develop has always been shared naturally in the search for harmony between experience and experimentation, to create an innovative product that is well-made and, at the same time, feasible and going to sell (Motta, 2018a, p. 49).

As in the past, spinners are often asked for new solutions on yarns; technicians may simply solve a fitting problem by changing the machine programming; the latest production technology provided by machine manufacturers can open new doors for combinations of shapes, colours and processing. Today, it is common practice for knitwear designers who work for brands to spend entire weeks in knitwear factories, where, alongside the staff, they work on the collections striving for the best balance between aesthetics, quality, feasibility and timings (ibid.).

2.5. Small and specialized

A whole supply chain made up by the smallest realities and the highest expertise

The most imaginative minds see the high-end *prêt-à-porter* brands, be they Italian or international, as large workshops where every kind of product is created from scratch under the strictest of secrecy, while in a district structure the reality is very different: the ideas, first of all, and the resulting products, travel across along the numerous small and medium-sized businesses, passing in the hands of those many different figures

unbeknownst to most (Motta, 2018a). In this sense, we can define Italian collective creativity as silent, as well: businesses, communities and people quietly contribute from season to season to the growth, survival and success of a system of which famous brands represent only the tip of the iceberg.

It may very well be true that some brands have the financial strength to build the entire production chain internally, but this happens very rarely and in most cases for each product category –leather goods, footwear, scarves and neckwear, jewellery or knitwear– production is entrusted to external companies. The reason behind this phenomenon is clear: to obtain a high-quality product we need a high level of specialisation and experience in each of these areas. Consequently, a very large part of the production of high-end brands ends up being distributed on the Italian territory, in the regions where they find ad hoc know-how and suppliers for each segment of their product range (Bertola and Colombi, 2014). As it happens for shoes in Marche region, for leather goods in Tuscany, for jewellery in Vicenza and Naples, for glasses in Belluno and for silk accessories in Como (Testa, 2003), knitwear has its districts as well, it has its districts, each of which covers its own segment on the market with different product ranges.

When talking about the distribution of production for knitwear in the various Italian districts, a difference must be clarified between two kinds of manufacture: the processing of raw materials and the production of finished clothing. These two facets, corresponding to the two macro-phases of knitwear supply chain, should normally belong to different districts, while it is not uncommon to find them merged together in some areas. It thus naturally happened that, where the spinning of yarns was settled as a traditional manufacture, small firms raised among the others to start working with those yarns and purpose solutions oriented to the finished product. This happened in the area around Biella, where the great majority of firms deal with the spinning of wool, but some knitwear factories and some fashion brands can

be found as well. Brescia is home to the spinning of cotton, right next to the hosiery district of Castel Goffredo; while the area around Prato focuses on the production of fancy yarns. Garment production also has its own dedicated spots and its specific segments: Veneto produces large quantities of medium and high-end garments, Umbria focuses on niche products with excellent materials, in Carpi and in the surrounding areas of southeast Lombardy high-quality *prêt-à-porter* clothing is created for both national and international markets (Motta, 2018a; Poletti, 2016).

Although spinning and garment production are still to be considered as the two main steps of a much more articulated supply chain, as the first one makes yarns as its end-product and the second one makes knitted clothes, the two are closely connected and spinners are an integral part of the creative and productive process for garment makers and brands. Their times are integrated with the ones of the fashion system, they follow the same trends, or they even anticipate them, their research and innovation on yarns pushes research and innovation on clothes forward.

Going back to the above-mentioned silent part of the supply chain it is a fact that especially in the medium-high range, there are few brands that make their own production internally; almost all of them do the creative part while they delegate samples development and actual production to other companies.

In light of these premises, to a first recon knitwear stakeholders can be divided into three main categories: **raw material processers**, **final product manufacturers** and **fashion brands**. To these we must add the producers of industrial knitting machines like the Japanese Shima Seiki and the German Stoll and the certificatory bodies or associations like The Woolmark Company, CELC, etc. These subjects do not fully belong to the district system, as they are not small or medium enterprises but rather big corporations of national and international level. Despite this, they recognize the importance of local economies and places their branch offices next to the most important knitwear districts; for instance, Stoll and Shima Seiki are present in Carpi, while The Woolmark Company and CELC chose Milan, the city where the Italian creativity converges (Volonté, 2008).

However, to a deeper observation the three identified categories are not exhaustive enough. The system is much more articulated precisely because of, or thanks to, the fragmented district structure: into these three macro categories there is a multitude of other specialized companies, each of which makes up a fundamental element for the realization of the finished product.

A fact of great relevance, as underlined by Bertola (2007), Conti and Zanolla Mancini (2011), Volonté (2012a), Colombo (2013), Continisio and Mora (2013), is the presence for Italian fashion system, and knitwear as part

of it, of a peculiar completeness of the textile-clothing chain which covers all the various phases with companies engaged in all the activities necessary for the production, from the transformation of raw materials to distribution (Continisio and Mora in Colombo, 2013). Every small step of the production chain is expertly managed by specialised companies of great experience clustered according to their area of expertise. There are no vertical companies, but all the production phases and the necessary services are localized in such small territories that they end up being single systems (Motta, 2018a) made of spinners, dyers, fabric knitting workshops, linkers workshops, ironers, machine manufacturers, maintenance services, spare parts warehouses and many others. «In place of just one large company, inevitably weighed-out by its own size, there [is] an integrated system of many different professionals ideally suited to promptly satisfying increasingly changeable seasonal demands» (Traini, 2004, p. 279).

We understand the importance of high specialization from the words released by Gianluca Mirabassi, chairman of the textile industry trade union of Confindustria Perugia, in an interview to Il Sole 24 Ore:

We define ourselves contemporary craftsmen, because our sector is the only one to be so highly artisanal and so highly technological. Some stages of processing can be automated, but there are others, such as the linking, namely the sewing for knitwear, where manual skills cannot be renounced, as they are micro operations that make the difference in quality (in Paris, 2012).

Such an artisanal expertise is a longstanding knowledge that cannot be replaced by a machine or be found or reconstructed elsewhere.

Keeping as reference the above-mentioned three categories –plus the extra actors–, we can state a more detailed list of the stakeholders operating on the knitwear supply chain:

Raw material processers, divided into two sub-categories:

- Firms which keep the entire production chain internally, going from the greasy fibre to the complete garment
- Firms which deal with just one step of the fibre processing:
  - Combing workshops
  - Dyers
  - Spinners
  - Yarn twisters
  - Finishing workshops

Final product manufacturers, divided into two sub-categories:

- Samples manufacturers
- Production manufacturers:
  - Paper pattern-makers
  - Programmers for knitting machines
  - Linkers workshops (firms which sew knitwear together with a specific machine called linker)
  - Sewing workshops (firms which sew knitwear together with the linear sewing machine, by cut-and-sew)
  - Dyers (of yarns or knitted fabrics)
  - Printers (of yarns or knitted fabrics)
  - Embroidery firms
  - Suppliers of buttons, zips, pearls and other applications
  - Finishing workshops and washers
  - Firms engaged in ironing, quality control, packaging

Fashion brands

- Brands with collections exclusively made of knitwear
- Brands with collections made of diverse product categories, from knitwear to fabric clothing and accessories

Machine manufacturers

- Maintenance services
- Spare parts warehouse
- Training

Certificatory bodies and non-profit organizations

As previously mentioned, among the manufacturers very few firms keep all the manufacture phases inside, because the flexible structure of the district economy allows them to delegate some phases to subcontractors, namely smaller workshops with higher expertise. To give some numbers as an example, the district around Carpi counted, in 2014[4], 261 firms producing the finished product and 618 subcontractors.

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[4] Data source: R&I srl - Osservatorio del settore tessile abbigliamento nel distretto di Carpi

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All of the actors along the supply chain widely recognize the key role of each of their suppliers and customers and are solidly aware of the creative value gained through the interaction between them. Due to this naturally rooted interactive dynamics, all of the subcontractors are commonly concentrated in a single district and orbit around the few medium-big enterprises based in the same local area. The only exception are embroiderers, who works not just on knitwear but on clothes in general and plus, embroidery itself is a so much specific technique with a lot of variables, that specific districts exist, located in Umbria and in the south of Italy, where women keep on doing it manually.

Among other subcontractors, knitting factories represents the highest specialized typology of businesses, with the majority of single-phase firms. Inside them, together with a great level of technological innovation despite the slowdown in investments imposed by the economic crisis, there are high technical and productive competences built up over time and made concrete in rich archives of stitches and knitted fabrics. They have not to be considered just as a making factory: they are, as said, the highest specialized typology of businesses and for this reason they are used to experiment with new stitches, yarns, and innovative technical solutions by exploiting in a very versatile way the industrial electronic machines. They offer to their clients – to fashion brands, or sometimes to converters– a fundamental support both in the creative conception of the collections as in the development of samples and in the industrialization process. «We are faced with a real project supply chain, spontaneously emerged, which today needs to be codified and made explicit in order to be supported with appropriate methods and tools» (Bertola, in Bertola and Colombi, 2010, p. 16). To do this, it is purpose of this research to understand how creativity is spread within all the diverse stakeholders, and consequently where the competences of a specialised knitwear designer are needed, even outside of the style departments of fashion brands.

2.6. Is Italian knitwear still strong? The issue of competitiveness for SMEs

In the last years of the twentieth century Italian fashion industry has recorded a very slow or even negative growth in production, with the raise of global competitiveness from other countries, China above all. Some years later, the economic crisis hit the market and almost halved, from 2001 to

2011[5], the number of SMEs operating at a national level. A large number of the bigger companies, that were financially stronger than micro and small ones and used to give work to the latter, started to relocate their production in foreign countries –with Eastern Europe, Turkey, and North Africa playing a crucial role (Giannelli and Saviolo 2001)– with competitive labour costs, lower taxation and looser rules about environment and occupational safety (Sassatelli, 2006).

This phenomenon had clearly negative impacts on the local system not just at an economical level, being affected work for local areas, but also for the chains of value generation through knowledge and creativity, that have been broken and are difficult to reconstruct elsewhere (Bertola, 2006). To Conti and Zanolla Mancini (2011) even in such difficult times there still are points in favour of keeping production in Italy and to use territorial resources, due to the unique assets of districts subject of this chapter: the highly creative and competitive work force, the integrated production chain, the subcontracting habit and the high-quality craftsmanship, all connected in "collective" processes of innovation (Bertola, 2005).

In this current transition scenario, what did happen to knitwear industry? The data are quite unusual, and they are consequence and cause of the above-mentioned small dimensions of knitwear firms. If decentralized production abroad reached, in 2013, the highest levels[6], with the value of production delegated to Italian subcontracting decreasing significantly during the years of crisis, not everything goes outwards, and knitwear companies' relocation follows an opposite trend. Knitwear companies are indeed above the activities that are increasingly rooted in Italian territory and in the districts, and this is happening for two main reasons. The first one is that the complexity of knitted products make the production methods to have considerable influence on the look of a finished garment, and thus require a high content of what Rullani (2014) defines generative knowledge, which include entrepreneurship, creativity, flexibility of market response, small series, high quality, specific technical knowledge. These activities, Rullani continues, are not transferable, nor are they easily imitated by others, requiring the contribution of personal and contextual intelligences that history has sedimented in the district but that are unique, or, again, difficult to replicate elsewhere. The second one is due to the micro or small dimension of knitwear businesses and their tendency to produce short series: regardless of the market segment in which they operate –being it medium, medium-high, or high– they have

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[5] Data source: R&I srl su dati Istat Censimenti industria e servizi, 2001-2011.
[6] Data source: Rapporto Osservatorio Distretti, 2014.

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always been able to keep strong local roots, or, in some cases, they managed to bring back production to Italy in answer to the request of foreign customers to have 100% made in Italy products: short series are indeed not convenient to be produced abroad, even because of the growth of costs in some of the countries of relocation, such as, for example, those of Eastern Europe.

This pattern is confirmed by data from the economic note of the *Osservatorio del settore tessile abbigliamento nel distretto di Carpi* (2014), which show that the dimensional difference between knitwear and fabric clothing companies is relevant and tends, in recent years, to accentuate: knitwear companies are on average much smaller compared to those of fabric clothing, and manage to keep themselves local and to sustain a 100% made in Italy production to a considerable extent, enforcing the bonding with local subcontractors.

These competitive advantages have allowed the legion of companies in the sector to continue to offer first-rate products and to remain a benchmark for the high-end *prêt-à-porter* sector, surviving –although with difficulty– during a period when almost all knitwear companies in Europe disappeared.

Despite their resistance, Italian knitwear companies are undoubtedly suffering and facing critical issues, as much as other enterprises in other districts are. An overview made by *Centro Studi Unioncamere* in the report of *Osservatorio Distretti* (2014) lists them as follows:

- a problem of generational turnover (reported by 60.4% of companies);
- the investments to other territories, in Italy and abroad (47.1%, probably by companies of a larger size);
- the lack of qualified human capital (40.8%);
- the presence of unfair competition phenomena determined in particular by the presence of companies managed by foreigners (36.5%), especially in the textile-clothing districts of Prato, Empoli and Carpi.

The report detects, through interviews with entrepreneurs, four consequent aspects of relevance concerning the priorities of intervention to keep the competitiveness of districts alive:

- the need to fight against illegal employment which generates unfair competition;
- investments in connection infrastructures;
- improvement of professional skills and the strengthening of training paths;
- strengthening of business networks, through specific tools and skills that allow companies to pursue this particular objective;

It is not the purpose of this book to address all of these issues, as they are general and mainly oriented to be solved with economic and political measures. It is therefore relevant for the author to recognize among those general problems the ones that strongly affects the knitwear sector and that design research could investigate in search of the opportunities of intervention both for academic research and for design educational paths.

The Italian context stands here as a privileged framework of intervention for experimental actions of innovation, due to the ability of companies to be flexible and open-minded, feature that constitute an asset to propose innovative solutions which include the involvement and enhancement of the fresh skills and creative abilities of young designers (Dell'Acqua Bellavitis, 2007). This is confirmed by data included again in the report of *Osservatorio Distretti* (2014, pp. 45-46), that say that only a small minority of the interviewed entrepreneurs puts the maximizing of the profit as the primary task of a company, while over the 80% of them gives strong importance to the company's ability to generate other kind of values able to nourish a productive culture based on quality, sustainability and beauty. «A company is not only a profit tool but also an active subject of the territory, a community of individuals, a structure that bears the values of the local dimension to which they belong» (ivi, pp. 52-53).

We will see in the following chapters what are the specific critical issues identified by knitwear stakeholders and how design research and innovation can impact in a positive way on the needs of this peculiar kind of system, always keeping in mind that, even if we think about knitwear industry as a whole, it is composed by the multitude of different stakeholders illustrated above.

The literature proved that that on the industrial side Italian knitwear –as well as fashion– has been able to articulate itself into all the production steps, from the yarn to the finished garments. It is also true that, as Bertola (2007) states, this phenomenon influences directly the design side, with creative figures multiplying and operating in a mutually supportive way not just for fashion brands but all along the supply chain.

This creativity, spread along the knitwear supply chain becomes a central issue for the present study: here, in light of the outlined structure of the industrial system, one of the first question to be addressed is **where does this peculiar kind of creativity needs the competences of a designer? And, consequently, where could a designer intervene and contribute to innovation?**

After the framework on knitwear as an industrial system given in this section, in the following ones we will see how the design process interacts with this system, what does it mean to design knitwear and what is the role

of designers when in charge of the creation and innovation on yarns, stitches, knitted fabrics, garment shaping, embroideries, all activities that enhance the finished garment and represent an asset for the differentiation of the made in Italy, high-quality product from the lower ones.

3. Design education and knowledge transfer

[Education] constitutes one of the mostly present strategic requirements in the development agenda of all the countries. The now mature debate on contemporary economies called knowledge economies, led to pay increasing attention on those processes able to support the transfer, processing and management of new knowledge. Education and scientific and technological research are the levers that allow the reproduction of these processes. The production of new methods, tools and strategies for education and research development is therefore a priority work area. (Bertola in Bertola and Maffei, 2009, p. 28)

3.1. The root of design education: from art schools to integrated knowledge

It was 2001 when Richard Buchanan (Buchanan, 2001), envisaged next to the traditional, old and venerable universities –which still give valuable theoretical knowledge– a new kind of university, where theory and practice would have been complemented towards a substantive knowledge about making or production. In this new kind of university, research would have been oriented to a dynamic balance among theory, practice and production, which, he said, was still missing at that time in the vision of most higher education institutions.

Until that moment, design education had been included among the disciplines taught inside art academies. So, if on the one hand there was a practical side almost ignored inside the academic world, on the other design teaching lived with the legacy of the creativity-focused and very artistic approach of art schools, which was not considered as proper or complete enough to enter universities. At the end of the last century, Buchanan continues, scholars in this field adverted the need for young designers «to have more knowledge and a broader humanistic point of view in order to deal with the complex problems that they must face in their professional careers».

From then on, design has furtherly evolved as a discipline object of research, and, with a common approach, design education started to find a

place in some leading research universities. It was almost for two decades that design have been facing the need to get structured as a scientific discipline, namely as a «totality of basic assumptions, concepts, theories, methods and tools that a specific group of scientists and researchers employs in its work», with the essential characteristic of a «progressive development, or rather the progress it makes in its research and practical activities» (Friedman, 2003a, p. 212).

Scholars were placing the groundworks of design research on one side, and on the other they were defining design education: in this direction, the investigations conducted by the Royal College of Art in the first years of the Eighties, as cited by Cross (1982), outlined that there are things to know, ways of knowing them, and ways of finding out about them that are specific to the design area. Moving from there, Cross started to develop his wide work on design education assuming the existence of a peculiar way to approach knowledge which places itself halfway between the codified ways of scientific culture and literary culture. Design started to be considered as a third domain of knowledge, the third way in which human beings know the world. From then on, Cross' **designerly way of knowing** meant to gather and apply both scientific knowledge and artistic skills to practical tasks, of which the designer is in charge as doer and maker (Cross, 1982).

Although the theory was beginning to draw the guidelines for teaching design in a designerly way, the traditional division of knowledges was still strong and rooted on the international scene as well as on the Italian one, focus of this research. The learning of traditional knowledge, delegated to universities, and that of practical knowledge, have long held separated training paths in terms of time and space. On the one hand, the two were vertically structured according to the deductive approach, in a consequential process that goes from the universal to the particular: the knowledge of theoretical contents, acquired in a traditional and often mechanical and notional way, preceded their practical application, phase that in most cases was delegated at the time of the exit of young people from the university and of their entrance into working life. In the same way were distinguished the places of learning and the interlocutors: the university classrooms were the place of theoretical learning, under the guidance of professors and researchers who had no contact with the external world; companies were the place of the learning of practical skills, an actual apprenticeship, where young professionals struggled in transforming their knowledge into know-how. This happened, explains Penati (2000a), as a consequence of the Fordist development model that clearly separated school and work, pursuing the division between

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thought and action because divided were the figures on working places, the thinkers above the doers.

However, given the evolution of society, of production systems, and the recognition of the importance of human resources as a lever for innovation, (Manzini, 2004; Rullani, 2004) design as a creative activity has found itself engaged in a system characterized by new complexity: this has generated the need of designers who possess a systemic knowledge that combines theoretical and cultural aspects coming from humanistic disciplines such as philosophy, sociology and ethics with practical aspects, able to intervene at an operational level while maintaining cultural and intellectual processing capacity (Penati, 2000a; Dell'Acqua, 2007).

On one side theoretical knowledge in itself could not be enough, on the other design education could not be limited to mere practical training: in his writings Cross, recalling Peter's criteria which validate activities and processes as "educational", confirms the fact that when dealing with design teaching, simple training in a skill is not enough. This concept entailed a fundamental change of perspective on design teaching, that lost the facet of a vocational training for a design profession, which indeed was the only provided kind of "design education" until then. «Design in general education is not primarily a preparation for a career, nor is it primarily a training in useful productive skills for "doing and making" in industry. It must be defined in terms of the intrinsic values of education» (Cross, 1982).

To Peters (1965) and Cross (1982), being educated means not just to pursue a result but to be conscious of the activity someone has done. This points to Schön's concept of being "reflective". To Schön (1983) indeed, designers always operate in peculiar situations, dealing with materials and using particular expressive means and distinctive languages that are proper of this discipline. They thus approach problems, think and make products through complex processes and, more than everything, relate to situations in a reflective way, which means that they reflect on what they are doing (reflection-in-action) and, afterwards, they reflect on what they have done (reflection-on-action), and they consequently learn from that.

In light of the concepts theorized by the philosopher and considering design as the activity which addresses 'ill-defined' and 'real' problems (Cross, 1982; Brown, 1989; Friedman, 2008), quite distinct from the well-structured ones addressed by the traditional domains of the sciences and the humanities, design was the discipline which could better benefit from experiential learning, in the overcoming of the division between thinking and acting. This approach is rooted into the design practice, which has always spontaneously

built and settled knowledge through the professional praxis and has in itself the 'reflective' character theorized by Schön (Bertola, 2010); it is therefore valid for design research –where for researchers practice actually becomes a research process– and has been applied to design education in universities as well, where students learn new knowledge by acting from time to time on real problem-based issues.

The benefits of this kind of teaching and learning system are still actual and recognized: it is noted in a recent investigation conducted by Christel (2016) that active learning in real problem-based situations develops skills such as critical thinking, creativity, understanding of concepts and problem-solving, but more than everything it gives students the ability to

apply knowledge to a current problem and then to transfer knowledge to new situations. Instead of having a textbook which provides facts and then tests the student's ability to recall such facts, it provides students the opportunity to directly apply that knowledge to a problem at hand (ivi, p. 2).

It is therefore an inductive approach to knowledge, which proceeds from the particular case to the universal, and aims to give students the ability to solve a specific problem in that particular moment, but to then know how to abstract what has been learned, apply it and replicate it to new creative processes. It closely resembles the process of applied research in design when, quoting Buchanan's words, it is directed towards many individual cases from which to «gather a hypothesis or several hypotheses that may explain how the design of a class of products takes place, the kind of reasoning that is effective in design for that class, and so forth» (Buchanan, 2001, p. 18). During the learning process, students have to gain logical, research and cognitive skills to be able to gather from individual experiences the ability to solve problems and to elaborate suitable solutions. This view leads to the idea that Bertola expresses about design being more relevant as a "cognitive process" than as a set of skills which allow someone to make artefacts.

She says that

in the contemporary context the learning capacity, that is the process of knowledge, has in fact become more important than the "content" of knowledge itself, since the latter has a very accelerated degree of obsolescence; in this context the peculiar way of "knowing" of the discipline of design seems to have a particular relevance (Bertola 2004, p. 57).

From these groundworks design teaching started to take structure with the awareness of this peculiar way of knowing, which moves into complexity –

a complexity made of technical, technological, scientific, epistemological, philosophical and anthropological contaminations–, and consequently deserves a strategy to be addressed (Pizzocaro, 2006, p. 77). Searching for a definition of what a strategy is, I found the one by Morin (1985, p. 29), who writes that the effective strategy to act into complexity is «the art of using the information produced during the action, to integrate them, to suddenly formulate determined schemes of action, and to be able to gather the maximum of certainty to deal with what is uncertain».

At this stage, isn't this what a designer always does? The structuring of design teaching was thus a design process, which moved from uncertainty, produced new schemes of actions, or better new teaching models, when the traditional ones were not enough to give students all the competences they need plus flexibility and inclination to innovation of processes.

Just few years later, Friedman's words effectively give an exhaustive definition of the designer, explicating the goal towards which everyone was working: the designer, Friedman writes,

is an analyst who discovers problems or who works with a problem in the light of a brief. The designer is a synthesist who helps to solve problems and a generalist who understands the range of talents that must be engaged to realize solutions. The designer is a leader who organizes teams when one range of talents is not enough. Moreover, the designer is a critic whose post-solution analysis considers whether the right problem has been solved (Friedman, 2003b, p. 511).

and is able to learn from the reached results by reflecting on the processes used, and to reach the key to improve design processes in the future by understanding them in the present (Eckert, 2006).

To reach the completeness of such a professional profile, design teaching can be presented as a patchwork of knowledge, skills and competences articulated as follows:

- **Ability of cultural elaboration**: as research is for designers a fundamental part of any project that is not a random artistic expression but a conscious and intellectual elaboration of inputs coming from other languages, cultures or productive sectors, collected, combined and hybridized.
- **Operative and technical know-how**: as innovative processes on products necessarily concern materials, techniques, productive processes, technological applications.
- **Awareness of the structure of design processes**: this is what designers learn through reflective practices, by acting in a particular situation, they

collect information about the structured organization behind it and become able to replicate it the next times.

- **Knowledge of the contemporary systemic dimension of the product**: not just as a product but as a system to be designed in its entirety (staging, communication, distribution, strategies).

3.1.1. The Italian context: from self-made designers to structured study paths

It is now necessary to take a closer look at the evolution of the design educational system in Italy. Despite the success of its products and its being famous all over the world, the lack of scientific research and of an educational system has affected Italian design for a long time, until Politecnico di Milano introduced this discipline inside the study course in Architecture in 1993 and only later, in 2000, established Industrial Design as a faculty next to Architecture and Engineering. At that time, Industrial design was already considered as a subject of scientific and technical studies in many foreign countries but had not yet found its place among the Italian study paths. Penati (2000b) assumes three reasons to explain this absence: firstly, Architecture faculties were established and widely recognized as the only higher institutions for teaching and learning disciplines related to the creative activity; secondly, the reputation and celebrity of Italian design worldwide often lazed and limited the drive for research and innovation, nurturing the illusion that no didactic paths are necessary when those who have not followed them succeeded so much in doing what they do; thirdly, Penati (ibid.) attributes the greatest responsibility for this lack precisely to the Italian productive system, so far from large companies, from standardization and economies of scale and connoted by a type of production that is industrial, but with a strong artisanal connotation. Design teaching was therefore for a long time left to art schools and professional institutes for industry and crafts, and in Italy the phenomenon has proved to be more rooted than abroad.

When they were finally facing the introduction of Industrial Design among university-level disciplines, researchers had firstly to define the boundaries of this discipline and to understand which competences and knowledge should have been transferred to young designers, on the basis of the recent developments in international studies. At the same time, they had to address a second important issue, precisely related to the relationship that scientific research and university education should have had with the peculiar economic background of Italian SMEs.

The issue to be addressed was that of give shape and content to the new professional profiles that, in addition to the conceptual and operational tools suitable to intervene on the wide range of design tasks, also had the ability to interact with the increasingly complex logic of the productive sphere and consumption (Penati, 2000b, p. 123) inside such an articulated and fragmented industrial system as the Italian one. Here, designers are charged with one more role: they become cultural mediators, namely professionals who mediates among the numerous actors involved in the realization of a product, rather than be limited to creation in itself (Giusti 2009; Mora 2006; Volonté, 2012b).

When dealing with the contemporary Italian industrial system we can add one more competence to the four mentioned of the ideal designer (ability of cultural elaboration, operative and technical now-how, awareness of the structure of design processes, knowledge of the contemporary systemic dimension of the product): it is **the awareness of the supply chain, its steps and stakeholders**, reached with a closer relationship between university and businesses –mainly SMEs–, from which students can learn to act as cultural mediators, facilitators and problem solver between stakeholders, and nevertheless to effectively frame their figures on the job market.

The collaboration between university and enterprises is, since the beginning, quite encouraged inside the study paths developed at Politecnico di Milano; and proved to be a necessity for the designer who works on this territory to properly deal with its specificities, at the same time it is made possible by the characteristics of the territory itself and is difficult to be replicable elsewhere.

3.1.2. Between flexibility and specialisms: the Italian industrial designer

Remaining in the Italian context, we return for a moment to consider the –now five– competences of the ideal designer: can be noted that some of them belong to the sphere of adaptive knowledge, some others are more concerned with technical know-how. In light of the historical division in different sectors of Italian design, and of the increasing specialization of companies not just in each one of these sectors, but rather in the sub-sectors with high degree of expertise, another issue to be tackled is the level of general and flexible knowledge to be taught to students against their technical specialization in this or that sector. This problem is also due to the contemporary uncertainty if the productive system itself, which expresses requests that are

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always on the fence between the need of high specialisms and the one of flexibility to answer variable markets (Deserti, 2000).

How could someone lead innovative processes on products without having a specialized know-how on how that objects are actually made, on how do the materials behave, on which steps does the production follow and so forth? On the other hand, a solely technical knowledge would limit the competences of the designer to the ones of the artisan, again with a weak capability of innovation.

We go back to the will of balance between the ability of cultural elaboration and the capability of operative intervention. It is clear that these are the two components of a well-made designer, but how can education find this balance? Deserti (ibid.) in an analysis on the possible innovation that education can bring to traditional Italian sectors answers that specialisms are needed by a "district" formative project and that they do not exclude general culture: the balance on different levels of basic knowledge, technical-professional one and transversal competences can be reached with a greater degree of flexibility in the training offer. To Deserti, the needs of each economic reality must be detected and addressed from time to time by education as they are peculiar and rapidly changing, while procedural tools and methods must be set as reference models.

This means that there must be a common "action plan" to each study course and specialism inside a Design faculty which partly replicates the basic knowledge which horizontally characterizes all the training profiles, and partly is characterized by specific didactic activities and by a specific and distinctive research (Penati, 2000b).

3.1.3. University and companies: a long-debated relationship

Let's now draw attention on the complicated relationship which elapses between university and enterprises.

The closeness and knowledge exchange between higher education institutions and private businesses is not a new debate: it has always been pursued on a research level, as companies were clearly able to see the benefits they could draw from experimentation conducted inside university departments. Companies acted as clients, which referred to the expertise of academic researchers to find new solutions to be applied in real life; many case studies can be found in the literature proving that the transferred knowledge has always been mainly a unidirectional transfer of technology from university to industry both on a national and international scale (Goldhor and Lund, 1983;

Fujisue, 1998; Dylan Jones-Evans *et al.*, 1999; Balconi, Breschi and Lissoni, 2000; Dooley and Kirk, 2007; Lööf and Broström, 2008).

In 1983, Schön promoted the idea of a more involving cooperation of the two parts during research activities: to him professionals, which used to act with no particular awareness of what they do in practice-based activities, could become "reflective" with the help of scholars and researchers: the latter, with their theoretical knowledge and their analytic abilities should have helped professionals to describe, analyse and criticize their practice-based knowledge, and to highlight and reflect in a new way on the issues and on the difficult problems met in real life. They could learn a method and improve the way they acted. To Corò and Micelli (2007b) even researchers inside companies, employed in the Research and Development departments need continuous contact with scientific institutions, where academic researchers and professors give essential contribution for increasing the potential for the exploitation of knowledge.

The integration of knowledge had rarely been pushed further and had hardly ever touched the educational sphere.

As said before, **designers learn from their actions and experiences**. As students, they combine both theoretical knowledge and practical application of what they have learned. To practically apply their knowledge, they are asked to give shape to the products they design by producing their own prototypes; workshops and facilities are thus a very important component of design universities, and the central role of hands-on work inside them is today widely recognized and constantly improved with the upgrade of technical facilities. Workshops and studios are actual classrooms where lessons are delivered and students spend time learning techniques, to verify their ideas through applied actions (Bertola, 2009).

Despite the successful inclusion of lessons delivered inside workshops, if designers, on the Italian context in particular, have to place themselves into reality as cultural mediators between stakeholders, this kind of practical experience is not enough to be aware of what happens outside. To Brown *et al.* (1989), «learning is maximized if the context for learning resembles the real-life context in which the to-be-learned material will be used». Almost thirty years later, the boundaries of research and experimentation in this direction have been pushed further: if students have to learn how to be cultural mediators during their studies, they consequently have to get in close contact with reality through experiences that are not just simulated but are truly reality based.

Scholars at Politecnico di Milano, who have always looked with interest to the surrounding industrial reality, understood that the boundaries between the traditional knowledge taught inside classrooms and the professional one that

was usually learned outside had to be contaminated because, on the one hand, the cultural capital that the designer refers to is that of the widespread culture of the Italian industrial system, which is hardly found in books, while on the other nothing prevents professionalizing knowledge from being supported by traditional learning tools in university classrooms. Contaminated forms of knowledge, learned with contaminated methods, in multiple places and times.

The purpose was that of make universities closer to industries, the public sphere closer to the private one, to someway merge the places of learning once understood that, while classrooms are the best place to transfer a notional kind of knowledge, the technological one of design is far more complex to transmit without hands-on experience. Celaschi (2000, p. 152) resumed the will with very effective words: «To pass from an education practiced only within the places of knowledge (the university) to one also made of places of experience (the world of production)».

This contamination, articulated on different levels, had to be designed, because it was, and still is, a complex issue to be addressed and organized, which goes far beyond the usual relationship to which both of the parts were used. The experimented typologies of interaction made at Politecnico di Milano, have been diverse during the last two decades, going from newly graduates placement to the involvement of professionals in the role of contract professors, from intensive weekly workshops in agreement with companies to internships held while students are still undergraduate.

The basic principle is the demolition of the rigid boundaries of training and the will to bring a plurality of benefits on both sides. Celaschi (ibid.) resumes the possible benefits of collaborative teaching as follows:
- students recognize the value of learning by doing as inductive learning process, applying what they have previously learned during projects with professors;
- companies and professionals can understand that the moment of learning is not fictitious or self-referential, but it is a unique opportunity to extent and apply research on production issues;
- both students and companies can benefit by knowing each other, as companies can identify the most interesting profiles to be inserted into their organic while students can be facilitated in their entrance into the job's world.

Indeed, collaborative teaching was not a novelty practice for the disciplines of the project on an international scale; thanks to their established pragmatic approach, American universities have had some previous experiences with the involvement of large companies. On the contrary, the Design faculty of Politecnico di Milano had to enter into the mature sectors of design for Made in Italy, with all that this entails, from small manufacturing

enterprises to low-level technology and district economies, facing its opportunities as well as its critical challenges.

During the years, experimentations with this approach proved to be a positive asset for designers' education even if with some limits, like the ones of the internships where students exit the university leaving researchers and professors behind to enter the unexplored corporate world keeping a weak bonding with their previous experience. Anyway, the will to experiment further will soon lead to new practices which do not just take universities closer to companies and companies closer to universities but will bring them into each other. This is exactly where the present research intends to intervene.

A full account on successful case studies in the literature (e.g. Scevola, 2000; Deserti, 2000) goes beyond the purpose of this book. The next section will narrow the attention on this aspect from the perspective of fashion design, to verify if and how the involvement of fashion companies is already integrated into fashion design study paths; to investigate the benefits in that particular context for students as well as for researchers and for companies, and to gather the background knowledge to identify further opportunities of experimentation in this sense, in the field of fashion first, and in the field of knitwear immediately after.

3.2. From designers to fashion designers

It is often taken as given that the designer must have completely mastered the technical side of dressmaking and have an innate feeling for the colour harmonies, the balance and arrangement of parts, the matching of different or similar materials and a feeling of rhythm […]. However, when one studies to what extent the designer is involved in the actual manufacturing and designing process of a garment, the degree of involvement varies from designer to designer, from company to company. Then the job description of the designer becomes questionable, and then the meaning of creativity also becomes questionable (Kawamura, 2005, p. 63).

3.2.1. The importance of the context

Since this study is addressing knitwear as a discipline included among the ones of industrial fashion design, and so among the more general disciplines of industrial design, a framed definition of the role of fashion designers working for the industry must be given. This section also has the aim to draw attention on the evolution of fashion design teaching from the ones of industrial design and on the peculiarities of its articulation in this specific field.

Fashion has been the last educational path to be introduced among the disciplines of design, left for the longest time, and with much more discrimination from scholars than other creative-industrial sectors, inside art schools and academies.

As we already said previously in this chapter (see Paragraph 2), in the fashion industry professional roles and functions have mainly derived naturally from the organizational needs of companies, without a dedicated educational path (Bertola, Colombi and Vacca, 2012): this is especially true for the Italian context, where, (as previously seen in Paragraphs 2.2, 2.4, 2.5 and 3.1) the industrial system raised spontaneously leaving the education of new figures on the parallel track, to art academies where an arts and craft approach relies «on an obsolete vision of fashion not as a modern industry but as an art's practice» (ivi, p. 2). In that condition, fashion design teaching as a branch of industrial design has been the one longer ignored by industrial design academics, who considered it as an ephemeral artistic practice. During this marginalization, while it was excluded from higher education institutions, fashion teaching structured with its own features in answering the demand of young talents, and often resembled the characteristics of the context where it was based. In this sense, albeit remaining inside art schools and academies, fashion design tended to take over time two main different paths with two relative approaches:

- The **creativity-focused approach**, which belongs to art schools and teaches fashion as an artistic expression of individual creativity
- The **product-focused approach**, born guided by the already existing proximity of the industry to apprenticeship schools.

Today, with a much more articulated training offer in this field, the two approaches are still present and often related to the territory in which fashion courses are delivered. Two clear examples of this dynamics are given by Volonté (2012b), when he observes the difference between the British way to teach fashion design and the Italian one. British schools, he says, give importance to the artistic side of fashion, and promote, for instance, the art of drawing and the experimental manipulation on materials and shape rather than more managerial or technical skills. On the other hand, it is common, and so it was even before the inclusion of fashion design among the academic industrial design culture, for Italian –especially Milanese– fashion schools to try to answer the need of the industry and thus to include in design study courses neighbouring disciplines as communication, retail, marketing, and management of fashion.

With the reflective character attributed to them by Schön (1983), designers are used to reflect on their experiences and to learn from multiple surrounding situations. It follows that differences in the occurring situations generate different kind of designers: their professional way of acting depends on the education they receive combined with the environment they are immersed into, from urban street styles, from the shape that the fashion world takes in their area of action, and moreover from the surrounding industry they become used to work with. Again Volonté (2010) assumes an effective view of the phenomenon: he notes that where designers find a dynamic, open-minded and welcoming industrial system, they are easily led to become successfully integrated in the companies along the supply chain and to gain direct knowledge of industrial production and its technical and economic aspects (Volonté, 2012b); by contrast, where the industrial system is mainly dominated by big mass-productive companies, or where it is suffering for delocalization on foreign markets (see Section 2) they do not find satisfaction or even interest in working for the industry and they move to a more individual and artistic way to apply their creativity.

The context does not influence just professionals, being for them source of inspiration, target scenario and work environment, but the ones who learn and the ones who teach as well.

It follows that the three stakeholders of this system, **fashion schools**, **industry** and **designers**, are kept in a cycle where each one strongly influences the others. As a consequence, fashion schools are spontaneously led to build their own identity –with the relative subjects, tools, methods and approaches– by answering the wills of designers on one side, and the consequence of the surrounding industrial conformation on the other.

We recall here some of the founding features of the Italian industrial system which have been furtherly discussed in the previous section of this chapter (see Section 2.2), to draw attention on the consequences of this bonding within the Italian scenario. In a district economy made of SMEs, mainly family-run, with high level of specialization and a good openness to knowledge exchange towards innovation, used to work in a system where collective creativity is the mostly used "design method", an individual and artistic way to be a creative proves itself to be useless.

We go back to what Volonté (2012b) labels as the dichotomy between the **"culture of visibility"** and **"culture of wearability"**: the first is the one of the eccentric *créateur*, who gives no importance to the feasibility or saleability of a product but just to its spectacular and disruptive appearance; the second one, that Au's (Au, 2003) investigation describes as typical of

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Milanese fashion designers, is the one of a designer who knows the way in which things are made and who considers fashion as a product to be worn.

Due to the framework given to this study, which concentrates on the Italian context and is based on industrial design studies, as a natural consequence it intends to leave aside the first approach to rather stress the attention on the second one.

3.2.2. Fashion design education

It is not just change, trend, spirit of times, sequence and combination of styles; it is not just relations between social classes, but the fullest expression of a postmodern industrial structure, which finds in the project its way of being (Fiorani, 2006, p. 7).

When a professional creative figure is deeply connected with the industrial background, knows how to deal with the most operational steps of production and in the meanwhile possesses the cultural knowledge to bring innovation inside products and processes, we can say that he/she has the desired features of an industrial designer. Moreover, if the project of fashion products fully belongs to Italy (Bertola, 2008), where it is born alongside its industrial background, and fashion consequently belongs to the sectors of excellence of Italian design and industry, the same features of industrial designers should fit to fashion designers, and the same educational methodologies are supposed to be easily transferred on a Fashion Design study path.

When, at the very end of the last century, academic researchers at Politecnico di Milano began to study how fashion design could leave art schools to enter among the disciplines of industrial design taught at a university level, the task revealed itself not so easy to be addressed.

The fashion system has always been an institution with its own specificities, fast changing dynamics, ephemeral aspects to be taken into account, strong cultural implications, high economic interests on the table every day: this made the codification of Fashion Design path inside university –it was the first try in Italy, at Politecnico di Milano, during A.Y. 1999-2000– quite controversial and criticized by those who see in it the will to support the market in all respects, corrupting the disciplinary integrity of design.

When Kawamura (2005) describes the difference between the fashion system as outlined above and simple clothing manufacture, she states that this difference lies just in the role of the designer, who makes clothing become fashion by adding the cultural component. This central role of the

designer as a cultural validator helped the acceptance of fashion design among the academics, even if it inclusion, Bertola, Penati and Seassaro (2000) write, was mainly supported by the peculiar structure and evolution of Italian fashion system which is today a complex network of relations between cultural knowledge, creative expression, technology, production and market; a network that has indeed so many similarities with the design system that it is quite common for product designers to end up designing clothes, and that also a vast majority of researchers and academics investigating the field of fashion have an industrial design background. On the other hand, the development of fashion as a design discipline had, and still has, necessarily to embrace those criticized specificities to fully understand what it means to become a fashion designer.

3.2.3. A fashionable *kind of complexity*

Scholars were thus faced with a supply chain already familiar with design processes, that were though spontaneously emerged, and so needed to be codified and made explicit in order to be supported with appropriate methods and tools by education (Bertola and Colombi, 2010). Assumed on the one hand the complexity of the Italian –and of the connected international– fashion system and on the other the multiple approaches adopted by the teaching of design, fashion design education had the duty to follow this complexity and this diversity, with various designs and various approaches to what is today a system of interconnected disciplines, in continuous dialogue with one another (Dell'Acqua Bellavitis, 2007; Signorini, 2014).

With no univocal approach to the discipline it is likely to have many different kinds of fashion designers. To frame them, I am taking once again as a reference the investigation conducted by Paolo Volonté (2012b) who recalls the categories identified by Ricchetti *et al.* (2006) as the four main options opened to a fashion designer in terms of job positions. I will report them here and take them as a starting point to open some further reflections on the contemporary professional figures of fashion designers.

Along their career, they may become:
- owners of a *maison* which does not directly produce clothes, but which licenses the production to external manufacturers (e.g. Valentino Garavani);
- designers and owners (like Giorgio Armani or Ralph Lauren) of an industrial plant with a creative activity strictly functional to industrial production;
- creative director (as Alessandro Michele for Gucci, or Pierpaolo Piccioli today for Valentino) of a company owned by others and determine its

stylistic choices and the brand image, without explicitly putting their signature on products' label;

- freelance professional hired on short-term contracts for specific commissions (a collection, an item of clothing, a line of accessories, etc.).

Must be admitted that these four categories regard the highest options possible, and therefore find more candidates among the graduates from the schools with the previously mentioned creativity-focused approach. In the fashion system as it is today, it is indeed more likely for designers who comes from a British school to be hired as creative directors, because the strong experimental and identity mark they gain at art schools is the key feature that most of the high-end fashion brands search to shape –or renew, or even confirm– their identity on an overcrowded and competitive market. It is an elective designer/brand match in terms of personal taste and brand image communicated to consumers. To Kawamura (2005) fashion brands need designers as they embody the brand itself in front of the public and put a face on the creation of the objects of its desire. In this way, «creative production does not dissolve into the anonymity of industrial production» (ibid.). But Kawamura also suggest we should not «overemphasize the individual artist a as a unique creator of a work because to do so writes out of the account the numerous other people involved in the production of any work» (Kawamura, 2005, p. 72).

As anyone can easily guess, not all the designers own a *maison*, neither direct it or create their own fashion label. What happens to the others? They usually occupy the plenty of different subordinate positions working inside *maisons*' style offices, or they hold position that are not considered as properly creative but where a creative sensitivity is needed, as visual merchandiser, press officer, retail manager and so on.

In all of these cases, the illustrated typologies of fashion designers are quite far from the concept of **collective creativity** which pervades the Italian fashion system, where the above-mentioned anonymity reveals at a closer look a richness in creativity, culture and job opportunities that is quite impossible to be found elsewhere.

To meet this particular way of working a new professional figure was needed, to ensure that those who were trained –or should be better said "educated", going back to Peters' idea (Peters, 1965)– inside a design university based on a dynamic industrial territory tended to orient their careers, as said, towards the productive context, and to end up applying their design thinking ability as problem solvers rather than as imaginative creators. The scholars at Politecnico di Milano took this perspective to understand which kind of

education would have been efficient both for students and for the context they would have been immersed into.

The challenge had been partially already tackled by other design disciplines: in the reorganization of enterprises described by Paola Bertola in *Design Multiverso* (Manzini and Bertola, 2004), with the crisis of the authorial professional model due to the raising complexity of industrial products and processes which necessarily need the contribution of many to the project (Manzini, 2004), aroused the need of a renewed professional figure while the traditional division of careers between creative, technical and managerial profiles progressively disappears.

Exactly as it happened for industrial design, the fashion process was becoming more and more complex and articulated: the new profiles would have been defined as **industrial designers for fashion**, intended as figures that combine the technical skills related to the product with the cultural values that characterize this specific sector (Dell'Acqua Bellavitis, 2007; Colombo, 2013) and that owns all the features of the industrial designer, able to «spark the dialogue and the processes of knowledge transfer, managing relationships and conflicts, dealing with complex problems and situations in a proactive way» (Bertola, 2004, p. 30).

All duties which seem to be far from creativity at first sight, and which are often considered by young students, still enchanted with the idea of the creative star described by Kawamura, as a limit to their dreams and aspiration of fame, often generated by the allure that society still gives to this particular sector. But they are not, if we go back to the concept of creativity expressed by De Bono, to which creativity is the ability to combine in a new way information that are already known (De Bono E., 2001). The designer thus place him/herself inside the fashion industry

as a privileged subject, for his/her imaginative skills and attitude to explore the context through learning by doing, in managing the critical issues of this network, in facilitating the processes of knowledge transfer between stakeholders that often have different backgrounds, and consequently different cognitive structures (Colombi, 2007, p. 9).

In her investigation on the role of fashion designers Colombi (ibid.) propose an evolution from the old idea of creative genius, still coming from the French artisanal tradition, to art director of a project team, a very common role in the last thirty years, up to the contemporary creative intermediary, a facilitator for the sharing of knowledge.

Regarding the latter, Colombi (ibid.) continues, today the design of a complex set of products as a fashion collection requires interdisciplinary competences and skills, and the interaction between specific professional figures that are so complementary between each other that the design activity is delegated to a creative team composed of designers, humanities experts, production technicians, product managers and business managers, not to leave aside the continuous dialogue with the brand manager and communication director. We return to the **collective creativity** which does not come from the idea of the individual but lies in the network of collaborative people who operates along the supply chain from its beginning, the raw material, to its end, the products, their distribution and communication.

Couldn't this be defined as "team-working", even if all those involved do not act in the same place and at the very same time? In a fragmented system where each step of the manufacturing process happens as an essential element in a connected combination of elements, the designer has the key role of director of such a heterogeneous team and has to combine his/her design attitude with the company DNA with no claim of personal extravagance or disruption.

Although fashion still communicates itself as the visionary artwork of a single mind and designers are still idealized as artists, the reality of doing fashion –not referring to massive productions of high-street brands, but to the high-quality products of high-end *prêt-à-porter* as the main segment of Italian production– is very different and is led by a designer always in search for balance between the ability to imagine, innovate, invent and the one to put all these elements strategically in reality.

Oriented towards this kind of designer, the educational method in use at Politecnico di Milano often collides with the wishes of students, who are used to approach fashion schools with a weak idea of the system that lies behind catwalks and with big dreams of professional realization as famous creative directors. In her investigation on British fashion educational methods, McRobbie (1998) widely noticed that students tend to idealize the fashion world with luxury and magic, with parties and exclusivity, and they reach a sudden disillusion when they enter into companies, totally unprepared to a working reality which turns out to be frustrating and exploiting.

Very little has changed in the last twenty years when we look at young graduates coming from the wide variety of international, creativity-focused fashion schools (Bignami, interviewed in Tartaglione and Gallante, 2010), with the myth of a glossy world made of money and notoriety and no idea of the daily effort it requires.

Often young designers have models that do not correspond to the reality of the market. In most cases, the goal is to work in the creative offices of big brands but in the field of fashion many jobs can be made, all useful and satisfying. (ivi, p. 65)

On the job market of the fashion industry there is still a very little room for merely artistically creative roles, and very few young designers have the talent, or the luck, to reach them. On the contrary, as Ornella Bignami said, there is a plenty of job opportunities inside the system of **collective creativity**, which deserve to be considered by young graduated and consequently by fashion design educational paths.

They are reported here, following the effective division in five main typologies presented by Bertola (2008) in her book *La moda progettata. Le (sette meno una) vie del design.*

- Activities belonging to the intermediate supply chain: crucial to the success and to the distinctive character of collections, they involve colour, yarn, fabric, prints and textile designers. They operate inside the small-medium manufacturing companies, in direct contact with fashion brands. They have design competences joined with a more technical and productive knowledge.
- Activities belonging to upstream phases of traditional creative processes: recently emerged, they involve all the processes of detection and interpretation of trends and evolving public taste needed in an expanding and undefined market as the contemporary one. The outcomes of this activity are trend books, namely actual projects expressed with the visualization of future scenarios of consumption assumed by the observation of the present.
- Activities of creative direction: namely the strategic definition of the brand identity and of the main themes of each new collection.
- Activities next to productive and technological processes: when the general idea of a collection has been defined by the creative director, designers start to operate more closely to the productive and technological steps of the chain. These figures work inside fashion brands and concentrate on the product development. They usually join design abilities with technical and operative knowledge.
- **Activities belonging to downstream phases of the finished products production**: they include any activity dedicated to the staging of a collection, from the fashion show to the selling of samples. They involve interior, light, sound and graphic designers, communication and event managers.

As we see, there is a lot of need of designing competences to make the supply chain as it is structured working in an integrated and efficient way. Therefore, it is not a matter of reducing student's enthusiasms, but to enhance their awareness about the existing creative opportunities «replacing the freedom of expression with the idea of "craft", luxury with quality and culture, fame with being "knowledge workers" whose creativity needs the contribution of many others to be able to express itself in the form of a product that thousands of people will buy (Bertola, 2008, p. 121).

3.2.4. Industrial fashion designers as cultural mediators in the collective creativity system

So even fashion designers, as industrial designers, are **cultural mediators** –or cultural intermediaries–. With a sociologic perspective, Giusti (2009) frames three areas of intervention for designers as cultural intermediary among actors and objects: **inspiration**, **collection process** and **production of value**.

In **inspiration**, fashion designer works as a translator of cultural forms into garments, using a large variety of sources and assembling existing artefacts and representations into new products, according to the register of the post-production.

During the **collection process** fashion designer mediates among a high number of different actors competing, sometimes strongly, for the definition of what the new collection will be and trying to impose their criteria and preferences. In this case, the designer provides not much the originality of creations but the unity of direction of the process.

Producing the symbolic value of fashion product means that fashion designer mediates between her proposals and consumer's attitude in a kind of "reversed" marketing and creating a genuine belief in the goods. In the last two areas, strong competitors are emerging: apparel merchandisers and celebrities. If fashion design as a profession took about hundred years to consolidate, in a changing context the man-in-the-middle's historical pivotal position is endangered (Giusti, 2009, p. 1).

How could education give young fashion graduates the ability to deal with these tasks? All of them, apparently quite immaterial and experience-based, should find a corresponding concrete competence which can be codified and transferred to students along their study path.

As this research investigates fashion design from the industrial design perspective, we move from the competences needed for design education

listed in Paragraph 3.1 to verify that they are still completely valid if applied to fashion design teaching.

- **Ability of cultural elaboration**. As widely discussed earlier, fashion as the project for industrial products has developed in Italy as detached from the French couture tradition. Research thus become a fundamental part of the design process, that has nothing to do with the visionary sketch of an artist under dreaming inspiration. I stressed the cultural aspect of fashion in Paragraph 2.2, and the elements that influence a designer's production a few paragraphs earlier, namely languages, cultures or productive sectors collected, combined and hybridized.
- **Operative and technical know-how**. Fashion has a multitude of highly differentiated sub-sectors. The design methodology may be the same, but, in some areas more than in others, technical knowledge about materials, techniques and productive processes, is essential not just to be able to foster innovation, but even to design feasible things, sustainable from a productive perspective in terms of time and resources. As outlined earlier, fashion is probably, among the creative industries, the cruellest and the most stressful with its fast-changing dynamics, high economic interests, tight timing. To know what someone is designing, how that product will be made, or how many hours will it take to the technicians to be realized is a very important time-saving asset.
- **Awareness of the structure of design processes**. This is what designers learn through reflective practices, by acting in a particular situation, they collect information about the structured organization behind it and become able to replicate it the next times.
- **Awareness of the supply chain, its steps and stakeholders**. This point on the list is likely much more well-fitting to fashion than to other fields of design, and the reasons should have been made clear right above. Charged with the allure of luxury, the numerous creative figures that secretly operate far from the light of catwalks are often ignored by students and labelled as simple doers of executive tasks. Education has the duty to transmit this hidden creativity, which is the heart of Italian fashion.
- **Knowledge of the contemporary systemic dimension of the product**. Is there an industry which builds stories on simple objects more than fashion does? Clothes when charged with immaterial values, become fashion: desirable, connotative of a community, identifier in the claim of one's individuality. A bag, a pair of shoes, a coat are just pieces to cover a body without the system built around them by the communication, the staging, the way in which they are presented and sold to the public.

Dell'Acqua Bellavitis (2013) describes the teaching method of Industrial Fashion Design in few and exhaustive words, resuming in them what has been said in this section. To him, whoever deals with the education of future figures in fashion design has the duty to develop and apply a teaching method which enhances individual creativity and makes it evolve, from a gifted artistic talent, to the learned ability to understand and control innovation processes aimed to generate new ideas and to transform them into economic value. This needs an interdisciplinary approach which combines different competences interfacing within each other and focusing from time to time on specific sectors. To have a holistic view on design methods thus does not mean to stop at generic knowledge. Specialisms are a reality to be pursued, each one with its own cultural values and social dynamics which lead to privilege a particular disciplinary aspect instead of another.

Given as the academic context where the present study is based, Politecnico di Milano can be taken as a reference to verify the concrete translation of the competences needed by students into a structured study course. Polytechnic education derives from the design culture of Italian design, synthesis between profession and artisanal know-how, experimentation and contamination of different knowledge and disciplines.

The Fashion Design Bachelor's degree at Politecnico di Milano[7] is composed of a two years' common path for all the students, to gain the basic knowledge through theoretical and practical courses, delivered in classrooms and in workshops. As a poli-techcnical school which has its roots into engineering, scientific subjects focused on fashion sector are included among the theoretical courses together with humanistic ones.

With the **theoretical courses**, students learn:

- historical-critical knowledge: sociology of consumption and fashion, culture of textiles and its historical evolution, study of semiotics and aesthetics, of anthropology; consumption trends and scenarios;
- scientific knowledge about materials and production techniques;
- knowledge in the field of engineering: prototyping and engineering of the product, processing and process technologies;
- knowledge in the field of economy and management: organizational and management models, strategy and business management; communication and sales strategies for fashion as visual merchandising, events, set-ups and show rooms, magazines, coordinated image.

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[7] Data accessed online at www.poliorientami.polimi.it/cosa-si-studia/corsi-di-laurea/design/design-della-moda/, June 30th, 2018.

With the **practical courses**, students learn all the skills needed to master the elements of design and creation of a fashion product through the concreteness of the manual work done inside workshops:
- representation techniques and tools, as sketching, technical drawing, photography, visual languages and colour perception;
- prototyping skills, as pattern-making, sewing, draping.

This background knowledge delivered at first and second year gives students, on one side, the tools to understand the industrial fashion system from a cultural perspective –changes in behavioural habits and cultural values of reference– and from a productive perspective –production processes and technologies–, on the other the know-how about how a garment is made, its feasibility, its journey from idea to finished product to be communicated and sold.

At the end of the second year, students have the opportunity to choose among three specialisms for the third year: they indeed can personalize their studies in the field of clothing/sportswear, jewellery and accessories or knitwear deepening both theoretical and practical skills in the chosen specialism.

3.2.5. Designerly ways of knowing *fashion*

The adopted formative approach towards a professional figure provided with this set of competences is proving to be successful and appreciated from companies, which in the latest years have shown a growing predilection for the skills owned by designers rather than for the artistic ones. If these are valuable knowledge, competences and skill for fashion designers to act successfully inside the fashion industry, the *designerly* way of knowing turns out to be suitable even for fashion design teaching. **Experiential learning**, **team working**, and **real problem-based situations** are constitutive of a teaching method oriented to enhance relations with professionals and entrepreneurs, combining cultural knowledge with specialization as «the tool that lets new graduates dialogue with the job market in an immediately practical way, leading to the employment in the best companies and encouraging an understanding of typical processes and operations in the sector» (Bertola, Colombi and Vacca, 2012, p. 3).

Not yet mentioned before, **team working** has to be outlined as a very important asset during the learning processes: to Brown, Collins and Duguid (1989, p. 39) in experiential learning students «no longer behave as students, but as practitioners, and develop their conceptual understanding through social interaction and collaboration in the culture of the domain, not of the school».

Collaborative working skills are essential in contemporary workplaces, especially inside creative industries, where creative processes, we have seen, are becoming more and more shared between people with expertise coming from various areas. Collaborative work in a university environment is commonly simulated through team working, where students cooperate in the development of a common project; this method creates a rich learning environment especially when students have different backgrounds to be shared.

Another important goal for teachers is to give students **a direct picture of the fashion field**, usually with highlights on some of its features delivered through visits to companies' headquarters, professionals' intervention in class, theoretical lessons, visits to fashion trade-fairs. All of these tools, certainly valid, leave students the task of integrating them and applying them into practice (Bertola, Colombi and Vacca, 2012). The more recent experimentations are moving towards the direct involvement of companies into teaching. Mainly undertaken by schools with an industry-focused approach as Politecnico di Milano[8] –the Milanese fashion schools are the ones that traditionally cultivate the closer relations with the surrounding manufacturing companies (Volonté, 2010)–, industry-university collaborative teaching is opening the boundaries of fashion education with the intent to provide students with the real problem-based learning typical of design processes. When students relate directly with professionals, they *learn by doing* (Schön 1983), experiment and practice the earlier provided theoretical contents, understanding their implications and possible development (Bertola, Colombi and Vacca, 2012). Students can therefore face real professional tasks which characterize fashion organizations, work on real projects or problems which are typical in fashion companies, and even confront people with technical competences rather than design, establishing an exchange of knowledge that is typical of the real relationship of the designer with all the other people he/she is used to deal with.

As earlier reported in this chapter (see Paragraph 2.4), the Italian scenario is quite a particular case: on the one hand there are small and medium enterprises owned by entrepreneurs which recognize in knowledge, culture and human resources an intensive capital of investment and do not just employ

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[8] "*The collaboration established with leading companies – such as Armani, Missoni, Valentino, Stone Island, Ermenegildo Zegna, Brioni, Valextra, Serapian, Samsonite, Decathlon, Alcantara, Vhernier, Roberto Coin, Bulgari, De Beers, Intimissimi, Yamamay - allows a constant exchange of knowledge and makes of Politecnico the school of reference for the fashion industry.*" Data accessed online at: www.polinternational.polimi.it/educational-offer/laurea-magistrale-equivalent-to-master-of-science-programmes/design-for-the-fashion-system/, accessed June 30th, 2018.

their time in improving production towards economic profit. With the presence of open-minded people who believe in the development of their businesses through innovation of materials, processes, ideas, has been quite natural to have them close to design universities since the beginning. When they find among students not just pretentious artists but rather collaborative designers with fresh minds and creative attitude, they are usually happy to give their contribution to the youngers' training.

On the other hand, there are still some difficulties in the set-up of collaborative teaching, for many different reasons: firstly, alongside those "enlightened" entrepreneurs, there are also those who are wary, convinced that the time and energies required by students gives one-way benefits and represents for the company a waste of time and an interference in businesses; secondly, time in fashion industries is becoming a more and more rare resource, especially for the small manufacturing companies which struggle everyday with the pressing requests of their clients. Even if they would collaborate, they can't because they have not enough resources.

It is aim of this study to bring further experimentation and new knowledge about the involvement processes of companies into teaching, concentrating the experimental activities on the specific field of knitwear as a peculiar area of fashion design Italian industry.

4. Framing Knitwear Design

4.1. Introduction

We have seen in this chapter, Section 2, that the literature about fashion and textile industrial districts in Italy often mentions knitwear as an important branch of the fashion system, placing it among the excellences of Made in Italy and of Italian design culture. Section 3 made the argument on design educational method and its transfer in the field of fashion, framing the figure of the ideal industrial designer for fashion, as someone who works for the industry while dealing with the typical features of the fashion creative process. Stated its importance as a highly specialized industry, this section gives an overview of what is known and established about knitwear design process, its specificities and criticalities, to understand the needs of such a sector and the way in which a specific knitwear design education could address the outlined shortcomings.

4.2. A little explored research field

This research settles in an area of inquiry with very few studies conducted before, especially from the domain of design studies.

It was 1997 when Eckert, undertaking her investigation on knitwear design processes, pointed out that although many books have been published about knitwear the vast majority of them are written for lay users. Two decades have passed, but the range of publications about the subject did not changed a lot.

At that time, Eckert distinguished the published books about knitwear into three categories: books made to learn how to knit by hand or with a domestic knitting machine, as *Complete Knitting Skills* (Tomkies, 2013), books that collect hand-knitting or machine-knitting patterns elements to be incorporated into the readers' own designs, for example the pattern collection published in *Burda* (1988), and design books by hand knitting designers containing complete designs which the readers are expected to produce with few variations, for example *Glorious Knitting* by Kaffe Fasset (1985).

The three categories outlined by Eckert are still the same today, and still constitute the majority of publications about knitwear. While internet, social networks, and new aggregation opportunities for people have made the access and the sharing of those information easier (Conti and Motta, 2014), knitwear is still largely seen as a craft activity for people who share the same passion of creating something on their own. Today there are several learning opportunities, from knitting courses to online tutorial platforms, but almost all of them simply address knitting as a leisure activity, with no consideration for it as a part of the culture of the project and therefore with no clue on its potential and possible integrations within a conscious design approach.

These sources of knowledge, from platforms to books and magazines, still contain no information about industrial practices or processes (Eckert, 1997), and they present knitwear as far from being considered as an industrial sector and integral part of the industrial design culture. Today, as far as the literature review could determine in the course of this research, the three categories proposed by Eckert can be integrated with three more typologies of books published in the last few years: the first is due to the new success gained by knitwear both on catwalk and as an art form, and includes few books issued during exhibitions like *Unravel. Knitwear in fashion* (Van Godtsenhoven, Dirix, Haegeman and Van Loon, 2011), catalogue of the namesake exhibition at MoMu - Mode Museum of the province of Antwerp, or *Missoni, l'arte, il colore* (Rossi and Savoia eds., 2015); the second includes monographs dedicated to the history of knitwear companies, which are starting, in Italy more

than abroad, to recognize their heritage as a cultural capital to be communicated (see *Filpucci. History tells the fut*ure, Edelkoort, 2017); the third contains the few books and scientific papers that have been written since the scientific community, together with some visionary companies and fashion journalists, has started to see knitwear as an expanding field, shifting from a hobby into project, strongly rooted into tradition as well as into the contemporary scenarios of production and consumption. Some of these publications are specifically dedicated to knitwear design as a discipline taught inside Higher Education Institutions (HEIs) within Fashion Design study paths, as *Basic Fashion Design: Knitwear* (Sissons, 2010) or *Design della maglieria. Strumenti e metodologie progettuali* (Conti, 2013). Some others are dedicated to knitwear as an excellence of Made in Italy that deepen the knowledge on yarns/knitwear districts on the Italian territory, as *Maglieria Made in Italy. Knitwear stories and knit talks* (Conti, Poletti and Rinaldi, 2016).

Although the new entries added some knowledge –or often simply made concrete on paper the tacit one kept inside companies– and new perspectives in the field, knitwear is still a very little researched area in terms of both technical and design information. An overview on the literature revealed that there are still no other references to systematic academic research on knitwear design, with the exception of Eckert's doctoral dissertation and of some following scientific papers from the same research group (Eckert,1997, p. 7): knitwear design process had not been previously studied in detail and has been left as a marginal area of inquiry for the next twenty years, although few mentions can be found on non-academic publications.

If few works have been written about knitwear design, the search for publications focusing on design education in this field led to an even more limited range of scientific literature. The investigation in this direction thus searched for further deepening in books mainly written by people belonging to the industrial side of knitwear, being them designers, consultants or marketing experts, who have told stories and impressions about this field based on their professional experiences.

This section aims to understand if the literature has previously explored the specific role of the knitwear designer and if the need for a specific knowledge for the project in this field has ever been expressed.

To give an overview on the actions that knitwear designers are in charge to do, it is important to understand which are the steps of the creative process they follow, alternating phases that are concerned with purely creative actions, phases concerned with operative technical decisions and others more closely related with the economic and systemic dynamics of the fashion industry, of which knitwear is certainly part.

The outline given here follows the picture of the knitwear design process reconstructed by Claudia Eckert in her doctoral dissertation (1997). Must be noted that Eckert concentrated her investigation mainly on British companies, which typically design for retail chains and undertake most of the process internally, from the idea to the finished product. Although the industrial practice can vary a lot from one kind of production to another, when narrowing the perspective on knitwear design process Eckert's model is suitable to be transferred with no massive changes to the Italian context and to be taken as an exhaustive reference. It is true, tough, that the fragmented district conformation in groups of micro and small enterprises of the Italian fashion system adds to an already articulated process one more level of complexity, related to the spread of production actions: each small step of creation and production is here delegated to different specialized stakeholders, instead of having the whole process concentrated in a single bigger firm. It is a task of this study to give a complete picture of the process with the involvement of all the diverse stakeholders active on the Italian industrial scene, to verify if and where there are further opportunities of intervention for designers.

Eckert's model divides the knitwear design process into three main phases.

- **Fashion research**: at this stage is decided the general idea of the collection, based on market research, competitors' placement, trends and creative suggestions from the designer. The outcome is the collection main theme with moodboard, colour palette and materials, which gives suggestions about how the garments will look. In knitwear this step also includes the research and selection of yarns and stitches.
- **Design**: this step contains the design of garments with their visual and tactile appearance.
- **Sampling**: a design idea is technically realised as a swatch or a garment, verified and approved or discarded for production.

Eckert then expands individual phases into flow diagrams (Fig. 5), marking decision points with diamond shape, and highlights the main figure in charge of any single step: in the scheme designers are red, fabric technicians blue, shape technicians green, and others are black.
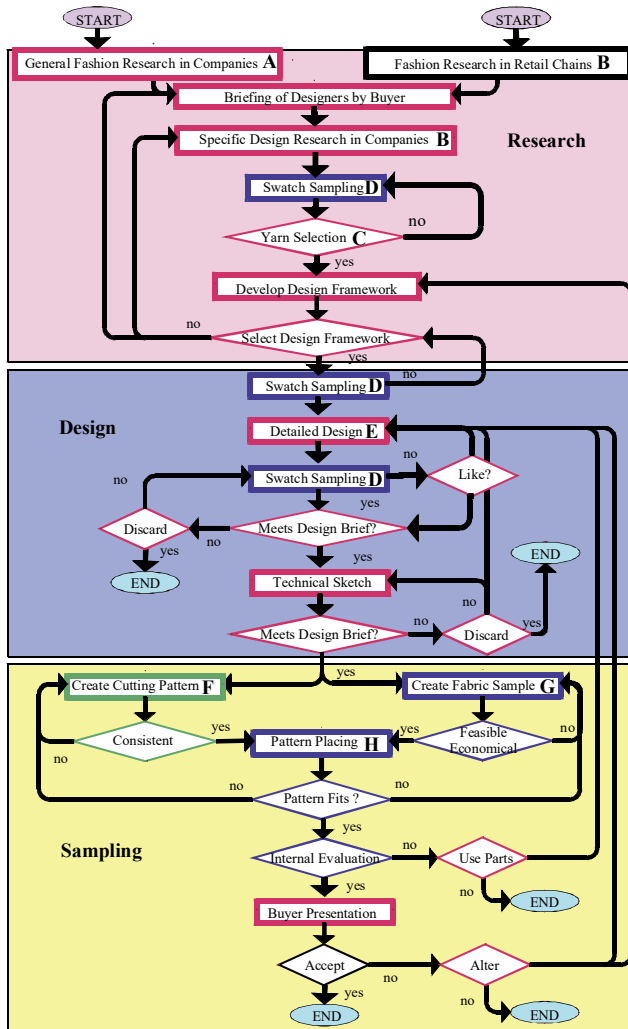
Fig. 5 - Knitwear design process: the model presented by Eckert (1997).

A detailed and very technical description of each step of the process can be found in Eckert's research (1997), which was the result of a meticulous work of observation of designers' practice and of other professionals working inside companies for a long period of time. Although it has a lot in common with the general fashion design process (Colombi, 2007) throughout her discussion Eckert explains which are the issues that emerge as typical features of knitwear design and make it one of a kind.

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- In knitwear the research phase includes also the selection of yarns. International yarn shows are attended by designers to gain an overview of the future trends, on colours and on new technological development of materials. At yarn shows designers make also contacts with yarn suppliers.
- Sometimes the creativity of designers overlaps with the innovation ability of spinners, when designers ask them to develop exclusive yarns for their specific necessities.
- Throughout the entire research phase, in parallel with the moodboard and the selection of colours and yarns designers also collect ideas about stitches to include in the collection and start trying them by doing swatches.
- Swatch sampling is spread all along the process and is repeated at least three times until the end of a season: the first supports the selection of yarns and stitches, the second supports the trials on designed fabrics for garments, the third supports the detailed definition of designs.
- In knitwear, the normal distinction between the design and sampling stages in the process is not clearly defined. Often design comes first, but the two stages can overlap, and designs can be revised during the sampling phase.
- The sampling process is long and expensive: from a starting point, the designer has to develop his/her own knitted fabric. Fabrics are not ready-made, but they require time to be processed and realised with machines, so any small variation has to be made from scratch. Moreover, designers often do not do this on their own, but delegate the passage to technicians.
- To be realised, a design has to be programmed for the knitting machine: programming has to consider diverse variables and the technician is in charge to make decisions about parameters which are different from yarn to yarn and from shape to shape (e.g. tension, stitch size, knitting time, or pulling weight). All these parameters affect the final aspect of a garment, so can be said that part of the design process is definitely worked out by technicians.
- Technicians also have the important task to interpret and translate designers' sketches into knitted structures. «Technicians need to work out which effect the designer has in mind, which machine operation are required for it and how it can be achieved on a particular knitting machine in a particular yarn» (ivi, p. 51).
- Knitwear can be cut-and-sewn or knitted directly into shape. The last one usually fits better on the body, avoids wasting of materials and does not have to be cut in the shape of a paper pattern. The fabric and the shape are created at the same time.

As said before, the process outlined by Eckert clearly highlights some peculiar features of knitwear design while framing it as perfectly integrated into the dynamics of the fashion industry. In this sense, great correspondence can be found with another model, proposed by Chiara Colombi in her doctoral dissertation (see Colombi, 2007) as a basis on which to build methods and approaches to be used for knowledge creation within the Fashion Design university courses at Politecnico di Milano. It is one of the scopes of this research to give an overview on the knitwear creative process in the contemporary Italian context, to see what stages involve which stakeholders and how the collective creativity typical of Italian knitwear influences the role of designers, their relations with the actors along the supply chain, the range of job opportunities they have ahead.

4.3. Framing the role of designers in the peculiar complexity of knitwear design process

4.3.1. Between garments and fabrics

According to Petre, Sharp and Johnson (2006), although it is an integral part of the fashion system and it shares similar processes and creative approach, knitwear design has its own peculiarities. To Traini (2004), these peculiarities lie primarily in the need for knitwear of specific knowledge and skills and of a long period of training. This statement immediately highlights one of the problems which recurs in the literature: the teaching approach of fashion schools, in Italy as well as abroad, does not seem always able to provide such a training in this field (ivi, p. 250), which is often left as a simple variation on the more generic training field of fashion design (Affinito, Conti and Motta, 2017), leading to a lack of young people approaching this sector with the right level of engagement.

But it is not just a matter of the limited presence of specialisms offered from education institutions: if compared to all the other fields of fashion design, knitwear is more difficult to approach as it reaches the highest levels of complexity of the design process. To Eckert (1999), this happens because knitwear design combines the creativity and the knowledge of fashion design, which is basically concerned with the shape of garments, with the ones of textile design, which usually creates fabric with woven or printed patterns, basically doubling the length of the design process. This «interplay between shape and fabric is the major source of complexity and difficulty in knitwear design» (ivi, p. 30): the project does not start with the simple selection of

ready-made fabrics but with the selection of yarns which still have to pass through a translation into fabrics, translation of which the designer is in charge. Must be said, though, that designers move into complexity, and for passionate designers who find it along their way knitwear becomes one of the most interesting challenge to be faced. Li Edelkoort notes that

the essence and beauty of knit lies in the fact that the designer invents everything from scratch; he creates the stitch, the handle, the weight and chooses the colour, deciding on texture and shape at the same time, mastering his own finishings and detailing (Edelkoort in Sissons, 2010, p. 65).

If professional knitwear designers can potentially control any kind of feature of their creations, this means that education in this field needs to enable them to do that, identifying new levels of knowledge to be transferred to students specialising in the field.

4.3.2. Between creativity and technique

Further research in the literature highlighted one more complementary issue: knitwear design is, to Eckert (1999) «the creation of a technically complex product according to aesthetic considerations», and this technical kind of knowledge is another source of complexity in the process.

Frisa and Danese (2011) note that the design and the perception of knitted garments are affected by each of the several steps of production, and this necessarily leads to an intense exchange of information between the time of creation and the time of production, the people who creates and the people who processes and physically makes. So, as seen in Paragraph 2.4, in knitwear –and especially in Italian knitwear where collective creativity is the common way to share knowledge– the experience of manufacturers, technicians and designers has always been shared «in a more obvious way than in other contexts, to the extent that it was not unusual to have both coincide» (ivi, p. 48). It is not by chance that Traini (2004), writing about the worry of companies about the future rolls of professionals, defines them as "technician-designers". But that was just a vision: although aesthetic and technical design, Eckert (1999, p. 33) continues, «can never be completely separated in knitwear», it is quite common to find the two areas of action sharply divided and belonging to different professional figures, to the designer the first, to knitwear technicians the latter. Indeed, despite what declared by Sandra Backlund about her creative process (in Sissons, 2010, p. 9), «it's a freedom

to be able to make your own fabric while working. For me it is the absolute challenge».

To Petre, Sharp and Johnson (2006) due to the technical nature of knit-wear those freedom imposes **particular design constraints**. The absolute challenge recalled by Backlund contains tight limits, starting from the choice of yarns: different yarns completely change the result in terms of weight, touch and texture and may introduce distortions due to their physical limita-tions; then, machine-knitting cannot always realize the desired outcome, and moreover there are costs to be considered, and the fast turn-around of con-temporary fashion system, with an average of six collections in a single year. Freedom has to consider that «the design must be suitable to be knitted», and then suitable to be sold and to be worn. (ivi, p. 185)

The strong presence of a technical part in the design process seems to find natural correspondence in the typical educational method of industrial fash-ion designer (see Paragraph 3.1) which combines cultural knowledge with operative know-how on production, far from the artistic artisanal creativity of *couturiers*. However, we have seen that design education have struggled for the last two decades in finding a balance between those two kinds of knowledge; now, the significant technical component of knitwear design process strongly unbalances the needed competences towards the operative side, creating a relevant issue to be addressed when fashion design education starts to deal with knitwear.

4.3.3. Between fashion and engineering

To trace the boundaries of knitwear design specificities, the most relevant work from a scientific point of view, rich of suggestions for the present study, has been the above-cited one conducted in the late Nineties by Claudia Eck-ert with Martin Stacey and Jennifer Wiley, who deeply investigated the role of the designer in its relationship with the very technical –almost engineer-ing– aspects of knitwear design process. The scholars thus approached knit-wear with the perspective of engineers as they are and chose it as an area of inquiry among all the disciplines of design exactly because of its similarities with some field of engineering design (Eckert, 1997; Eckert, Stacey and Wiley, 2002). Knitwear design, they say, resembles many branches of engi-neering design in its being a team activity with problematic interaction be-tween designers and technicians; the first are in charge of the aesthetic fea-tures of garments, the second have the task to add details when programming the industrial knitting machines. In the traditional division of roles they

observed, designers typically produced large numbers of designs –hundreds, or even thousands– in a very condensed time and relatively few of them were chosen to be furtherly detailed; the detailed design was done by knitting machine technicians with the transfer of designs from sketches to programs for computer controlled knitting machines (Eckert and Stacey, 2001). During their investigation they observed a clear division of tasks: although they are part of the same design process, designers and technicians have very different competences, follow different training paths and talk different languages. This gap of knowledge between them is, to Eckert *et al.*, the main cause of ineffectiveness along knitwear design process.

In those years, they saw in the technological development of software and in computing programming an opportunity to facilitate communication, to save time and improve productiveness; must be noted that at that time the professional boundaries of the industrial designer as described in Section 2.3 were being defined by the rising research towards industrial design education: designers were still perceived as creators more than as facilitators, and they were concerned more with style and products rather than processes.

Twenty years after, technology has actually come to the aid of designers, programmers and technicians. Despite this, and despite designers should have taken the new role of mediators along the creative and manufacturing process, the communication problems and the complexity of this field still nurture the division of competences between creative and technical tasks that Eckert, Stacey and Wiley outlined in their works. These are still the main critical issues when designing knitwear, and the same when questioning about an effective way to teach knitwear design.

Observing the Italian knitwear industry, also Traini (2004) observes the delicate balance between designers and technicians. As illustrated in Paragraph 2.4, technicians are not just industrial machine programmers, but include many other figures with operative competences as machine operators, linkers, pattern-makers. The designer must work in a close symbiosis with all those people, in «a delicate balance between rules and freedom, experimentation and experience, past and future» (ivi, p. 241). Technicians needs to knit what designers think (Eckert, 1999) and try to make them understand the limits of the material, while designers encourage technicians to push the technical limits to seek something new and experiment. While being quite complicated, this is the most common way to bring innovation inside knitwear design processes: to be able to pursue this kind of innovation through dialogue is one of the fundamental skills of a well-prepared knitwear designer.

4.3.4. The issue of communication: tools for knitwear designers

In such a close relationship, communication is, as briefly mentioned before, the most important asset to avoid the waste of material and immaterial resources, and it is made harder than in other textile domain (Eckert, 1999, p. 35) by the technical complexity of the knitted product.

Barriers become even stronger when the steps of product development happen in different places and different companies, as it is in Italian district economy: designers sketch their ideas and then send drawings to another company to do the machine programming, then another one will receive the programs and will knit samples to be returned to the designer at fashion brands headquarter. It happens that, inside different companies, people with different roles think about the product in different ways: «designers think primarily in terms of the visual appearance of a garment, and technicians think in terms of structural properties and their technical realization» (ibid.). Although this multiple perspective is fundamental to take care of any aspect of garments making, the lack of a common language and of direct contact between people increases the duration and iteration of the process.

Schön (1983, p. 105) wrote that drawing and speaking are parallel ways of designing, and combined the constitute the *language of the project*, in which verbal and non-verbal dimensions are closely connected. When communication does not happen in presence, we need tools to represent and describe in detail what we cannot say with words. If sketching is traditionally the designers' own way of expressing themselves, the technical definition of knitted products needs new levels of this language, as sketches are not enough to communicate its complexity.

Drawing is though the first step of a long way and deserves some considerations when it comes to knitwear: sketches here must be as clear as possible, unambiguous, well defined and immediate. This means, (Traini 2004) continues, that who sketches must know the criticalities of the product, how do materials behave, and which level of complexity can the diverse techniques reach. For knitwear, drawings must be indeed much more technical than inspirational as they do not describe an allure or a general effect, but they should faithfully reproduce every aspect of the garment, in particular the chosen knit stitch, and provide all the details necessary to support the making. It is almost impossible to sketch in an unambiguous way the structure of a stitch and even more to differentiate it from other similar ones.

To overcome this difficulty, it is possible to add writings on sketches, but this outlines another problem: as Eckert (1999) explains, knitted structures are extremely difficult to communicate due to the absence of a notation that

is both easy to use and complete. Stitches, trims, shapes, even materials are called in many ways, sometimes they change their names from company to company, and often they have no denomination at all.

«Designers therefore point to swatches or garments to specify what they want and describe modifications to them verbally» (ivi, p. 35). The material samples are a decisive step of product development and an important aid in communicating technical features. As the sketches, they have to be detailed and precise, because

it is not possible to create a mock-up of a knitted garment in another material to communicate the design without creating knitted fabric. Only a swatch can communicate an intended design accurately and give information about how to create it (ivi, p. 36).

To Cross (1989), in most design domains an accurate description requires a large investment of effort in working out details, and so a high degree of commitment to a design. This statement is extremely suitable for knitwear, where the representation –through sketches, technical drawings, samples, schemes– must reach a very detailed level of accuracy and must include all the elements to be effective, as each possible representation tool to describe garments leave out important information. In this analysis of the articulated "written" language of knitwear I found suggestions regarding the communicative tools to be provided to young knit designers, here resumed in a first brief list which will be furtherly addressed along the development of the research itself: it seems to be useful for young knit designers to learn a common language, professionally oriented, with a combination of drawing abilities, technical words, knowledge about stitches and ability to make samples.

4.3.5. Critical issues highlighted in the literature

As can be easily guessed through the overview on the features which make the design process of knitwear unique and different from the other fields of fashion, what is often presented as source of complexity is indeed a critical issue which heavily affects the efficiency of creation and production. The cited authors who have studied knitwear have outlined these criticalities and assumed some solutions: even if they have been mentioned between the lines all along this section, I find useful to recap them here, as they allow me to start to analyse the possible answers that a specific educational path for knitwear designers could give.

Some words must be firstly spent on contexts and times: at the time the authors wrote about knitwear –from the late Nineties onwards– fashion was already facing though times due to decentralization in Eastern countries and to the more and more tight timings required by the market in the crazy parade of collections, which went from two to six a year, reaching sometimes in more recent years the almost unsustainable peaks of sixteen, including spring-summer, fall-winter, pre-collections, cruises –or resort– and special editions both for menswear and womenswear. On one side, the displacement of production took work away, on the other the high pressure was over-whelming the small companies still active on the original territory. In such conditions, to be ready and responsive to the market's and to clients' demand is crucial, exactly as it is to make the creative and productive process as effective as possible.

In *Unravel: Knitwear in Fashion* (2011) we can read the words by Karen Van Godtsenhoven, Belgian knitwear designer:

nearly all the textile companies have disappeared because of the high cost of labour. […] It is difficult to find companies in Europe that want to make anything in order than simple knit V-necks for supermarkets. Small-scale production does not leave companies with adequate margins. I used to work closely with knitting workshops in Antwerp and Brussels, but they have gone out of business. It takes a lot of time and energy to think up and develop new things every season; moreover, developing samples and prototypes is very labour intensive. All the top companies are in Italy, but they work mainly for large luxury players like Prada, Missoni and Alaïa. In Belgium, you still have one family-owned, industrial company, Cousy in East Flanders. It is a minor miracle. They really brainstorm with designers and constantly look for ways to innovate (ivi, p. 92).

These words give an immediate idea of the difficulties that knitwear faced in Europe in the last two decades; on the other hand, they confirm the leading role of Italy on the high-end market and recognize the innovative added value of the way of working of small family-run businesses which almost disappeared abroad but still continue to characterise Italian knitwear.

Eckert and Demaid (1997) argued that there is a strong inefficiency affecting knitwear design process, which, under the time pressure of the fashion field, is unacceptable for companies. This inefficiency, with the consequent waste of time and resources, is to the authors imputable to the already mentioned lack of technical knowledge of designers and to the difficult communication between different professional figures.

Eckert observed, in 1999, that most designers were trained in fashion or textile design and were not taught knitwear in depth (Eckert, 1999). This

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means that both of them owned half of the needed knowledge. Traini (2004) confirmed the argument and will be objective of this study to understand if something has changed, how and where. Designers notably have little technical knowledge of how the products are made (Eckert and Demaid, 1997): their technical training is often left just to what they can pick up during their work on side of technicians rather than to a planned program of learning. Companies should invest in appropriate technical training courses for designers (ibid.), but they did not –and neither do today– have the time and the money to allow that. During some interviews made by Eckert, technicians express their worries about the fact that designers did not «receive enough technical training in the construction of knitted structures or programming CAD systems during knitwear design courses at college» (Eckert, 1999, p. 39); many of them, she reports, would like designers to have greater technical knowledge and «think that better technical training for designers would be the single thing that would most improve the design process», avoiding the waste of time on searching for solutions on the numerous impractical designs (ibid.). As a proof, she interviewed also designers who have received CAD programming training, who declared their satisfaction in opening their eyes on the problems technicians are used to face every day. Even if the courses would never be enough to learn how to program complex garments, it is important for them to understand how they work.

As a consequence, the figure of the designer is detached from the one of the technician and the two find difficulties in speaking to each other and in understanding the respective different ways of thinking and approaching the product. The problem is even more pronounced when it comes to young designers: while the new graduates have strong stylistic ambitions, continues Traini (2004), they have scarce familiarity with the goods and the production systems, and find in technicians colleagues that «do not exactly shine for their initiative and creativity», making the positive transfer of knowledge a distant mirage (ivi, p. 251).

Directly linked to the results of a more or less effectiveness of education, these statements constitute another starting point for this research to understand where the scientific research and the enhancement of academic study courses in knitwear design could find opportunities of intervention.

4.3.6. The issue of innovation

To Petre, Sharp and Johnson (2006) commercial knitwear requires designers to express their artistic creativity within a lot of pragmatic

constraints, in the highly competitive environment of manufacturing industry. In such a context, innovation is not the flamboyant aesthetic evolution of couture, but often lies in pushing those pragmatic constraints to their limits, to realize something in line with fashion trends but somehow different from other products on the market. To do that, designers need to overcome the problem of hard dialogue and work in close cooperation with technicians, who are able to control the machines and often to make them do things that seemed unfeasible. This places innovation halfway between being an opportunity to go further and a problem to be solved.

In a series of interviews conducted by Eckert, Stacey and Wiley (2002) and collected in a paper about the balance between expertise and creativity in knitwear design, they report some statements released by designers dealing with technicians and vice versa. They write that knitwear designers often collide with technicians that «assert that a design could not be programmed until bullied into producing it» (ivi, p. 56); on the other side, technicians complain about the non-feasibility of the vast majority of designs at their intended price point. Although this clearly belongs to the sphere of critical issues seen in the previous paragraphs, it is when people face the problems and struggle to find solutions that innovation enters into knitwear design process.

It is a long-standing matter, that can be found in the words by Luciano Polato, reported by Mazzucotelli Salice and Mora, He is a heels maker in Italy, and even if he has nothing to do with knitwear, his words are representative of a very common way of thinking and working in the small and almost artisanal Italian industrial realities.

 Usually style never goes well with technique and this is a fact. So when a designer comes here he would never have a technician on his side. Why? Because technique sometimes limits creativity, and we know that very well. [...] our strength is knowing how to realize the initial designs of the designers, not limiting the technical aspect. So I let myself catch up a little sometimes I do things that maybe at first sight seemed unattainable, and then I can even try to carry them forward. This is part of my job: trying to make things more and more bizarre and bring them back to reality (in Colombo, 2013, p. 132).

If there is something unfeasible, the skills of experienced technicians allow them to understand how to propose to the designer solutions to make something very similar to the eye but feasible, in terms of what the machine can realize or simply in terms of less time required to be knitted.

In her book, Traini (2004) outlines the features of the ideal programmer, which should know about knitwear as well as about the operation of the knitting machine and the opportunities and limits of yarns and stitches. If a

programmer gathers all these competences and is able to make full use of the today's most evolved machines, he/she will not have the trivial role of executor but will be the designer's most important collaborator in the construction and innovation on the product.

This is the most desirable kind of innovation, an innovation design-driven that arises from shared knowledge between people and even between companies in the typical dynamic of district economy. Although being the most successful on a finished product, it is very time and energy demanding both for designers and technicians, and not always possible to be pursued. The tight timing of fashion system often leaves space just for other kinds of lighter innovation that does not touch the processes or manufacture technologies but lies in a simpler renewing of the products' aesthetics. This lighter innovation, which would be better called just renewal, often does not take place within companies but comes from the outside, from those activities Bertola (2008) defines as **belonging to upstream phases of traditional creative processes** (see also Paragraph 3.2), or happens as a consequence of imitation or adaptation of designs.

Again in Eckert, Stacey and Wiley (2002) the authors give an overview on the –more or less intentional– "suppliers" of renewal.

- **Sampling agencies**: they develop their own collections of stitches by experimenting with materials and textures with no consideration or restriction concerning garment shapes or manufacturing constraints.
- **Couture houses and market-leading upmarket knitwear companies**: here, with less restrictions on costs and more investments recognized to innovative designs, sampling and experimentations are taken as a reference from other brands to introduce new stitches or techniques in their collections.
- **Companies designing for conservative markets**: here innovation is a subtle difference of new products from those of past seasons. It is an "adaptive" innovation, which just modifies something in textures or in materials.

This is a very common typology of innovation in those contexts (e.g. the Anglo-Saxon one) where, as Eckert and Stacey (1999; 2002) verified, there is a predominant belief –in universities as well as in business environments– that creativity gives its ultimate expression when is free from technical constraints. Where innovation is led by the eccentric couture taken as a reference by most of the fashion brand, everyone believes that too much of technical knowledge restricts designers' creativity and that artistic creativity is opposed to problem solving ability. In such a different context as the Italian one, this vision has no match with the framework given to the figure of the designer as a problem solver, even more so if he/she does not work for

French couture but for a *prêt-à-porter* brand or an Italian manufacture. The work made by Volonté confirms this difference, outlining in a research made on Milanese fashion designers, that «the designer's creativity is useless if it is not constrained by limits that give it value» (2012, p. 417).

Also Eckert, Stacey and Wiley (2002) answered to this emerged issue with the support of psychological studies of creativity and of "convergent" and "divergent" thinking, showing that «problem solving ability and fluency of idea generation are orthogonal abilities, and that success in most creative activities requires both creativity and the problem solving ability» (ivi, p. 53). Alongside this consideration, Eckert *et al.* made another reflection which should be noted in a study dealing with knitwear design education as this one is. They assumed the possibility that the technical expertise gained by professional designers during the years could eventually limit their freedom in creativity, making them more prudent and less likely to exit their safe area; on the contrary, they said, novices are more likely to explore and bring disruptive ideas into companies as they are still not familiar with the constraints of the market, even if this happens at the price of a great effort invested in infeasible designs (ibid.).

4.4. Conclusion: what kind of perspective on knitwear design education?

The outlined consideration lead to the needs of a better understanding of the role of knitwear designers and on the theme of education in the field.

What is the balance to reach between creativity and technique in a knitwear designer's cultural background? Where does the designer's intervention end and where does the technician's start? Where do they overlap?

If knitwear design is much more technical than other fields, what kind of importance has to take technical knowledge in the study path, as long as it does not restrict designers' creativity? (Eckert *et al.*, 2002)

Moreover, they shed a new perspective on what young people can offer to a knitwear company: what if we consider novices not as young postgraduates newly hired by companies, but as students still designing inside the protected environment of university, sharing their ideas with more expert designers or with technical professionals?

If «novices, especially students, often have more time, more enthusiasm, greater willingness to fight for what they want, and less pressure to produce adequate results quickly rather than good results slowly» (ivi, p. 58), could they be a positive asset towards innovation for companies if they share their

ideas with more expert designers or with technical professionals while they are still studying?

This is the starting point to design experimental actions and open up new avenues for knitwear design education inside universities.

3. Crossing boundaries: from the knitwear industry to design universities and return

<div style="border: 1px solid black; padding: 20px;">

WHAT YOU WILL FIND IN THIS CHAPTER, IF YOU ARE:

AN ACADEMIC

- A parallel overview on knitwear both as an industrial system and as a design discipline
- The voices of privileged witnesses among expert professionals in the sector
- The areas to intervene on with experimental innovation

A STUDENT

- The detailed outline of the creative process of knitwear, from the very first idea to the industrial product, and the role you will take in each step of the project as a professional knit designer
- The desiderata of real working people in terms of dialogue with designers

A PROFESSIONAL

- The voice of colleagues working for excellent companies, with different tasks along the chain, giving an overview on the Italian districts of knitwear
- Information about the study paths of Italian and international young designers
- What is being done now and what direction knit design education will take in a foreseeable future

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1. Knitwear as an industrial system

1.1. Who needs a knitwear designer?

Chapter 2, Sections 2 and 4 explain the reasons why this study focuses on Italian knitwear as a product that owns all the features of the "beautiful and well done" made in Italy, realized by a very special industrial system which is reference and supplier of the vast majority of Italian and international high-end *prêt-à-porter* brands. Here, inside industrial districts, the knitwear process is organized according to the different steps of a normal fashion design production process, but involves many more actors than just fashion brands: Italian knitwear is ideated and produced not just within the brands' headquarters, but with the involvement of many other stakeholders, who are not only entrusted as makers but are fundamental participants into creativity, active contributors in terms of technical knowledge as well as of creative solutions from season to season.

This is part of what, with Bertola's words, has been previously defined as "collective creativity", and deserves here a deeper description. Only partially reported by the literature, the entire system has been studied through interviews and direct observation, giving the evidence of a system where each reality does not just work for itself, but is rather a place open to the ideas and the creativity coming from the surrounding territory. The observation made through company visits combined with dialogues with different professional figures of the sector, participation in yarns trade fairs, attendance to specific courses and interviews with experts outlined the succession of stages in the complete process of Italian knitwear –from the raw fibres to the garments sold in shops–, framed the work made by each stakeholder and the role of designers inside them. The process can be visualized as in Figure 1, with 9 phases, each one held by a leading stakeholder and, depending on the task, with the contribution of others.

The following section of this chapter goes through each step, describing the whole process with the aim to understand the active roles and to see, outside of the style departments of fashion brands, where do designers intervene on the chain and whoever needs the competences of a specialised knitwear designer.

1. Colour and trend research	SPINNERS / TREND FORECASTERS + DESIGNER
2. Yarns development and production	SPINNERS + DESIGNER
3. Yarns trade fairs (Pitti Filati, Première Vision)	SPINNERS / KNIT FACTORIES / DESIGNERS / BRANDS / STUDENTS AND FASHION SCHOOLS / MACHINE PRODUCERS / CERTIFICATORY BODIES
4. Research and creative design process	BRANDS + DESIGNER
5. Design of the collection	BRANDS + DESIGNER
6. Study of prototypes with design and pattern amendments	KNIT FACTORIES + DESIGNER
7. Pre-production samples development, selling and consolidation of orders	KNIT FACTORIES / BRANDS (commercial)
8. Production and quality control	KNIT FACTORIES + THIRD CONTRACTORS
9. Press, PR and distribution	BRANDS / COMMUNICATION AGENCIES / PR + DESIGNER

Fig. 1 - The steps of the knitwear process and the stakeholders in charge of each steps. In red, the leading stakeholder.

1.2. Knitwear design process: an overview

1.2.1. Colour and trend research

Knitwear design process does not begin with the idea inside fashion brands headquarter. It begins some steps earlier, with the research on trend and colours concerning the yarn and made by spinning mills to design their yarn collections.

Trend research and colour research are the very starting point of the process, and they happen almost two years before the collections go on sale in stores. Spinners are in charge to propose new colour palettes and new ideas about yarns, and also to develop new technologies of production following macro trends[1], e.g. sustainability, or active lifestyle, or travel attitude[2].

Color research is usually delegated to trend forecasting offices or freelance designers (e.g. Ornella Bignami's Color Coloris, or The Woolmark Company), who detect and interpret the evolving taste and visualize it through colour suggestions or books of images. Some of them hire a trend researcher inside the company and have a long-lasting collaboration with

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[1] Oberved at Pitti Filati research area, Pitti Filati 79, 80, 81, 82, 83.
[2] Observed at Filmar, Zegna Bariffa Lane Borgosesia.

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him/her, some others prefer to change the researchers to avoid repetitions over the seasons.

The experts sometimes discuss with the company's owner or the marketing manager, to gather information about the products from their experiences and entrepreneurial intuition[3].

Once the research is completed, trend researchers compose colour folders, sometimes accompanied by pictures to give a background atmosphere to the collection. In some cases, this set is seen by spinners' clients as an inspiring added value to the act of purchasing yarns, in some others it can be a distraction. It usually depends on the kind of product the spinner is selling[4]. Different product categories often have indeed different trend research behind with different outcomes, some keep more basic colours, like hosiery, some renew themselves more frequently and with decisive changes, like technical yarns[5].

Technological innovation follows a slightly different path from the one on colours. Sometimes it is driven by a client's request:

An agent can come and ask for a new title, according to his needs. A single request must be refused, as it is not sustainable. But when the market asks, we answer. We often propose a new product that fails for the first season and proves to be a great success in the following ones[6].

Usually, new purposes in terms of yarn come for a 20% from clients, and from an 80% from technological research on yarn production and processes developed inside the company.

1.2.2. Yarns development and production

Based on the colour research and on the emerged trends and requests, spinners start with the development of yarns.

The study on new yarns

contains a very important part of creativity, especially in Italy, where we have avantgarde spinning not just good at making classic yarns, with extraordinary blends

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[3] Observed in Filmar, Zegna Baruffa Lane Borgosesia, Filpucci, Lanificio dell'Olivo.
[4] Observed in Filmar, Zegna Baruffa Lane Borgosesia, Lanificio dell'Olivo, Filpucci
[5] Michelle Marzoli, Filmar, interview, July 16th, 2016
[6] Michelle Marzoli, Filmar, interview, July 16th, 2016.

and exceptional hands, but also at inventing new yarns - effects, surfaces, colour combinations, mixtures, melange, and more[7].

Here, one of the widely emerged problems is that there are no yarn designers[8].

Why no designer wants to be a yarn designer? It would be great for spinning mills and brands to be able to understand each other[9].

To the majority of people interviewed, research and innovation on yarns is fundamental. Innovation usually follows two possible pathways: the routine one, which follows the trend research and renews the yarn at an aesthetic level; and the much more complex one of true product innovation, which creates new yarns completely different from any other yarn on the market or highly technically advanced[10]. This second kind of innovation is quite difficult to happen: one example above the others, Cashwool by Zegna Baruffa Lane Borgosesia has been launched in 1978 as the first processed wool that did not felt, and the same company took over forty years to develop H2DRY[11], a product as ground-breaking as the first one[12] .

Spinners usually have close relations with fashion brands and work together with them in search for new kind of yarns. Deanna Veroni, of Modateca Deanna, affirms that this relationship has gained strength in the last decades, due to the value of opinions and knowledge exchange on the mutual needs

that lead to innovate the product both on the side of the raw material and on the side of the finished garment. We must not forget that some of the most important elements in the design of a new collection are closely linked to the relationship between these two actors in the supply chain, let's think, for example, about the theme of colours, the rendering of fabrics or yarns, certain types of workmanship (Deanna Veroni, Modateca Deanna, interviewed in Tartaglione and Gallante, 2010, p. 89).

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[7] Ornella Bignami, Elementi Moda, interview, October 7th, 2016.

[8] Michelle Marzoli, Filmar, interview, July 16th, 2016. Ornella Bignami, Elementi Moda. Interview, October 7th, 2016. Luciano Bandi, Zegna Baruffa Lane Borgosesia, interview, October 10th, 2016.

[9] Luciano Bandi, Zegna Baruffa Lane Borgosesia, interview, October 10th, 2016.

[10] Luciano Bandi, Zegna Baruffa Lane Borgosesia, interview, October 10th, 2016.

[11] www.h2dry.it/ available online, accessed June 30, 2018.

[12] Luciano Bandi, Zegna Baruffa Lane Borgosesia, interview, October 10th, 2016. Observed also at Zegna Baruffa Lane Borgosesia corner at Pitti Filati 80.

As for the above-mentioned involvement of fashion brands in the leading of trend research, also for new yarn development their role depends on the brand and its identity. There are those who work more on modelling, those who follow fashion and those who concentrate on materials. Missoni, for example, is a very particular reality which works with classic products focusing on colours rather than on the yarn qualities. Donna Karan does a much more innovative work on the yarn aspect, she

arrives with a cup split in half and asks you for a yarn that gives the effect of that broken surface[13]

In the same way, Chanel uses to ask for combination of yarns, gauges, patterns, and is not as interested in plain yarns as Armani could be.

The ability of spinners lies in identifying their interlocutor and knowing how to present the product to make it attractive to the philosophy of each particular brand. Some interviewees affirm that even more depends on the designer who works for that brand: if he/she has no knowledge about knitwear, it is less likely for him/her to have specific requests and so to lead spinners towards innovation.

We immediately realize when a person has experience: if a designer chooses 45 articles out of 60 he/she does not know how to orientate him/herself, because who knows the product and its features knows what he/she wants and requires just 4 articles, already knowing he/she will keep two[14].

Investments on technological innovation are not proportional to companies' dimensions. There are big important companies with a very traditionalist attitude and very small realities, often new-born, which invest all their energy and economic resources into technological development (e.g. Dryarn, Solvron, Orange Fiber[15]).

Another important contribution to technological innovation comes from machine producers like Shima Seiki; here I report an example told by Alessandro Pontieri, in his contribution collected for this research:

Just yesterday we had here an Italian spinning mill that produces cotton, pure or in blends, with endless color charts, which brought us the proposal of a new yarn to

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[13] Luciano Bandi, Zegna Baruffa Lane Borgosesia, interview, October 10th, 2016.
[14] Luciano Bandi, Zegna Baruffa Lane Borgosesia, interview, October 10th, 2016.
[15] For further information see Motta, M., and Conti, G.M. (2018). Teaching knitwear design: design practice for traditional manual knowledge innovation. *The International Journal of Design Education 12*(2), 13-23.

make shoes. How can a spinning that produces cotton enter the shoe market? Cotton is not suitable for shoe production, it is not strong enough. They have transformed a cotton yarn so as to make it stiffer, inserting a thermo-shrinking yarn into it: with the heat it melts together with the fibre and makes the finished product resistant. This addition also allows to adjust the rigidity of the final result by inserting more or less twistings of heat-shrinking material. This means to make innovation, and the most enlightened spinning mills work with us to develop materials with the best possible output on our machines[16].

While production of truly innovative proposals follows the phase of research and development, the one renewed just by aesthetic innovation goes on in parallel. The biggest companies manage to keep the entire process inside, the smaller ones delegate some steps of the processing to third contractors, specialised into dyeing, twisting, finishing, usually concentrated into the same district, e.g. Biella, Brescia, Prato.

1.2.3. Yarns trade fairs

The work done by spinners is presented at national and international yarn trade fairs. The most important are Pitti Filati in Florence and Première Vision Yarns (formerly Expofil) in Paris. There are also some more local yarn shows as FILO, in Milan. Here designers can get an idea on the overcoming trends, new colours and materials to use in their collections. Pitti Filati, taken as an example among the others, has two editions per year, one at the end of January with the presentation of Spring-Summer collections, and on at the end of June with the Fall-Winter. Yarn shows take place one and a half year earlier than the season they present: in January 2018, Pitti Filati showed Spring-Summer 2019, in June 2018 Fall-Winter 2019-2020.

Pitti Filati is a very important window for spinners, as at least one designer of each fashion brand, being them high-end Italian labels or smaller independent design studios,[17] attend the show. Each spinning mill has its own stand where yarns are presented to clients by appointment and often orders are concluded, and where they present, in spaces open to the public, the novelties of the season.[18] Yarns are presented in cardboards and yarn folders

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[16] Alessandro Pontieri, Shima Seiki, contribute, October 19th, 2017.

[17] Designers from Ermenegildo Zegna, Valentino, Fendi, Brekka, IF Isabella Francese, Luca Airoldi Handmade, Woolrich have been met while attending diverse editions of Pitti Filati.

[18] Observed at Pitti Filati 78, 79, 80, 81, 82, 83.

often include swatches of about 15cmx15cm, to give not just the colour effect of the yarn but also the feels, the weights and the texture when knitted[19].

Although spinners are the main stakeholders of yarn shows, these events are the phase of knitwear design process with the involvement of the highest diversity of stakeholders. Everyone has its role and is there to create and keep relationships with clients and suppliers[20].

Machine producers – Both Shima Seiki and Stoll have their corner and are kept busy in presenting the latest innovations on machines and the potential they offer in terms of knitted fabrics and garments. Knitwear factories are their main clients, but they also closely dialogue with freelance programmers.

Certificatory bodies – e.g. The Woolmark Company presents at Pitti Filati its Wool Lab, a trend book which collects all the innovations developed with the use of Merino wool for that season. Their clients are spinners, designers and fashion brands, but also everyone else who deals with materials, from technicians to fashion students.

Knitwear factories – People working into knitwear factories attend yarn shows to get suggestions on trends and on technological developments. Briefly mentioned in Chapter 2, we will see after that knitwear factories are often in charge of all the creative process from sketches to the finished product. This means that to get inspiration from experimental purposes of spinners and trend researchers is fundamental for them as well, not just for designers belonging to fashion labels.

Fashion Schools – It can happen that fashion schools finds in shows the occasion to present the work of their students, in closure of a study course or a master; they can be proper catwalks[21], or smaller exhibitions often sponsored by a spinning mill.

Students and new talents – As international events, Pitti Filati and other yarn shows are a unique window for young talents to present their work. Students or young designers are often involved as participants in contests; above all, the most important one worldwide is *Feel the Yarn,* held once a year in the June edition of Pitti Filati, where students from a panel of selected international

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[19] Observed at Pitti Filati 78, 79, 80, 81, 82, 83. Ohisical examples of cardboards collected from Filmar, Zegna Baruffa Lane Borgosesia, Lanificio dell'Olivo, Iafil, BE.MI.VA, Pecci Filati, Filati Biagioli Modesto.

[20] Roberto Rubertelli, Maglificio Ellynore, interview, May 17th, 2017. Ornella Bignami, Elementi Moda, interview, October 7th, 2016. Observed at Pitti Filati.

[21] On the first day of Pitti Filati 2017 a catwalk presented the twelve final works of students of the Master in CKD – Creative Knitwear Design, delivered by Modateca Deanna with Accademia Costume and Moda in Rome in partnership with The Woolmark Company, Diesel, Avant Toi, Laura Lusuardi, Amora Carbajal and Loma.

schools that are specialising in knitwear design compete with two authorial outfits to win a traineeship in the style department of a fashion brand.

Designers and Brands – The shows are for them the very first step of the research that will lead to the new collection. Here they collect ideas, photos, business contacts, they can consult the most updated trend books and specialised magazines, see the latest technological innovation. Sometimes spinners or other stakeholders organize in collaboration with designers' small exhibitions on their work[22].

1.2.4. Research and creative design process

It includes two phases. Phase 1 is the definition of the theme of the collection and the research towards the articulation in sub-themes. The outcome is the general atmosphere of the collection, guided by a moodboard, a colour palette and a material palette. It is usually held by the creative director of a brand and by the style department. Phase 2 consists in the definition of the concept with a more commercial perspective, considering guidelines for the aesthetic of garments (shapes, colours, materials, allure) and the complete architecture of the collection. The collection is organised in a grid considering a series of analysis of all the information coming from the marketing and the commercial offices in relation to the previous season, such as the most sold items and the market trend on the most saleable items for that season (Mauro Fabbri, Staff International, in Tartaglione and Gallante, 2010; see also Bertola and Colombi, 2010). The analysis is done by the brand manager, the commercial department and the product manager with the style department strongly involved, in respect of the different roles, to get a fair balance of the collection.

Both phases belong almost entirely to the fashion brand, with no work delegated outside, as it gives the main idea of the collection which will guide designers through the development of each category of products.

Concerning this phase, a further specification must be given about two main categories of fashion brands: there are brands that offer a complete range of products which includes knitwear alongside clothing and accessories, and brands that design and produce just knitwear. For the former this phase usually precedes the yarn selection, as the creative director, who does not deal directly and only with knitwear, set the overall picture to give

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[22] See the retrospective "FINESTRE SULL'ANIMA // VIEWS ON A SOUL" first edition of a project by Modateca Deanna which focused on knitwear collections by Marina Spadafora. More online at www.pittimmagine.com/en/corporate/fairs/filati/events/2018/modatecadeanna.html, accessed June 30th, 2018.

guidelines for each part of the style department to develop proposals in their particular line of products –bags, furs, knitwear, jewellery, shoes and so forth–. For the latter this phase can go together with the yarn selection and the chosen yarns partly guide the general idea of the collection[23]. This way of working demonstrates how the creative process in knitwear is closely bounded with materials and is much more influenced by yarns than the common fashion process.

1.2.5. Design of the collection

Once settled the overall mood and the colour and style guidelines, the designer works out the visual and tactile appearance of each individual garment (Eckert, 1997).

As reported in Chapter 2.4.2, the cases observed by Eckert (ibid.) were mainly British and German big companies, with a medium-level product innovated from season to season looking at the research made by higher fashion brands, and entirely inside the company. As illustrated in Chapter 2.2, when narrowing the attention on the high-end *prêt-à-porter* brands, this is a very uncommon practice in the knitwear sector. These brands need to communicate a strong identity, to distinguish from others and to be innovators on the market and therefore to concentrate a lot of energy in the research and design phase of any new collection. In these circumstances, a design phase held inside a brand's headquarter means that that brand has high economic resources and gives even higher value to the specialised knowledge of its designers; consequently, it is likely for that brand to represent a reference for others and to dedicate important investments to knitwear products.

This is the case of Missoni or Brunello Cucinelli, which are able to keep inside and to control such a complex creative process. In these particular cases, the creative director collects inputs from the people around him/her, about anything that could be inspirational like art, architecture, different fashion movements, postcards, prints and so forth.

Due to their strong identity, both the mentioned brands have their own way of undertaking designs, consolidated during the decades. Missoni usually starts from colours, choosing 28 colours for each season's colour card. The collection is anticipated by the pre-collection with 8 different colours out of 28, so that once on the catwalk, the main collection will be different

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[23] Roberto Rubertelli, Maglificio Ellynore, interview, May 17th, 2017. Luciano Bandi, Zegna Baruffa Lane Borgosesia, interview, October 10th, 2016.

from the already seen one. They choose different yarns for every season and develop knitted stitches, jacquards, prints ideas, colorways, weights, experimenting with different yarns to create new textures and trying everything on the Stoll machines inside the company or with hand machines. From here, they select the best ideas and design the shapes, which usually come from the observed tendencies[24].

Brunello Cucinelli follows a slightly different path. The brand is much more traditional than Missoni in terms of shapes and its value is the highest quality ever reachable by natural yarns used to produce what they call "luxury handicraft". Positioning its products quite far from the fashion excesses, the creative process is concrete and oriented to the market evaluation. The inspiration comes from around the world, where the people in charge of trend research detect interesting realities from a creative point of view but always remains connected to reality and wearability (interview to Federica Rosi, Brunello Cucinelli in Tartaglione and Gallante, 2010, p. 41). Indeed, the two creative directors, one for womenswear and one for menswear, are at the same time product managers, because the design of a collection is never a pure creative act, but always experimented to understand its portability (ibid.). Together with the general idea of a wearable collection, the creative team concentrates on the product and the process starts from the yarn, with 20x20cm samples to then create the designs based on that material, on its qualities and properties, always verified on the manual and electronic machines inside the company[25].

These two exceptional cases are representative of those few brands that are able to undertake the entire process by themselves and have to be mentioned for their importance on the market as deputies of the values of Made in Italy knitwear worldwide and perpetrators of its reputation.

In some other cases, the design of a collection is asked to an external studio, specialized on the knitwear product or on consulting on specific themes, as IF Isabella Francese or Elementi Moda by Ornella Bignami. In these studios, experts work on the ideation and development of the product with the right technical knowledge and with the facilities needed to try out swatches and samples while designing. Interviewed by Tartaglione and Gallante (2010), Ornella Bignami tells that

A collection is the result of a joint work that sees all the protagonists of the creative process putting their ideas on the table and assessing their functionality with others. Of course, we must defend our ideas because we believe in it, but we must

[24] Missoni, observation and Liz Griffiths, Missoni, dialogue.
[25] Brunello Cucinelli, visit to the company, observation.

have a certain willingness to mediate. Other companies, which have their own internal staff working on the collection, only ask us to intervene with a limited number of models and this indifferently either for the top collection of the line, or for the sports line, or for the models of the second line.

Alongside brands who do the design on their own, and brand who delegate it to creative studios, it must be noted that the more often recurring situation on the Italian scenario is the one of high-end *prêt-à-porter* brands delegating a part or the entirety of the design process to manufacturers, namely to small and medium enterprises highly specialized in the transformation of a sketch into a finished product[26].

Thus, for this phase, **the main stakeholders are designers hired by brands together with people working on the product development inside knitwear factories.** As said in Chapter 2, those people are used to experiment with new stitches, yarns, and innovative technical solutions and offer their clients a fundamental support in the creative conception of garments as well as in the development of samples and in the industrialization process.

The business relation between brands and knitwear factories depends on the presence inside the brand's style department of a group of specialized designers in charge of knitwear.

The higher specialised are the designers behind the brands, the less time you waste, as they know the raw materials and they do not have a total knowledge of technical problems but are aware of them. The less prepared they are, the more we can run into situations where the style [department] asks for things that are not feasible or does not have clear ideas about price targets for creating a product[27].

When designers know knitwear, their work is developed in close dialogue with the people inside the knitwear factory who give their support and share their creative-technical expertise: it is common for designers to spend entire weeks away from their headquarters to work inside the knitwear factory during the phase of garments design[28]. If the brand's designer does not have any knowledge about knitwear, the entire process of product development is delegated to creative figures inside factories.

This could happen in three different ways.
- The brand gives some sketches, often ill-defined or hardly feasible from a knitwear perspective, or comes with just an idea, a picture, an old

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[26] Observed at MF1, Ghioldi, Maglificio Ellynore, Maglificio Pini.
[27] Roberto Rubertelli, Maglificio Ellynore, interview, May 17th, 2017.
[28] Observed at MF1, Maglificio Ellynore, Maglificio Pini.

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sweater and the employees in the factory are in charge of defining details, of adjusting what could not work and of making things feasible and economically sustainable[29].
- The brand gives just the general idea of the collection as developed in phase 4 and asks the factory for new designs *"We have clients who ask us to make the entire process from scratch, from the selection of yarns to the finished garment"*[30].
- The brand comes to the knitwear factory asking to see some garments from the archive or some swatches, and starts from there, together with the professionals of the knitwear factory, to elaborate new designs[31].

The relationship between designers and factories are usually of mutual trust and long-lasting. It is not uncommon that when a designer changes his/her workplace going from one brand to another, suppliers change their clients, losing the contract with the old brand to establish a new one with the other[32]. This happens because if suppliers need their clients, the brands need reliable suppliers who know how to make the product with the required quality[33].

When interviewed for the present research, Rita Airaghi, chairwoman of Fondazione Ferrè in Milan, told this story:

Among the various collaborations began that with Maglificio di Vignola which is located in the district of Carpi, territory of knitwear factories. The luck of Ferrè, and the mutual of the knitwear factory, was to work with them with no interruption: when the GF was born, he continued to be a consultant for their small commercial line -and for another line that they had created- but, above all, they have become the producers of Gianfranco Ferrè knitwear. This means that this legendary première named Denis, a typical feminine Emilian name, has worked with Gianfranco from beginning to end and both were dependent on each other. Mrs. Denis couldn't breathe if Gianfranco did not assign her difficult things to realize, if he did not multiply the requests, and with her everything could be done: going forward over the years, looking at Gianfranco's sketches, there are almost no more notes because she was able to perfectly read the drawings; a great fortune, that does not always happen[34].

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[29] Observed at MF1, Maglificio Pini, Maglificio Ellynore.
[30] Knitwear factory owner in Veneto, dialogue held at Pitti Filati 81, June 2017.
[31] Observed at MF1, Ghioldi, Maglificio Ellynore, Maglificio Pini.
[32] Michelle Marzoli, Filmar, interview, July 16th, 2016.
[33] Roberto Rubertelli, Maglificio Ellynore, interview, May 17th, 2017.
[34] Rita Airaghi, Fondazione Ferrè, interview, December 22nd, 2016.

On the same theme, Giuseppe Pini, founder and owner of Maglificio Pini, in Forlì, says that

Research and curiosity are important, even when your company is, like us, a service provider. The definition "sub-contractor" is perhaps not so beautiful, but that's what happens: we offer the customer a collaboration, on samples development, study and research, and in many cases we even propose. We know knitwear and we can create something innovative or ideate and realize something that the designer would like to see but of which he has no precise idea. Our task is to grasp that idea, understand it and process it, offering new solutions and building a mutual trust relationship with our clients[35].

To Raffaella Pinori from Pinori Filati (interview reported in Tartaglione and Gallante, 2010, p. 57) knitwear factories

are co-designers, […] and offer companies with a known brand their knitwear collection. This is especially true of companies specializing in tailoring, which have very little culture about knitwear, but who decide to include knitted garments in their collection, also because at the moment it is one of the items that sells the most. Indeed, for this reason companies are seeking to create creative knitwear teams within their own company.

This is why even knitwear factories needs designers and hire designers to work on the product development. To distinguish the traditional role of designers inside fashion brands from the less known one of designers inside knitwear factories, from now on in this chapter I will refer to the first as *fashion designers*, and to the second as *designer-technicians.* We will see throughout the discussion that these are just two names used here for convenience to distinguish the two figures, but do not mean that *designer-technicians* should be the only one to own technical competences, or that *fashion designers* are more fashionable than the others. Where I talk about *designers*, in general terms, it means that that particular task can be undertaken by both the figures, depending on the competences in knitwear owned by the fashion designer and the proportion of work delegated from the brand to the knitwear factory.

If for the general fashion design process the design of the collection articulates into consequential phases, namely sketches, technical drawings, selection of fabrics and suppliers, technical sheets elaboration, final balance on materials and orders, to then go on with the sampling (Colombi, 2007), the specific case of knitwear follows different phases with frequently overlapping boundaries.

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[35] Giuseppe Pini, Maglificio Pini, interview, May 17th, 2017.

In knitwear, designers have to project the way in which they will use **yarns, stitches**, and the way in which those elements will impact on the **shapes** (see Chapter 2, Section 4). If sketches –that are the way in which designers represent the shape of garments– normally come before materials, in knitwear materials and textures, namely yarns and stitches, are variables to be considered as areas of intervention, and to be studied throughout the creative process.

In its essential form knitting means to fabricate a fabric composed of vertical columns weaving a continuous yarn. Starting from the basic stitches, knit and purl, you can create different textures and patterns (Catarini 2012, p. 15).

We experiment with stitches and textures, and once the shapes are designed the knitted ideas are designated to the more appropriate model. Sometimes the knit can inspire a shape[36].

Yarns

The first important thing when dealing with yarns is **a close dialogue between spinners**, **brands** and **knitwear factories**:

To talk with spinning mills is very important: the dialogue with their technicians makes it possible to know whether a yarn twists in the machine or not, if it works well, when it gives the best result, if there are particular precautions to be foreseen. It is also in this way that we make innovation[37].

With the knowledge coming from this dialogue, a designer can intervene on a yarn in many ways. The challenge is to design with a material which is completely different from fabric in physical-mechanical and conceptual terms. A yarn can be natural, synthetic or mixed, more or less elastic, more or less hairy, more or less fine; it requires adaptation of processing methods by machine and it must be worked with the right stitch size and machine gauge and each of its features affects the final result. It is common that during the development of a project the designer encounters the need to intervene on a yarn to obtain the desired leverage, or even to create his own yarn from scratch. He/she can double it or match it with other yarns to create new effects, create a colour gradient coupling two threads, make the feel of a dry wool softer by inserting mohair, stiffen the cotton with a thin nylon, create

[36] Liz Griffiths, Missoni, dialogue.
[37] Giuseppe Pini, Maglificio Pini, interview, May 17th, 2017.

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his own bulky yarn by knitting a tubular out of a thin yarn. Finally, various materials such as rubber, neoprene, jeans, paper, metal can be knitted by hand or applied to machine-knitting (Motta and Conti, 2018).

Stitches

Together with yarns, designers work on knit stitches and textures, to give the knitted fabric its visual and tactile features. Stitches and texture can delimit or completely distort the shapes and the volumes of a finished garment or can make a garment unique even if applied on a basic shape; this is why this part of the project often comes when there is still no defined idea about the final shapes, namely when designs have not yet been sketched. The study on stitches requires technical knowledge on how they are made and on how they come out from the movements of needles combined with a sort of mental catalogue a designer should have collected with experience. Stitch design and development becomes more successful when it is done by the **designer together with technicians and machine programmers**[38].

Shapes

Designing knitwear means designing garments starting from a single yarn. To start from an element much closer to the mono dimensionality to obtain a three-dimensional object totally changes the way of conceiving the shapes and their construction. Knitting is the first form of additive making[39], as a knitted garment is traditionally made putting one stitch after the other without cuts and shaped through increases and decreases with no waste of material. In this way, while the machine works it creates the fabric and the garment at the same time. Designers should understand and master this process to sketch feasible shapes and to invent new ways to shape models.

Knitwear has its own particular mean to pursue the study on these three variables that is to make swatches. As explained by Eckert (1997, see also Chapter 2.4) knitwear structures and material feelings are not just difficult to be described with words or to be drawn, but also difficult to be imagined and processed by a designer's mind. To visualize the future effect on garments, to try new textures and experiment with yarns, *designer-technicians* are used to produce small swatches. Swatches are trials of yarns and stitches together,

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[38] Roberto Vavassori, Hosio, interview, March 16th, 2017.
[39] Simone Cesano, Adidas, recorded dialogue.

which give an interpretation to the *fashion designer*'s request; «you do not do just one swatch, but ten, twenty, or more»[40].

Swatches can be specifically elaborated after a sketch or can come earlier and decide the shape and volumes of a garment. This is why sampling, as well as the evolution of designs, goes on along the whole process from the beginning to the defined garment and why the boundaries between swatch sampling and design are not defined: can be said they are two essential components of the same creative activity.

Although at a very early stage swatches could be made by hand or with a domestic knitting machine directly by designers, to get a likely result they must be knitted with the industrial machine and need a high technical knowledge. This step indeed is part of the service given by knitwear factories and requires the intervention of programmers and of machine operators to translate sketches, description, words, pictures into computing programs first, and into a swatch feasible by the machine right after.

In many cases, due to the very nature of conceptual design that is floating and unspecific (Eckert, 1997), designers are led to change their ideas on designs after technicians interpret and translate their creative suggestions into technical solutions. Due to their high technical expertise, the contribution of technicians often gives a valuable input to the collection development.

We never say that one thing cannot be done: we give alternatives, we try to explain –in a way that is never too technical, because it would be useless– and even if the requests are absurd, our skill must be in the ability to propose alternatives and to approach what the client asks[41].

Technicians need to work out which effect the designer has in mind, which machine operations are required for it and how it can be achieved on a particular knitting machine in a particular yarn. This interpretation process is the detailed design. To produce a swatch the technician needs to gain access to a CAD system and program the knitting machine, gain access to the knitting machine, set up the machine, knit the fabric, wash it in finishing lotion and tumble dry it. The whole process can take three hours for a simple alteration. The programming time for the fabric depends on the structure (Eckert, 1997. p. 51).

When the creative process is entirely delegated to a knitwear factory, namely when the style department of the brand gives just the general idea and asks to the factory for designs, *designer-technicians* who work in there

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[40] Giuseppe Pini, Maglificio Pini, interview, May 17th, 2017.
[41] Giuseppe Pini, Maglificio Pini, interview, May 17th, 2017.

are more professionally oriented to the technical side of knitwear, and it is less likely that they design something in need of massive changes. People from the creative stages (designers-technicians) and people from the technical ones (programmers and machine operators) talk the same language and thus meet less criticalities along the product development.

This is a verticalized company, within which we have everything at our fingertips: when we think about a sweater, we are able to understand how to do it, knitting and linking it, washing and trying it in just a few hours. This allows us to really do research on the product[42].

When the use of yarns, the textures and the shapes are defined, we have the complete detailed designs ready for more technical studies on the incoming prototypes. Sketches are transferred on technical sheets (see Eckert, 1997, p. 46) which contain a brief verbal description, a technical drawing, measurements, technical specification on yarns, stitches, gauges and processing and sometimes additional information about trims and shape details. The previously made swatches, or new ones made on purpose at this stage are now useful to put a garment to measure with a simple proportion between the number of stitches, needles and ranks, and centimetres.

1.2.6. Study of prototypes with design and pattern amendments

The study on prototypes, also named "sampling" is the stage where designs are transformed into actual garments.

It can be resumed into three activities, namely the study of pattern and paper patterns, the further definition of technical solutions and technologies to be used to make each particular garment, the programming of garment pieces on computers for the knitting machine. They are all usually held inside knitwear factories, but sometimes they can be delegated outside, to specialised smaller workshops.

Pattern-makers are in charge of the study of patterns and paper patterns: they own tailoring and modelling skills specifically adapted to knitwear, which can be either cut-and-sew or knitted into shape. The first one follows the same process as tailoring, where patterns are placed on fabric panels to cut out the shape; the second one needs patterns to be studied and then passed to the machine programmer that works following the measurements and the shapes given. Even if it takes longer, the knit-into-shape technique

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[42] Roberto Vavassori, Hosio, interview, March 16th, 2017.

gives strength to the fabric from the structural point of view, it allows to better take care of the details and it gives a better wearability on the shoulder, the armhole, the neckline; moreover, it minimizes waste, which is very important especially when working with precious yarns[43].

Often pattern-makers use their experience to give designers advices about some changes in shapes to avoid defects, or some interesting solutions for a particular case. This happens because, even if the designer is technically skilled, he/she does not deal with these technical activities full-time: development of sizes, fabric cutting, industrialization are tasks that need the collaboration of dedicated professional figures.

The same is for machine programming: when the pattern is ready, programmers and machine operators search for the best technical solutions and machine technologies to be used to achieve the desired result. In this phase, programmers can also intervene on designs with their experience to simplify garments or knitted fabric to save time while knitting. It often happens that a fabric very demanding in terms of time could be replaced with something faster and more economical to be knitted.

The programming[44] of electronic machine needs the specific training delivered by machine producers which lasts between three and four months, plus not less than three years of everyday practice to become an expert programmer[45]. Shima Seiki's software is completely different from the Stoll's one[46], so it is unlikely for a programmer to be able to work on both; despite some exceptions, they usually tend to specialize with one or the other, and then to work just with Shima Seiki's machines or with Stoll's.

The professional figure of programmer is thus the most wanted and difficult to find for companies and indeed the best paid inside a knitwear factory[47]. The bigger companies hire full-time programmers internally, while the smaller ones rely on freelances just for the limited times of the year when garments are designed and ready to be programmed[48].

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[43] Giuseppe Pini, Maglificio Pini, interview, May 17th, 2017.

[44] The author attended two weeks of Shima Seiki programming courses. Programming also observed in MF1 and discussed with MF1 employees.

[45] Roberto Rubertelli, Maglificio Ellynore, interview, May 17th, 2017.

[46] Observed during the attended course in Shima Seiki. Also observed in MF1 and discussed with MF1 employees, Stoll, Shima Seiki, freelance programmers.

[47] Observed and discussed in MF1, Hosio, Ghioldi, Maglificio Pini, Maglificio Ellynore, Shima Seiki.

[48] Observed and discussed in MF1, Hosio, Ghioldi, Maglificio Pini, Maglificio Ellynore, Shima Seiki.

To program a knitting machine means to translate the pattern shape into the symbolic notation of the CAD system (Eckert, 1997, p. 49) and then to give the machine all the instruction to process those codes into needles and carriage movements. These parameters are set by programmers together with machine operators, as the former work mainly in front of the computer and the latter spend the entire day on the machine, setting and checking everything is going well.[49] When the program file is prepared, and all the technical specifications are defined and contained in the updated technical sheet the first sample of a garment is ready to be knitted. While cut-and-sew garments are cut out and overlocked to avoid unravelling before the assembling, shaped garments are linked with linkers, special machines which connect each stitch to another. In both cases garments are then trimmed, washed in finishing solution, dried, and steamed into shape (Eckert, 1997, p. 54)[50].

This making/finishing phase is totally entrusted to the dexterity and experience of the operators who physically work on the sewing machines and on the linkers; they give to each piece the attention to detail that leads to a high-end product[51].

Once the pieces are ready, they are presented to the brand's designers and product manager who review the collection, do the fittings and sometimes ask for changes until the prototype is approved. The observation and the interviewed people confirm that this is a long process, made even longer by its being dislocated among sub-contractors.

1.2.7. Pre-production samples development, selling and consolidation of orders

We know that if you move that stitch, or if you use one yarn instead of another, you get new results; for us this study, especially today that there is almost no seasonality, is continuous, and today we have a company department entirely dedicated to the sample collection[52].

The design process, which goes from stage 4 to stage 6, concludes with stage 7, when the prototypes have been approved and final samples are realized to be presented to buyers. Knitwear factories usually realise the final

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[49] Observed in MF1, Maglificio Pini.

[50] Observed in MF1, Maglificio Ellynore, Maglificio Pini, Brunello Cucinelli, Hosio.

[51] Roberto Rubertelli, Maglificio Ellynore, interview, May 17th, 2017. Observed at MF1, Maglificio Ellynore, Hosio.

[52] Giuseppe Pini, Maglificio Pini, interview, May 17th, 2017.

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sample plus two or three reproductions, to be sent to the brands' showrooms for the selling. Samples are also the pieces which go on catwalks just before the selling and which will be soon used for shootings in the communication campaign. Once the orders are consolidated the brands come back to knitwear factories with the numbers for production[53].

This stage contains a very critical issue for many factories: sampling is a quite important phase from an economic point of view (e.g. in the district of Carpi, it represents the 6,6% of the incomings) but it is not enough for a company to survive, as it is a very demanding process, expensive in terms of human resources, competences, materials and time[54]. There are indeed many brands who exploit the Italian know-how and the ability to ideate and deliver high-quality samples to then transfer the production abroad, where it is cheaper[55]. Although some factories are now entirely dedicated to sample collections, they need to be in charge also of production –even when they delegate it to surrounding small workshops– to make the volumes of incomings needed to survive.

1.2.8. Production and quality control

Knitwear is so vast that every company develops its specificities: who has good skills on the intarsia is not said to have the same skills in doing stitched sweaters, who is good at working fancy yarns maybe cannot work with the same nicety carded ones or combed wool or cashmere. They are like many microworlds within a larger system[56].

This is why it is quite uncommon for Italian factories to undertake the entire production of all the diverse garments of a collection. They partially, or totally, delegate it to subcontractors, due to the required specialization of each step together with economic reasons.

This is the only choice today for companies to survive because it is the only way to contain cost[57].

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[53] Roberto Rubertelli, Maglificio Ellynore, interview, May 17th, 2017.
[54] Data from the note of the *Osservatorio del settore tessile abbigliamento nel distretto di Carpi,* 2014.
[55] Ivi, p.90
[56] Monica Cortesi, Ghioldi, interview, July 19th, 2017.
[57] Roberto Vavassori, Hosio, interview, March 16th, 2017.

In addition to the expertise asset and to the economic convenience, there is also a technical reason for sub-contracting: industrial knitting machines are expensive, and they do not own all the same features; Shima Seikis are good for operated stitches, jacquard or whole garment knitting, while Stolls are better for intarsia. During the years, workshops focused on Shimas rather than Stolls or vice versa, hired specialised programmers and gained the related skills, orientating themselves towards some kind of techniques and products instead of some others.

Knitwear factories maintain a long-lasting relation with these specialised contractors which own the know-how needed to achieve the quality standards set by the brands[58].

Once produced, all the pieces come back to the place they have been developed from sketch to sample (often the leading knitwear factory, less frequently the brands' headquarter, just when the process is undertaken internally) to pass the quality control. To reach the highest standards, a garment can pass through until seven controls: each time a subcontractor makes a passage, all the pieces are checked to be move forward to the next step. This explains why the concentration of companies into districts and the creation of a reliable network is so important to limit transport times and costs[59].

1.2.9. Distribution, press and PR

When the orders are delivered the brand is again in charge with its internal commercial offices of organising the distribution of the collection in shops. At the same time the communication campaign, designed internally or delegated to communication agencies or to important artistic personalities on the scene, is published on magazines, web and other media. Alongside advertising, events are now becoming more and more important for a brand to present its collections to the public. Although the communication machine is out of the focus of this research, it is notable that the creative director and his/her team own a decision role concerning this phase as well.

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[58] Roberto Rubertelli, Maglificio Ellynore, interview, May 17th, 2017
[59] Observed at Cucinelli, Missoni, Maglificio Ellynore, Maglificio Pini, MF1, Ghioldi.
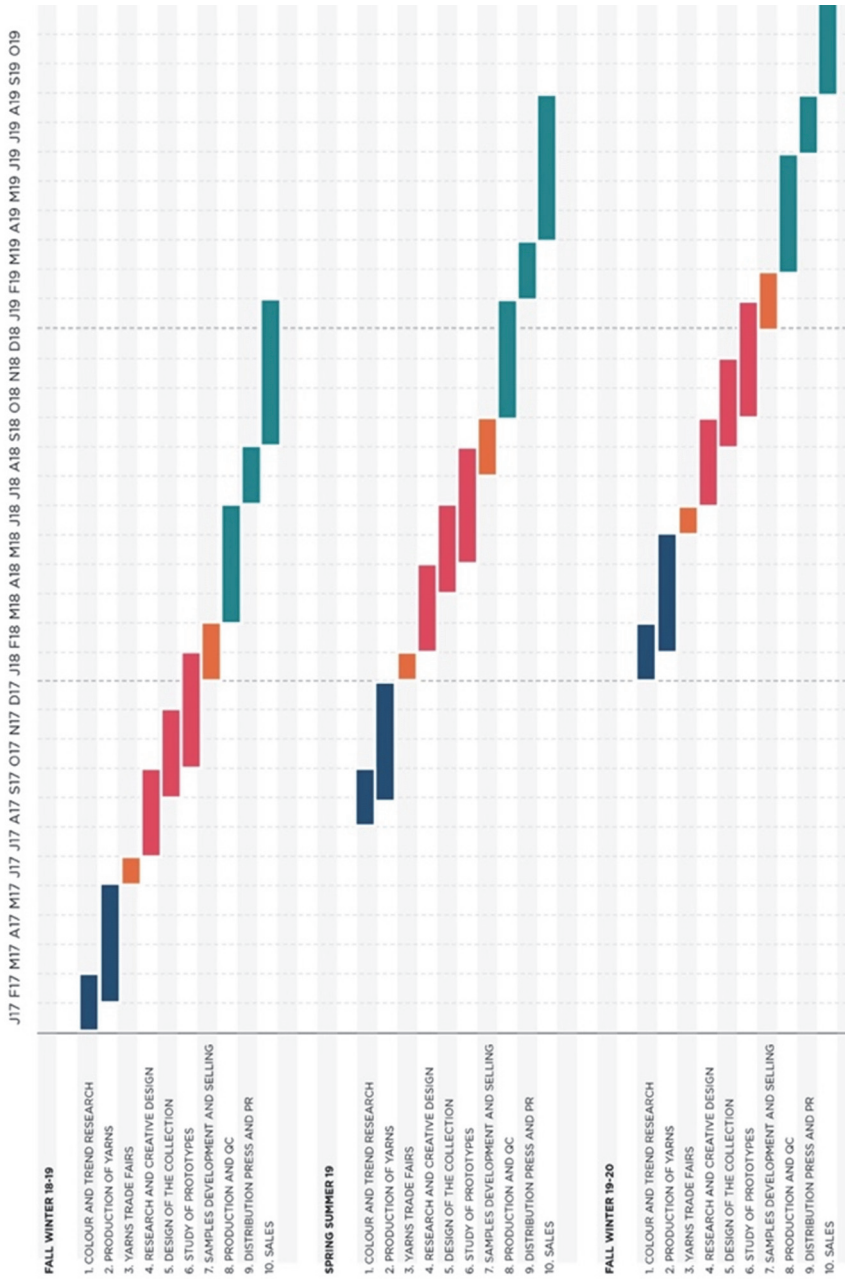
Fig. 8 - Visualization of the creative and productive process of knitwear. Timeline and phases of 3 subsequent seasons.

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1.2.10. Conclusions

- Everyone has its own role due to the needed high specialization, but the interaction with other stakeholders continues during the whole process.
- There is no compartmentalized work. The flowing of knowledge and information between the brand and the other stakeholders is an ongoing practice which needs to be fostered and enhanced. Dialogue, in a common language, is one of the fundamental assets for the process to work.
- The process seems to be linear, but especially in the design phases and in the research and development of products, boundaries between stakeholders use to overlap and the various stages do not always follow a precise order. The complexity of the process and of the product thus causes the need of frequent going back and forth along the stages.
- Recalling the words by Ornella Bignami (Tartaglione and Gallante, 2010) can be said that for such a specific product as knitwear, alongside the work of a *fashion-designer* the intervention of the *designer-technician* is also important, and the two are meant to work side by side, combining their competences. On the other side, brands must avoid the mistake of relying totally on the product manager, an extremely important role in a company today: even when it has a very high sensitivity it cannot replace a creative figure because it is too tied to market problems and influenced by issues such as positioning, price range, industrialization costs (ibid.). Again, it is a matter of cooperation and interweaving of competencies.
- Since creativity and problems to be solved, which are the two action territories of industrial designers (see Chapter 2, Section 3) are so spread in all the stages, as well as the proper knitwear technical knowledge, the initial question *who does need the competences of a specialized knitwear designer?* finds the more convincing answer in *almost everyone along the chain.*
- Many are indeed the steps where a knitwear designer directly gives his/her contribution, not just in the common role of the one who takes inspiration here and there and sketches garments: there is space for the competences of a specialized knitwear designer in many steps and with all the stakeholders.
- Quickly retracing the just treated steps of the process, it emerges the need of the competences of a specialised designer which is not just a **creative director,** but also can act on activities belonging to the **intermediate supply chain** (e.g. inside knitwear factories) as well as on the **upstream phases of traditional creative processes** (trend research and yarn research and development inside spinning mills), can intervene in

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the **productive and technological processes** and have a role also in the **downstream phases of the finished products production**[60].

1.3. The needs of knitwear industry: interviews with professionals

The interviews here reported, made with "privileged witnesses" of the sector, representative of the most varied sample of stakeholders possible, allowed the research to deepen the focus on some interesting topics as the wishes of companies in terms of young graduates, their opinions on the current training offer and on the eventual ongoing relationships with universities. Interviewees stressed some fundamental reflections on the relationship between the knitwear sector and the universities, highlighting the most fertile grounds for this research to act with experimentations.

Gave their contribution with interviews:

- Michelle Marzoli, Marketing Manager at Filmar Network – Filmar, Filati Color, Filodiscozia
- Ornella Bignami, Owner of Elementi Moda Studio and Italian partner of CELC - Confederation Européenne du Lin et du Chanvre (European Confederation of Flax and Hemp)
- Luciano Bandi, Marketing and Sales Managing Director at Zegna Baruffa Lane Borgosesia SpA
- Rita Airaghi, Director and General Manager at Fondazione Ferrè
- Roberto Vavassori, Ceo and Creative Director at Hosio
- Birgit Gahlen, Textile Engineer and Global Fashion Coordinator at The Woolmark Company Italia
- Giuseppe Pini, Owner at Maglificio Pini
- Roberto Rubertelli, Owner at Maglificio Ellynore
- Marco Ghioldi e Monica Cortesi, Owner and Knitwear Product Manager at Ghioldi
- Marta Santambrogio, Freelance Designer and Consultant
- Alessandro Pontieri, Shima Seiki Italia

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[60] See the five main typologies of positions for fashion designers presented by Bertola (2008, pp. 41-44) and resumed in Chapter 1, Section 3.

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Other witnesses have been collected from:

- Luca Missoni, owner at Missoni
- Liz Griffiths, Head of Colour and Textile Department at Missoni
- Martina Pini, Sales Manager at Maglificio Pini
- Renzo Prandoni, Shima Seiki Italia
- Davide Barbieri, Sales Manager at Shima Seiki Italia
- Christian Metzel, Shima Seiki Italia
- Federica Muschio, Shima Seiki Italia
- Sara Massi, Style Unit Manager at Filpucci
- Pierfrancesca Solinas, CSR Manager at Filmar
- Mario Foroni, Owner at Maglificio MF1
- Elisa Moro, Project Manager at Maglificio MF1
- Alessandra Contessotto, Trade Marketing Manager at Loro Piana
- Francesco Magri, Country Manager and Director at The Woolmark Company Italia and Iberia
- Monica Lasagni, Marketing/Fashion and Technology at Stoll Italia
- Brunello Cucinelli, Owner and Creative Director at Brunello Cucinelli
- Patrizio Terzi, Shima Seiki programmer at Imax
- Giuliano Marelli, Owner at Studio Marelli
- Simone Cesano, Senior Director Design Operations at Adidas

1.3.1. Critical issues as emergent needs

Critical issues and *desiderata*

One of the main critical issues is the **lack of a common language** already outlined by Eckert (1997, see also Chapter 2, Section 4). This is partly due to the complexity of knitwear structure and the difficulty to be communicated, partly due to the fragmented system where it is not uncommon for different professionals to talk different languages and to refer in different ways to the same thing, finally due to the lack of specific knowledge of designers who often do not know the knitwear product and its fundamental, technical language.

I saw sketches delivered to a knitwear factory where you could not tell if the sweater was a round neck or a V-neck, and it was up to the skills of those who worked there to interpret and realize the product. And I saw other drawings that looked like photographs. Just think about the contemporary production, which is

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largely decentralized: the clarity of that sketch is crucial because it will go to China or Bangladesh for the making, and if a wrong sweater comes back the costs rise in an exorbitant way[61].

As Luciano Bandi says, effective communication is crucial for decentralized productions, but it is a very important time-saving asset even when the idea of a sweater travels from the brands headquarter, that maybe is located in London, Paris or New York, to one of the SMEs in Italian districts, and here passes from hand to hand and then goes to a smaller workshop for the finishes, and back again to the brands headquarter for the final checks.

It is not just a matter of locations: even inside the same company it is obvious that being able to talk between each other in a conscious way makes the work more fluent and easier:

The technician who works with me is very prepared, but he needs me to give him the first input. Last night, I had a thing in mind: he did four tests before he gained a satisfactory result, and it happened only this morning. He has to understand what the designer has in mind and I must be able to explain it to him, even if it is right that I do not have his technical competence to do it. Not everyone should know how to do everything, but we must know how to speak to each other[62].

Students do not know anything about technical drawings. You need a minimum of communication between the designer and the person who realizes things. Ferrè drew in his own [artistic] way because he had Denis who quickly understood, today we need to know how to translate an artistic sketch into a technical drawing![63]

It is not just a matter of representation, but of a general **missing of technical knowledge**, underlined by Eckert in 1997 (Eckert, 1997) and still felt as an important critical issue by the vast majority of interviewees, twenty years later. To Luciano Bandi, creativity is not enough for knitwear:

What I think knitwear designers are missing today –if you want with fabrics can be a little simpler– is technical knowledge, which must be very strong. Creativity is not enough –this is my experience, as a person who every day speaks with knitwear designers– today, the new generations are not able to speak the same language. We need aware interlocutors who have a great creative capacity[64].

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[61] Luciano Bandi, Zegna Baruffa Lane Borgosesia, interview, October 10th, 2016.
[62] Roberto Vavassori, Hosio, interview, March 16th, 2017.
[63] Rita Airaghi, Fondazione Ferrè, interview, December 22nd, 2016.
[64] Luciano Bandi, Zegna Baruffa Lane Borgosesia, interview, October 10th, 2016.

If creativity is not enough, Ornella Bignami notes the fundamental steps to learn that much desired technical knowledge:

While for woven fabric clothes there is a variety of fabrics to choose from and therefore a product to start with, knitwear starts from a single yarn, then the fabric is invented: not just in shape and colour but also in texture, weight, lightness, stitches, chromatic and material combination. There is one more step to be taken, and this assumes, today more than ever, the technical knowledge of what knitting machines –which are very advanced– are able to do. They are an incredible support to creativity, which opens up perspectives that the manual rectilinear machines can no longer give. It is still necessary to go through the fundamental step of the manual machine, to understand what the mechanism is. The mechanism of industrial machines even starts from hand-knitting. We are back to say that knowing the technology is very important, but the work on manual machines allows those who start to understand how to move the needles and the yarn with them[65].

The noted difference between knitwear and fabric clothing is outlined also by Roberto Rubertelli at Maglificio Ellynore, who confirms Bignami's words and adds a list of the areas of useful specific knowledge, closely linked to the knitted product:

Inside a company there is not just the style department, but there are many roles and the knitwear sector is special because it starts from the yarn: a fabric is ready-made, you just need a needle and a thread and at the end of the day you can get something; this cannot happen in knitwear, because if you do not know the material and the way to work it, the yarn remains there because you do not know what to do with it. Here is the first difficulty: the knitted fabric must be created, it passes from the knitting machine and you have to understand and know how a knitting machine works. Learning how a manual knitting machine works at school is very important, because you acquire the awareness of how the needles work, how the knit is made, what can be easily done and what is not, you learn what a yarn title is, and that a bulky yarn and a small needle cannot get along; you learn that the title is linked to the length, and then you learn how to manage the amount of yarn. Then there is the whole world of raw materials, and that of the assemblages –with linkers, linear machines, overlockers– and still many other variables: it comes that there is not only style, but we must teach all these aspects, because if the designer has an idea of how the product works, he thinks about it more closely to the production reality, to its feasibility and to the needs of the brand. A designer who knows the product is a designer who can meet the target of the brand he works for[66].

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[65] Ornella Bignami, Elementi Moda, interview, October 7th, 2016.
[66] Roberto Rubertelli, Maglificio Ellynore, interview, May 17th, 2017.

We go back to the balance between theory and practice, combined towards the feasibility of the product and the needs of the market.

The first thing is the awareness of the market and of the product: who draws must think of collections that are feasible, saleable and responsive to the needs of the consumer. From the point of view of preparation, those who today must face a new job in a knitwear company, surely must possess both a theoretical and practical preparation. The theoretical part allows you to face certain problems and to speak the same language of the interlocutor you are facing, practice allows you to experience in the field. And then do, do, do and make mistakes, do not wait for things to happen. This is perhaps a lack on the part of the entrepreneur, who today does not give his employee time to make mistakes, he wants precision and efficiency[67].

We do not expect everyone to know everything, but we wish even young graduates to know what to ask and to whom when they find themselves dealing with a company. When on the client's side there is a person who owns knowledge about the product, everyone works better, and you immediately set a relationship of trust, because if the client asks for something knowing what he/she is talking about, no one can say that it cannot be made. When the client does not know the technical aspects and asks for the impossible, and does not understand a negative answer from us, we all lose time to make samples, to prove him/her that the result is different from the expected one. It all depends on the individual path of the person who is in the style office: there are no customers who have the production, the printing or the knitting inside, most of the customers are a sort of centre for producing ideas, therefore there is no way to immerse themselves in the productive reality[68].

As anticipated by Bignami, the recent **technological developments** set a new challenge for designers that have to deal with constantly renewed electronic industrial machines. Machines are the instruments to make what a designer thinks, and it still often happens that

They draw impossible things, that machines are not able to do, or they draw extremely simple things because they do not know that machines can do something more[69].

I am sure that knitwear designers with a background knowledge about these tools could really push themselves further, in the research on stitches and garments[70].

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[67] Roberto Vavassori, Hosio, interview, March 16th, 2017.
[68] Marta Santambrogio, Ghioldi, contribute, March 19th, 2018.
[69] Luciano Bandi, Zegna Baruffa Lane Borgosesia, interview, October 10th, 2016.
[70] Alessandro Pontieri, Shima Seiki, contribute, October 19th, 2017.

In such a course [a course when design students learn how to knit their projects out of an industrial knitting machine] you cannot have many students, because they have to be followed. The electronic machines are very different from the domestic ones where nothing bad can happen: they are all closed for security reasons, they are complex, you work only through the computer programming and you cannot intervene manually. The machines that are on the market today are these, so if you want to take advantage of the possibilities they offer, you need to know them[71].

Today [the creation of yarns] is a process that can be done with appropriate programs even digitally, so through the simulation of a computer you can show fantasies that no one had thought before. With these software –the ones we have here are those of Shima Seiki– there is the possibility to display the yarn effect in a very realistic way. It is clear that we need to know how to use them, because digital is a very useful tool but it has its rules and its limits[72].

On the other hand, there is the perceived risk about a progressive focusing –that can easily become a limitation– of knowledge on the newest technologies, while the previous steps should not be skipped during the learning process.

We are back to say that knowing the technology is very important, but the work on manual machines allows those who start to understand how to move the needles and the yarn with them[73].

Learning to work on a manual machine is a fundamental step, because while the carriage runs I see the needles moving and the result that comes from it. Today there are thousands of automatisms in the machine, so if I want a particular stitch I insert the input and automatically the machine reads it and makes it. This weakens the contact with the difficulties that exist, while until a few years ago the programming took place giving commands for every single movement of the needles; the process was longer and more complex, but those who did it were aware of what they were doing. Today the risk is that there is a talent in programming, but a lack from the point of view of 'how to knit', so when there is a problem they not always know how to solve it[74].

The problem of "modern" technicians (besides their existence in a small number) is that starting from the bases directly on electronic machines they have not gained experience on manual machines, and for this they do not own the ability to convert the old techniques into something that electronic machines can do. All the evolutions

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[71] Ornella Bignami, Elementi Moda, interview, October 7th, 2016.
[72] Ornella Bignami, Elementi Moda, interview, October 7th, 2016.
[73] Ornella Bignami, Elementi Moda, interview, October 7th, 2016.
[74] Monica Cortesi, Ghioldi, interview, July 19th, 2017.

of the machines that have been done so far have never evolved knitwear, but just the speed at which it is made. Although these machines are versatile, they will never succeed in replacing the sensibility of a person working on a manual machine[75].

The last two reported extracts dwell on the eventual risks of a lack of knowledge of technician-programmers, detaching a little from the answers that this study searches about the competences to be owned by the figure of the designer. These worries, anyway, highlight the potential loose of specialised technical knowledge which is complementary with the one of designers and has always been able, until now, to complete it towards the well-thought and well-realized products of Made in Italy. The issue should therefore be considered by whoever deals with the training of programmers, while design education could intervene on neighbouring areas:

Even the knitting machines producers, like Shima Seiki and Stoll, deliver internal knitting courses, but they do it for companies and for those who will program their machines, because they are rightly interested in a more commercial aspect and the courses are purely technical, not creative. Here we build a course that is both creative and technical: the technology is not studied in detail because the designer will always have the support of technicians and will not work physically on the machines, but to use the correct language, to know what to ask and what to expect from a technician and how to direct people's work on machines is really very important[76].

I am not afraid of the tight time of the university semester, because design students do not have to become technicians, they will not have to know how to set up a machine with stitch size, speed, position of yarn guides; the important thing is that they understand what happens to a programmer in front of the monitor[77].

Another widely outlined issue is the complete lack of interest from designers in what Paragraphs 1.2.2, 1.2.3 and 1.2.5 of this chapter illustrates as an integral part of the knitwear process, not just in terms of production but in terms of design and creativity: the **research and development on yarns**. Ornella Bignami talked a lot about this topic in her interview.

The design of a yarn is as important as the design of a garment, and I find it a pity that talented young people do not think about developing their creativity right

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[75] Hosio, technician, dialogue, March 16th, 2017.
[76] Ornella Bignami, Elementi Moda, interview, October 7th, 2016. Talking about the course on Shima Seikis machines for knitwear designers of FIT in Milan delivered by Politecnico di Milano within the spaces and with the facilities of Elementi Moda.
[77] Alessandro Pontieri, Shima Seiki, contribute, October 19th, 2017.

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on the yarn. This is an aspect that no school has ever faced, and, in my opinion, it would be another job opportunity, very interesting for young people now entering the job market[78].

When it comes to knitwear, it is not always immediately visible how a knit product is born, that it comes from a yarn: the spinning part is often unknown to young designers. The spinning is a sector that already contains a very important part of creativity, especially in Italy, where we have avantgarde spinning not only good at making classic yarns, with extraordinary blends and exceptional hands, but also at inventing new yarns - effects, surfaces, colour combinations, mixtures, melange, fusions and more. Talking about knitting without building a minimum of background knowledge in this area is a lack. In my work experience I am often in contact with young students of Italian and international schools and I realize that they do not know what the right titles are [of a yarn] to be worked on machines. […] It was very important for me the training I made working in fibre companies, synthetic and natural. I worked with Woolmark for twenty years, with Montefibre for acrylic fibres, nylon and polyester for at least as many, and this gave me the opportunity to actually know how these fibres are processed and how you can develop new products, thinking how to use them in function of a knit product. Fortunately, in Italy we have an event like Pitti Filati, which allows us to have a 360-degree view of what are the most interesting productions of knitting yarns. It is also a fair to visit from a didactic point of view, to be visited with criteria, planning meetings with companies to understand what the new yarns, new technologies and trends in that area are. The design of a yarn is as important as the design of a garment, and I find it a pity that talented young people do not think about developing their creativity right on it. It is also a great challenge: to create a yarn, to present it to the knitwear factory that will work it showing the effect you have developed and the potential of that material through samples and stitches is a great research that does not necessarily require to reach the shape, the garment, but can pull all creativity out of the yarn. This is an aspect that no school has ever faced, and, in my opinion, it would be another job opportunity, very interesting for young people who are now entering the job market[79].

In most cases I have to say that there is no interest in this field by the students. I found very few people interested in thinking of a new yarn. In most cases, the most creative thing that students do is to take two yarns, put them together, work them to get something more personal in their collection. Perhaps they are not solicited, perhaps they do not know that it is an interesting field of development. Probably we do

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[78] Ornella Bignami, Elementi Moda, interview, October 7th, 2016.
[79] Ornella Bignami, Elementi Moda, interview, October 7th, 2016.

not talk about it as a possibility of individual intervention where you can act with your own creativity[80].

To Bandi, even communication between stakeholders would benefit from an improvement of this kind of competence:

There are no yarn designers. Knitwear designers who want to get a certain type of sweater, must know which yarn best suits his needs. Why no designer wants to be a yarn designer? It would be great for spinning mills and brands to be able to understand each other [81].

The uniqueness of knitwear sector

All the extracts reported so far outline critical issues or *desiderata* which are very specific of the knitwear sector. They could be enough to assume **the need of a specific training for knitwear design** and to start to trace guidelines for tools and methods in this sense. To support this thesis, this need has been made furtherly explicit by interviewees, who declare the uniqueness of this sector and of its manufacturing area, together with the consequent uniqueness of the figures operating into it.

In the knitwear world more than everywhere else it takes concreteness, ideas that are then feasible. We need a down-to-earth generation of designers with technical background –though not trained as technicians–; this kind of figure is essential for everyone in the sector[82].

As widely addressed in the previous chapters, (see Chapter 2, Sections 2 and 4) and furtherly confirmed in the literature, the highly technical aspects of knitwear influence the competences a young designer should have and make its hard skills important as the soft ones.

When interviewed, Monica Cortesi outlined what she thinks is one of the most critical issues when a manufacturer dialogues with non-specialised designers. She answered the question: **does it happen to you to receive absurd requests from brands' designers?** with these words:

It constantly happens, and when it happens we try to talk with the client to understand what result he wants to get and to give alternative solutions. It happens

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[80] Ornella Bignami, Elementi Moda, interview, October 7th, 2016.
[81] Luciano Bandi, Zegna Baruffa Lane Borgosesia, interview, October 10th, 2016.
[82] Alessandra Contessotto, Loro Piana.

because knitwear is a world unto itself: if in the style department there is a knitwear designer you can see it immediately, otherwise they almost do not make knitwear. American brands, if they cannot afford an in-house knitwear designer, rely at least on external advice, to be able to have the right expertise to know how to transmit information. There are a lot of differences in the preparation of designers: Europeans have a kind of approach, the Asians are very technical, Americans sometimes lack the technical ability to understand that a sweater, which is beautiful when sketched, will not work with that yarn, because it will stretch ten centimetres once hanged. We must always find the right middle way between those who want to be an experimenter and those who understand that the clothes must be part of the market and must be sold, because we do not have to make prototypes but pieces to sell and reproduce to create work for the industry. How could university help us in reaching this result? By making students closer to the realization of the prototype and so to the ability to use a knitting machine, so that they are able to give indications once inserted in a production chain, and moreover able to not be mocked. What I think today in the university is missing is the ability of young designers to interact with those who materially make the product; but doing so means knowing the processing stages of the product[83].

Other witnesses report the same perspective on this issue, wishing a greater proximity of university courses to the specificities of the manufacturing reality of knitwear to avoid for young designers the illusion they are all going to become famous creatives successfully working for luxury brands:

We all had basic fundamental technical training to perform these activities. They cannot think that everyone will work at Gucci, Dolce & Gabbana or similar companies as soon as they leave the school, partly because their training is absolutely partial, very theoretical, with no knowledge, or almost, of the industrial production reality. And then not everyone can become a creative director, companies also need other figures that nobody considers. I am thinking, for example, of model makers, of prototype makers, in the case of finished product companies; […] to solve the problem it would be necessary for our young people to lower their expectations, at least in the short term, as happens abroad. In our industries we do not need only graduates with the expectation of being a manager within a few years of being hired. As for this professional figure, the real problem is disillusionment, in the sense that everyone thinks of being a Tom Ford, but then they realize that they are not, and they must agree to play their role both as employees and professionals, for small or

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[83] Monica Cortesi, Ghioldi, interview, July 19th, 2017.

medium-sized companies, which represent the overwhelming majority of the Italian Fashion System[84].

Few of these guys really have anything to say in creative terms, they simply have a stereotypical view of the designer's role and try to follow that dream. If you tell them that in the industry there is more need of a good modeller or a sampler knitter rather than a stylist, they look at you as if you were proposing a third-world job. Unfortunately, these professions do not have appeal to young people, while they are in demand and among other things they really allow companies to move forward and continue to cultivate a product know-how. In Italy, even high-level fashion schools, […] have plans that often make me think. I do not say that it is not important to study History of Costume of the 1300s or 1500s, but the question is different. What kind of professional figures does the Italian fashion companies need today? This is the question that the school should try to answer in terms of training. I am afraid, instead, that there is too much theory and little practice-technique[85].

If you ask students what they want to do after graduation or university, I believe that almost all answer they want to become designers [employed in the style department with only creative tasks]. However, we know that out of ten people who want to become designers, only one will do it and there will be those who become product managers, who will model, who will be programmers, who will be hired by spinning mills. We need a school path that makes young people mature, aware of the opportunities offered by the labour market in this sector, so that adapting their aspirations to real job opportunities they can create jobs for everyone. The school does not have an easy task, and it struggles above all in the first part, the technical one of knitting, even because it misses facilities, and together with facilities it misses trained teachers. We need to make students aware of all aspects of the supply chain, so that they do not have to resign themselves in not becoming designers, but they can be passionate about weaving, spinning, knitting, about the product and the making[86].

What I think today in the university is missing is the ability of young designers to interact with those who materially make the product; but doing so means knowing the processing stages of the product[87].

Marco Ghioldi sums in few lines the competence he sees as fundamental and the way a student should get it.

They must know how to make a product from the beginning to the end. Maybe not perfectly, but they must know the production cycle and have experienced it at

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[84] Raffaella Pinori, Pinori Filati, interviewed in Tartaglione and Gallante, 2010, p. 57.
[85] Marina D'Altri, Studio DeRosa, interviewed in Tartaglione and Gallante, 2010, p. 97.
[86] Roberto Rubertelli, Maglificio Ellynore, interview, May 17th, 2017.
[87] Luciano Bandi, Zegna Baruffa Lane Borgosesia, interview, October 10th, 2016.

least once, the theoretical preparation is not enough. It is not enough to know what a stocking stitch is and what a rib is, you must have tried to do them. The basic grid, the one that gives you the foundations on which to build then with the experience certainly start from there. The modelling, the use of colour, are all successive enrichments, but if you have a clear idea of how the stitches are made and how the jersey works, you have the needed basics to start with[88].

We are back to the "other kind of creativity", mainly unknown to students, much more oriented to daily problem solving and deeply immersed, or even better hidden, in manufacturing companies.

Is not size development design? The archive, is not it design? Printing is not design? There is no robot in charge, there is always someone who "thinks and does", which definitely is Design. There's a world outside of the style offices, beside these unidentified sheds, and it's where everything happens[89].

The greatest ambition would be to be able to train people with a broad and well-rounded knowledge on knitwear; today the machines are programmed through computers, but those who control the machines must know how knitwear works, otherwise they could not understand if the machine is working well[90].

General impressions and advices

I collected also more general impressions and advices, naturally addressed by each witness from the perspective of knitwear even if possibly transferable to –or from– other fields of design.

The first one is that companies often feel they are not considered by fashion schools. In difficult times like the contemporary ones, where small business struggle to make ends meet and more than that they do not have time to dedicate to a proper training for young people, there is a certain will of receiving some help by universities, that should **operate closer to the industry**.

Today companies do not have the economic resources, or do not want to invest them, to train young people. It is necessary for universities to provide basic training on which it is easy for the company to build further knowledge. […] It is the basic training that companies do not want to do: today we are in a position where companies no longer hire people because they do not have the economic resources, or do

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[88] Marco Ghioldi, Ghioldi, interview, July 19th, 2017.
[89] Marta Santambrogio, Ghioldi, contribute, March 19th, 2018.
[90] Giuseppe Pini, Maglificio Pini, interview, May 17th, 2017.

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not want to invest them, to train young people. In textile companies, that are very small companies, internal training courses are often too expensive; it has always been a one-to-one training, to those who need it at that moment and in that position[91].

In recent years, the dynamism of the companies is such as it does not create younger levers. The only real place where young people can learn is the company, but no company today –in the current difficult situation– is able to support its costs[92].

Luciano Bandi detects this lack not just the operative know-how, but also the soft skills students should learn:

It is necessary for universities to provide basic training on which it is easy for the company to build further knowledge [93].

He also proposes that a key could be to

find teaching methods, or in-depth tools that allow people to be more involved in the production cycle, and consequently […] to have, when they arrive on the market, a reality-based knowledge and a theoretical one that comes from the school.[94]

These competences, Bandi continues, are to be delivered by universities together with companies, in a relationship that needs new experimentation.

Students can visit a company, but it would also be useful for someone from the companies to enter the university and deliver, if not a course, because of the timing, three, four lessons on a specific topic depending on the industrial experience he or her has behind. This is a way for students to combine the theoretical part that comes from the teachers and the practical part that comes from those who experience the company every day. It is important to create a continuous relationship between companies and universities, because the university is the only interlocutor that can give the company new ideas, and companies are the only one to be able to give students an industry-oriented mind-set[95].

Working together is an aim to pursue even if the main difficulty today is still to make companies understand how they could benefit from collaborative teaching. Inside companies there is still the belief that the university is too highly placed, but

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[91] Luciano Bandi, Zegna Baruffa Lane Borgosesia, interview, October 10th, 2016.
[92] Mauro Fabbri, Staff International, in Tartaglione and Gallante, 2010. Translated by the author.
[93] Luciano Bandi, Zegna Baruffa Lane Borgosesia, interview, October 10th, 2016.
[94] Luciano Bandi, Zegna Baruffa Lane Borgosesia, interview, October 10th, 2016.
[95] Luciano Bandi, Zegna Baruffa Lane Borgosesia, interview, October 10th, 2016.

In our experiences we had to deal with professors that managed with culture, experience and academia to highlight criticalities that we, industry, did not have the tools to perceive, analyse and verify. Those people do not enter the company but cooperate and create contacts between university and the company itself. Students, young designers, on the contrary have to immerge themselves into the industrial culture and mind-set, and so it is useful for them to listen to people belonging to that reality telling their experience, their way of working.

It takes the theory, delivered by professors, and the experience of those who work in the industry: it does not mean giving conflicting information but creating opportunities for debate, also observing real problems[96].

The school should give a knowledge, an approach, a way of doing but cannot give complete knowledge. It should give the necessary tools to understand what is happening in the company, and then it should be the direct contact with the work to deepen the technical aspects[97].

In the desired closer connection with reality based experienced, **team-working** is cited by more than one interviewee as a component of the above-mentioned complete knowledge, belonging to the sphere of soft skills, adaptable to different problems and situations. Interviewees recognize in team-working a good way to develop a constructive approach to the work environment but also, in a more concrete way, an opportunity to simulate the interaction between the various tasks which in reality belong to different working roles.

Students should always work in team, as teams are just like style offices, where everyone has its own task, due to its talent[98].

It is about creating a culture that is not made up of fragmented sectors of industry, but of a cohesive industry: when you work in a team in the style office, you work in a team for the company, so that style and product communicate and they understand each other. A mentality that is not that of I want, I can, I command, but that is part of an economic world that has certain stakes […]. [They should learn] to work in a team. I have to pass a well-done work on to those close to me, I must not get rid of a problem. We go back to the Japanese concept for which your colleague is a customer, in the circle of total quality[99].

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[96] Luciano Bandi, Zegna Baruffa Lane Borgosesia, interview, October 10th, 2016.
[97] Giuseppe Pini, Maglificio Pini, interview, May 17th, 2017.
[98] Luca Missoni, Missoni, dialogue.
[99] Luciano Bandi, Zegna Baruffa Lane Borgosesia, interview, October 10th, 2016.

Today there is not much team spirit anymore. Within the small as within the big companies lack the desire for comparison. Experiences outside companies could be useful to consolidate the team spirit inside. The predisposition to collaborate is therefore one of the necessary requisites[100].

Findings

The analysis on the interviews and other collected witnesses underlined the needs of the knitwear industry in terms of young designers, which deliver to the main necessity of specifically trained professionals in the field and can be listed as follows:

- designers with the ability to communicate effectively with the technical language of knitwear;
- designers who own specific technical knowledge;
- designers aware of how do new technologies work;
- yarn designers;
- designers who have a picture of the whole manufacturing process, with its stakeholders as well as its production steps;
- designers who own soft skills, teamworking above the others.

«The negative aspects are important motivations for pursuing change and important starting point for the creative part of a design process» (Hertzum in Simonsen *et al.,* 2014, p. 28). Being this study addressed by a designer making design research, the needs outlined in this chapter are the starting points to undertake the phases of applied research planned for the following stages, that are completely comparable to actions of design.

All of these identified needed skills, competences or knowledge, have some components that could be delivered from university through theoretical and practical lessons, and some others, more technical and reality-based, that could be more effectively learnt with the direct contact between students and companies. In this sense, it was purpose of the experimental activities to pursue the balance between what is learnt inside the university walls and what could be transferred in a better way through the direct contact with the outside world.

Before the experimental phase, the research goes on to define, with the help of direct observation and of a map of the features of teaching methods

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[100] Roberto Vavassori, Hosio, interview, March 16th, 2017.

already in use, the instruments needed by the educational system –in terms of competences, actions, facilities– to answer the highlighted needs.

Before moving to the educational side of knitwear design, some more issues emerged throughout the interviews deserve attention: professionals, indeed, did not just complain about the lacks of the system but often gave relevant suggestions or illustrated some best practices, reported through their words in the following section, that concludes this chapter.

Good practices, Initiatives and Ideas for the Future

The interviews show that a close and constructive relationship with education is not just a desire: among the interlocutors, I found openness to the students and in many cases the will to experience some form of collaboration with the university; alongside these, which are for the present study opportunities for intervention and experimentation, the interviews show the story of some good practices, initiatives and ideas that can be an excellent point of reference and beginning for the actions of the research itself.

In particular, fertile areas of intervention are those situations in which companies have the vision to understand that students are certainly a useful resource in the short term, but above all to understand that if they are well educated, there will be long-term benefits with positive effects on many aspects of the labour market.

Unlike the previous ones, which were part of broader unstructured discussions where interlocutors were left free of streaming their ideas and words, the extracts reported in this section answer direct questions that intentionally investigate the already existing connection areas between industry and universities.

One of the best successfully tested experiences turned out to be Feel the Yarn, an international contest made specifically for knitwear which involve spinning mills not just in its panel but as true partners for young designers, still undergraduates. The contest is here told through the words by Ornella Bignami, its organizer. Other interesting experimental activities emerged from the interviews are the field projects organized by The Woolmark Company Italia, here framed by Birgit Gahlen.

Monica Cortesi e Marco Ghioldi, Ghioldi
What motivates you to look for collaboration with the university?
"We do not have our own collection, so, to present new proposals to customers, a forge of thought such as the university, where I imagine young

people open, ready to absorb the stimuli and to reprocess them in a new way, can become a rich resource."

How do you think the presence of a company in the classroom can be useful for students?

"Sooner or later these guys will have to face the difficulties with which we constantly clash, on a market that has a calendar to be respected. It is a matter of thinking of a product that is reproducible while safeguarding the quality of the handcraft. The fashion system works in this way today; it can evolve, it can change, but if students begin to understand its mechanisms they will be able to insert themselves more easily and to promote change."

Luciano Bandi, Zegna Baruffa Lane Borgosesia

How could a yarn design workshop be organized? What tools should be given to students?

"I would tell students what I'd like for my company in a given season. We could identify macro-areas, and then give some theoretical tools, giving them a picture of the company: We are leaders for the woollen product, we would like innovative ideas in the fashion field using this product *or, moving away from the fashion field,* we would like to push the wool product in a different field such as activewear, sportswear, etc. *Then it's their task to identify interesting ideas, perhaps in other areas, and seek solutions.*

Spinning companies struggle in finding people who study yarns, who study how to make a yarn before designing a finished product. Material engineers, chemists and physicists make fantastic experiments, why cannot be designers to design a yarn? And if the final result is an unattainable experimentation, if it does not go into production, it doesn't matter because such a project is an exercise that helps to understand the value of time when it is invested in understanding why certain things can or can't be done.

This can only be done at the university, where you have the opportunity to spend time on projects that are not feasible; in a company you can't."

What does Zegna Baruffa do with universities?

"We have a very close collaboration with some design schools, which we sponsor and help by donating yarns (e.g. to Royal College, FIT, Politecnico di Milano); we are always available to intervene with single students (Luca Larenza has had the yarns for the International Woolmark Prize). We also started a collaboration with the Department of Physics of Milano Bicocca and with the Department of Energy of the Politecnico di Milano for a project

linked to the functionalization of certain products to increase their performance through new technologies. We can't further."

Michelle Marzoli, Filmar

What does Filmar do with universities?

"During the year, we sponsor universities by donating yarns for students' degree theses. In particular we donate to students of Politecnico di Milano, and through Ornella Bignami also to the FIT - Fashion Institute of Technology class studying at Politecnico too. Once they have defined their projects, we get the requests for the yarns, we send them, when the finished garments are shown, we photograph them and use them for our communication. Also in this case we show the garments at Pitti or at other fairs."

Do you have some other active collaborations with design students?

"Filoscozia Academy is a completed project, which aimed to revitalize the brand Filoscozia. We had this desire and we contacted Ornella Bignami who took care of the project involving NABA. With their students we designed very special items, followed by the launch of the new Filoscozia brand at Première Vision in Paris, with an advertising campaign. This was a first step that served to bring attention to Filoscozia, brands have begun to buy the labels and understand that adding them to the finished product is a plus in the eyes of the consumer."

Ornella Bignami, Elementi Moda

Which tools would be needed to design a yarn? How is it done in a company and how could the process be transferred at an educational level?

"In a company there are spinning technicians who have adequate machinery. An interesting experience is the one I did with the tutors of a Thai university: I procured simple yarns with different effects –more or less hairy, thinner, bigger, shiny or opaque, the transparent nylon, the non-twisted, the black one, etc.– and then we did a real workshop in which with all these material elements we simulated the process with which in spinning mills they look for new effects of fancy yarns. I had given themes, and each of the participants built, starting from those simple elements, some really interesting fantasies and effects.

Tell me something more about the international contest Feel the Yarn.

"Feel the Yarn is an unusual contest. It was born seven years ago and is held once a year, because being financed by spinning mills and Pitti Filati,

they are much more interested in winter collections, so it is held during the June edition when they present the winter collection.

The project was born thinking about the commercial: the spinning mills were wondering what to do to promote their products –they were starting to feel the economic crisis and China was becoming an important competitor– and from one of the spinning mills came the idea to a competition, which I thought should be particular and unique in its kind.

It is particular due to its close relationship with the schools: we have had schools from all over the world, from Bunka Fashion College to Parsons, to the Royal College, Polimoda, Politecnico di Milano. Through the school tutors we make a selection of two students per institution and by the draw we combine them with one of the 25 spinning mills which sponsor the initiative; the students then realize the garments choosing the yarns from those produced by the spinning mill they are matched to.

The garments are exhibited at Pitti [Filati] and evaluated by a technical jury, made up of designers and expert journalists or knitwear professionals who are able to assess the quality and creativity of a product, and by a "popular" jury, composed of all the visitors. The audience votes –this year we have had more than 1300 cards– which means that it is interested, that looks at the work of the youngsters, asks what they have done and why.

For this reason, almost all the young designers find job collaborations. It works very well as a showcase, there are two small cash prizes, but the exhibition is what is really extraordinary.

As I said, however, it is not just a competition, but it is something more: in the first editions we had bigger budgets and we had all the students come for a week in Italy, spending a few days in the spinning to which they were matched and a few days with me, visiting companies in the areas between Biella and Prato. We were looking to visit companies that show them particular techniques or finishing, to understand what's behind this sector and what it can offer.

Today the budgets have decreased, but we still have three days, before Pitti, in which the students do this tour, as the formative part of the competition is still very important.

Last but not least, the combination with spinning mills has proved to potentially become something more: often the spinning itself asks the students to make garments for its presentations, and this already constitutes an opportunity for collaboration and work, but above all they build and consolidate an engaging relationship, and students tend to return to the spinning as buyers. They come back as designers, with companies or with their own line,

and they know what to do, what to look for, they have a personal relationship with some of the companies and this is extremely important.

There are many competitions, often they do not have an initial selection or do not have a specific address: Feel the Yarn is for knitwear. The selected universities are universities that have knitting courses, and this is important to see who and how does what."

How do you choose schools?
"The first requirement is that they have a knitting course. The second is the availability of the school; some really want to participate and return, even if as far as possible I try to replace two or three every year, to widen the circle and involve new realities.

We had Brazil, Ireland, Finland, England is always present –with the Royal College of Art but also with Nottingham Trent University and London College of Fashion, that this year have asked to participate–."

Do you notice differences in preparation between schools?
"Absolutely yes. Strong differences. First of all because the English schools have always run knitting courses, thanks to the English knitwear tradition: the first knitwear brands (Pringle, Ballantyne, etc.) were born in England. They have specific courses, and for this reason England is usually distinguished by the technical competence that the students acquire, as well as by creativity.

At the Royal College for example, which offers postgraduate courses and therefore has students who are no longer very young who have chosen to specialize in this sector, students live inside the school, and stay on the machines at night to be able to bring out something good. Those are schools that are spaces to work in, without lessons or schedules, it is a different approach.

The other school from which come always remarkable things is the Parsons School, which has very American-minded, realistic and concrete students, but at the same time they know how to be creative and even in the simplicity they make particular choices, whether it's materials or research of detail. They do wearable things –from Polimoda on the other hand always come very rich garments, and you could take ten things out of one– and really know how to calibrate elements. In fact, they reflect the mental form of American designers, just as in British students the whimsical British approach is recognized.

The other school that always has very creative students is the Hong Kong Polytechnic, which has so far had a very good tutor who was able to bring

out extraordinary things from her students. Much depends on the tutors: how much they know how to motivate, how competent they are in the subject, how much empathy they have, this too counts a lot.”

Do they have industrial machines at the Hong Kong Polytechnic?

“No, they do not have them in school, but they have built partnerships with external companies that make machines and technical staff available when they have to do something more special. The staff of external companies is all involved in the productions so the time they can dedicate to students is limited and the students have to arrive with the most developed project possible.

At Bunka Fashion College instead there is a studio inside the school with all the machines, all the gauges, and the fascinating thing is that in this space students collaborate with each other even if they attend different courses, from knitwear to textile and modelling.”

The difference between those who have industrial machines available and who do not...

“Lies is the result, because it can be seen on the finished product, for many reasons. The idea can be there and visible, but the manual machine then limits students during the realization.”

How the participating spinning mills are selected?

“Most are part of a consortium and are those that have expressed the need for a competition and are therefore involved since the first edition. We have then expanded to others and every year new spinning mills are invited. Not all of them have an interest in participating, partly because the sponsorship has a cost in raw materials but also in cash.”

Birgit Gahlen, The Woolmark Company Italia

How much time and energy do you dedicate to education with The Woolmark Company?

“Our company is not specialized in education, but since we promote a fibre, and we want to increase the demand for wool, it is very difficult for us to reach the final consumer. For this reason we must educate, and the sooner we start the better: Woolmark Italia has chosen to start at university level, in other countries, for example in Australia, where this fibre is produced, they starts even at elementary schools.

For us it is a project in which we invest more and more time and resources: we can do both lectures and interventions in classroom, we support

individual students, putting them in touch with the companies that are available to help them for the realization of their degree collections, but we also create what we call "field projects".

How do field projects work?
"We create projects that are developed between universities, Woolmark and a brand. The brand launches the brief and the students prepare the project, while Woolmark takes care of telling the wool working process, its characteristics, and above all, what can be created with wool. We do this on a theoretical level, with lectures, but also with visits to various companies and by helping students to find the right material for their projects."

Can you give some example of field project?
"We have Woolmark field projects with Politecnico di Milano and Missoni, with Accademia Costume e Moda and Brioni, with Polimoda and the Australian Embassy, with Marangoni and Max Mara."

Is your training support also given to companies?
"Yes, we also take care of business training, to educate the brand staff on the use of wool. We receive more and more requests from universities as well as from companies, because we have created a package that I consider very valid, which addresses the entire cycle of wool from the raw material to the finished product. El Conte Inglès, Tommy Hilfiger, Giorgio Armani and Max Mara are excellent examples of the companies we have supported, including providing digital training material via the internet. However, influencing students, telling them that wool is a versatile raw material is very important to us."

The search for the brands to involve starts from Woolmark?
"No, it's brands that ask us to participate, and even universities."

This seems to mean that are not just universities to have an interest in involving brands in teaching, with benefits for students. What is the advantage for a brand, according to you?
"Companies get to know each other, they look for new interpretations of their brand and their products among the students' ideas, and they can find future collaborators."

<u>Does Woolmark lead field projects even abroad?</u>

"Yes, we started with Italy two years ago from an idea of our Italian department and we have set an example for other countries: London has had an experience with textile printing, and next year a program of lectures and visits to the company will start in France with a University of Luxury Design."

<u>Are you also involved in competitions for young designers?</u>

"There is the International Woolmark Prize, a very important competition for young designers who are not students anymore, because to participate you need to have had your own brand for at least four seasons.

It also happens to do competitions within the field project: on a class of 50 students we choose the best 10, which physically realize their collection; among these we choose a winner, who is rewarded with an internship at the company or in the style office that collaborates with us.

A very important project that I have not mentioned before is the collaboration with the Master CKD - Creative Knit Design *delivered by Accademia Costume e Moda and Modateca Deanna: here we start with an input from the Wool Lab, the guys create themes, projects and knit samples that we will insert in our Wool Lab and that will be used to create garments and organize a show. A project therefore not an end in itself but with visible results."*

2. Knitwear as a design discipline

To propose improvement means to know the existing, to collect good practices and to avoid repeating mistakes which have already been made elsewhere. It also means to identify space to act towards innovation, searching for them where the boundaries between the two areas overlap. Do the two environments get in contact somehow? Are design universities already answering some of the emerged industrial needs? What can be done as an improvement in this sense?

The observation of teaching activities at Politecnico di Milano, together with a mapping work on the most important national and international universities delivering specific courses in knitwear design, led to comprehend the possibilities, the difficulties and the needs of knitwear design when considered as a discipline to be taught at university, and to assume a set of possible actions to be undertaken for push the experimentation towards the industrial world.

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The participative observation[101] considered all the variables concerning the ways of teaching and learning, including the different tasks given to students, the different competences of professors and the different background of students, not forgetting also the concrete side of timing and of the available facilities.

It revealed the importance of some components that make students able to master a knitwear design project from the beginning to the end, exploiting all the properties of knitwear and enhancing its peculiarities by facing the project in a conscious and specific way. They confirmed the issues emerged from the prior phases of the research, answering questions about the tools and methods currently in use to teach knitwear design, their efficiency in responding to the outlined needs of the industry, the expertise that a teacher should own and transfer, the critical issues to be addressed while teaching such a specific subject.

Here are, briefly resumed, the collected findings:
- The integration of the culture of the project and of skills belonging to the technical, managerial and scientific domains proved to be the combination that more closely reach the teaching methods of industrial design disciplines illustrated in Chapter 2.3.1[102].

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[101] Made during Academic Year 2015-2016, from October to July[101] and intended to observe the tools and methods in use at Politecnico di Milano, School of Design, inside the courses and workshops already going on in the field of knitwear.

The five participative observation activities (POAs), despite being all related to Politecnico di Milano, had been source of comparable data due to the varied duration, public, context and typology of each activity.

POA 1: **Final Synthesis Studio in Knitwear Design**
POA 2: **Workshop at MAD, Master in Accessory Design, POLI.design**
POA 3: **Workshop at DDM, post-graduate course in Knitwear Design, POLI.design**
POA 4: **BA Thesis development for Knitwear Design students at Politecnico di Milano, School of Design**
POA 5: **Feel the Yarn, international contest**

Each activity have been observed and compared according to a set of criteria *(Time / Number of participants / Participants' background / Team or individual working / Facilities / Teachers' experience / Project brief / Course structure / Purpose and related outcome)*, which have been identified as focal points of influence on didactic activities and on their results after the literature review on the topic of design education and after the recognition of the needs of companies. The set criteria allowed a comparative evaluation of the activities and of the reached results of each activity.

[102] In this perspective, an example is the inclusion of material engineering in a KD course, which albeit seeming a very scientific subject for a creative university, made students able to manage in a good way the drop of clothes and the behaviour of yarns, which means better results in terms of a well-made garment, well fitting, and a much higher possibility to reach unexpected aesthetic boundaries.

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- Four months are a short time to learn the knowable on knitwear, but enough to give students a competitive asset when they search for job positions in the field. Time is a very important component to be optimized when teaching knitwear design.
- Hands-on learning depends on the facilities owned by universities. The more equipped they are, and the more specialised the teachers, the more complex, complete and innovative are the instruments at students' disposal to push their works further.
- It is not a novelty: as explained in Chapter 2.3.1, reality-based experiences are stronger than simulated ones. The involvement of spinners and the series of visits inside companies in POA 5 made the experience interesting for being direct and real, even if with some space for improvement, as noted above.

Alongside the several highlighted opportunities, criticalities emerged as issues to be solved:
- Time is a problematic issue: short activities were difficult to be addressed and sometimes made students frustrated as they did not own the instruments to understand the structures of knitwear.
- Knitwear technologies are expensive, and universities often do not have funds, or spaces, or the dedicated technical employers to arrange a fully equipped workshop where students can practice and develop the technical skills required by the industry.
- Knitwear needs a knowledge composed by many specialties, each one is not trivial at all. To transfer them to students, HEIs need to hire specialised figures, both from the academic area and from the professional one.

As said before, the analysis on the educational standpoint was not an end in itself but was meant to be observed together with the parallel industrial one. In this sense, given the identified needs and desiderata of the knitwear industry, the research assumed hypotheses of intervention for HEIs to address them.

	POSSIBLE ACTIONS					
EMERGED INDUSTRIAL NEEDS	Theoretical lessons made by academics, professionals, visiting	Specialty courses	Facilities: domestic and electronic machines	Closer relationship with companies	Fabric and yarn design included in the study path	Teamworking
Ability to communicate effectively with the technical language of knitwear	high	medium	low	high		
Specific technical knowledge	high	high	high	low	medium	
Awareness of how do new technologies work			high			
Yarn designers		low			high	
Knowledge of manufacturing process, stakeholders and production steps	medium	low		high		
Soft skills, teamworking above the others				medium		high

Fig. 2 - The three shades of colours indicates the intensity of impact of each action on the respective need. The darker the red, the highest the impact.

Alongside this, to extend the view on the state of the art of KD teaching, other universities, in Italy and abroad, have been selected with the aim to analyse their way of working and to verify if, where and how the detected possible actions were already accomplished.[103]

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[103] Ten universities have been mapped with desk research, observation and interviews to teachers and students. The selection followed two criteria:
- They had been selected at least one time to participate in Feel the Yarn, which is the only internationally recognized contest with a specific focus on knitwear.
- They dedicate a whole study course, a master's degree or at least a specialism to knitwear or knit design in their study programme.

The selected universities were:
- IUAV, Venice, Italy
- Accademia Costume e Moda, Rome, Italy
- Kingston University, Kingston, United Kingdom
- Royal College of Art, London, United Kingdom
- Birmingham City University, Birmingham, United Kingdom
- Nottingham Trent University, Nottingham, United Kingdom
- Fashion Institute of Technology, New York, United States
- Philadelphia University, Philadelphia, United States
- Parsons School of Design, New York, United States
- Honk Kong Polytechnic University, Hong Kong, Hong Kong

Fig. 3 - Comparison between the mapped universities and the tools and actions needed to answer the needs of the industry

Figure 3 outlines which of the mapped universities is already working towards what the preliminary observation stated as possible actions of improvement for KD education.

The exposed findings still leave an open question: is there space to intervene, modify or improve what is being done? Can be said that, if Figure 3 highlights the answers given by mapped universities to the emerged needs, the high amount of white spaces is a proof of the still present detachment between HEIs and the industry, and thus represent a space for intervention with the following experimental phases of this research.

3. Conclusions

Given these directions to intervene on didactics keeping the eye on the knitwear industry, this twofold preliminary research confirmed what had been found in the literature and led to the formulation of the two pillars that guided the following experimental activities of this study.

First, the high importance of a technical, technological and updated knowledge defined that **in knitwear design there can be no creation without a technical background**. Alongside all the interviews can be found the evidence that knitwear is not at all just a creative exercise but a technique, a tool for creation that has to be mastered and needs a high level of specialization. To be able to interact with multitude of stakeholders and professional figures that operate in the outlined phases of the process, the knowledge of designers has to be creative, but cannot miss the technical part.

Second, the interviews and the collected general advices reported in Section 2, with a large part of the interviewees reporting the belief that industry and university should be more deeply connected, defined **innovative ways of relationship between university and industry to be a facilitating asset to effectively answer the emerged needs of the knitwear industry.** To make this practice effective, namely to create a consequential relation between the concrete industrial needs, the proposed activity and the reached results, it comes the need for the academia to have a flexible set of teaching tools and methods, made to model from time to time each activity towards the desired result.

4. Knitwear design education:
   a teaching framework

1. A framework for knitwear design education

Chapter 3 assumes the useful actions, tools and equipment to be undertaken to intervene on the aspects of KD education in order to give an effective response to the needs of knitwear industry. The chapter outlined important assets for KD education to be effective, stating that it is important to:
- address the knitwear sector with specializing courses which dedicate the needed amount of time and the needed competences to the complexity of teaching KD;
- equip the school with state-of-the-art facilities, to improve the technical knowledge with practical experience;
- include lessons to transfer cultural, scientific and technical kinds of knowledge which are preliminary to the design phase;
- improve the soft skills of students to orient them to a industrial mindset;
- give more attention to the yarn, which is a distinctive part of any knitwear project.

On the one hand the outlined actions, which, as seen, are often not assessed by the Italian HEIs as well as by the international ones, include some issues which depend on economic resources owned by schools, some others which should be demanded to the general organization of disciplines and study paths inside universities and departments. Issues 1 and 2, which precisely concern the capability of HEIs to improve state-of-the-art, usually expensive- facilities and the revision of the structure of a whole study path to introduce a knitwear specialism and to include time demanding activities, go beyond the power of intervention of this study and its experimentations.

On the other hand, all the findings collected so far, through the preliminary research as well as through the search in the literature, have made me able to identify with issues 3, 4 and 5 the areas which allow a concrete intervention for the present research. The above-mentioned indications have been consequently detailed towards the outlining of a framework made of concrete **actions, subjects and tools for knitwear design education**.

Keeping in mind the multidisciplinary knowledge to be owned by a designer (see Chapter 2, Sections 3 and 4), the assumed framework is intended to combine the design values with creative notions, manual craftmanship and technical skills. The framework is intended to be a resource for teachers, professors and researchers inside HEIs to orient any design process and teaching experience in the occurring contexts. It is composed by all the elements needed to build an effective knowledge in the field of knitwear, which, as part of a design method, should be «selected, adapted and appropriated to

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the specific project and situation at hand» (Bratteteing *et al.*, 2012, p. 2 in Simonsen *et al.*, 2014, p. 5), always taking in considerations that the new professional figures will have to answer the desires of companies.

The designed framework is based on the simplified design model given by Hertzum (in Simonsen *et al.*, 2014, p. 27), that presents four basic elements. First, designers –students, in the case– must understand the **existing situation** through experience and through the learning of a common language for communication. Second, designers must explore the **technological possibilities** at their disposal. Third, the **design process** must be organized and planned, to match the situation and the technological possibilities. Fourth, the **new situation** must be envisioned and concretely experienced with prototypes and simulations.
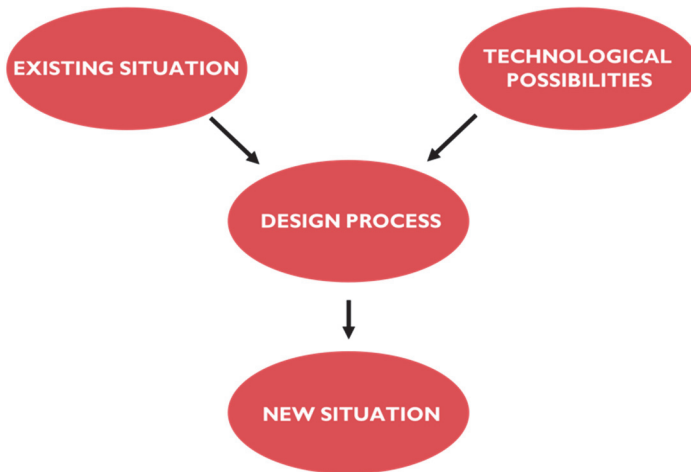
Fig. 1 - The design model given by Hertzum (2014).

Taking Hertzum's model as a reference, it has been applied and adapted to KD process with the aim to define it as connected to a validated and recognizable design model while, at the same time, to make it suitable to the specific features of KD and to outline the components of the ideal complete KD education. Teaching KD means thus to make students able to reach the four objectives of Hertzum's model, namely to provide them with different skills through lectures, practical lessons, tutorials and experiential learning.

All the previous work demonstrated that in knitwear design, more than everywhere else, the design process and the making of samples and

prototypes to envision the new situation are two integral parts of one bigger stage of the project: they are not consequent, but they result from a series of activities which go back and forth from one to the other. For this reason, KD framework is composed by three elements instead of four, incorporating the prototyping moment in the middle of the design process.

A first outline of the framework was indeed organised as follows, with the three objectives composed of all the useful skills to be taught to knitwear designers. The lectures, practical lessons, tutorials and experiential learning constituting each objective will be furtherly described in the following paragraphs.

1. **To give an overview on the existing situation**
   - Knitwear history and contemporary scenarios
   - Materials
   - Material engineering
   - Management and supply chain
   - Technical language
2. **To show the technological possibilities**
   - Hand-knitting
   - Machine-knitting
   - Shaping
   - Finishing
   - Programming industrial machines
3. **To structure the design process**
   - Launch of the brief
   - Market research, brand positioning, target profiling
   - Mood and concept
   - Sketches and collection architecture
   - Research on yarns, textures and colours
   - Stitches and structures development
   - Prototyping
   - Final presentation

1.1. To give an overview on the existing situation

1.1.1. On knitwear history and contemporary scenarios

Lectures given by researchers or professors on the topics are useful to gain knowledge about the history of knitwear and about the cultural values it is charged with, and to understand the role of knitwear in the contemporary

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fashion scenarios. As previously mentioned in Chapter 2, knitwear is nowadays placing itself far from outdated craftmanship and finding a place success and respect on catwalks. Lessons on contemporary scenarios can be focused on several topics concerning knitwear as trends, experimentations, new brands, young designers, lifestyle and furniture, art, technology development.

1.1.2. On materials

Lectures given by expert teachers or professionals about yarns, their technical features, different fibres with their properties and applications, their usability for apparel and their benefits on human body rather than for furniture or home textile. These lectures can also be integrated with samples for students to be seen and touched, to make them directly experience the material and to make comparisons between them. In some cases, focuses on particular materials –e.g. wool, linen, cotton– can be made by visiting lecturers, namely spinners or employees of certificatory bodies as The Woolmark Company or CELC, who have a specific experience in promoting that kind of fibre.

1.1.3. On material engineering

Knitwear is a complex structure made by a unique yarn interweaved with itself one stitch after the other. This series of subsequent weaves build a fabric with peculiar properties which influence the thickness, the resistance, the stretch of the knitted fabric and thus the drop and the wearability of the final garment. Theory on material engineering thus include lectures on the properties of knitted structures like stretch and recovery, dimensional stability, thickness and compression properties, pilling and abrasion resistance, as well as on processes for innovative materials for knitwear, like metallization (lamé yarns, Lurex, etc.) and manufacture of sportswear structures.

1.1.4. On management and supply chain

If, as illustrated in Chapter 2, Section 3, designers are not going to be artists but creators of industrial products, it is important for professionals approaching the job market to get a complete picture of the supply chain and of the production process. Lesson on management, on knitwear stakeholders, on how to design a collection –apart from inspirations– focusing on target

profiling, on commercial data and on the building of the architecture of a collection is a fundamental of KD education. Students also have to get knowledge about what are the most useful and common documents along the production phases, such as a technical sheets or bills of materials, and to know how to fill them in in a proper way, which means to know how to communicate their ideas by translating sketches into operative directions.

1.1.5. On the technical language of knitwear

Even if they just graduated, or they are entering the job world, the usage of a naïve vocabulary, not specific nor technical, is widely perceived as a serious lack by any company or professional, especially in such a sectorial world as knitwear is. Students have to present their works using the right words, as *yarn* instead of *thread* or *wire*, *gauge* instead of *number*, *yarn count* instead of *big* or *small yarn.*

By listening to the proper language of knitwear spoken by teachers and technicians, students can surely acquire some words, but it could happen that they do not meet many others. In this sense, the study of a prepared glossary and its verification during the practical activities can be a good solution.

1.2. To Show the technological possibilities

1.2.1. Hand-knitting

The first approach to knitwear consists in the learning of manual techniques: hand-knitting made students understand how the yarn is moving and how this movement will be later transposed to the machine. Tellier-Loumagne notes that

to associate the training on the machine to the hand-knitting techniques is highly recommended. In fact, on knitting machines, the needle activity is hidden from the cart when, on the other hand, the hand-knitting allows to observe each operation. (2006, p. 12)

As already illustrated elsewhere (Motta and Conti, 2018), alongside the technical language used among workers inside companies, there is the ancient, unwritten and unspoken alphabet made of movements of needles and hands which have been passed down within generations. It is very difficult to learn how to knit from a book: every area of the world has indeed created its own

system of words or graphics to represent stitches; for example, while Europe and US use two different descriptive terminologies, in Japan each movement correspond to a graphic sign which "draws" it on paper (ibid.). With a so complex interpretation of languages, the presence of the professor in the classroom is fundamental to show students how stitches are made, as «the only alphabet universally understood is that of gestures» (ivi, p. 20). The module starts from the basic knit and purl, going towards their combinations in different textures (e.g. ribs, moss stitch, garter stitch), to reach the most complex stitches used for modelling knitwear (e.g., increases and decreases, seams, openwork stitches) and techniques to solve problems (e.g., how to catch a fallen stitch, how to go back on the needle, how to rebuild the work).

The purpose is, as again Tellier-Loumagne (2006) recalls, to awake, through the learning of basic techniques, students' creativity and to promote «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 2006, 12).

1.2.2. Machine-knitting

Machine-knitting owns the same role as hand-knitting, namely the technical background knowledge which serves as a tool to foster creativity. Student should familiarize with Brother knitting machines, which are versatile and on which the fabric can be easily manipulated, to then pass to semi-industrial machines (e.g. Coppo, Dubied, Sant'Agostino) which are the link between the domestic ones and the contemporary industrial power machines (e.g. Shima Seiki and Stoll).

1.2.3. Shaping

The common process of realization of a garment passes through the stage of pattern making: a paper pattern of each piece is made with rulers and precise calculations to be placed on plain fabric, cut out and then sew together with other pieces to gain a 3D aspect. If this is an essential step for tailoring, knitwear needs a different approach: as previously said, it can be fully-fashioned or cut-and-sew.

In both cases paper patterns are required but are strongly influenced by the characteristics of the material and of the knitted structure: for example, the elasticity of a knitted fabric often makes darts and precise curves useless,

or pleats are often made directly on the machine with no need of calculation on paper. Moreover, shaped knitwear is made without any cut, modelled through increases and decreases without any waste of material, with a process that is rather addictive and does not resemble anything known before. These features concern the knowledge of a new method of construction on the body which has to be studied and understood by students with practice.

1.2.4. Finishes

Concerning the prototype making, trims and finishes are very important because their accuracy decides the final aesthetic of the product and makes it potentially saleable on the market. Some practical lessons on the topic are indeed useful for students to understand how to properly sew knitted pieces together using linkers, overlockers or linear sewing machines, how to handle the critical areas of a garment as shoulders, armholes, sides and underarms, how to apply borders or to fix defects.

1.2.5. Programming industrial machines

The aim of a Knitwear Design study course is not to form programmers-technicians. Despite this, the inclusion of the basics of programming and of the functioning of power machines can give added value to the knowledge of young knitwear designers, as it makes them aware of many aspects outlined as critical in the previous chapters: first, they learn which process a programmer goes through when he/she receives the technical sheets to be coded into a program; second, they understand what is industrially feasible by the machine and sustainable in terms of time and costs; third, 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.

1.2.6. Visits to companies and fairs

To take students on study trips and guide them during the visits to companies and trade fairs is an important phase of learning directly from the context. There are, indeed, a lot of notions, concerning theoretical, technical and design knowledge that students can acquire faster and effectively with this

direct kind of experiences, by touching materials, seeing machinery at work, listening to professionals talking in their working environment.

Visits to trade fairs could be made even by students on their own, but the presence of a teacher allow them to make questions and to get immediate answers, to get a general idea of the system and at the same time to improve the detailed knowledge.

1.3. To Structure the design process

Students are guided through the stages of the design process which are accurately similar to the real ones illustrated in Chapter 3, following the nature of the word "project", whose etymology comes from the Latin *projectare,* namely "throw-forward": in this view, designers prefigure what they intend to make happen. For knitwear design as well as for the other areas of the discipline the approach is tied to reflecting before acting, and is opposed to the no-method approach of working led by the case and waiting to have the right idea. «The method of traditional knitting, as well as the one of industrial knitwear production, is thus for its features a really integrant part of the Culture of the Project» (Motta, in Affinito, Conti, Motta, 2017) and in its educational aspects needs to be structured and not led by the case.

Nothing could be left to chance otherwise the dress that you create could bring disproportions, unsuitable volumes, incorrect fits. Unlike the tailoring, knitting must be planned, thought in advance, calculated stitch by stitch. Today doing knitwear design means investigating how to solve problems through an activity that creates, to those in charge, many constraints (Conti in Conti, Poletti, Rinaldi 2016, p. 25).

1.3.1. Launch of the brief

As noted by Brown (2009), limits and constraints support designers to proceed from the divergent to the convergent phase of the design process. All the steps of Track 3 are indeed regulated by constraints: some of them are inherent in the complex nature of knitwear, as seen in Chapter 2, Section 4 and in Chapter 3, Section 2, some other are set by teachers –researchers, professors or professionals– within the launch of the project brief to simulate real problem-based situations. The brief, and the consequent required outcomes, can be very strictly defined or can leave students freer to experiment.

In a didactic exercise, a brief can even concern not just apparel, but lifestyle objects, textiles, yarn development.

1.3.2. Market research, brand positioning, target profiling

The activities at this stage depend on the given brief: if students are assigned a brand to design for, in order to make the activity closer to reality, they will analyse and frame the features of that brand to understand what to design. On the other hand, if there is no brand to refer to, they should anyway detect their reference target and their competitors, to understand which kind of product would be credible on the real market.

Part of this initial phase of analysis is a market research on knitwear products to be actively done by students into shops: they have to take photos and build a detailed catalogue of what exists, to gather information and references about stitches and feelings given by yarns and structures, material mixtures, trims, prices, shapes, commercial or experimental knitwear.

1.3.3. Mood and concept

Mood and concept are the steps where students give their very own and personal perspective on the project. A moodboard and the deriving concept are usually a collection of images disposed in a meaningful way on boards, developed with the supervision of teachers in the intent to open interesting ways of interpretation and valid hints for the future designs.

1.3.4. Sketches and collection architecture; research on yarns, textures and colours; stitches and structures development

The three steps are presented together as they are not consequent but can be simultaneous and influenced by each other, exactly as it happens for the same stages of the process inside companies.

Once again students are, under the guidance of teachers and technicians- in charge of actively make things, as making is indeed the key point of the implementation of a knitting project: as Micelli (2011, p. 29) says, *"making things"* makes people –and thus students– more aware and it allows them to deal with the material world and to think better (Conti in Affinito, Conti and Motta, 2017). The hands-on activities are here the ones which foster innovation

through the research on yarns, on new mixtures, on new ways to exploit and manipulate the knitting machine to reach the imagined result, on new interaction between the artisanal knowledge and technological research, on new ways of application of materials, volumes and texture on the sketched garments.

The complexity of knitwear leads the designer to a long, thorough and detailed research along these phases, which often requires to overthrow the common order of tasks of clothing development and to begin to think and to design the soul of knitwear, starting from the yarn (Motta in Affinito, Conti and Motta, 2017).

You can then design the yarn itself, combine several yarns together, or even use non-traditional materials and then continue with the project of the stitch to be worked by hand or machine, to make a fabric. All these components influence the final garment and determine its features so decisively that it is not uncommon to find fashion sketches made before and completely altered after the experimentations made with yarns (ivi, p. 2768).

1.3.5. Prototyping

The making of prototypes is for students the moment of application and the final test on their ideas and experimentations. They are asked to give shape to the products they designed with the support of technicians inside workshops (Bertola, 2009. See also Chapter 2, Section 3.2).

1.3.6. Final presentation

As written by Affinito (in Affinito, Conti and Motta, 2017) the value of a project cannot be parted from the possibility to be told. In an educational experience, students have to demonstrate they can present, both with their own words and with visual proposals, not just the finished product, but the motivations for each decision undertaken during the creative process and the answers given to the imposed brief through mood boards, concept boards, technical details and innovative proposals. «Verifying the quality of their insights, keeping an open mind on options and variations, as well as in the real world, is an integral part of the design method» (ivi, p. 2763).

2. Framework Application

In light of the description of all the modules included in the in-development framework, three different kinds of knowledge can be recognised, each one related to the three objectives of the model stated at the beginning of this chapter. This led to structure and visualise the framework on three tracks (Fig. 2):

Track 1 (T1): theoretical knowledge, which makes the students understand the current situation.

Track 2 (T2): practical activities, which gives an overview on the technical and technological possibilities at students' disposal.

Track 3 (T3): design process, which guide students through all the phases of knitwear design.

Track 1 THEORETICAL KNOWLEDGE	Track 2 PRACTICAL ACTIVITIES	Track 3 DESIGN PROCESS
To make the students understand the current situation	To give an overview on the technical and technological possibilities at students' disposal	To guide students through all the phases of knitwear design
Knitwear history and contemporary scenarios	Hand knitting	Launch of the brief
Materials	Machine knitting	Market research, brand positioning, target profiling
Material engineering	Shaping	Mood and concept
Management and supply chain	Finishings	Sketches and collection architecture
Technical language of knitwear	Programming industrial machines	Research on yarns, textures and colours
	Visits to companies and fairs	Stitches and structures development
		Prototyping
		Final presentation

Fig. 2 - overview of the three tracks and on the modules composing the ideal didactic experience for knitwear design

The generated framework for knitwear design education had to be applied and verified in all its components through a consequent experimental phase made of eight didactic activities of applied research where the author was involved as a researcher and as a teaching assistant. This role allowed multiple actions and developments of experimental nature:

- to set the structure of the activities according to the framework, and to codify the tools and methods needed throughout the phases of KD learning process;
- to understand from time to time which are the tools to be put on the line to model the teaching activity on times, contexts and participants' (students, teachers and companies) target;
- to monitor students' learnings and improvements and to consequently evaluate the effectiveness of the designed framework;
- to observe the effects of the involvement of companies into teaching in experimental ways, to see what changes and if activities give better benefits to participants when the company undertake an active role into them.

The modules of the framework have been applied in different ways, in some cases in their completeness, in some others just partially. Not all the tools and modules have thus been applied to all the activities, to give this study the possibility to evaluate the results of their addiction or removal.

To conduce this kind of comparative analysis, the eight experimental activities have been made different for:
- timeline;
- number of participants;
- participants' background;
- involvement of one or more companies into teaching;
- setting/educational context/typology of course.

In the following pages, Chart 1 presents the experimental activities in chronological order and visually resumes the differences between them, while Figure 3 presents the visual model – used to evaluate each activity– in its completeness with the legend.

Conducted in sub sequential order, the experiences have been defined following an iterative process, where the observation and the reflection on the previous one had an influence on the actions undertaken in the followings.

Each experimental activity has been here resumed in a diagram (a, b, c, d, e, f, g and h) with a graphic representation of all the modules (undertaken actions, treated subjects or used tools) belonging to each track.

Each diagram reports:
- which modules of Track 1, 2 and 3 have been used in relation to participants, time and setting;
- the completeness of the knowledge transferred by each action, subject and tool, on a growing scale from 1 to 5;

- the impact and the evidence of each action, subject and tool on the final outcome produced by participants, on a growing scale from 1 to 5;
- the contribution of the involvement of one or more companies into the teaching/learning process, when it improved or enforced the knowledge already owned or brought new knowledge.

Chart 1 - Comparative summary of the experimental activities.

	TIME	n° OF PARTICIPANTS	BACKGROUND IN KD	COMPANIES INVOLVED	SETTING
MISSONI PROJECT Final Synthesis Studio A.Y. 2016/17	4 months	48	none	Missoni The Woolmark Company Zegna Baruffa LB	3rd year curricular BA course at Polimi
WS Design with Linen A.Y. 2016/17	1 week + 5 months	48	basics	CELC	3rd year curricular ws at Polimi
MAD 2017	5 days	15	none	none	Thematic ws in Master course at POLI.design
DDM 2017	6 weeks	8	varied	none	Post Graduate course at POLI.design
BCU WS A.Y. 2016/17	5 days	11	none	none	Elective ws for Level 4 students at BCU
BA THESES A.Y. 2016/17	5 months	43	6 months	none	BA Theses developm. at Polimi
FEEL THE YARN 2017	4 months	2	6 months	Pecci Filati Filpucci	International contest
KNIT GAME Loro Piana 2017	3 months	2	6 months	Loro Piana	International contest

COMPLETE VISUAL MODEL

Track 1 THEORETICAL KNOWLEDGE
5 4 3 2 1

Knitwear history & Contemporary scenarios · Materials · Material engineering · Management and supply chain · Technical language of knitwear

Track 2 PRACTICAL ACTIVITIES
5 4 3 2 1

Hand knitting · Machine knitting · Shaping · Finishings · Programming industrial machines · Visits to companies and trade fairs

Track 3 DESIGN PROCESS
5 4 3 2 1

Launch of the brief · Market research Brand positioning Target profiling · Mood and concept · Sketches and collection architecture · Research on yarns, textures and colours · Stitches and structures development · Prototyping · Final presentation
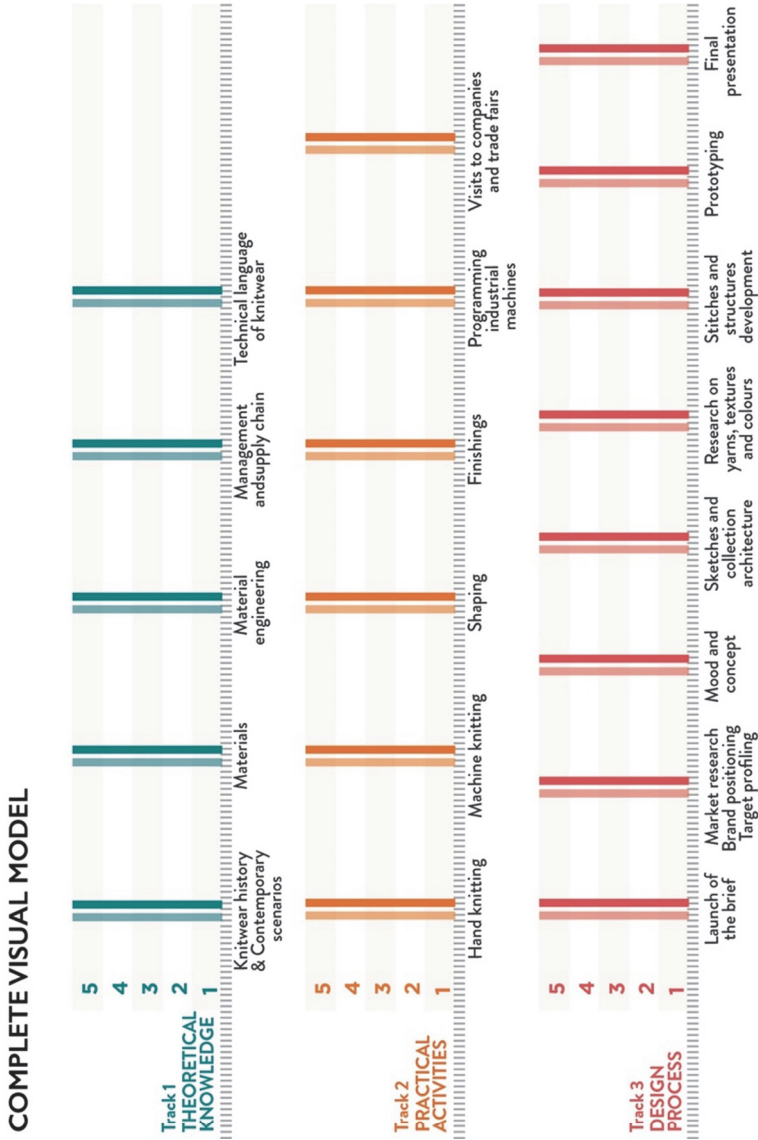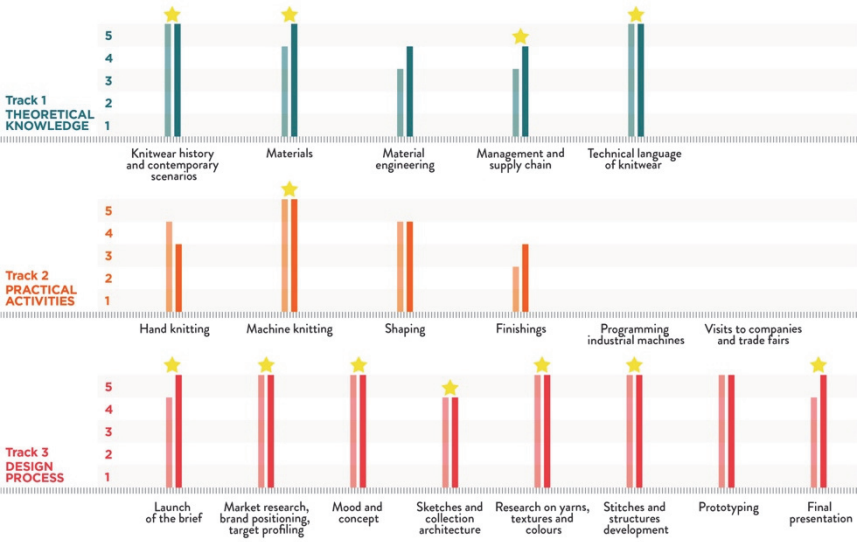
Fig. 3 - Complete visual model applied to the analysis of each experimental activity with legend. Followed by diagrams a, b, c, d, e, f, g and h, each one reporting the data of one of the experimental activities.

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MISSONI PROJECT
Final Synthesis Studio A.Y. 2016/17

a.

WORKSHOP Design with Linen
A.Y. 2016/17

b.

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MAD
2017

Track 1
THEORETICAL
KNOWLEDGE

Knitwear history and contemporary scenarios | Materials | Material engineering | Management and supply chain | Technical language of knitwear

Track 2
PRACTICAL
ACTIVITIES

Hand knitting | Machine knitting | Shaping | Finishings | Programming industrial machines | Visits to companies and trade fairs

Track 3
DESIGN
PROCESS

Launch of the brief | Market research, brand positioning, target profiling | Mood and concept | Sketches and collection architecture | Research on yarns, textures and colours | Stitches and structures development | Prototyping | Final presentation

c.

DDM
2017

Track 1
THEORETICAL
KNOWLEDGE

Knitwear history and contemporary scenarios | Materials | Material engineering | Management and supply chain | Technical language of knitwear

Track 2
PRACTICAL
ACTIVITIES

Hand knitting | Machine knitting | Shaping | Finishings | Programming industrial machines | Visits to companies and trade fairs

Track 3
DESIGN
PROCESS

Launch of the brief | Market research, brand positioning, target profiling | Mood and concept | Sketches and collection architecture | Research on yarns, textures and colours | Stitches and structures development | Prototyping | Final presentation

d.

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BA THESIS DEVELOPMENT
A.Y. 2016/17
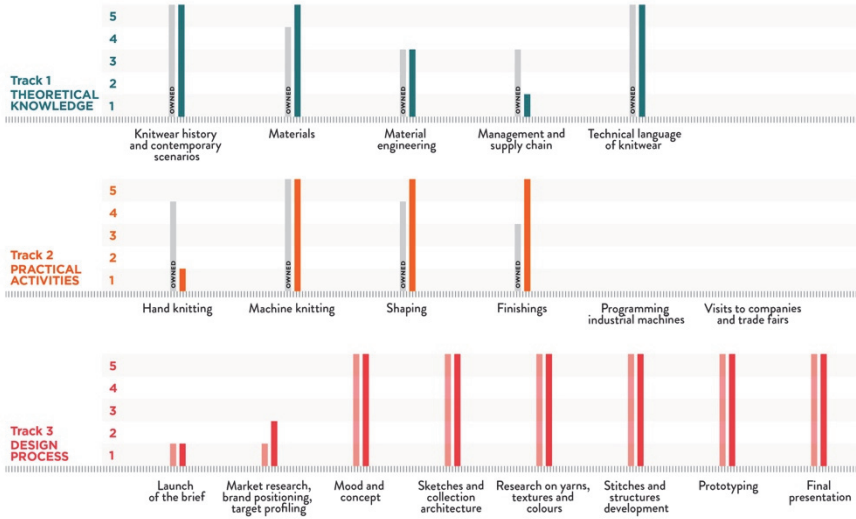
e.

BCU WS
A.Y. 2016/17
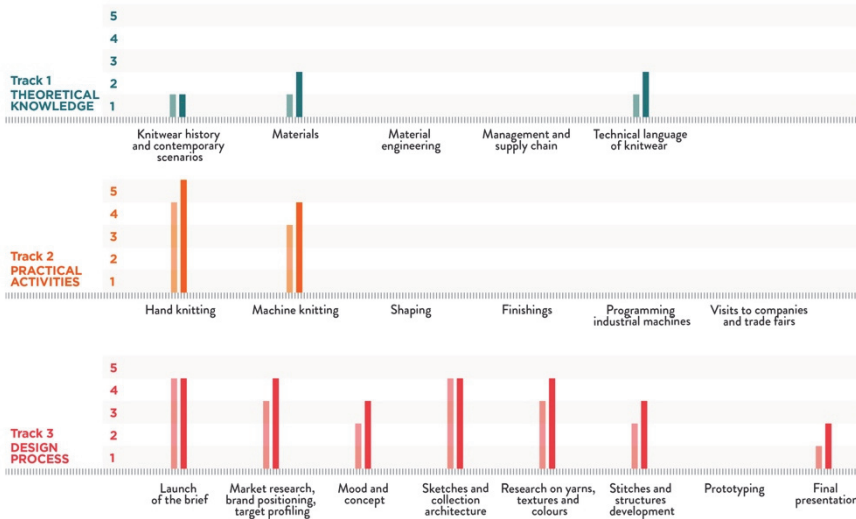
f.

FEEL THE YARN
2017

g.

KNIT GAME Loro Piana
2017
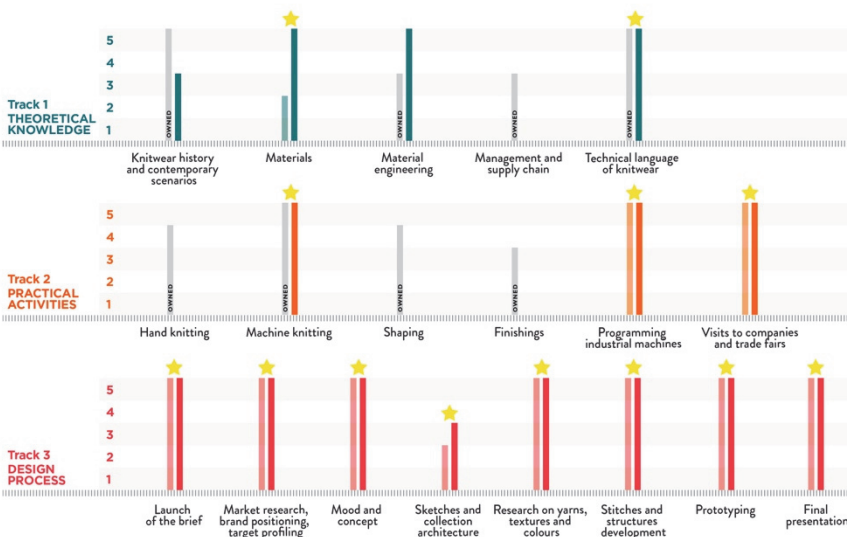
h.

3. Findings

3.1. Verify the designed framework

Activities with the most complete set of modules (Diagrams a, f, h) applied are also the most effective. This verifies the framework when used in its completeness and made it codifiable as a toolkit containing all the needed elements for a complete KD education. The absence of some modules in the most complete experimental activities, e.g. Missoni Project or Knit Game (Diagrams a and h), have been not just shortcomings but opportunities to verify what should be addressed in the future and how the framework should be actually structured.
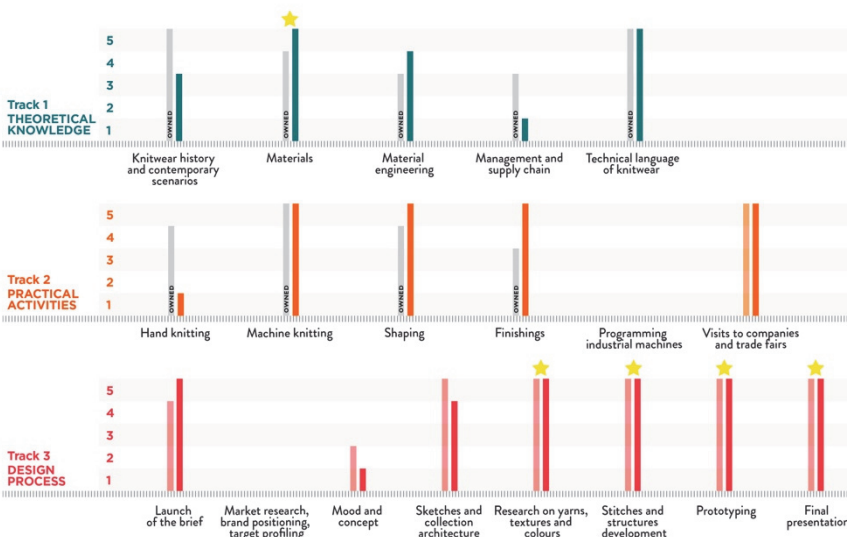
3.2. Verify the impact of each module on the others

If in knitwear design there can be no creation without a technical background, the experimental phase demonstrated that the theoretical knowledge learnt through lectures and other traditional methods (Track 1) and the technical and experiential knowledge learnt through hands-on activities (Track 2) have direct impact on the way participants address the process of KD (Track 3).

The importance of T1 and T2 has been proved also by the weaknesses outlined during the experiences where they had to be totally or partially removed (e.g. *MAD 2017* and *BCU workshop*; see Diagrams c and e) due to time restrictions or setting limitations. The successful results of experiments which did not include structured modules belonging to Track 1 and 2 (e.g. *Feel the Yarn* and *Knit Game*; see Diagrams g and h) are due to the already owned background of participants. On the other hand, DDM 2017 (Diagram d) proved, with a strong technical background and the reported weakness in the design activities, that learning technical knowledge does not mean to be able to act as a designer.

The arrows in Figure 4 outline which modules of Tracks 1 and 2, **theory** and **practice**, resulted to directly impact on the **design process** in Track 3, as they give the basic theoretical and practical instruments and background to students to address the creative stages of the project (evidence in Diagram a when compared with Diagrams c, d and e).
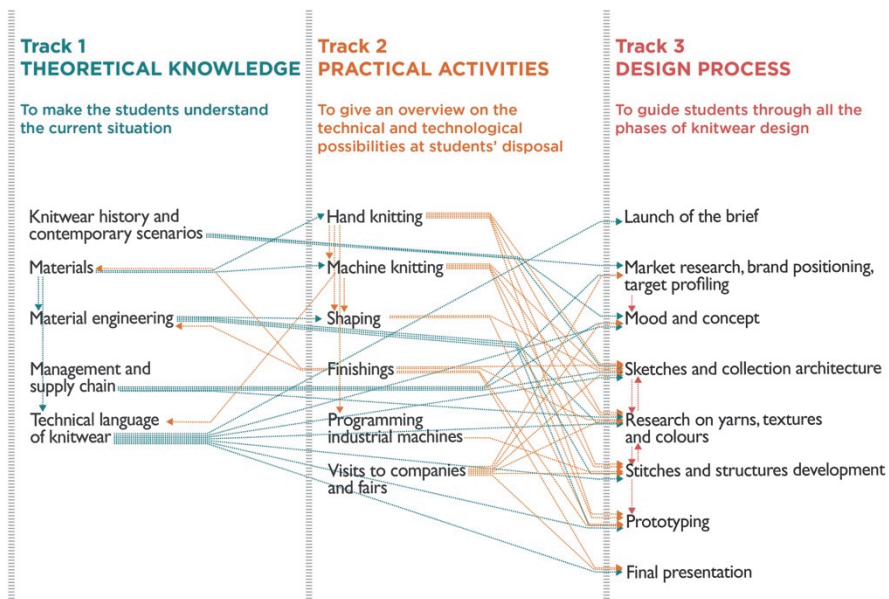
Fig. 4 - Arrows highlight the impact of each teaching module of Track 1 and 2 on the design process in Track 3.

The arrows also highlight some other features of the interaction between the modules composing each track:

- in almost all the experimental activities some modules of T1 give a knowledge contribution to T2;
- the modules are not designed to be delivered one after the other: as in the case of the *Sketches and collection architecture*, *Research on yarns, textures and colours*, and *Stitches and structures development,* due to the peculiar features of knitwear some actions overlap and influence each other;
- even if the modules are not meant to be necessarily consequent in terms of time, some modules are essential to better address the following ones, to avoid difficulties inside them and to reach better effectiveness, even if they seem not to be made explicit in the final outcome. This is the case, for example, of the hand knitting module as preparatory to the machine-knitting one (Diagrams b, f, g and h), or of the machine-knitting one as essential to understand how the industrial power machines work (see Diagram h).

3.3. Modelling the activities on times, contexts and participant's target

The experimental phase proved the impossibility, as well as the usefulness, of applying the complete framework to any kind of activity. The framework has been indeed intentionally designed as flexible, modular and adaptive to make whoever –among teachers, professors and researchers– uses it able to adjust it to the needs of students and of the company when involved, always taking in consideration the times and the settings at disposal.

T1, T2 and T3 are not rigidly structured in a didactic way: some modules can be skipped if participants already own the needed knowledge (e.g. in the *BA Thesis development*; see Diagram f) or if the project brief focuses on a particular aspect of knit design (e.g. *Workshop Design with Linen*; see Diagram b*)*. Must be also noted that the experiments which involved companies demonstrated how knowledge transfer can happen in some areas even if those modules are not addressed as specific didactical activities: *Knit Game* and *Feel the Yarn* have been in this sense the perfect testing ground, proving that the dialogue with the experts and the direct contact with the industrial environment bring a spontaneous deepening of knowledge on diverse topics belonging to T1 and T2.

3.4. Experiment the added value of the involvement of a company in the teaching/learning experience

All the activities of this phase, whether they involved a company or not, were intended to verify if a closer relation of HEIs with the industry could be truly effective and beneficial on multiple levels for students, universities and companies.

The overview on the visual schematization of each activity highlights two issues: first, the activities with no company involved are weaker in the final results as well as in the effectiveness of the learning experience (see Diagrams c, d and e); second, the active involvement of companies into teaching impacts on several areas of knowledge even when there are no actual teaching sessions in that area (confront T1 and T2 in Diagrams g and h). Students *learn by doing* (Dewey, 1938) and by experiencing reality, by dialoguing with experts, by being immersed in real situation.

Regarding this aspect, the beginning of this chapter outlined the difficulty for this study to address two of the important assets (time and facilities) that KD education needs to be effective, as they go beyond the possibilities of

intervention of the experimental actions. The experimental activities revealed though that the lack of economic resources to improve facilities at students' disposal and the lack of time which often affects some very intense and concentrated didactic activities can be, if not directly and permanently solved, partially overcome by the closer relationship between the industry and HEIs. The close contact with the industrial environment indeed accelerates learning times by immersing the students in a reality-based context where they can learn focused, detailed and industry-oriented knowledge; companies, moreover, could supply to the lack of facilities inside HEIs by making their machinery and their materials available for students to work on (as happened during *Design with Linen, Feel the Yand* and *Knit Game*).

The experimental activities have been also useful to evaluate the benefits of such an approach, benefits which have to be considered, as said, on multiple levels for all the categories of people taking part in each experience. They are listed below and visually resumed in relation with the conducted experiments in Figure 5, that confirms the strength of teaching and learning with the active participation of the industry.

Benefits for students

- Increasing of students' awareness of the knitwear industrial scenario and their capability to deal with it.
- Speeding up of students' effective integration into the labor market and increased visibility for their work.
- Increased competitiveness on the labor market due to a sectorial education for knitwear industry.
- Opportunities to focus on techniques and to access facilities outside the university.
- Direct dialogue with experts to enhance both technical and creative skills.

Benefits for HEIs' staff

- Innovation, experimentation and verification of updated tools and methods used to teach knitwear design.
- Improvement of the competences of the higher education staff with a real and business connected problem-based approach.

- Capability to answer in a more effective way the new skills needed into knitwear industry through a specific and suitable set of teaching tools and methods.
- Opportunity to build more effective teaching experiences with the help of companies in terms of sectorial competences.
- Opportunity to overcome the shortcomings which usually affects HEIs concerning materials and facilities.

Benefits for companies

- Access to updated knowledge to develop innovation.
- Access to fresh ideas and solutions to exploit the company's products.
- Chance to get direct contact with students and to work with them before a job interview, to model new professionals towards their needs.
- Increasing of the innovation capability of enterprises due to the design-driven mindset carried by professors and researchers and transferred to graduated students and employees that came in contact with the teaching environment.
- Gained visibility for the company among the stakeholders of the sector through the exhibition of the students' work.
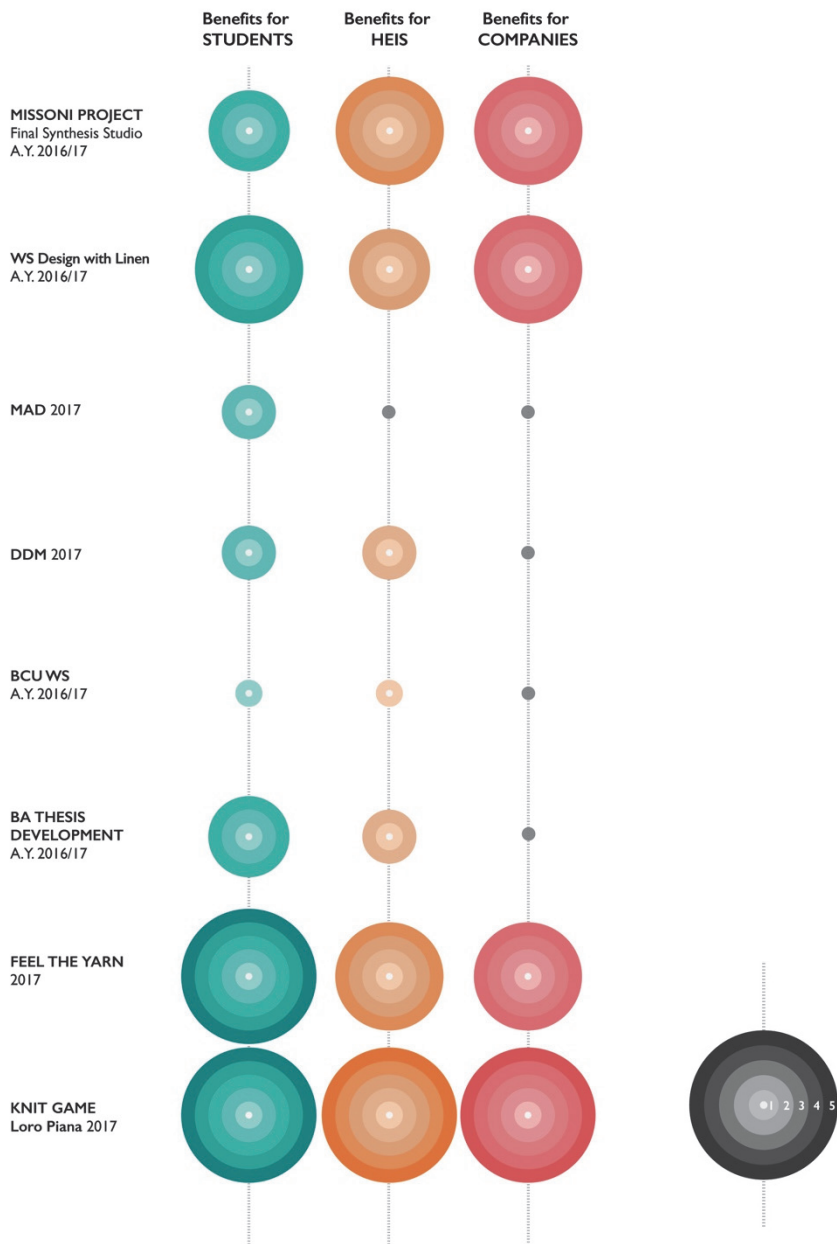
Fig. 5 - Visualization of the benefits for students, HEIs and companies in each exper-imental activity

5. University meets the industry: experimental actions

WHAT YOU WILL FIND IN THIS CHAPTER, IF YOU ARE:

AN ACADEMIC

- The detailed description of experimental actions with their ex-post evaluation, to use as a first example to build new ones
- Some of the possible responses from the entrepreneurial world to experimental teaching and learning

A STUDENT

- The description of what your older colleagues experienced when attending workshops and courses and dealing with the reality of a company
- Their voice and opinions about the experiences they made inside –or together with– companies
- Some best practices among the knit design projects that resulted from the experimental actions

A PROFESSIONAL

- Examples of successful cooperation between the university and the entrepreneurial world, where students, teachers and companies get mutual benefits
- Innovative design practices to bring new knowledge in your work environment
- The evidence of the quality and the detail of knit design projects when students-designers dialogue with companies

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1. Further perspectives on collaborative teaching in knitwear design

If the codification of a designed framework to be used and modelled on the needs of students, teachers and companies gives to professors and researchers the tools to structure the ideal way to act on KD teaching inside universities, the involvement of companies set itself as a completion and as an improvement of the undertaken actions, putting as a consequential purpose for this research to make this kind of approach as effective as possible on the previously mentioned benefits for students, HEIs and companies.

This experimental phase aimed indeed to experiment new ways and good practices of collaborative teaching, moving further from what has been already done in the fields of fashion and design, as well as in the field of knitwear (see Chapter 2, Section 3). This means that the participation of the industry should go beyond **sponsorships**, which, although being useful for single students to have free, good-quality material to work with, add a very little knowledge to the one already owned; should go beyond **traineeships**, which are still the main way for young professionals to experience the job world, but, even with the best efforts for cooperation, are still highly detached from the educational environment; should go beyond **contests**, which are mainly reserved to selected students –often the most ambitious ones– and usually make them compete with spectacular designs and no clue of industrial dynamics, turning out to be individual journeys with a final judgement from a jury; and, finally, should go beyond the common formula of **workshops**, which, although being valuable didactic exercises with a reality-based brief, often see in a very short and concentrated amount of time the participation of professionals at the beginning, for the launch of the brief, and at the end, for the final presentations.

If some of the activities used for a first application of the framework (see Chapter 3) tried to work in this direction by extending the time of the workshop *Design with Linen*, or by leading students to ask for the participative help of the spinners with *Feel the Yarn* projects, there was still a lot to do in terms of cooperation to reach an integrated teaching method that becomes the backbone of a discipline that meets the needs of companies.

This research needed to push the boundaries of collaborative teaching in knitwear design by exploring new typologies of involvement of different kind of stakeholders, exploiting the variety of companies along the chain and going beyond the more common cooperation with fashion brands.

The intent is to improve the added values that companies could bring to the activities included in the framework through four pilot activities, planned

with the aim to test good practices and codify new guidelines to be applied together with the didactic modules contained in the framework.

As written in Chapter 2 and briefly resumed here above, the shortcomings highlighted in the already ongoing collaborative experiences, focusing in particular on the knitwear design field, are mainly referable to:
- the short time dedicated by the company to the students;
- briefs which simulate reality but are not actually real;
- lessons held inside classrooms or workshops with inadequate facilities;
- loose relationship and few meetings with the experts from the company;
- the exclusive dialogue with the design unit of companies, with no contact for students with the other stakeholders along the chain;
- the lack of technical knowledge transferred, due to a preference for the creative side of the project;
- the difficulty for companies to understand and reach concrete benefits that they could exploit on their everyday work life.

For each one of the detected issues an answer has been assumed, to be experimented during the pilot activities: Chart 1 resumes them in consequence of the correspondent shortcomings.

Chart 1 - Summary of the actual shortcomings of cooperation between the industry and HEIs in the field of Knitwear Design, with the corresponding answers experimented with the pilot activities.

ACTUAL SHORTCOMINGS	EXPERIMENTAL ANSWERS
Short time dedicated by the company to the students	Longer times
Briefs which simulate reality but are not actually real	Reality-based brief addressing the real needs of the company
Loose relationship and few meetings with the experts from the company	Constant feedbacks from companies on design and product development
Lessons held inside classrooms or workshops with inadequate facilities	Students immersed in the industrial environment to develop part of their work
Exclusive dialogue with the design units, with no contact for students with the other stakeholders along the chain	Closeness to manufacture with the involvement of diverse stakeholders
Lack of technical knowledge transferred, due to a preference for the creative side of the project	Collaborative development of student's projects with expert technicians inside companies
Difficulty for companies to understand and reach concrete benefits that they could exploit on everyday work life	Pursuing of concrete benefits for the companies as well as for students and HEIs

2. Pilot actions

The following pilot activities, resumed in Chart 2 and presented in this chapter in chronological order, have been held during Academic Year 2017-18. As for the first set of experimental actions (see Chapter 4) the didactic activities have been diversified for number of participants, participants' background, setting, duration and applied solutions and are described along the chapter through the brief given by the company/ies, a description of the activities and the analysis of the final results, with a highlight on the benefits for participants.

Chart 2 - Summary of the features of the four pilot activities conducted during Experimental Phase 2.

	TIME	n° OF STUDENTS	BACKGROUND IN KD	COMPANIES INVOLVED	SETTING
WORKSHOP with Ghioldi	2 months	46	5 months	Ghioldi	3rd year curricular ws at Polimi
WORKSHOP with Filoscozia	3 months	40	5 months	Filoscozia, Filmar and others	Extra curricular ws at Polimi
DDM 2018	8 weeks	8	varied	The Woolmark Company CELC MF1	Post Grad specialization course at POLI.design
BA THESES with Ghioldi	3 months	8	6 months	Ghioldi	BA Theses developm at Polimi

2.1. Workshop with Ghioldi

Curricular workshop at Politecnico di Milano, School of Design, Fashion Design Study Course, 3rd year.

Data

Time	Launch of the brief in mid-January 1 intensive week in February 12th – 16th, 2018 Periodic reviews and final presentation on March 15th, 2018
Number of participants	46
Participants' background	Two years of Fashion Design, and one semester of Knitwear Design at Politecnico di Milano, School of Design.
Team / individual working	Teamworking 10 teams, 5 or 6 students each
Facilities	- **Knit Lab** workshop with 24 manual domestic machines (Brother), gauge 5; 6 manual industrial machines (Coppo), diverse gauges;

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	-	**Knit 2** workshop with 16 manual domestic machines (Silver Reed) gauge 5, 8 manual industrial machines (Coppo), gauge 7.[1]
Teachers	- -	Prof. Giovanni Maria Conti, fashion design professor Martina Motta, Ph.D. researcher, specialised in knitwear design, teaching assistant.
Involved companies		**Ghioldi** Team: - Teresa Cairoli, owner - Marco Ghioldi, owner - Marta Santambrogio, R&D area manager - Francesco Lana, R&D and archive

Project brief given by the company

"*Given a base garment supplied by the company, study alternative finishes, variations of modelling, additions or interventions with knitwear.*
Students are free to experiment with the provided materials or self-produced ones, with machine or hand-knitted edges, crochet or embroidery etc., by breaking existing items and reassemble them with new elements. Each team will develop a common concept on which each student will develop his/her own project and prototype. The 5/6 final pieces will compose a capsule collection.
The ten groups of students will focus on two different topics:
- *Knitting new solutions: with studies and interventions on woven stitches; study and development of graphic effects obtained by designing the jacquard on the reverse side and exploiting the floating yarns; with the mix of different yarns to create simple 3D structures;*
- *Intervention above printed garments given by the company. The company brings 25 printed sweaters on which the students will add their intervention. The prints are inspired by the Munari-theme of the collection that Ghioldi is developing for the clients.*"

[1] "Knit 2", opened at Politecnico di Milano in November 2017, replicated the model of "Knit Lab" almost doubling the number of manual machines, linkers, linear sewing machines and Coppo machines. The new workshop is also equipped with two industrial power machines Shima Seiki, gauge 7 and gauge 12, and six Shima Seiki computers Apex3 to program the machines, although they were still not accessible during A.Y. 2017-18 due to the time required by the training of technicians and teachers with courses at Shima Seiki.

Description of the activities

Three weeks before the official starting date, Teresa Cairoli and Marta Santambrogio came to Politecnico di Milano to present the company to the students and to immerse them in the context of the current collection they were designing for clients. Marta Santambrogio said that this would have been the best start possible to give an overview on the reality they were going to work with. In that occasion Teresa Cairoli, together with professor Conti also launched the brief, asking the students to start to research and collect suggestions from Bruno Munari's work, to read books, detect interesting images and concepts, to be ready to start with the design work in the intensive week planned for February.

During that week the schedule, set by the company, included two days of concept development and three days of hands-on activities, with the constant presence of Marta Santambrogio, prof. Conti and the author as teaching assistant. Marta and Marco Ghioldi had asked to keep a record of the making times, always thinking in the perspective of the industrial reality. The five working days concentrated on the concept development of design-oriented products: Marta asked for a reason for each choice made by the students, and made clear the fact they were working for a converter company, namely for a company which gives to its clients –high-end national and international fashion brands– along with high quality manufacturing in printing and knitting, a support on product development without being invasive on the client's identity. Students had to propose design-oriented solutions in the mean that they have to think towards the needs of that particular company, and thus to build a catalogue of interesting proposals which Ghioldi could present to its clients and where clients could see possible innovations applicable on their own products.

On Friday, after 5 working days and reviews, the students presented the set concept and received a feedback which guided them to the final prototype. A month later the students were invited to visit the company and to present their work: in this occasion Marco Ghioldi selected with Marta Santambrogio the best project to be integrated in Ghioldi's collection and to be presented to clients.

The company used the workshop to detect the students which seemed more in line with the company's philosophy, to think about a future collaboration in the development of their graduation thesis project.

Along the whole duration of the workshop, Marta Santambrogio and Francesco Lana documented the work of the students with notes and pictures to use this material on the Instagram page of Ghioldi to promote the collaboration of the company with Politecnico di Milano.

Results

Here reported the words which Marta Santambrogio, Teresa Cairoli and professor Conti said to the students at the end of the workshop. In the first part, Marta Santambrogio outlines the successful aspects of the experience as well as some shortcomings, in the second one they all express with effective words the vision which guided the collaboration, and which set also the initial purpose of this whole present research.

Marta Santambrogio:
"We looked at all the projects and evaluated: the industrial feasibility, the degree of novelty and freshness compared to what already exists, the production costs of what has been proposed to us and finally the level of execution. For example, many have used some handwork: they are reproducible, even where the machine cannot get anything similar, they could be done by hand. But if 100% of the proposal is hand-embroidery, that work reaches a production cost that makes it unfeasible. It is not hand-embroidery in itself that is wrong, it is the quantity that is used in relation to the totality of the idea.

There are ideas that can be new in a university context, but unfortunately when a company already works with names like Prabal Gurung, Tom Browne, Missoni, those are things already seen.

Then there are projects where you have intervened by hand on the machines: those are not really possible, because they are not reproducible with industrial machines. You could do it once, maybe if if the machine were from Marco [Ghioldi, owner of the company] *he would try, but since we rely on suppliers for prototyping and production, it is not possible. We can resume the results as follows: 10 complete projects, presentable to customers, 2 non-feasible, 5 successful projects, beautiful and easy, the rest are too expensive for the company."*

Teresa Cairoli:
"The important thing is that we worked together, university and industry. To say that students are the future is an alibi, they are the resources of the present and should be valued. On their part they need humility, dedication, availability, trust in the future."

Professor Giovanni Maria Conti:
"It is very important that you start to understand the consequences of your project ideas. This is essential, start thinking that everything you do has

a cost for the company and represents an investment. You have arrived at a stage where you must have acquired such awareness to be able to speak with a company, which judges your work on the basis of feasibility, costs, the actual possibility of production, where it is not a question of good or bad, but feasible or not feasible. We must be very aware that our school, which was founded by companies –because Politecnico was born like this, founded by engineers who wanted to train other engineers– is at their service, to train people who will go to work with them."

Marta Santambrogio:

"I hope that today's visit has been useful, to make you realize, as a shock, what is the path from a sketch to production and that you are not joking. We don't want students to know everything, but to know what to ask and who to ask to, when they find themselves inside a company.

Size development is not design? The archive is not design? Printing is not design? It is not a robot to do that, there is always someone who "thinks and does", which is Design. There's a world outside of the style offices, beside these unidentified sheds, and it's where everything happens.

Creativity on paper is one thing, problem-solving creativity is different: the client has given me a design, how do I solve it at the production level? We test, improvise solutions and it is the kind of creativity that I prefer, because it is about solving a creative problem in a creative way.

When on the client's side there is a person with the knowledge of the product, everyone works better, and you immediately set a relationship of trust, because if the client asks for something knowing what he/she is talking about, anyone can say that it cannot be made. When the client does not know the technical aspects and asks for the impossible, and does not understand a negative answer from us, we all lose time to make samples, to prove him/her that the result is different from the expected one. It all depends on the individual path of the person who is in the style office, because there are no customers who have the production, the printing or the knitting inside, most of the customers are a sorting centre of goods and ideas, therefore there is no way to immerse yourself in the productive reality."

The reported words highlight the presence of the key features which were set as desirable when the workshop had been planned.
- A longer and articulated workshop which included different kind of activities, from an autonomous research to the guided development of the concept, until the direct contact with the reality of the industry.

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- A reality-based brief with a real perspective for the final outcomes, which would be used by the company not just as inspirational material but as a finished product to work with.
- People from the company who understood that they could use the collaboration to get real benefits; they are not doing a favour to young students, but they could pull results from the university and transfer them to the industrial reality. Moreover, they understood that cooperating with the fifth university in the world ranking for Arts and Design area gives to the company a return in terms of image and deserves to be communicated to clients, suppliers and other stakeholders.
- In this perspective, they have real interest and dedicate time and energy to the activities, being present and acting as professional guides for the students, in continuous dialogue with teachers inside the university to help their presence to be effective also on the educational side.
- A collaboration with a new kind of stakeholder, which is different from a fashion brand and thus follows different guidelines and pursues different objectives; a converter needs innovation and experimentation on products which are far from the strong identity that a brand has to give to its collection. On the other side, if this is a new challenge for students, such a company can find at Politecnico di Milano, with its product-oriented methodology, an inclination to the kind of creativity above-mentioned by Marta Santambrogio, which is often missing inside other creativity-oriented fashion schools (confront Chapter 2, Section 3.2).
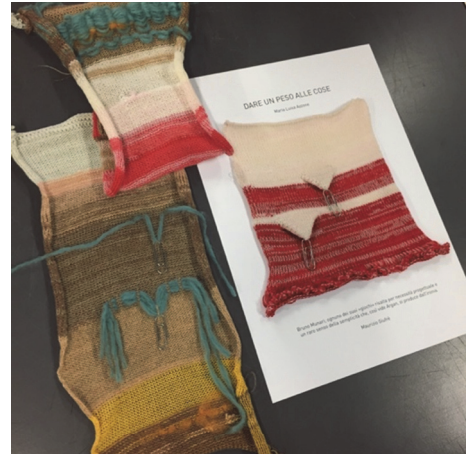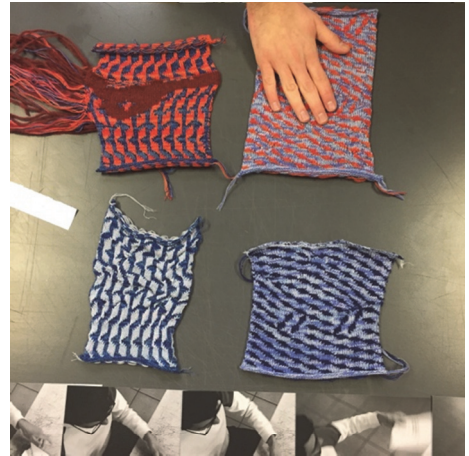
Figg. 1, 2, 3, 4 - Some pictures of the delivered concepts.

2.2. Workshop with Filoscozia

Curricular workshop at Politecnico di Milano, School of Design, Fashion Design Study Course, 3rd year.

Data

Time	Launch of the brief in mid-February Periodic reviews every two weeks until the final presentation in May 2018
Number of participants	40
Participants' background	Two years of Fashion Design, and one semester of Knitwear Design at Politecnico di Milano, School of Design.
Team / individual working	Teamworking 9 teams, 4 or 5 students each
Facilities	- **Knit Lab** workshop with 24 manual domestic machines (Brother), gauge 5; 6 manual industrial machines (Coppo), gauge 1; - **Knit 2** workshop with 16 manual domestic machines (Silver Reed) gauge 5, 8 manual industrial machines (Coppo), gauge 7.
Teachers	- Prof. Giovanni Maria Conti, fashion design professor - Martina Motta, Ph.D. researcher, specialised in knitwear design, teaching assistant.
Involved companies	**Filoscozia** Team: - Michelle Marzoli, Marketing Manager at Filmar Network (Filmar, Filati Color, Filodiscozia) - Pierfrancesca Solinas, CSR Manager at Filmar - Federico Badini Confalonieri, Cool Hunter at Filmar - Bruno Del Pozzo, Filmar agent

Project brief given by the company

"Filoscozia was born from a consortium of 25 companies which produced high quality mercerized cotton recognized worldwide for its characteristic of shine, resistance, absorption and non-shrinking qualities and

traditionally used for men's hosiery and underwear. Today Filmar and Co-tonificio Olcese are the only two companies accredited for the sale of the brand and which can guarantee through the brand and the labels that a product is made with the original Filoscozia. In the early 2010 Filmar took charge of the logo restyling is now looking for ideas to relaunch Filoscozia as a brand.

The aim of the project is to promote and enhance the use of Filoscozia through the creation of original and youth collections that go beyond the established image of the brand normally linked to underwear and classic hosiery, by exploiting its characteristic of being comfortable on the skin, long-lasting, silky, low pilling and with vivid and shiny tones. Each group will have to propose a concept to relaunch the brand among young people, where it is almost unknown, by developing products as well as marketing and communication ideas. The best projects will be exposed at Pitti Filati in January 2019."

Description of the activities

The workshop was organized as an extra-curricular activity to answer a need which Filmar presented to the Knitwear Design research team at Politecnico di Milano.

Michelle Marzoli and Bruno Del Pozzo came in February at Politecnico di Milano to launch the brief and to give all the information about the features of Filoscozia yarns. They also showed the yarn cardboards with all the different titles and colours which the company had in stock service, so that once designed the concept each group of students could ask for the needed quantity of yarn to realize the prototypes.

The students started with the project guided by teachers with weekly reviews, while Michelle Marzoli came back to the university every two weeks, to check the progresses and to give directions.

With the real intention to present the best results to clients at Pitti Filati to show new potential exploitations of Filoscozia, Michelle Marzoli led the students to deliver the best products in terms of communication and of realized objects, and made herself available to make contacts with her clients to help the students in prototyping when they did not have the right facilities or technical expertise to do it on their own.

The project ended with the final delivery in April 2018, but some of the students went on collaborating with the company to furtherly develop the ideas or to finish the prototypes.

Results

The most innovative feature of the workshop was the network that Michelle Marzoli has been able to build between Filoscozia, students and her clients: depending on the project and the category of products to be produced, Michelle used the contacts of Filmar, which as a spinning mill has relations with the most diverse manufacturing companies that buy its yarns, to identify a company to support the students in the realization of their prototypes. This allowed the students to relate with a real context and to verify the feasibility of their ideas, being in the position of the designers that work for a brand and dialogue with suppliers and manufacturers in search for the balance between product identity, innovation, feasibility, sustainability and quality.

In the following pages is reported an example of one of the outcomes designed by Francesca Marchi, Teresa Paterlini, Margherita Roncaia, Caterina Santullo, Laura Scarpellini, Giulia Tangari.
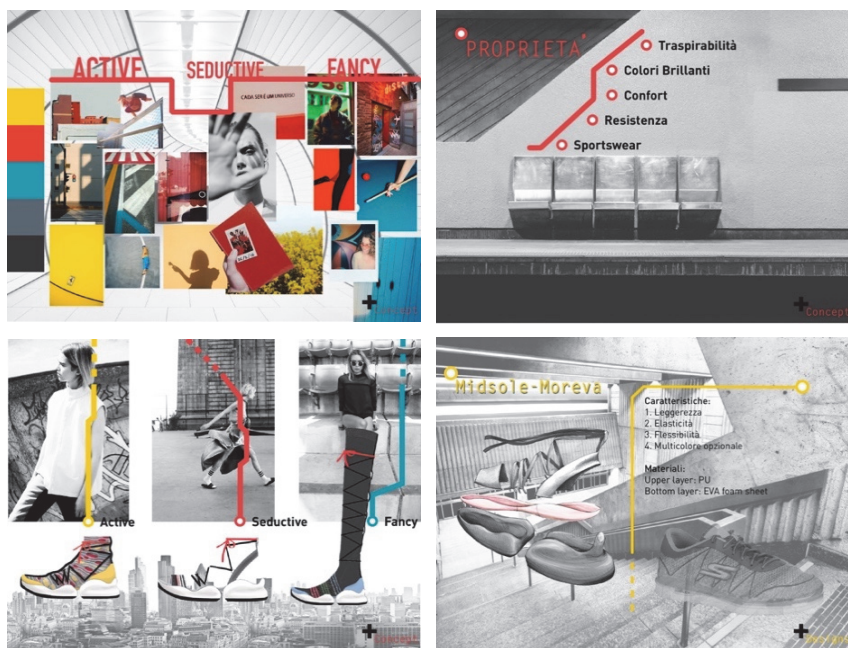
Figg. 5, 6, 7 - Filoshoes*, Moodboard and concept, properties of the product.*

Figg. 8, 9, 10 - Filoshoes*, sole, midsole and upper design.*
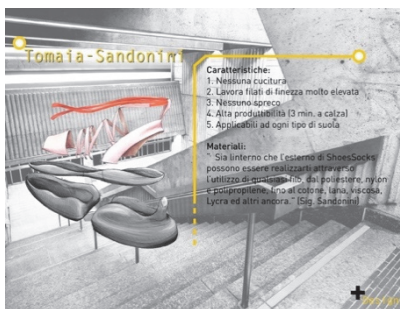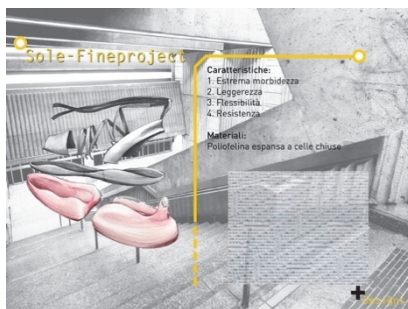

Fig. 11 - Filoshoes*, branding and distribution strategy.*

As can be seen from the reported presentation of the project, Filoshoes intended to use the properties of Filoscozia (breathability, shiny colours, comfort and resistance) to explore the field of sportswear and to propose an innovative evolution of Filoscozia socks into three different shoes. They

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imagined a sporty look, active and good for everyday-life in a contemporary city; they studied colours and did research on materials to be matched with Filoscozia for the upper part and on technology to realize the sole; they produced swatches and found the right knit stitches to model the shape of the three proposed shoes both aesthetically and functionally. Once they collected all the technical information, Michelle Marzoli send them to Sandonini, a small company which deals with seamless knitting machinery and also produces innovative products by altering and adapting common machinery to visionary ideas. Sandonini invited the students to visit the company and to discuss together about their shoes and finally helped them to realize the final prototype.

Here below are the words of Teresa Paterlini, Francesca Marchi and Giulia Tangari, three of the students, when asked for an opinion on the experience.

"The project consists of three models of shoes with the sole of the same shape but with a different upper part.

We went to Filmar, who told us that they gave a good amount of yarn to Sandonini in exchange for their willingness to work with us, and encouraged us to ask Sandonini as much help as possible. Filmar would like to be able to produce 20 prototypes of our shoes, to be able to leave a pair to each one of us, to be used for our graduation thesis, and to have enough to bring and present them to Pitti Filati. Michelle has even proposed to do the shooting together, but since the shoes will not be the center of our thesis but just an accessory for the knitwear collection and everyone will have its collection that will speak different languages, we preferred to remain autonomous.

We went to Sandonini, and it was very interesting: they have an area in the firm which is full of disused circular machines, disassembled and reassembled, which they take and modify to obtain products that with the normal machines at their disposal cannot be reached. We talked all day with this exceptional sixty-year-old gentleman, who spends all day on the machines and knows which yarns to use, and which not: even if he is not, officially, we would call him a true designer, a problem-solver.

We showed him our swatches, he asked us how we made them, and he smiled at our answer "with the home knitting machines", telling us that there is an abyss between those machines we used and their circular ones, and that not everything that is done with one can then be translated with the other. He explained to us that they modify circular machines but that to date these machines are used only on an experimental level, to carry out tests and research within the company, not for production. He showed us what can be done with those machines, jacquard stitches and tucks, and he asked us to

elaborate something with those stitches, even though he advised us to go a bit further to try to compare the limits of the company with our new ideas.

In the company they use a plastic yarn, the Grilon, which when ironed melts and takes and maintains the desired shape. We were told that their will is to ask a spinner to produce a yarn that has Grilon in the centre, wrapped inside other fibres. From here Federico, from Filmar, who was with us at Sandonini, told us that it would be very nice to think of developing together a yarn to be presented at Pitti Filati."

As can be read above, the dialogue with Sandonini and Filmar promoted innovation and gave new, effective and reality-based knowledge to students concerning materials, machinery, feasibility, and also marketing and communication of products.

As for the workshop with Ghioldi, the added value of the experience has been recognized by students, by teachers and by the company as well, and once again presents the desired key features:

- a longer and articulated workshop which included different kind of activities, from an autonomous research to the guided development of the concept, from the focus on the side of marketing and communication to the one of production and research for innovation within manufacturing;
- a reality-based brief which had to address a real need of the company, where students acted as professional ideas suppliers;
- in Filmar, as well as in Ghioldi, we found people, (Michelle, Federico and Piera) who believe in the potential of such a collaboration to give real benefits and in the power of the ideas of students to be afterwards communicated to the public. In this case, as it happened for Ghioldi, the project has been communicated on Filmar and Filoscozia social networks in search for a return in terms of image. In this perspective, they had real interest and dedicate time and energy to the activities, being present and acting as professional guides for the students, in continuous dialogue with teachers inside the university to help their presence to be effective also on the educational side;
- as said before, Filmar, as the owner of the label Filoscozia and as a spinning mill, has been able to create a network involving teachers, students, the brand, the spinner itself and manufacturers, in the interest to reach a high quality and presentable result as well as to give students the opportunity to deal with all the stakeholders normally involved in the development of a project. Students were moreover immersed in the industrial environment and got direct confront with technical experts inside participating companies.

A clear view on the reciprocal benefits of such an experience can be found in the words by Piera Solinas, CSR Manager at Filmar, presenting Filoscozia project at UNIDO offices in Egypt, in July 2018:

"In a company, you never have time to train young minds and, in the meantime, you cannot innovate if you do not have fresh minds. That's why it is so important for the industry to understand what they can take from education, that is not a waste of time. With Filoscozia researchers and professors have been able to detect the practical needs and to translate these needs into teaching experience. This is the right way to serve the industry by training the students."

2.3. DDM with MF1

Post-graduate course DDM – Design della Maglieria at POLI.design

Data

Time	Launch of the brief in mid-February Periodic reviews every two weeks until the final presentation in May 2018
Number of participants	8
Participants' background	Varied: 3 fashion designers, 1 beachwear brand owner, 4 participants with technical background in machine/hand-knitting.
Team / individual working	Individual
Facilities	- **Knit Lab** workshop with 24 manual domestic machines (Brother), gauge 5; 6 manual industrial machines (Coppo), gauge 1 - **Knit 2** workshop with 16 manual domestic machines (Silver Reed) gauge 5, 8 manual industrial machines (Coppo), gauge 7 **Inside MF1**: - Physical archive with more than 7000 garments catalogued; - Digital archive to be consulted;

	- All the machinery inside a knitwear factory: manual machines, Shima Seiki machines, Apex3 computers, linkers, linear sewing machines, ironing, washing.
Teachers	- Prof. Giovanni Maria Conti, Fashion Design researcher - Prof. Manuela Rubertelli, product consultant for knitwear - Prof. Giuliano Marelli, knit designer, owner of Studio Marelli - Prof. Silvana Musella Guida, Fashion Designer and Professor - Prof. Francesca Fontana, product manager consultant - Prof. Rossana Gaddi, Graphic Designer - Lucia Tarantino, knitwear technician - Laura Vicelli, knitwear technician - Martina Motta, Ph.D. researcher, specialised in knitwear design - Laura Affinito, freelance product and knitwear designer - Giulia Ardenghi, freelance designer, archive expert
Involved companies	**MF1** Team: - Mario Foroni, owner - Paola Foroni, owner - Elisa Moro, project manager - Designers working in the product development unit of MF1 - Machine Technicians - Programmer Technicians - Modellers, pattern-makers, and other technical figures working on the making of garments.

Aim of the course and project brief given by the company

DDM – Design della Maglieria is a post-graduate course offered by consortium POLI.design at Politecnico di Milano which aims to form knitwear designers ready for a specialised job in the sector.

Some shortcomings of the previous editions of the course emerged during the participative observation in one of the design modules of DDM 2016, when the entire course was ground of experimentation for the first experimental phase of the present research. The previous editions, indeed, due to the focus on the importance of a technical background, concentrated a lot on manual activities (hand and domestic machine-knitting) and therefore had the need to reduce and simplify the design part. Although the teaching

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activities were mainly oriented to the industrial product, the final results were very basic and marked a detachment from the industrial reality aspects.

When designing the fourth edition, the findings of the ongoing research suggested opportunities for improvement on the training offer. If it is true that DDM suffered a lack of contact with the industrial reality, one of the main obstacles in this sense was the concentrated schedule of the course, which also forced the concentration of content in a field where, as seen, time is a determining factor for complete learning.

POLI.design authorized the addition of a package of hours, allowing to extend the duration of the course from 6 to 8 weeks: it was a good opportunity to rethink the design module inside DDM in light of the recent conclusion of the first experimental phase, which had revealed how the contact with the industrial environment accelerates learning times by immersing the students in a reality-based context where they can learn focused, detailed and industry-oriented knowledge. This was the opportunity to include DDM 2018 in the second phase of experimentation of this research, not only by involving the company in a process of collaborative teaching, but immersing the participants physically inside a company, MF1 knitwear factory, with which the research team had just concluded another project.

MF1 is one of the most important knitwear factories in Italy and produces for high-end national and international fashion brands as Gucci, Alexander McQueen, Victoria Beckham, March Jacobs, Calvin Klein and many others. In over 40 years of activity, its owners, Mario and Paola Foroni, collected a copy of more than 7000 of the samples they had produced and built an archive which is today a physical resource for designers and many other professional figures in the knitwear sector, as it illustrates customs and styles of the last forty years.

With MF1, the research team that works on knit design at the Design Department of Politecnico di Milano pursued the digitisation of the archive with the research project *Digiknit. Digitisation of the most important historical collection of Made in Italy knitted garments, for the development of innovative digital services able to encourage the creative process and breathe new life into manufacturing within the knitwear sector*[2], that created a digital catalogue where each item has been photographed and can be found together with its technical specifications. The aim was, for the company, to simplify the process of consultancy and of developing new products, and for the entire

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[2] Further information available in Conti G.M. (ed.), *Maglia, punto. Forty years of hidden treasures from MF1 archive*, Silvana Editoriale, Cinisello Balsamo, 2018.

sector to make a resource that is rarely available accessible to designers, professionals, and R&D operators with the help of new technologies.

«However, the digital archive is not just a tool for knitwear design professionals. It also aims to become an innovative tool for training future professionals. This is made possible thanks to the participation of the research group on knit design at the Design Department of Politecnico di Milano; what is strategic and at the basis of the project is the idea of a web-based platform, not just a digital cataloguing of knitwear items, but also a digital tool that implements and enriches the stylistic and creative process for new generations of knitwear designers» (Conti, 2018, pp. 32-33).

It was exactly this last aspect that MF1 asked to test as the final objective of its involvement in the teaching activity inside DDM 2018. The request made to the team of professors and researchers previously involved in Digiknit was to organize a knitwear design activity where students should have drawn inspiration from the archive, consulting it both digitally and physically.

From a didactic point of view, this had the aim to reproduce what usually happens with knitwear designer consulting archives and taking inspiration or direct technical references from past collections, keeping in mind that, for novices in the field, it assumes also the traits of a reality-based learning experience. Since it was included as a pilot activity for this study, the author stressed on the opportunity to take students inside the company and to make them work not just with the archive, but alongside technicians and creative figures in the development of their own capsule collection.

In light of the company's requests and of the new planning made for the course, DDM 2018 followed a similar structure to the ones of the previous editions for the first 3 weeks, to leave the university and be transferred inside the company for the following 3 weeks, and to conclude the path back again at Politecnico di Milano:

- Week 1: technical hand-knitting module + theoretical lessons on knitwear in contemporary fashion and on materials and yarns + focus on linen fibre made by Ornella Bignami, external lecturer from CELC + focus on wool made by Birgit Gahlen, external lecturer from the Woolmark Company
- Week 2: design with hand-knitting
- Week 3: technical machine-knitting module
- Week 4: archive research and concept development at MF1
- Week 5, 6: design and prototyping of a knitwear collection at MF1
- Week 7: product management module
- Week 6: portfolio making and presentation

The author took, as for the previous year, the two roles of researcher and teacher: as a researcher, she created the opportunity for students to be

immersed for three weeks in the working environment to verify the benefits and the shortcomings for the purpose of this study; as a teacher-researcher during the module delivered in MF1, she acted as a mediator between the students and the workers, always applying the tools and the methods elaborated in the prior phases of this research. The project brief, here reported as it was presented to the students, was set together with MF1.

"Through the research and the observation of the garments inside the archive of MF1, detect the most significant garments from the point of view of materials, structures and colour interactions. From here, select the dominant colour of the collection and start to widen the research with images and materials, to identify which secondary colours can be used to complete and enhance the colour palette. The selection must take place with the awareness of working on colour contrast, saturation or desaturation, tone on tone, etc.

With the selected tones, search for materials and start to develop stitches and swatches. On the basis of the elaborated swatches, design a capsule collection of 3/4 outfits in a collection logic, with simple modelling study and development of the technical sheet. Realize, with the support of the MF1 technicians, a simple cloth or garment, representative of the entire collection, with the use of industrial machines."

Description of the activities

Due to the focus of this chapter, the description of the activities concentrates on the 3 weeks module held in MF1, which is the main innovation compared to the previous editions.

Week 1: After a visit around MF1 with Mario and Paola Foroni, the students were given a space in the upper floor of the factory, equipped with big tables and some manual machines Coppo, where Laura Affinito presented the brief together with Elisa Moro from MF1. The first days were dedicated to the exploration of the archive, where students recorded everything they found interesting through photos, sketches and notes and identified the main colours and stitches they want to reproduce or to intervene on in their collection.

On Thursday Giulia Ardenghi gave a lecture on the importance of the archives and of the research inside them for a fashion brand as well as for manufacturing companies as MF1, marking the difference between the two typologies through her experience at Bottega Veneta, where the archive has a function, a use and a value that are strongly linked to heritage of the brand

identity. An archive like the one of MF1 becomes a repository of another kind of knowledge, related to a database of design cues that in addition to being memory is also a trigger for future innovation.

Students were then guided through the selection of yarns among the many available in MF1 warehouses and started, with the help of a technician, to make the first samples of colour and material combination on the Coppo machines. Coppo were completely new to the majority of the mas the technical module delivered at Politecnico di Milano did not address that kind of machines, but with the induction made by the technician and the help of the teacher they managed to quickly move the first steps.

Week 2: The design work concentrated on surfaces, textures and knit structures. With the first swatches made on the Coppo machines, some of the students were already able to ask to programmers downstairs to translate that sample into a computer program and to try it on the Shima Seiki machine.

With the first samples they were guided by the author, as the teacher, towards the final definition of their concept and the development of the collection. While they were working, we were able to discuss about the fundamentals of the structure of a collection, with a focus of seasonality, balance of the thicknesses, use of materials, stitches, filling of technical sheets.

At the end of Week 3 all the garments were designed and the main one was defined in detail, waiting to go through the programming and sampling phase at the beginning of week 3.

Although a significant part of this work has been guided by an academic teacher –represented by the author–, the fact of being inside the knitwear factory allowed students to search for constant feedback and advices from the girls of the product development and often from MF1 owner and director, Paola Foroni. Mrs Foroni, with her life-time experience, has been a very strong reference for them and give a decisive contribution to the design of feasible and industrially reproducible products.

Week 3: From the whole capsule collection, following the advice of Paola Foroni combined with the teacher's one, each student chose the garment to realize and worked together with a programmer-technician and a machine-technician to realize it on the Shima Seiki machines. The making of the prototype involved not just technicians but all the professional figures inside MF1, from the modellers to the linkers and the sewers.

*Fig. 12 - Stitch sample made by hand and refined with hand-embroidery. Author: Maria Cristina Bertesago*
Fig. 13 - The hand-knitted stitch translated to a electronically-programmed sample by the technician, first trial. Author: Maria Cristina Bertesago

Figg. 14, 15 - The hand-knitted stitch translated to an electronically-programmed sample by the technician, second and third trial. Author: Maria Cristina Bertesago
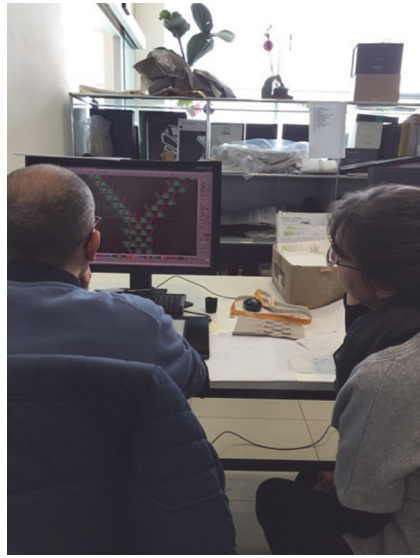
Figg. 16, 17 - Students working together with Mario Foroni, owner of MF1, and with the programmer-technician to reach the desired result.

Figg. 18, 19 - Moodboard and swatches. Authors: Giorgia Colleoni, Lorenza Piasso

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Results

Here is reported the brief interview made to three of the eight students right after the final presentation of their work, in MF1, which highlights the benefits they recognised in the experience and give some suggestions for further improvement.

What is the added value of the experience in a knitwear factory? What did you have the opportunity to learn that you could not understand in a classroom or in a university lab?

F.C.: "*We faced the difficulty and complexity of industrial knitwear: hand-knitting is simple, but when we had to deal with the technicians the process was much longer, complicated and often it is not easy to translate what one has in mind or what has been created manually in something that can be done by the machine. This was useful to really understand how the creation of a stich and then of a garment works, of how much longer and less immediate is the process: we have the idea that technology can do everything, but we have learned that it is not so simple.*"

G.C.: "*I really appreciated to sit next to the programmer to study the stitch together and understand how the industrial machine programming works.*"

L.T.: "*We also learned the technical jargon, while we talked with the programmers, the modelers, the embroiderers.*"

G.C.: "*Even just talking to Mrs. Paola, who may have just put down the phone talking to the designer of Calvin Klein, and soon after she turned to me and asked me what I was doing and what I wanted to achieve with my project: it taught me to talk about my project quickly and effectively, to convince others about the validity of my idea in an immediate way. This is an asset that we could find only here, being in the company and not in the workshop inside university.*

To Interface with the people who do this every day, wether they are workers on the machines or on the linkers, or those who speak directly with the client, with the designer, and must satisfy him or her. From these figures comes that extra advice, the right one on our garments: it takes too much time to knit it and it goes over cost, the sleeve drawn in that way will stretch, and much more. There are qualified technicians and teachers inside the university, but the experience of those who have been working for twenty years on the product, collection after collection, can only be found in a company."

F.C.: "*We do not underestimate the yarns and materials that we had available, it was just a particular yarn that I found here to give me the starting point to develop my collection.*"

What would you change? Would you spend the entire time of the course in MF1?

G.C.: "*No, I needed the first 'preparatory' weeks. For example, I had no idea what a manual machine was and how it worked, and with the week in the workshop at Politecnico a world opened up for me. Indeed, it would take more time, an intensive week does not leave time to experiment and prove yourself.*"

F.C.: "*To extend the period at Politecnico would be useful to get more prepared for the work in the knitwear factory. We needed a bit more practice to come here and be ready for the fast rythms of work life.*"

Would you spend more time in MF1?

F.C.: "*I would come with an already defined idea of the collection, to start immediately to work side by side with professionals and take advantage of the time available to us.*"

L.T.: "*It helped me a lot in MF1 to have the samples available, because it made me understand which techniques I could use to make the effects I had in mind with my moodboard. To arrive with a defined moodboard, some drawings and some tests would have earned us a few days of work in the knitwear factory. A first idea at the university, and then its transformation and translation in stitches and structures here.*"

G.C.: "*There is another thing: you imagine a result that comes from your initial inspiration, but what you get working on the industrial machine is still different and pushes you to develop your idea in other directions, it brings you other ideas.*"

Although the students' words give a good overview on the added values and knowledge gathered when directly immersed in an industry while still being in the role of students, where mistakes and experiments are allowed, here are outlined the key features which made this possible:

- The restricted number of students. The same activities would have been very difficult to accomplish with a larger number of people, that may also interfere with the normal workflow of the factory.
- The brief was reality-based on the expressed need of a company that asked for the help of an HEI, and even if the exploitation of the archive could seem a less business-focused objective than the ones set in the other

pilots, with a less concrete outcome, the archive is for the company a mean for competitive differentiation and students have been used to experiment new ways of fruition of that precious content. As in the other pilots, students acted as professionals explaining their ideas to creative experts and technicians and moving, together with them, towards design-driven solutions.

- Fundamental was the openness of the people working in MF1, ready to share their knowledge and to listen to the students in search for the best technical and aesthetic solutions.
- The opportunity for students to be designers inside a manufacturing company. This meant that, being directly connected with the ones who make knitwear, they quickly learnt how to communicate with words, drawings and technical sheets as they could listen to people and observe the real working material, to transfer everything on their projects.
- Students were immersed in the industrial environment, they worked side-by-side with creative figures and with technicians and they were directly hands-on, in all the phases of the realization of their prototypes; they experienced what can be done and what is unfeasible, what is too expensive and what could be disruptive, going far beyond a sketch on a piece of paper.

To conclude, the words written by Giovanni Maria Conti about the experience resume its main mission:

it is clear that the strengthened collaboration between the two organisations, one entrepreneurial and the other academic, increases the opportunities for the specific training of students interested in specialising in this sector, by assisting their integration into the world of work, thanks to the added value and skills acquired during their hands-on experience. (Conti, 2018b, p. 33)

2.4. BA Thesis development with Ghioldi

Politecnico di Milano, School of Design, Fashion Design Study Course

Data

Time	Launch of the brief in mid-April Graduation in July 2018
Number of participants	8
Participants' background	Two years of Fashion Design, and one semester of Knitwear Design at Politecnico di Milano, School of Design.
Team / individual working	Individual
Facilities	- **Knit Lab** workshop with 24 manual domestic machines (Brother), gauge 5; 6 manual industrial machines (Coppo), gauge 1 - **Knit 2** workshop with 16 manual domestic machines (Silver Reed) gauge 5, 8 manual industrial machines (Coppo), gauge 7 - Ink-jet and screen-printing industrial machines inside Ghioldi
Teachers	- Prof. Giovanni Maria Conti, Fashion Design researcher - Martina Motta, Ph.D. researcher, specialised in knitwear design, as a teaching assistant
Involved companies	**Ghioldi** Team: - Teresa Cairoli, owner - Marco Ghioldi, owner - Marta Santambrogio, R&D area manager - Francesco Lana, R&D and archive

Project brief given by the company

Born as a printing works in Appiano Gentile, in the district of Como, for ten years now Ghioldi has transformed part of the company in a converter which deals with knitwear, acting as a link between high-end national and international fashion brands and the knitting manufacturers on the Italian territory and

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delivering this service with the role of consultant which can take charge of pro-gramming and controlling all the phases of product development.[3]

Despite being rarely the one who gives the first creative input, Ghioldi's team is always searching for innovation on processes and techniques to place the company as a leader on the market and to present valuable things to their clients. This is why Ghioldi was asked if interested to follow some of the Knitwear Design students at Politecnico di Milano during their final Thesis project and why they gave a positive answer.

The intention of Ghioldi was to combine the strong printing side of the company with the youngest knitwear unit, to find new solutions to apply printing techniques on knitted backgrounds. The brief, transcribed here, thus moved from the classic themes of traditional printed silks, one given to each student to be reinterpreted with a young and contemporary sensitivity through the technical knowledge on knitwear they had acquired during their study path.

"With the assigned theme, one for each student, everyone will design a capsule collection and realize one or two prototypes in the contemporary perspectives of hybridization between apparel and sportswear, of everyday technology, on folk globalization. The identified themes, listed below, are recurrent in every textile/manufacturing archive and are part of the common jargon of this sector. Ghioldi selected the classic themes of the winter season with the intention to present the works at Première Vision in Paris, in September 2018.

1) Tartan
2) Animalier
3) Heraldic-riding-hermes
4) Carpets
5) Paisley
6) Male textile world (Pied-de-poule, Chevron, Prince of Wales etc.)
7) Winter flowers
8) Graphic/Optical

It is important that the students visually understand the themes, and then revisit them. These themes cyclically return every season, they reassure and are familiar to consumers, but at the same time difficult because they must be continually reinvented without being distorted. Every project should

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[3] For a more complete overview on Ghioldi see the extracts of the interview collected for this research and reported in Chapter 4.3, the full transcript of the interview in original lan-guage reported in Appendix B, the company's description in Appendix A.

begin with an iconographic research on the fashion shows of the last few years, to see how each theme is interpreted, creating a sort of editorial about each theme, like the magazines do. Some of the assigned themes are more likely to be developed in a graphic way, some others with a work about textures, some others with a re-interpretation of colours and materials."

Description of the activities

The company wanted to be present during the whole process and to follow the students properly; for this reason, they used the workshop in which they participated in March to observe the students' inclinations and to select, together with professors and researchers, eight of them, since it would have been impossible to take all the 46 students and to have them in presence inside the company to realize the prototypes.

The eight students developed their own project with periodic reviews with teachers and with a constant confrontation with Marta Santambrogio and Francesco Lana, from Ghioldi, on the design part, and with Marco Ghioldi for the work on technical solutions and for the collection of the needed information about the printing techniques they aimed to use.

During the three months they received from Ghioldi some feedbacks and observations, but, most important, the opportunity to observe the manufacturing processes inside the headquarter to understand which one would have fitted better to their own project, and the chance to get a concrete help towards the experiential learning of new knowledge about printing.

They developed the swatches with knit stitches and structures, they selected the final yarns and did some trials –with graphic software first, with home-made stencils right after– of printing to define in detail the aspect and the colours. They mainly worked on the knit part at the university, under the supervision of teachers and of machine technicians, while they did the majority of the trials with printing at Ghioldi, where they were made able to understand whether they need digital printing or screen printing, depending on the yarns they used, the coverage they wanted to reach with colour, the thickness of the underlying fabric. This process required several swatches of the chosen stitches/structures, to try the different effects of printing and to avoid mistakes on the final prototype. In some cases, structures had to be modified to privilege printing or even to make it feasible, in some others printing solutions have been adapted to the knits.

Once the sampling phase was complete, the students realised all the parts of the final garments in the workshop at Politecnico di Milano, and, before

sewing them, went to Ghioldi to print. The company always welcomed the students in two groups, scheduling appointments from time to time to avoid congested days of work for big clients, to ensure to have some machinery free to be used and to dedicate to students the right amount of time and energy. Marta Santambrogio attended the final presentations during graduation day, July 24th, 2018, and all the projects will be presented at the corner of Ghioldi at Première Vision, in September 2018.

Results

A wide extract of the Thesis booklet gives here an overview on "Breaking the Grid" by Margherita Baggio, one of the eight projects made in collaboration with Ghioldi.

After the preliminary research on the classic theme of Scottish check Tartan, with highlights on its history and symbolic meanings, the project gives a translation of the traditional check motifs in the contemporary society, using distortion to intervene on its rigorous lines. The design process went on with the definition stitches, which were studied to be in line with the concept and with the match of stitches to the six outfits of a complete capsule collection. Here below, after the moodboard, the main stitches and the outline of the collection, there is the technical sheet of the trousers, which were the printed piece of the realised outfit[4]. Once defined all the knitting features, the student explains how she proceeded with the printing process, motivating choices and illustrating the undertaken technical solutions. In the end, the outfit is presented with the shooting.

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[4] The complete version of the booklet contains also the analysis on the cultural features of tartan, textual introduction to the project, all the technical drawings of the capsule and the three technical sheets of each one of the realised pieces, which together compose outfit 1.
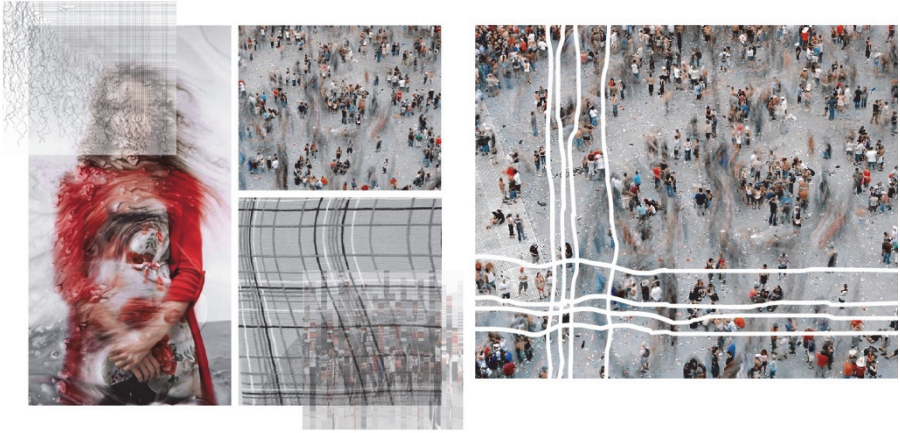
Figg. 20, 21 - Breaking the Grid, Moodboard and Concept

Figg. 22, 23 - Breaking the Grid, study on stitches

	TITOLO	COMPOSIZIONE	COLORE	QUANTITÀ	AZIENDA
Art. 1	2/48	43% VI, 35% Nylon microfibra , 22% Nylon confort	803	1200 gr	Pecci
Art. 2	2/48	43% VI, 35% Nylon microfibra , 22% Nylon confort	802	600 gr	Pecci
Art. 3	2/48	43% VI, 35% Nylon microfibra , 22% Nylon confort	25311	400 gr	Pecci
Art. 4	2/30	80% WV, 20% PA	630018	300 gr	Zegna Baruffa
Art. 5	2/60	55%WS, 45% SE	15-145347	200 gr	Botto Giuseppe
Art. 6	2/30	100% WV	027738	10 gr	Zegna Baruffa

Fig. 24 - Breaking the Grid, Selection and features of yarns

COLLEZIONE

Fig. 25 - Breaking the Grid, collection overview

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STAMPA PIGMENTO

Fig. 26 - Breaking the Grid, print, printing process and photos of the printing on samples at Ghioldi

SCHEDA TECNICA

Fig. 27 - Breaking the Grid, technical sheet of the trousers

Figg. 28, 29 - Breaking the Grid, Shooting

The analysis on the reached outcomes shows satisfying results and can be declared as successful in terms of final product and presentation. The interest of this study is, therefore, to enhance the quality and the areas of knowledge learned by students, to accelerate their integration with the working reality as well as to answer the specific needs of the company we are working with. The observation of students' work and the role of link between them and Ghioldi that the author undertook allowed her to evaluate the pilot activity in this perspective, with its strengths and shortcomings.

The thing I liked the most has been to enter in the world of printing while maintaining my inclination towards knit design. In Ghioldi I have been able to dialogue with experts and to put my knit abilities –even if I know they still have to improve– together with their expertise on printing to reach something unexpected.

These words, collected from one of the students, highlight the main benefit detected for this pilot: working with two fields and two techniques at the same time, knitwear and printing, while opening their eyes on the new world of printing, widened their perspective on what they already knew about knitwear, sometimes even jeopardising it.

They learnt, by doing, that a lot of the properties they used to consider as positive in knitwear, when dealing with printing on a knitted fabric become problems to be solved, or, in other words, criticalities to be addressed with design-thinking. They learnt, for example, that some processing operations and some washes, which are good to fix colours, could be dangerous for knitted yarns like wool, as they can felt or corrode it; that some colours do not give the desired effect on hairy yarns; that printing on a common piece

of knitwear, maybe a sleeve or a back, which they proudly shaped, is not so easy to be placed and should be done on a rectangular piece of fabric to be cut-and-sew only later.

Another beneficial result for students is that they were led to experiment in a quite autonomous way with knitted structures and to take the complete charge of what they were doing when they went to propose it to Ghioldi. Here they learned how to discuss about their choices in a professional way and to establish a constructive dialogue which was more similar to an exchange of knowledge than to a trainer/observer relationship. In this perspective, they mainly worked towards the development of innovative structures of the knitted fabric –they stressed the owned knowledge– to make them interact with the overlaid printing –and added new one–.

The continuous dialogue with the company experts was useful on two levels: first, it guided them towards a contemporary concept, in line with the purpose of the market and promising concerning the possible development of creative ideas; second, it led them towards an industrial way of thinking, firstly in terms of feasibility with the available technologies, and after in terms of costs and production times, to reach a reality-based, concrete result which would have been useful for the company not just as an inspiration but also as a product to be exposed and communicated.

The added value of this pilot activity is shown by all the involved participants: the students showed satisfaction while working and on the reached results; teachers gave their positive opinion on the learning experience as well as on the final outcomes; Ghioldi gave a good feedback and, at the end of the second experience of collaborative teaching of the company with Knitwear Design students at Politecnico di Milano, expressed the will to repeat it during the next Academic Year. To allow a comparison with the previously described pilots, here are the key features, listed as in the others, which led to the recognized success:

- A longer and articulated activity with a restricted number of students, which allowed a more intense deepening on each project.
- A reality-based brief which addressed a real need of the company, where students acted as professional ideas suppliers and as problem-solvers together with the experts in the company.
- The presence of diverse figures, with different competences, who believed in the benefits that students could take into the company and were thus interested in listening to the students, in searching for innovation among their proposals, in dedicating time and working –rather that economic– energy to them, always confronting with teachers to make the cooperation effective also on the educational side.

- These people recognise the value of students work and the potential that it brings with itself so much that they used it as a communication tool on social networks.
- The peculiar asset of a company as Ghioldi, which has a long history as a printing manufacture in one of the most traditional Italian districts and had the courage to innovate in the completely different field of knitwear.
- Students were moreover immersed in the industrial environment, they worked side-by-side with creative figures and with technicians and they were directly hands-on, in all the phases of the realization of their prototypes.
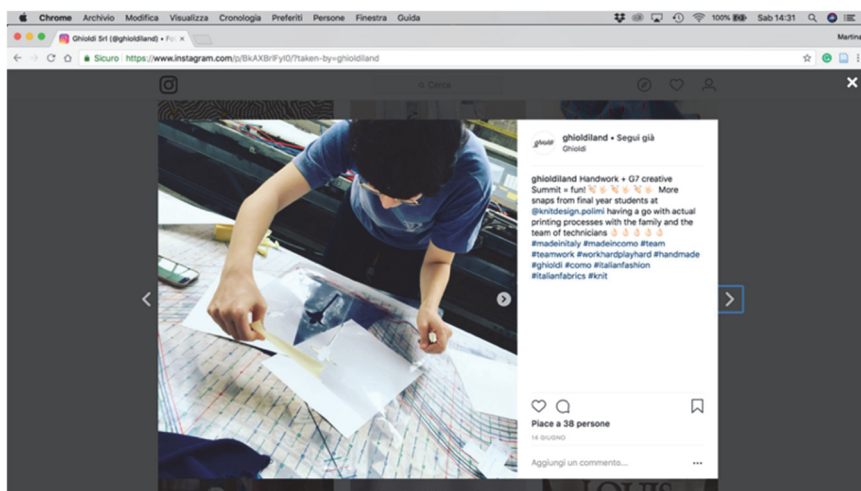
Fig. 30 - Screenshot from Ghioldi's Instagram feed @ghioldiland

3. Findings

Chart 3 resumes the actions undertaken in the four described pilot actions of the second experimental phase of this research. It outlines the completeness of each pilot in the application of the actions assumed as positive assets towards the creation of added value for all the participants involved in each experience. The crosses, that indicate the absence of an applied action, occur in two cases, both concerning the workshop delivered with Ghioldi. The possibility during that first pilot to immerse the students directly into the industrial environment unfortunately did not go beyond a simple –despite very interesting and eye-opening– visit to the company, with consequently no chance for

students to work hands-on with employers but just to watch them in action. This was due to the large number of students involved with a single company, which arises as the main limit to similar experimental actions.

Chart 3 - Comparison of the added values applied in every pilot action.

| EXPERIMENTAL ANSWERS	WORKSHOP Ghioldi	WORKSHOP Filoscozia	DDM 2018	BA THESIS with Ghioldi
Longer times	✔	✔	✔	✔
Reality-based brief addressing the real needs of the company	✔	✔	✔	✔
Students immersed in the industrial environment to develop part of their work	✘	✔	✔	✔
Constant feedbacks from companies on design and product development	✔	✔	✔	✔
Closeness to manufacture with the involvement of diverse stakeholders	✔	✔	✔	✔
Collaborative development of student's projects with expert technicians inside companies	✘	✔	✔	✔
Pursuing of concrete benefits for the companies as well as for students	✔	✔	✔	✔

The important contribution given by the people from Ghioldi in terms of reviews and guidance for the design process and for the technical development of their products made the pilot effective and successful despite the impossibility to make the students experience directly the steps of the manufacturing process. To evaluate the comprehensive effectiveness of this phase, the specific benefits of each pilot have been evaluated referring to the list of benefits emerged and reported in Chapter 4, articulated in multiple levels with the improvements for students, higher education institutions' staff, and companies. They are resumed in Chart 4, which highlights how every pilot activity gave the presence of five out of five benefits for each category of participants.

Chart 4 – Benefits of each pilot activity on the participants.
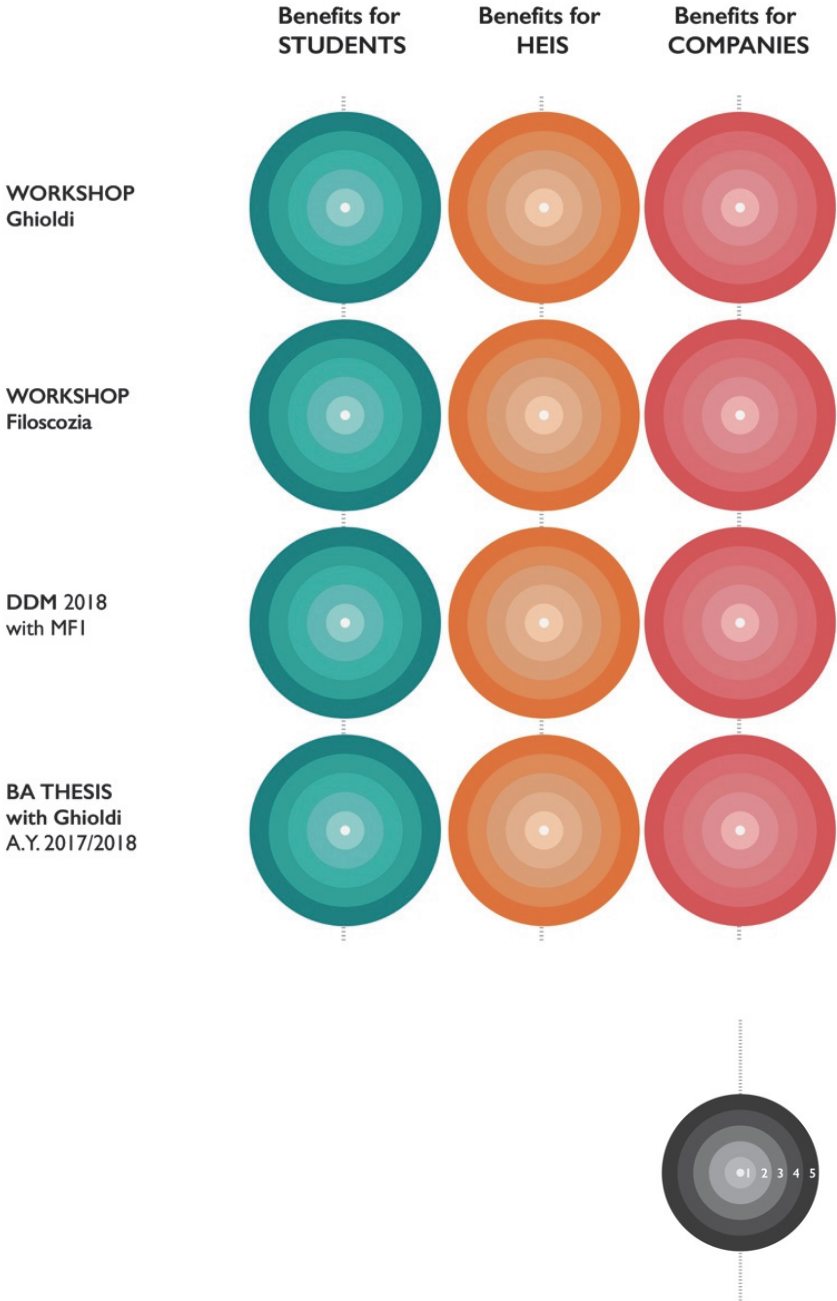
With the verified growth of the benefits, the pilots confirmed the strength of teaching and learning with the active participation of the industry and outlines the evidence of mutual advantages for everyone: the newly structured collaborative teaching represents, in knitwear design, a unique opportunity for researchers and professor to address state-of-the-art topics and to gather results on two sides: they serve the knitwear industry and its specific needs by training the students, while they use the industry to give students more effective learning experiences.

This second experimental phase was also useful to furtherly validate the framework designed and applied during the first experimental phase (see Chapter 4). In every pilot activity the modules contained in the framework have been delivered and modelled on the specific cases. This led to one more aspect to be underlined, namely the confirmation of the actual impact that the active involvement of companies had on the knowledge transferred through the framework. Whether students had background (as in the workshop with Ghioldi, with Filoscozia, and in the thesis with Ghioldi) or not (as in DDM 2018 with MF1) the knowledge gathered from the relationship with the people inside the companies added experience and expanded the prior knowledge delivered by teachers, bringing a direct and recognizable impact on the three knowledge tracks.

The improvement can be seen also in the diagrams below, that report the same visualization of the four pilots as for the experimental activities described in Chapter 4.

LEGEND

Track n°   5 4 3 2 1   5 4 3 2 1   5 4 3 2 1

Completeness of the knowledge trasferred by the

Level of impact and evidence of the

when the **involvement of companies** in the learning/teaching experience

Action / Subject / Tool

Action / Subject / Tool

through lectures one-to-one tutorials manuals and didactic material

on the final outcomes

improved the owned knowledge or gave new one on the specific
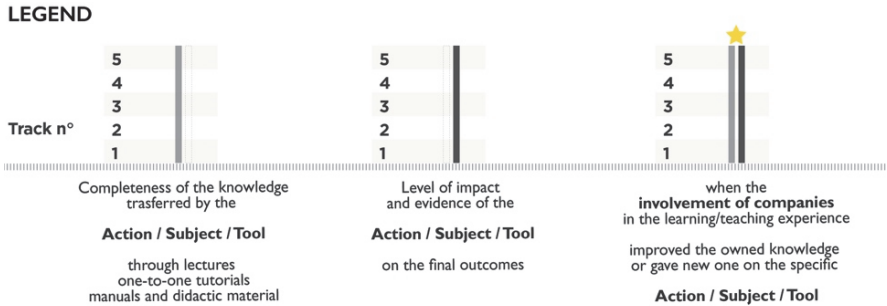
Action / Subject / Tool

Fig. 31, 32, 33, 34 – Visual models reporting the features of each pilot activity due to the legend here above.
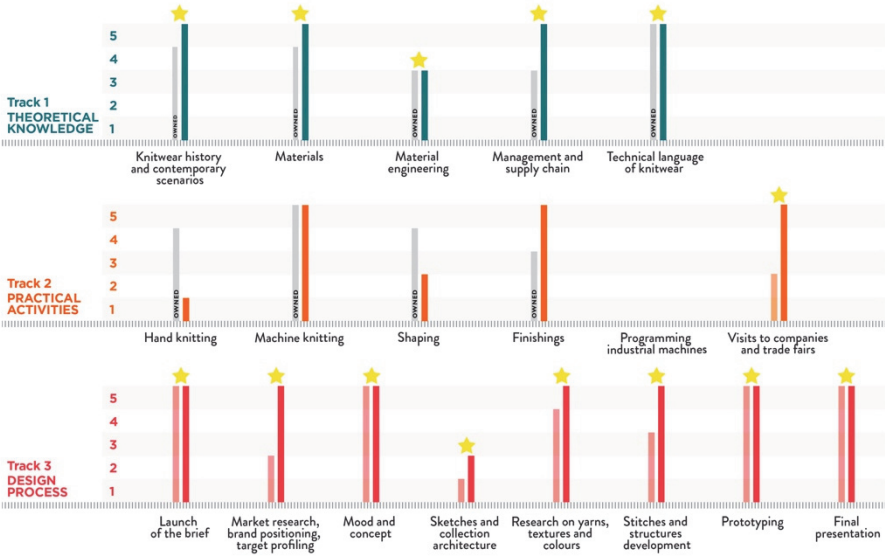
WORKSHOP with Ghioldi
A.Y. 2017/18

Fig. 31

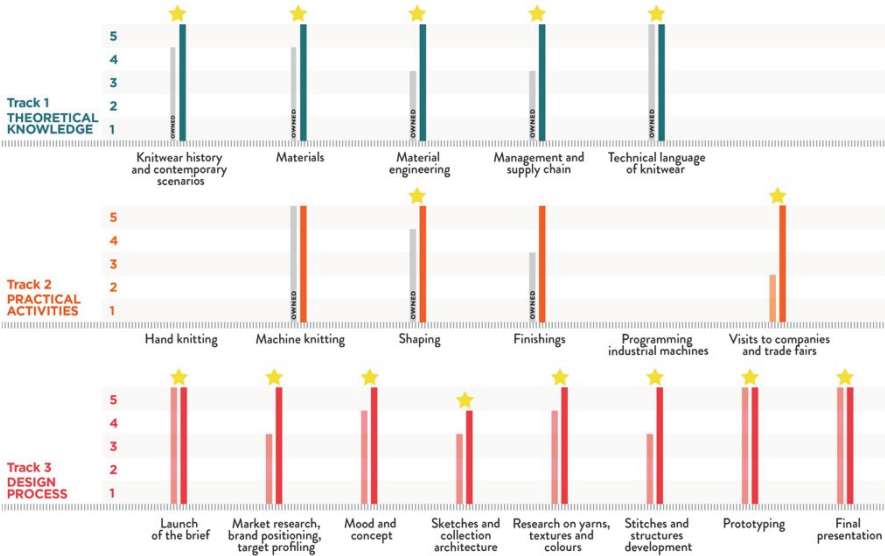**WORKSHOP with Filoscozia**
A.Y. 2017/18

Fig. 32

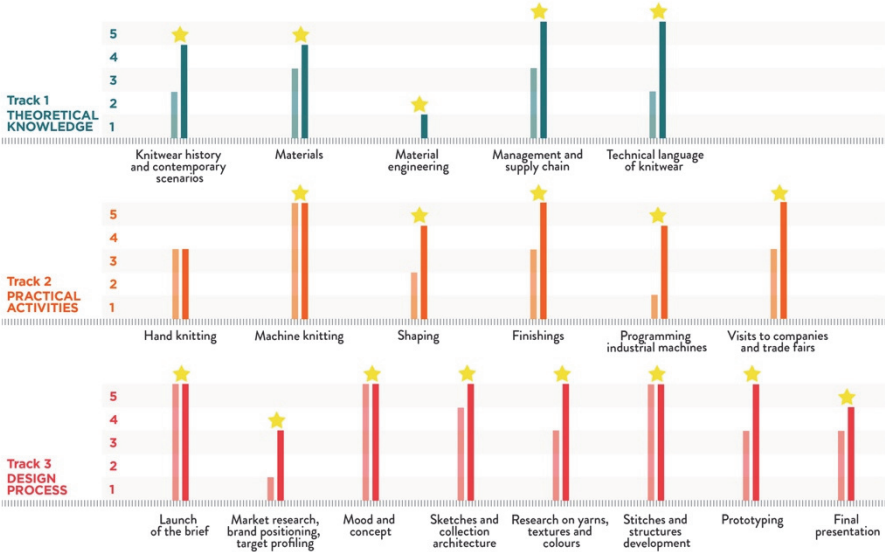**DDM 2018 with MFI**

Fig. 33

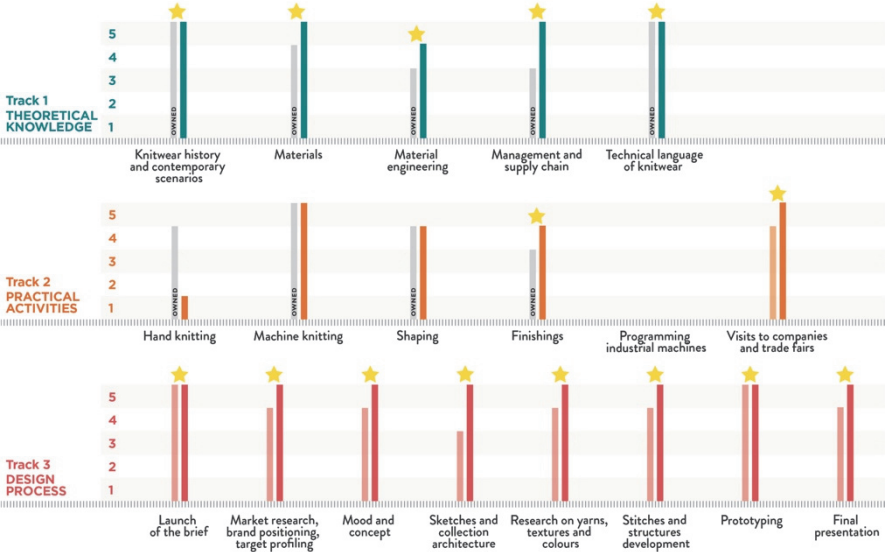**BA THESIS DEVELOPMENT with Ghioldi**
A.Y. 2017/18

Fig. 34

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The overview on the diagrams highlight that the presence of a company, marked with a star, improve the level of completeness of the knowledge delivered through traditional didactic methods inside the university environment (namely lectures, one-to-one tutorials, notional study on manuals), and increases the impact of that specific kind of knowledge on the final outcomes delivered by students.

Alongside the positive aspects, the analysis on the pilot actions also outlined some shortcomings to be considered which are mainly due to the pressure of the fashion system on knitwear stakeholders. As already reported in Chapter 2, Section 4, small and medium enterprises are fighting against the unequal competition of the eastern markets by contracting the expenses in terms of money, but also in terms of time and immaterial resources. Being small, they often deal with few important clients and they work hard to keep them, to please and satisfy all their requests. Employers, from the design unit as well as from the technical one, are always busy and they often work overtime, spaces are organized to be functional and exploited as best as they can. In such conditions, even when we have a truly collaborative company, the most immersive teaching activities are more difficult to be managed and require a small number of students, contained times and a strict schedule of appointments for students to work and use the company's spaces and to receive the help of experts inside.

This uncertain aspect represents a criticality to be addressed with constant dedication from time to time by researchers and professors, together with the company's professionals.

Final objective of this chapter, the described pilots with successes and shortcomings, made this study able to organize and codify those that were initially just experimental answers in a set of guidelines to be transferred to further teaching/learning activities, even in different contexts.

The guidelines can be presented as a list of good practices to undertake when designing a collaborative teaching experience, grouped according to their impact on the feasibility and success of collaborative teaching: some of them **propose** actions to make cooperation desirable and effective, others **facilitate** it with advice on times and schedule, and others are directly intended to transfer knowledge and **build** new one for the participants.

PROPOSE
- Gain the ability to welcome and give prompt response to reality-based brief which address a need expressed by the involved company.

- Act to reach concrete benefits for students, researchers and professors in HEIs and companies.

FACILITATE
- Organize longer teaching experiences to respect the availability of the company's professionals and to allow their real and constructive participation.
- Schedule constant feedbacks from diverse professional figures on design, research, technical choices.

BUILD
- Immerse students in the industrial environment through visits and lectures with professionals but also through having them working on their projects inside the company.
- Give a closer overview on the professional opportunities of manufacture, with the involvement of different stakeholders.
- Give students the opportunity to be hands-on on their projects and to realize their own prototypes under the supervision of teachers at the university, and under the guidance of technical experts inside the company.

6. Results and further considerations

1. Final outcomes and main results

The research work showed, during each one of its steps, the complexity of the knitwear industrial system and the important role that a well-prepared designer could have in addressing its critical issues. If, on one hand, the whole study demonstrated how difficult and limiting would be to code a rigidly structured practice for teaching knitwear design, on the other, the field experiences proved how the training of knitwear designers can be pursued with an adaptable didactic approach, to be adjusted from time to time to the context. This led to the development of a specific teaching strategy for this particular sector, composed by **a framework,** containing a set of teaching tools and methods for knitwear design teaching, and **guidelines** for the direct involvement of knitwear stakeholders into design teaching.

The **framework** responds to the necessity to support people operating in HEIs –being them professors, researchers or associates– providing them with a methodological framework and relative tools to model the teaching activities in the field of KD. As explained in detail in Chapter 4, the designed framework is divided in the three tracks which compose the complete specific knowledge to be delivered to the new professional figures of knitwear designers, made of theoretical and technical background oriented towards an industrial design process.

Figure 1 resumes them, before tackling the consequent results.
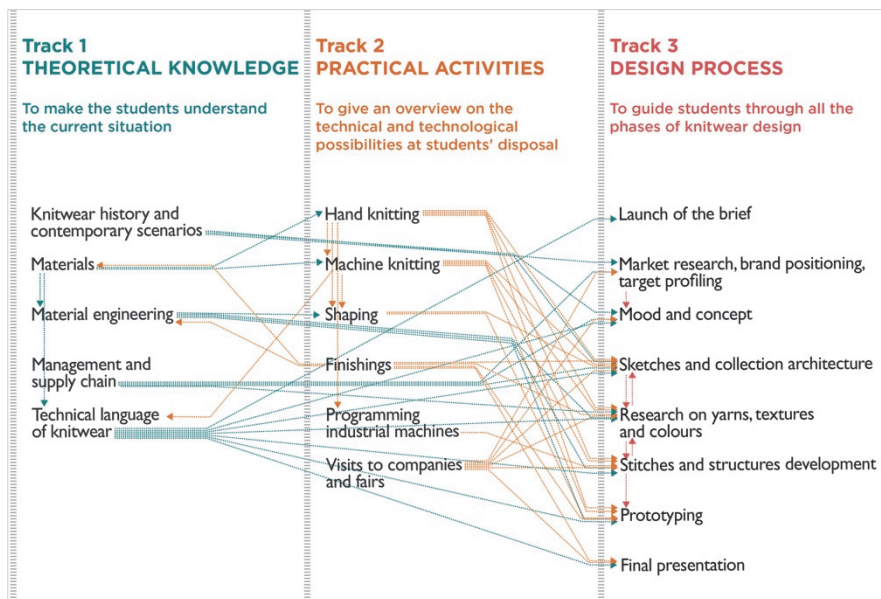
Fig. 1 - Summary of the framework. Arrows highlight the impact of each teaching module on the others.

The main results about the framework can be summarized as follows.

- Due to the reached results of the two experimental phases of this research, the designed framework can be positively evaluated and responds to the necessity, confirmed in Chapter 4, to have a specific training for the education of knitwear designers by providing a set of tools and methods to be applied by teachers in HEIs.
- The three tracks, initially conceived as three separated areas of knowledge, are strongly interconnected and influenced by each other: designers use the knowledge acquired with T1 and T2 to apply it on the activities of T3, but they also do the reverse, as they refine that background knowledge while they go through the steps of the design process.
- The three tracks contained in the framework are flexible and adaptive, to give to whoever –among teachers, professors and researchers– uses it the ability to model them depending on the situation, according to the background of participants, the available time, spaces and facilities, the expressed need of the company when involved.

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- The relations identified and made explicit between the modules and the three tracks allow teachers to be aware of the importance of each module and to select them according to the situation, and students to orient themselves among the different modules.

The **guidelines**, second outcome of this research work, provide to HEIs the ability to answer the needs of the industry by improving students' learning, giving them, meanwhile, the opportunity to apply the theoretical and technical basis they have learned on a real problem-based context, to get an industrial mind-set and the ability to dialogue with stakeholders, to frame the industrial reality and to know it in all its steps.

Chart 1 resumes them in the previously explained division between **propose**, **facilitate** and **build** and highlights for each one the main responsible of the action and the main beneficiaries between participants.

Chart 1 - Summary of the guidelines.

	GUIDELINES	STUDENTS	HEIs staff	COMPANY
PROPOSE	Gain the ability to welcome and give prompt response to reality-based brief which address a need expressed by the involved company	○ (active role)	● (main responsible)	☆○ (beneficiary + active role)
PROPOSE	Act to reach concrete benefits for students, researchers and professors in HEIs and companies	☆○ (beneficiary + active role)	☆● (beneficiary + main responsible)	☆○ (beneficiary + active role)
FACILITATE	Organize longer teaching experiences to respect the availability of the company's professionals and to allow their real and constructive participation	☆○ (beneficiary + active role)	● (main responsible)	☆○ (beneficiary + active role)
FACILITATE	Schedule constant feedbacks from diverse professional figures on design, research, technical choices	☆○ (beneficiary + active role)	● (main responsible)	○ (active role)
BUILD	Immerse students in the industrial environment through visits and lectures with professionals but also through having them working on their projects inside the company	☆○ (beneficiary + active role)	○ (active role)	● (main responsible)
BUILD	Give a closer overview on the professional opportunities of manufacture, with the involvement of different stakeholders	☆○ (beneficiary + active role)	○ (active role)	● (main responsible)
BUILD	Give students the opportunity to be hands-on on their projects and to realize prototypes under the supervision of teachers at the university, and under the guidance of technical experts inside the company	☆○ (beneficiary + active role)	○ (active role)	● (main responsible)

LEGEND
● Main responsible of the action   ○ With active role in the action   ☆ Main beneficiary/ies of the action

The main results about the guidelines can be summarized as follows.

- After an explorative test during the first set of teaching activities made to apply the framework (see Chapter 4, Section 2), the pilot actions reported in Chapter 5 specifically addressed the experimentation of good practices of involvement of companies into teaching, towards the definition of replicable guidelines for collaborations between design universities and the knitwear industry. Given the results of the entire experimentation, the defined guidelines can be positively evaluated as effective in providing HEIs with tools to design teaching activities that address the needs of the industry by training the students.
- The guidelines are designed to be selected and to model the cooperation from time to time, depending on the concrete need of the involved company, the typology of stakeholder, the background of participants and the expected results.
- The guidelines are also designed considering the reality-based needs of a company in terms of time, spaces, facilities and not just in terms of ideas. In this way, they can facilitate the exceeding of the limitations identified as shortcomings during the pilot actions.
- The guidelines actively involve all the participants in the teaching/learning experience, outlining the main responsible and the main beneficiary for each single action. This aspect constitutes a directive for researchers and professors in HEIs to know from time to time where to intervene on the collaborative teaching and to model it as required by the current situation.

Although the framework and the guidelines could be considered as two different purposes to be reached, they have been developed with a set of experimental activities that have been consequent, connected and strongly influencing each other.

As direct consequences of the experimental activities, the two –framework and guidelines– impact on each other and are designed as modular and combinable, intended to be used together. They can indeed be consequential in terms of time, or can be applied in parallel, depending on variables such as the number of students, their background, the type of companies involved and their needs, the setting and the available time. Together, they build an integrated teaching method intended to become the backbone of a discipline that makes HEIs able to understand the practical needs of knitwear industry and to translate them into educational experiences.

2. Complemented application of the outcomes in an integrated teaching strategy

As reported in Figure 1 (see also Chapter 4) the framework is composed of three tracks of knowledge which are not intended to be consecutive in terms of time but could overlap and be pursued in parallel just respecting the natural consequentiality of the basic knowledge which comes before the complex one.

It comes that the three tracks of the designed toolkit can be represented also as intersecting areas, composed of smaller modules which can be chosen to model each teaching activity depending on the situation. In the same way, the three groups of guidelines are non-consequent and not required to be present in each experience. Guidelines could be combined and applied to reach a different result from time to time, to meet the needs of the company and to model the experience even in response to time, space, availability restrictions.

The two experimental phases demonstrated that the involvement of companies, even if it often happens when students already own a technical and theoretical background, integrates it and is often able to create new knowledge, be it theoretical, practical, or concerning the design process. The set of tools and methods resumed in the framework and the good practices defined with the guidelines are thus not strictly consequential but can be integrated and adopted at the same time.

Figure 2 gives the visual representation of the two outcomes as modular: the framework is composed by squares that represent the modules belonging to each track, depending on the colour; the seven guidelines have different shades of blue corresponding to the three kinds of impact on the feasibility and success of the collaboration. The two outcomes are then presented as combined and integrated in a single scheme.

3. Findings and hypotheses of scalability

One of the fundamental topics of the present research is the way it refers to didactic activities not as an end in themselves, but as a tool to build strong relationships and knowledge exchange between universities and companies.

The approach taken with this study is the industry-focused teaching method experimented in the research environment of Politecnico di Milano.
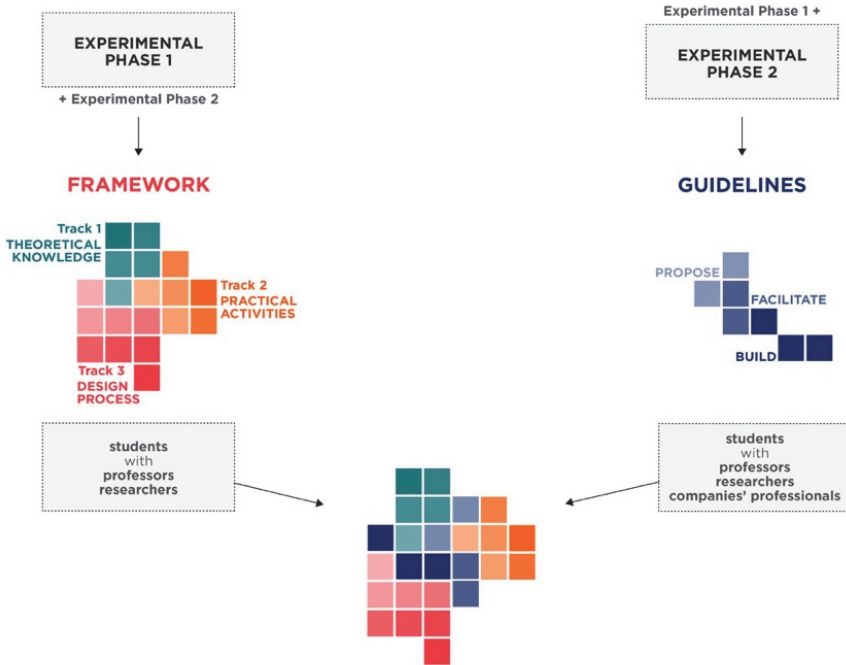
Fig. 2 - Visualization of the integration of the toolkit modules with the guidelines.

The cited approach, which also drove the development of the experimental phases described in Chapters 4 and 5, derives from the prior investigation on the needs of the industry illustrated in Chapter 3, and has consequently two main key features:

- the teaching of a technical and theoretical background, with the aim for students to learn how to control the technical features of a product, to push innovation further and to orient the project towards a real feasible and reproducible product (Motta, 2018a)
- the opportunity to learn about the industry first-hand, through the direct involvement of companies into teaching

Moreover, the territorial boundaries, here exactly chosen for the specific features of the Italian supply chain, have been a fertile ground for experimental activities and strongly influenced the research process and its results.

It is clear that the educational context in which teachers and researchers operate, and the industrial environment they are in contact with, influence

the features and the results of didactic activities and the facilities/opportunities at their and at students' disposal.

This makes the transferability of the elaborated teaching strategy subject to the conditions found in other contexts and countries. There are, indeed, some features that these contexts should have –at least one of them– to open hypothesis of scalability:

- the presence of a knitwear supply chain, with more than one single typology of stakeholder;
- the consequent natural inclination for education to be oriented towards building an industrial mindset for students, since industry and manufacture are the environment where the majority of students will find their job placement;
- open-minded enterprises and entrepreneurs with a long-term vision, who see in students a resource and aim to share their knowledge.

In this perspective, here are listed some areas suitable for the teaching strategy to be transferred and adapted, as they own one or more of the outlined features:

- **Portugal**, that is strong in good quality production and also owns a lot of spinning mills. Portuguese enterprises set long-lasting relationship with international fashion brands and are appreciated also for the creative contribute they are able to give during product development. Portugal is moreover part of the European culture and close to the Italian one. Here, design universities have strong relationships with the Italian ones and the knowledge flows through the high frequency of mobility of students and professors between the two areas. Being located in such a productive territory, Portuguese universities are –like the Italian ones– more oriented towards fashion as an industrial system rather than as a form of art.
- **Eastern Europe,** Romania above the others, where there is a high presence of knitwear factories that produce medium-high quality knitwear for European and American fashion brands. Here, we find a strong academic tradition for textile engineering that feeds the industry with highly technically prepared professionals.
- **Hong Kong**, that is a commercial strategic platform for international fashion brands, as it offers a good quality textile industry, especially concerning yarns and wool processing. As a result of the increase in production costs and stringent environmental standards, production shifted to China and Southeast Asia, and Hong Kong has therefore specialized in the supply of goods with high added value, such as knitted fabrics (knitwear and jersey). Here design universities are oriented towards this kind

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of production and already own collaborations with companies that are used to help students in the industrial development of their projects.

- **Central and South America** (Mexico, Brazil, Colombia, Peru, Bolivia and Ecuador): these countries are suppliers of European and Northern American brands, and thus own a developed industrial manufacturing sector to produce both good and medium quality knitwear. Some of them, e.g. Peru and Colombia, also own a traditional expertise in manual artisanal knitting techniques, due to the historical presence of alpacas that give the raw fibre to be processed and transformed into knitted garments. Here high-end fashion brands rely on artisans to realise garments that require high quality manual work at a sustainable price; this aspect is both an economic advantage for the country and a critical issue for the exploitation of skilled workforce by more powerful foreign stakeholders. Among the actions that many of these countries are undertaking to avoid exploitation and to enforce their industrial system there is the aim to build their own identity in terms of design. To move in this direction, they are starting from design universities, where study programs are modelled on the European ones and thus share with them the inclination to answer the needs of the industry with new talents.

4. Conclusions

The research gives back a framework of the Italian knitwear industry in its entirety, highlighting its specificities and criticalities as a peculiar branch of the fashion system. Once given this picture, the investigation approaches knitwear industry from the domain of design studies, opening several questions, focusing, on one side, on the role that academic research in design and design education should take in such a context, on the other on who a specifically trained knitwear designer is, what competences should he/she have, where his/her intervention is essential on the production chain.

The undertaken investigation on the knitwear industry fully highlighted the expressed need of a specific teaching approach for knitwear design with dedicated tools and methods. The following analysis, resulted in the designed framework, codified the competences to be transferred to knitwear designers as linked to creativity and technique, composed by a multifaceted knowledge that includes the learning of theory and practice about materials, material engineering, management, contemporary culture of fashion, production, manufacture, knitting techniques, software, and the ability to apply all this background to the phases of a design-driven creative process.

The key point of this work is to use teaching activities not just as they are inside universities but as a tool to build connections between HEIs and the knitwear industry and to bring new knowledge not just for students but for researchers as well as for companies. For this reason, the entire experimentation led to the design of a teaching strategy structured to deliver the needed competences while pursuing the training of knitwear designers with a very adaptable didactic approach, to be adjusted from time to time to the context. Teachers –professors and researchers– are provided with the tools to foresee the expected result of the teaching activity, and to manage it from a methodological point of view to make it as effective as possible. This means that, depending on the request made by the stakeholder/s, professors and researchers can undertake an activity of an entrepreneurial nature, using teaching as a verification tool and choosing the most suitable methods and their application towards the desired result, according to the students' background and the available time and facilities.

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Traditionally associated with craftmanship and manual work, knitwear seems a quite unusual subject of investigation for scientific research. This book places it as an integrative part of the industrial design culture where the dialogue between a productive system of excellence and the design discipline taught in universities becomes a topic of central concern.

From an industrial standpoint, knitwear is a fertile ground of technological experimentation while being at the same time one of the most traditional sectors of Made in Italy. The complexity of a long and fragmented production chain is an interesting challenge for designers but affects the training and the knowledge transfer inside companies. On the academic side, the presence of such an industry creates the urgency for higher education to understand how to train knit designers as new professionals, and thus the opportunity for knitwear to be recognized as a discipline deserving specific teaching strategies and a focused scientific research.

The present book reports an experimentation conducted in the unique conditions of the Italian industrial design culture, that defined tools and methods to train knit designers not as artists, but with the technical and cultural knowledge and the project-oriented mindset that is typical of industrial design disciplines.

These contents are of interest for the academy, as they constitute a tool to design teaching experiences oriented to such a specific industrial sector; for those approaching knitwear design, as it is a pool of information on the complexity of knitwear, a map of the background knowledge, collected and rearranged, and a compass to be guided in building one's own skills; for professionals, who will find here their history, the opinions of colleagues, the opportunity to integrate their knowledge and to learn more about the in-depth experimental, technical and design work that takes place at Politecnico di Milano.

Martina Motta, PhD in Design, is a post-doc Research Fellow at the Design Department of Politecnico di Milano and an Adjunct Professor of Fashion Institute of Technology program in Milan. In her research she explores contemporary fashion with a focus on knitwear design, knitting technologies and graphic design for knitwear. She works towards a new didactical approach to knitwear design that considers it as a system where designers deal with a wide variety of stakeholders and where each moment – project, production, distribution, communication –, as part of this whole system, is included in the design process. She has been involved in various research projects and exhibitions in the field and contributed to create a rich network with the most relevant Italian and international knitwear brands that are now partners of the Politecnico Knitwear Design studio.

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