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Design Driven Innovation for Italian Knitwear: Research Through Design in Knitwear Manufacturing

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Abstract: Based on a literature review concerning the role and impact of doctoral research in Design within a corporate organisation, this article proposes a transposition of such debate to the Italian Knitwear Industry.

While large companies have long regarded Design as a key asset of corporate research and innovation (Muratovski, 2015), this article argues that small and medium-sized enterprises (SMEs) often lack a specific innovation strategy and underestimate the potential of applying a Design perspective to their research activities.

Moving away from the 'closed' approach based on a dedicated research team installed within the company, highly innovative companies have recently adopted an 'open' strategy for research and innovation, networking with knowledge holders outside the boundaries of their organisation, thus bridging internal and external know-how (Bogers et al., 2019).

This paper applies this approach to the Italian knitwear industry, discussing how the more companies are able to connect with academic research facilities, the more they can intercept different knowledge and information flows, thus creating new opportunities for the industrial ecosystem.

Keywords: Knitwear Design, Design Driven Innovation, Research Through Design, Italian Knitting Industry

1. Introduction

The Italian industrial fabric is generally made up of small and medium-sized enterprises (SMEs), currently facing the issue of which innovation model is most promising (Bettiol & Micelli, 2005, pp. 45-76).

Moving away from the research model that once belonged only to large corporations and multinationals, in which R&D is conceived as a closed, internal department of the organisation itself (Chesbrough, 2003), nowadays innovating can be interpreted as borrowing significant contributions from various stakeholders, putting them together, 'connecting' external and internal knowledge (Bogers et al., 2019).

While, on the one hand, the abandonment of the traditional R&D approach in favour of this new 'open' model represents a discontinuity with the past for large companies and multinationals, on the other hand, this approach represents an extraordinary new opportunity for SMEs to recognize the innovation paradigm within their own organization.

Conceiving research as an internal department is an approach that finds suitable applications in large companies. On the contrary, it can be read as an unsustainable cost centre for the corporate structure of a small company, characterised by a hyper-segmentation of knowledge probably based on a short-term view and difficult to combine with complex innovation models or long-term R&D strategies.

Consequently, the 'open' model under discussion here may find promising applications for SMEs, as it enables them to reduce the cost of research and tailor it to specific business needs by seeking knowledge where it is already available.

Based on these premises, the present investigation aims to transpose such considerations to the Italian Knitwear Industry, examining its state of the art and proposing new scenarios for research and innovation.

The paper will examine how Italian knitting firms are, on average, organized into districts of small manufacturing organizations (Carrosio & Mosconi, 2022) that traditionally base their business model on the increasing aesthetic sophistication of their goods (Bettiol & Micelli 2005; Bettiol, 2015).

Their production approach combines extremely modern and digitized textile technology on the one hand, and totally craft-based activities tied to manual processing on the other. The question, then, becomes whether universities and other academic institutions can conduct a different level of in-depth research on such issues. In particular, doctoral research paths are interpreted as possibilities for new research and innovation paradigms for the knitwear industry.

Since knitwear can be investigated in various scientific fields, from economics to textile engineering, from materials chemistry to design, the paper takes the latter as the central perspective.

Finally, this research is part of an executive research project signed between a Polytechnic University and a world-leading luxury knitwear manufacturer on innovation and new development paradigms in the industry under consideration.

The methodology and research tools consist, on the one hand, in a systematic literature review on the subject of knitwear and, on the other, in an empirical experimentation through the use of the prototyping method as an investigative tool.

The reference paradigm is *research through design* (Frayling 1993; 2015) as opposed to *research for design* and *research into design*.

2. A knowledge-based society. Why do we need doctoral research?

In most industrialised countries, the debate surrounding the definition of the 'knowledge-based society' began between the 1960s and 1970s. The knowledge society is conceived as a social arrangement in which education is a decisive factor for economic growth and knowledge becomes one of the elements from which added value is derived (Drucker, 1969, pp. 263-286).

The academic discourse, debating between immaterial production and the creation of new wealth, tends to focus on how a knowledge-based society can achieve development and economic growth.

On the contrary, the Italian industrial structure of small and medium-sized enterprises struggles to recognise the usefulness of academic research, especially when applied to the so-called creative industries (Jones, Lorenzen, Sapsed, 2015).

It is in this context that in Italy, in 1980, the doctoral programs were launched, initially as a fundamental and necessary stage to embark on an academic career, to be then conceived, towards the end of the 1990s, as a third level of university education, helpful in weaving relations with the social and productive economic system (Di Maio, Gaeta, 2021).

In the knowledge-based society, therefore, those who are in charge of innovation can no longer be considered individually, as was the case in the past. Instead, the realisation of innovative processes is the effect of a collaboration between the actors aimed at enhancing resources, including intellectual ones (Ballarino, De Toni, Regini, 2021).

As argued by Ballarino, De Toni and Regini (2021), the difficulty in the crossover between academia and the market for Italian PhDs has its deep roots in the conviction, very strong and felt in the university world for some cultural and disciplinary spheres, that the primary, if not the sole role of the doctoral program is the preparation for an academic career.

On the other hand, the origin and peculiar structure of the corporate and production world in Italy has, to some extent, privileged in-house professional training processes, especially for top management figures. In recent years the situation has begun to change, with the implementation of Industrial and Executive Doctorates¹.

These doctoral programmes aim to make the research activity carried out in universities interact with the needs of companies to create faster and more practical applications in production activities.

Thus, PhD programmes provide an opportunity to bring high-level specialised skills into companies. At the same time, promoting industrial doctorates is a valuable opportunity for academic institutions to foster the transfer of research to companies.

In this way, universities can create fruitful contamination with working environments, allowing doctoral students to orient themselves toward an informed professional choice and discover the added value of (industrial) research.

Against this background, this paper argues that, while representing an essential bridge between doctoral training and the labour market, this approach poses the risk of underestimating what a university preparation, even an eminently academic one, can offer in any context of development and research, with the result of distorting the type of doctoral training.

3. Design Research, a new paradigm for innovation.

The case study of Knitwear Design

As pointed out by Muratovski (2010), the most common problem that designers face in corporate contexts is the misconception of the profession, according to which they are primarily perceived as decorators, craftsmen, or stylists.

While this vision corresponds to a market need, it does not exploit the full potential of design. In fact, Design Research (Jones, 1998) deals with understanding needs and ability to transform obtained data into knowledge that can be applied to creating, executing, and disseminating diverse solutions to the general public.

¹ For a more detailed analysis see AAVV, (2019) *Dottorati industriali: esperienze a confronto*, I Quaderni dell'Osservatorio Università-Imprese # 02, Fondazione CRUI.

Design concentrate on the interactions that take place between people and goods or services, as well as the memories and possible new meanings that these interactions create. It may also encourage or stimulate a variety of behaviors, as well as elicit pleasant or negative sentiments.

Ultimately, design may serve as a foundation for creating solutions that can be shared with the target audience via a variety of communication methods.

Equally, Design Research deals with the understanding of human needs and desires and has the capacity to turn gathered information into knowledge that can be used for developing, implementing and communicating various solutions to the public. It focuses on the moments of engagement that occur between people and products or services, and the memories these moments engender.

By evoking positive or negative feelings, it can also stimulate or motivate a range of behaviours. In this way, such research has the potential to be used as a framework for developing solutions that can be transferred to the desired audience by using various communication techniques (Muratovski, 2010).

With the advent of digital technologies and the phenomenon of manufacturing relocation from the West to the East, product designers have found themselves having to apply their knowledge and skills to different industries in order to remain relevant.

The concept of *Design Thinking* (Cross, 1982; 2023) stems precisely from this economic shift, in a scenario where design is increasingly seen as a field of thinking rather than making.

Against this background, various leading international businesses acknowledged how the mere development of goods and services is no longer sufficient in a highly competitive global market, and a new phase of business innovation concentrated on designing systems for living, working, and entertaining.

In their quest for innovation, some pioneering companies have begun to look at the design process as a source of inspiration, investing in their own design department instead of outsourcing such capabilities. Such framework has emerged since the 2000s, with large companies mainly located in North America and the Anglo-Saxon world investing in design for the innovation of their businesses (Muratovski, 2015). It is the case of companies of the scale of Apple Inc., Nike Inc., The Coca Cola Company, and IBM Corporation², which have variously employed designers as executive figures to pivot their innovation strategy.

Nevertheless, the problem is that design is often added at the end of the equation rather than at the beginning (Frayling, 2015).

As it is infrequent for research projects to start with design, they usually start with something else, such as a technical or a business approach, and design comes in as completion or to make it look smarter. So, in this regard, design fails to drive the process, and therein lies a significant challenge for practitioners.

The next sections will discuss how a design approach to innovation can be extended to knitting manufacturing companies, introducing the role of design researchers, bridging academia and applied R&D activities.

3.1 Knitwear design: innovation beyond technological pushes

As previously mentioned, this article explores the different possibilities of applying the design-driven innovation approach (Rampino, 2012, p. 35) to manufacturing and craft activities.

² For a more detailed analysis see Muratovski (2015).

The author chooses to apply these theories to the Italian knitwear sector, an industrial area that hinges on many of the elements described in the previous paragraphs, including the misconception of the designer's role as a purely creative presence and the mistrust of manufacturing companies towards academic research (Motta, 2019, pp. 33-37).

From an academic point of view, many authors highlight how Knitwear is often underestimated as a design category and subsequently needs to develop a distinctive research methodology (Conti & Motta, 2018; Eckert 2001; Motta, 2019; Sayer, et al., 2006).

It is commonly addressed and generalised as part of the broader fashion design discourse, entailing the risk of ignoring the specificities of knitwear design, such as the possibilities of combining different materials in one, choosing among hundreds of knitting structures, tailoring clothing by mapping the body to custom measurements, or even the possibility of designing a garment with zero waste (Lo Scocco G. et al., 2022).

To properly identify possible innovation drives, the paper compares companies that produce knitwear with those that produce clothing using woven fabrics.

The fabric creation phase (*Knitting*) and the production phase (*Linking and Sewing*) both take place within the same company³. This production model contrasts with companies producing woven garments, where only the second phase takes place, as other companies (*Weaving*) produce the fabric that arrives ready to be cut and sewn⁴.

Knitting companies, therefore, have a very unique labour organisation in which very different skills are required at the same time: technical knowledge of machinery, textile chemistry and computer programming, on the one hand, and purely craft skills needed for garment making and finishing, on the other.

Since a significant portion of the company depends on the textile technology employed, considerable investment efforts are typically made to purchase state-of-the-art textile machinery, making technological innovation the main driver of the industry under consideration. On the contrary, the artisanal part of the business, often the subject of relocation to countries where labour costs are lower, relies on traditional models with little investment in technological advances.

In other words, this manufacturing industry has consolidated itself over the last twenty-five years as a junction between cutting-edge technology and traditional craftsmanship of garment making (Lo Scocco G., 2022).

This paper, therefore, argues that ignoring the prerogatives of knitwear design may lead to misconceiving innovation in knitwear as purely technology-driven and therefore linked almost exclusively to the machinery sector, underestimating the importance of other models of innovation such as market-driven innovation or innovation of meaning, which will be discussed in section 3.2.

So far we have discussed how the typical business segmentation of knitting companies finally results in a research model entangling several application alternatives (Orazi, Sofritti, 2021).

Taking a step back, knitwear, as a technique for producing a textile element, has long been associated with the idea of manual and hobby work. Even after the introduction of industrial looms in the 16th century, the manual element remained very much present (Tremelloni, 1975, pp. 147-158).

³ More specifically, if on the one hand, knitting companies manage the entire cycle - including the design stage, on the other hand, there are purely productive companies that specialize in a single phase of the process (either Knitting or Linking & Sewing), known as second-level suppliers (Motta, 2019; Tremelloni, 1975).

⁴ See Tremelloni (1975) and Ray (2022) for an in-depth view of knitting technology.

With the introduction of CNC (Computer Numerical Control) Knitwear towards the end of the 1970s, there was a quick transition from a scenario defined by the high degree of craftsmanship of individual manufacturers to a new view of technology that profoundly transformed the industry (Conti, 2019, pp. 25-50).

Modern knitwear companies are, therefore, places with indispensable high investments in technology, which requires economic planning on the one hand, and a method for strategic innovation on the other.

It follows that knitting technology, in addition to the figure of the programming technician, requires a design mind that can outline original scenarios for its application on the market.



Figure 1. A Computer Numerically Controlled Knitting Machine.

Consequently, since technology has become a predominant part of knitting companies, the professional figure of the knitter has moved from that of a craftsman with manual skills to that of a software programmer.

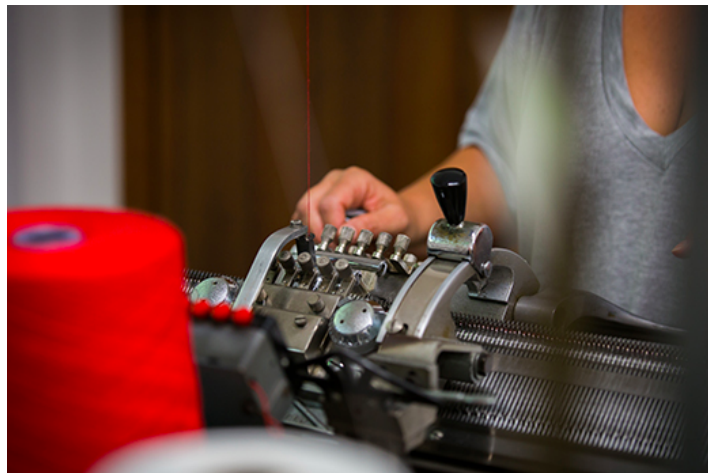


Figure 2. The carriage of a manual knitting machine diffusely used for production until 1970s, operated by hand

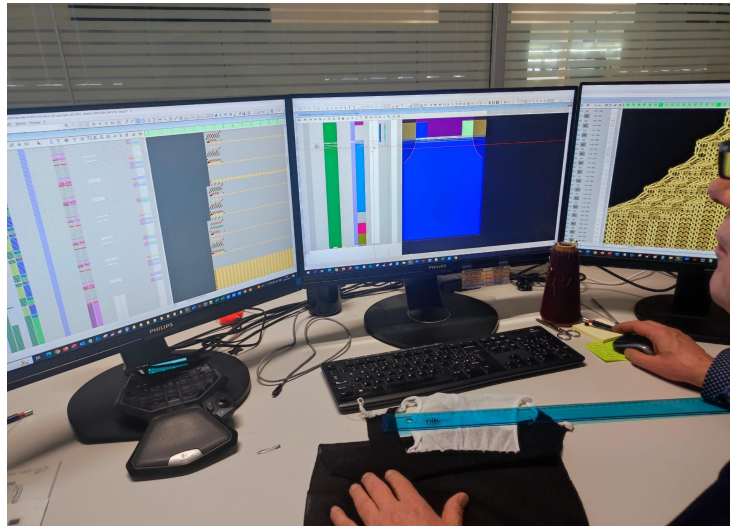


Figure 3. A programming workstation operated by a programmer technician checking the physical result on three diverse virtual environments on the screen.

This digitalization process allows to produce highly refined and creative products, that would have not been conceivable using manual production techniques or mechanical looms (Lo Scocco G. et al., 2022).

In this sense, the contribution of design has become much more relevant than in the past. Accordingly, this new approach has called for a change in the mindset of all actors in the supply chain and for the first time, research and development activities become eligible within this industry area.

However, it was and still is common in such manufacturing business environments to identify the idea of research with technological innovation alone, leaving out that approach to innovation based on the aesthetic refinement of a product and even more on its meaning or intended use (Verganti, 2006).

From here, the need for a strategy to integrate design research as a critical asset for innovation in the Italian knitwear manufacturing sector.

Although it may seem intuitive, the first step in embedding design capabilities into smaller businesses is demonstrating to the management how design can be a tool for solid growth. This entails collecting the body of research on the effects of design on business and presenting how other SMEs have applied design to address typical business challenges through case studies (Ward, Runcie & Morris, 2009).

Following this approach companies would gain in terms of innovation by recognising the importance of investing in design and involve management throughout the process to enable timely strategic choices. For example, in the programming phase of knitting machinery, it is possible to invest in research activities beyond the standardisation of command packages found in the software embedded in the machinery by following the path of free programming, *ad hoc* for the intended product result.

Such research activities can be properly applied in the sector under consideration through the supervision of a new professional figure, the *knit-researcher*.

To conclude, many executives believe that design can help them primarily in rebranding or changing the company's or its products' aesthetics; on the contrary, they often find that it can support them in redefining strategies, reorganise the product line, saving on expenses, or access new markets.

3.2 Innovation of meaning within Knitwear Design

Depending on the approach taken, innovation can be driven by three different elements: the technological one (*technology-driven innovation*), the market-driven one (*market-driven innovation*) and the one taking design as a reference point (*design-driven innovation*) (Rampino, 2012, pp. 25-36).

Most textile companies make contact with the academic community to investigate technological innovations involving textile machinery and related software, leaving aside other possible dimensions of innovation, particularly those about product, processes, and meaning.

This is in contrast to what happens in different but adjacent areas of design, such as furniture and architecture, where designers' contribution was the key to their success and marked the advent of industrial design in general (Rampino, 2012).

Such a strategy for innovation focuses on radical changes in meaning that manufacturers want to put into products.

Discussing such meaning is often a complex exercise. A product's significance is difficult to define, express, regulate, and measure. As a result, it is hard to precisely identify the design's contribution to the product innovation process.

The challenge of quantifying a product's value and cultural significance is closely related to estimating the worth produced by design innovation (Ravasi & Lojacono, 2005).

A new product on the market might be deemed innovative from a financial perspective if it produces profitable returns for the company. Nevertheless, the value of design-led innovation is not always measurable in terms of commercial profitability.

For instance, despite its lack of commercial success, a product resulting from design-led innovation may have significant communicative value for the business. In other cases, a design-led innovation process may allow a company to experiment and investigate new market niches or manufacturing opportunities as well as explore new linguistic or interpretive approaches to consumer demands.

According to Magistretti, Dell'Era and Verganti (2020), innovation of meaning might also come by suddenly recognizing a different, hitherto dormant opportunity in an already developed and marketed technology. The opportunity revealed in such an "epiphany" may not require higher technical performance, but merely an application of the technology itself in a completely new field.

This contribution finally argues that applying such theories and approaches to innovation in knitwear design finds a particularly fertile and evolving terrain.

Conclusions

In the paper, we argued that a central issue for manufacturing companies is the complementary nature of knowledge and the importance of identifying different capabilities to be harmonised on shared goals, actions and incentives.

Furthermore, this contribution disclosed how, while academia struggles to integrate a specific design methodology for Knitwear Design into its teaching, practitioners often ignore the Design Thinking perspective for strategic innovation (Motta, 2019, pp. 64-73). As a result, design fails to drive the process, posing a significant challenge for both academics practitioners.

As it emerged from paragraph 3, Design Research enhances companies' ability to make effective and profitable decisions by harnessing the involvement of various stakeholders, both internal and external.

The specific argument this paper puts forward is that this role can be effectively, if not uniquely, played by the design researcher.

In general, overcoming the approach to research solely based on the ability to intercept technological innovations represents one of the most significant challenges for the contemporary Italian manufacturing sector.

The same observation applies to the Italian and European legislator, who must acknowledge such an approach to R&D and innovation in the form of incentives to companies, whether big corporations or SMEs.

A further challenge consists in supporting practitioners to recognise how manufacturing companies, whether they have high or no technological content, can benefit significantly from access to design research.

To the often raised objection that a researcher classified as a company's executive is a cost centre, it is possible to respond by assuming that such a figure can also be incardinated within the industrial district in which such companies operate. By doing so, there will be a sharing, on the one hand of the relative costs and, on the other, of the generated knowledge.

Based on these considerations, Knitwear Design might, in the near future, be able to find convincing design ideas even in sectors far removed from fashion, such as architecture, automotive or medical equipment.

Research through design, if appropriately structured within a discourse between academia and companies, and with the introduction of supportive economic policies, could be a very effective tool to achieve these goals, supporting knitwear towards the challenges of the future in the manufacturing, economical, and creative field.

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