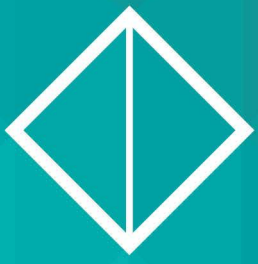
FUTURE CAPABILITIES FOR CREATIVITY AND DESIGN

HOW DIGITAL TRANSFORMATION IS RESHAPING FASHION CAREERS AND HIGHER EDUCATION

edited by
Paola Bertola, Marzia Mortati, Angelica Vandi



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DIGIMOOD CONSORTIUM

DigiMooD
DIGITAL MODULES OF DIDACTIC FOR CULTURAL AND CREATIVE INDUSTRY

Co-funded by the Creative Europe Programme of the European Union

POLITECNICO MILANO 1863
DIPARTIMENTO DI DESIGN

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institut FRANÇAIS de la MODE

FASHION TECHNOLOGY ACCELERATOR

ASSOLOMBARDA

ÉCOLE
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FASHION IN PROCESS

The series offers a contemporary reading of the fashion system focusing in particular on creative and design processes that characterize this sector. The series aims to collect the results of studies and critical readings which take distance from the traditional identification of creative processes as mere stylistic activities, and instead contextualize them within complex systems and organizations and describe their nature through a multidisciplinary approach.

SCIENTIFIC BOARD

PART I
CAPABILITIES FOR CREATIVITY AND DESIGN: UNDERTAKING TRANSFORMATION?

CHAPTER

2.

EDUCATION, FASHION AND THE DIGITAL TURN

PAOLA BERTOLA
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2.1 UNIVERSITIES, TECHNOLOGICAL CHANGE, AND DESIGN EDUCATION

The development of European universities dates back to the Middle Ages with important roles having been played by cloisters and Catholic culture and a general focus on philosophy, theology and humanities (Cohen, 1994). During the Age of Enlightenment, with the advent of the first Industrial Revolution, European universities were reshaped through disciplinary reorganization that placed particular emphasis on scientific studies. The importance of these disciplines increased at the start of the Second Industrial Revolution, and all major Western countries committed to the creation of research centres and universities with a technical-scientific focus (Detti and Gozzini, 2009). This process was driven by the goal of creating institutionalized places with formalized research practices that are strongly interconnected to their local industrial systems and often involved in their establishment and financing. The Third Industrial Revolution with information technologies, their application to automation, and the spread of globalization processes that transform markets and internationalize production supply chains has further accelerated the transformation of Western economies. Within this phase, an unprecedented development of social sciences took place in academic studies with a specific focus on organizational sciences and economics (Wong, 1991; Frank and Gabler, 2006). The Third Industrial Revolution is driven by the visions developed during this phase, such as neoclassical economic theories and the so-called 'endogenous growth' theory, which create the theoretical foundations for the financialization process of the economy (Piketty 2016). Therefore, during this phase, the rise of business schools in universities reached its peak, and the United States gained global leadership in academic studies and research (Baker, 2014). At the end of the 20th century, network technologies and global connectivity gave new strength to the globalization of finances, knowledge and flows of people, opening up to the so-called Fourth Industrial Revolution. This cycle occurred in half the time of previous transformation cycles; and the outcomes of this last phase of development are critical, reflecting a progressive separation of financial systems from real economies. Outbreaks of financial crises (2000 and 2007) highlight several limitations of the economic theories and models developed in the second half of the 20th century (Galimberti, 2002; Gallino, 2014). As a result of this process, a new transformation in academics started with a slowdown in the rise of social and economic sciences and growing attention being paid to scientific and technological disciplines. This science-tech turn is also supported by the rise of 'unicorns' in the digital industry, feeding a new focus on innovation in digital technologies and boosting both the demand and investment in training and research in these fields (Morozov, 2016). Therefore, a new expansion phase for technical universities has occurred, which also brings with it three challenges: how to manage the potential and risks of contemporary technologies and their implications, how to cope with the acceleration of change and the need for continuous reskilling, and how to implement real knowledge democratization and inclusion in education.

The first challenge relates to the nature and impacts of several contemporary technologies that are highly unexplored. In fact, for the first time in the history of humanity, technologies no longer simply process data and information faster and in greater quantities, but they also replicate cognitive processes; therefore, these technologies learn and make decisions, as studies and applications on neural networks and artificial intelligence demonstrate (Russell, 2019; Harari, 2017). In addition, a convergence process between the biological sciences and the information sciences (so-called NBIC convergence) has been triggered, which brings with it unexplored potential and enormous ethical questions (Roco and Bainbridge, 2003; Roco, 2016). While this process is strongly supported by a 'tech-driven' perspective in the North American debate, a more critical view has emerged in Europe, embracing the need to integrate arts and humanities into this convergence. Within this context, the link between science and technology and the humanities is seen as increasingly important to drive future transformations through responsible practices and towards equitable solutions (AA.VV., 2005).

The second challenge relates to the speed of the technological development in recent decades, which has been dramatically increasing. The Fourth Industrial Revolution started just half a century after the Third Industrial Revolution while the previous cycles took almost a hundred years. Moreover, during the last twenty years, the advancements in all major scientific and technological domains have been notable and frequently driven by private entities rather than research and academic institutions, often by start-ups suddenly becoming market leaders (see Google and Amazon). Simultaneously, traditional business organizations have been affected by a quick downskilling of their personnel due to the acceleration of technological changes and their difficulties of updating job profiles simply through generational turnover (Frey and Osborne, 2013; 2015).

The third challenge relates to how the network technologies brought by the Fourth Industrial Revolution impact knowledge sharing and creation processes. The utopian ideology of an open knowledge society elaborated by Silicon Valley's pioneers quickly clashes with markets and geopolitical dynamics, even increasing the polarization of the amount of knowledge between developing and recessive areas and regions. The digital divide is increasing the inequality, and the democratization of knowledge is only happening in some parts of the planet. The recent pandemic has only confirmed this distortion, where the massive shift to online education has excluded several areas and communities from access to education. This has occurred on both a macro scale, where students in entire geographical areas were not able to attend schools and universities; and on a micro scale, where small communities and families did not have the tools and infrastructure to access online education, even in Western countries and advanced urban environments.

Responding to these three challenges is an ambitious goal for academic institutions and certainly for technical universities and design education. However, to properly pursue this objective, it is important to understand the impacts of digital transformation in specific domains, whereas the ongoing transition in the fashion industry is particularly critical and the amount of future job transformation is expected to be massive.

2.2 DIGITIZATION AND THE TRANSFORMATION OF THE FASHION SYSTEM

Fashion has been a long-lasting protagonist in industrial revolutions' cycles; and the textile and garment industry has been central in the transformation of the UK since the late 18th century, contributing then to the entire early industrialization of Europe. Not by chance, the steam machines applied to weaving and textile production are still symbols of the First Industrial Revolution (Gallimore, 1993).

Since the last decades of the 18th century, technological evolution has been transforming manufacturing, shaping the forms of our economies and societies; and the fashion industry has always followed this cycle, sometimes as a driver of change. Examining the speed of transformation characterizing the first three industrial revolutions, each cycle took almost a century to develop from the first meccanization of manufacturing through water- and steam-powered technologies to the introduction of electrically powered mass production and finally to electronically controlled and computer-aided manufacturing. However, the current so-called Fourth Industrial Revolution took half of the time to occur, showing not only that advances in technology promote radical changes, but also that the speed of radical changes is accelerating **[fig. 2]**; however, fashion seems to be slower in adapting to the current transition and in taking advantage of its innovation potential. The ongoing Fourth Industrial Revolution is based on network technologies and the convergence between physical and digital environments, where advanced robotic automation is controlled by a set of technologies (Gilchrist, 2016; Swab, 2016). This transformation is also referred to as 'Industry 4.0' (I4.0), a name derived from a strategic initiative launched in Germany in 2011 and then followed by similar plans all over Europe. This model also aims to implement digital manufacturing by increasing digitization and the interconnection of products, value chains and business models. It also aims to support networking among industry partners (BMBF, 2011).

This transition has been impacting all industries, including fashion; however, while traditional established companies have been slow in their adaptation to the new paradigm, two kinds of new players have entered the fashion system and reconfigured the competitive landscape.

First, since the first decade of the new millennium, tech 'colossi', such as Google and Amazon, have identified fashion as a promising field for expanding their businesses. Second, a new generation of start-ups has populated the fashion market with fresher business ideas.

In the first case, tech colossi could rely and exploit a unique key asset: their large and powerful online customer networks. These networks are empowered by AI to profile users and customize their fashion retail offerings, supported by globally widespread logistics. An example of this approach is the case of Prime Wardrobe, an online advanced retail service developed by Amazon that is ready to shift to directly produce private labels and to become a competitor not only for fashion retailers, but also for traditional fashion manufacturers.

In the second case, new start-ups, mainly coming from other industries (i.e., ICT), have been creating a lively ecosystem of new fashion services, products, solutions and business models to quickly take advantage of the potential of digital technologies. Today, within the retail business, the top 10 international players, such as YNAP Group, Asos and Farfetch, have not been present in the market for more than 10 years ago and are now considered 'unicorns'. Fashion is now proven to be a fertile ground for tech start-ups to grow fast, and the shift between just retailing into covering the entire value chain including manufacturing is just a step ahead and is already occurring (CB Insights).

While this new fashion-tech system was spreading, traditional established fashion companies were slow to embrace the digital transformation, and they responded through two main strategies.

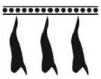
First, the established fashion companies were driven by technical/engineering approaches rather than a systemic design-driven approach, often implementing technological transformation through a narrow perspective that examined the latest technology/software solution to streamline or substitute part of already existing processes.

1st INDUSTRIAL REVOLUTION

End of 18th century

Follows introduction of **water- and steam-powered** mechanical manufacturing facilities

1742 *Cotton factories established in England*
1767 *James Hargreaves invents the spinning jenny*
1784 *First mechanical loom*
1790 *Samuel Slater builds the first cotton spinning mill*
1793 *Eli Whitney introduces the cotton gin*
1814 *Francis Cabot Lowell introduces the power loom*
1846 *Elias Howe patents the sewing machine*
1856 *Synthetic dyes*
1863 *First Graded pattern*



2nd INDUSTRIAL REVOLUTION

Start of 20th century

Follows introduction of **electrically-powered mass production** based on the division of labour

1870 *First production line*
1872 *Electric cutting knives*
1880s *Electric sewing machines*
Progressive line assembly
Contract system
1890s *Pressing machines*
1960s *Automated sewing systems*
Numerically controlled cutting system
Computerized grading

3rd INDUSTRIAL REVOLUTION

Start of 1970s

Uses **electronics and IT** to achieve further automation of manufacturing

1969 *First programmable logic controller (PLC)*
1970s *Laser single-ply cutter*
Computerized marker-making system
1990s *3D modeling and texture mapping*
Body scanning
Digital printing
2000s *Computerized nonlinear grading explored*
Digital communications prevail

4th INDUSTRIAL REVOLUTION

Today

Based on **Cyber-Phisical Systems**

2010 *Compressed calendar through PLM*
Increased mass customization
2011 *Industry 4.0*

Figure 2 **The 4 cycles of industrial revolutions in the fashion industry.**

Second, lacking R&D and ICT system cultures, the established fashion companies have embraced the open innovation paradigm, meaning they have sought new ideas outside the boundaries of their organizations (Chesbrough, 2003; Huston and Sakkab, 2006). First, traditional retailers, such as Galerie la Fayette and Nieman Marcus; then fast fashion kings, such as H&M and C&A; and finally the luxury industry, represented by groups such as LVMH and Kering, have developed open innovation strategies. Therefore, they have started to create and sponsor venture fund incubators, accelerators and promising start-ups to internalize outsourced innovations.

The first approach is more typical of the early wave of I4.0 plans, which were too often factory-centred and too simplistic. In fact, the potential of connecting machines and humans within smart factories has much larger implications if digital technologies are applied to link resources across companies' boundaries. Digital networks can create an integrated system of actors, assets and stakeholders where not only supply chains can be tuned in real time with the factory, but also retail channels and even products and final customers can communicate and exchange data in real time. Therefore, a factory can become a knot of a complex networked ecosystem within a model where the roles of different processes and functions, including design, should be rethought. In light of this expected reconfigured system, it is crucial to identify the most promising innovation trajectories to redesign higher education to be able to respond to the future job demand.

2.3 FASHION 4.0 AND EMERGING INNOVATION TRAJECTORIES

The potential of digitalization processes coming from all sets of Industry 4.0 technologies produces impacts that overcome the boundaries of factories. In fact, their added value relies not only, as in the Third Industrial Revolution, on an enhanced computational capacity of calculation, but also on the possibility to connect virtual and physical realities (the Internet of People [IoP] and the Internet of Things [IoT]) and, furthermore, to replicate, for the first time in human history, cognitive processes enabling machine learning and decision making (Artificial Intelligence [AI]; (Ustundag and Cevikcan, 2017)

Given this premise, it is clear the need for a further systemic approach to digitization overcoming the I4.0 manufacturing-centred vision to approach the entire ecosystem that links 'smart factories' to 'smart networks' and 'smart products' (AA.VV., 2016)

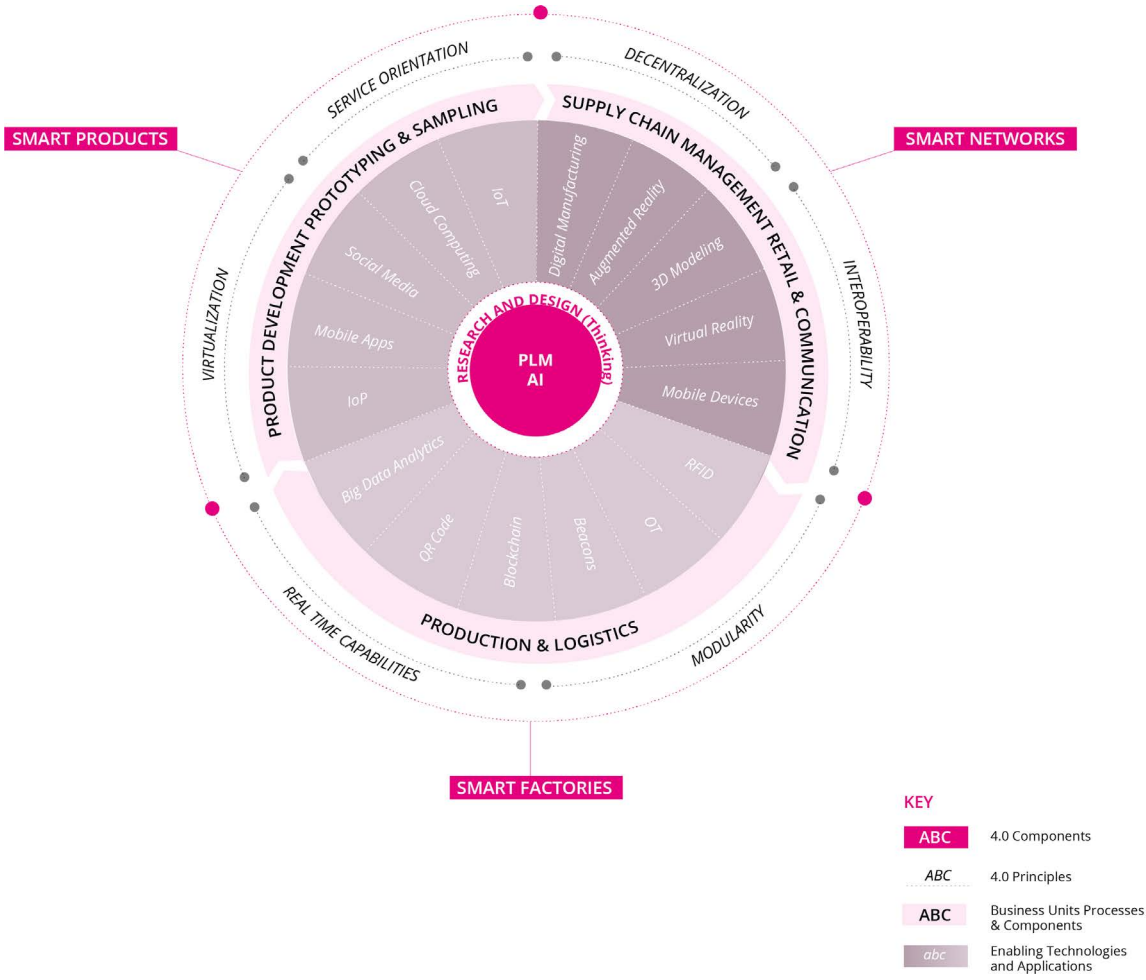


Figure 3 **Fashion 4.0 integrated model.**

Within this tripolar model **[fig. 3]**, all main processes of the fashion cycle can be represented: the 'smart factory' relates to production and logistic; the 'smart networks' relates to supply chain management, retail and communication; the 'smart product' relates to products development, prototyping and sampling; and finally, research & design, centrally positioned, function as the ideal connection among the key processes of the entire ecosystem. In figure 3, the 'engine' of the model that can nurture a new design-driven approach is represented by a set of technologies and applications supporting the implementation of the Industry 4.0 paradigm. To understand the main implications of this new conception of the fashion cycle empowered by the full integration of Industry 4.0 technology, it is useful to refer to the six I4.0 design principles introduced by Mario Hermann, Tobias Pentek and Otto Boris: interoperability, virtualization, decentralization, modularity, service orientation, and real-time capability. They are particularly useful to foresee the main innovation trajectories enabled by this model (Hermann, Pentek and Otto, 2016).

Virtualization means that all processes within the three domains of smart factories, smart products and smart networks should be completely virtualized whether they are digital or exist in the physical world. This implies that there should be a virtual copy of the fashion creation, manufacturing and distribution cycle that is always updated. Virtualization is currently implementable though the integration of several tech solutions, such as all types of sensors and tracking systems, ranging from the environmental ones applied to factories to blockchain systems and RFID chips embedded into products. Among the many benefits of this approach, one is particularly important given contemporary consumer attitudes: the possibility of reaching a level of radical transparency. After acknowledging the many negative social and environmental impacts of fashion and understanding the extensive use of individual data by brands for commercial purposes, people are now seeking transparency (McKynsey, 2019). Therefore, virtualization can offer not only real-time control of all processes, but also a powerful lever to increase the perceived value of brands by their customers.

Decentralization refers to the creation of a flexible distributed supply chain network that enhances the capacity of the entire supply chain system to adapt to turbulence, such as by adjusting production cycles to local market variations. The principle can be applied to the whole value chain including not only manufacturing suppliers, but also the retail network, merging physical and digital channels. Decentralization implemented in a fully integrated ecosystem can be enabled by several tech solutions, such as digitized manufacturing (CAD-CAM, 3D modelling and printing, etc.) and all supply chain management information systems (i.e., Enterprise Resources Planning [ERP] and Product Lifecycle Management [PLM] systems). Among the many benefits of this approach, the so-called 'distributed manufacturing' model is certainly very promising. This would imply the implementation of interconnected light manufacturing knots empowered by real-time information exchange and globally spread to be as close as possible to final markets. This could dramatically reduce the logistics costs and environmental impacts by relying on locally-based sourcing-manufacturing-retail systems directly linked to the design headquarters. If traditional fashion brands are slow to embrace this concept, the design-driven maker culture and fab-lab networks are pushing towards this direction (Birtchnell and Urry, 2016).

Interoperability is the characteristic of a product or system to work and interact with other products or systems without any restrictions, where humans enter as interfaces within a hybrid cyber-physical model. This model can be easily enabled by the integration of IoT and IoP technologies within a new *phygital* interaction paradigm that could inform and connect the entire value chain from smart factories to smart networks and products. For example, in fashion collection development, the hybridization of craft techniques and touches with advanced technologies represents a powerful strategy of differentiation and a very interesting trajectory for future job evolution and development. Several instances have already shown the potential of this paradigm by redesigning factories as open cyberphysical environments where augmented individuals can become Industry 4.0 craftsmen, opening design an unexplored spectrum of possibilities (Bertola and Teunissen, 2018).

Modularity is intended to be a system designed through modular subsystems and components that is able to flexibly adapt to changing requirements by replacing or expanding single modules. Therefore, modular systems can be easily adjusted in the case of seasonal fluctuations or changed product-system characteristics. This principle results in several benefits in terms of flexibility and efficiency within manufacturing and can also be applied to how brands conceive their collections and single products, overcoming traditional concepts such as seasonality or even size and gender. Confirming this trend, cross-seasonal and transformable garments composed of basics and genderless pieces that perfectly fit new GenZ consumer choices, well representing ongoing social and cultural transformations and the growing sensitivity towards sustainable consumption practices, are spreading in markets (Fletcher, 2008; 2015).

The service orientation principle, where any interaction across functions and business units and any touch point beyond the company's borders is conceived as a service, is intended to support the development of a diffused service approach within the whole network of the company. Several different network systems, collaborative tools and dashboards can allow all internal organization participants and external stakeholders to easily access and exchange information through service interfaces with greater benefits in communication and efficiency. An increasing service orientation can open new business scenarios for fashion, especially in the context of the interactions between brands and their customers. The shift of consumers from a passive reception of brand communication to an active interaction enabled by social media is changing the fashion paradigm, even allowing its transition from being a product-centred system to entering the service economy paradigm by adopting new business models typical of the sharing economy, such as second-hand models and rentals.

Finally, the real-time capability principle refers to the possibility of designing a fully virtualized product lifecycle management system and requires that data be collected and analysed in real time to inform all process planning. Therefore, a real-time capability does not imply only a continuous flow of data, but it also implies the capacity to process and synthesize data to make the data available to different functions in a form that can enable real-time decision making and reactions. This can be enabled today by advanced and fully integrated EPR and PLM systems connecting all processes: design, product development, manufacturing, retailing and product use and disposal. Therefore, contemporary data management and network technologies can facilitate the so-called 'mass customization' to be implemented in much easier ways than three decades ago when it was theorized (Pine, 1993). Today, real-time interaction with users through social media, e-commerce and data management empowered by AI can finally allow on-demand customized production to occur with the benefit of disintermediation between brands and consumers. This represents a real opportunity for design to be directly informed by users' demand and to shift from designing products to designing systems and platforms to enable users to co-create their own products.

The implications brought by a full integration of the I4.0 model and its design principles are providing scenarios in which the global fashion system can be completely reshaped following emerging innovation trajectories. They show a future where technologies, properly guided through a design-driven approach, can inform a transparent, circular, sustainable and user-centred fashion cycle.

2.4 FASHION EDUCATION AND THE NEED FOR A PARADIGM SHIFT

The I4.0 paradigm and the potential of digital technologies can drive a positive redesign of the entire fashion system, impacting all functions; however, it also raises a crucial dilemma for the design process itself due the specific nature of contemporary technologies. In fact, as underlined in the previous sections, these technologies are able not only to accelerate processes, but also to autonomously learn and make decisions, thereby replicating cognitive processes. While several reports on the impacts of digital transformation on the nature of jobs still support the idea that creative processes cannot currently be replicated by technologies (Frey and Osborne, 2013; 2015), there are results that provide different conclusions, where advanced AI applications are applied in creative contexts, sometimes overcoming humans' performance (Bostrom, 2014). In light of these circumstances, a deep reflection on the consequences of the current transition on design in all its application and domains of practice, including fashion, is certainly needed. Only through this analysis would it be possible to reshape education to meet the requirements of future jobs by redesigning knowledge pillars, competences and skills to achieve this purpose. However, despite the urgency, not all domains of design education are moving to drive the change, and fashion education seems somehow very conservative in this respect. This dates back to its specific history and evolution, which has been establishing fashion schools as isolated experiences within the larger system of design education.

Design developed as a formalized professional practice and discipline through different approaches and schools during the shift from the artisanal and farming society into the industrial one (Heskett, 1980; De Fusco, 1985). In an early phase, the arts & crafts movement played a very important role in formalizing design education. This movement was born as a reaction to the standardized products generated by the rigid constraints of the early 19th century's manufacturing system. The aim was to give back the qualities and uniqueness that 'Masters of Arts' were previously able to create to daily life objects (Cumming and Kaplan, 1991). The original model of design schools is rooted in the arts & crafts vision, flourishing all over Europe and developing many of the approaches still existing today in design education. For example, the workshop-based learning model is the most archetypical expression of design pedagogy, and it is directly connected to the original apprenticeship systems in masters of arts ateliers, which characterized preindustrial societies. However, this original model has developed further through subsequent experiences, among which two are particularly relevant: the Bauhaus (1919–1933) and the Ulm schools (1953–1968). The original goal of the Weimar school was the reunification of all disciplines in a single 'art of building' able to bend the industry to a new language that could also embed the typical expressive qualities of arts and craftsmanship (Forgács, 1995; Bergdoll and Dickerman, 2017). Some principle of the Bauhaus school then developed into more radical experiences such as 'functionalism' and 'rationalism', which inspired the so-called modern movement (Bradbury et al., 2018), opening to a push towards a 'scientization' of design. However, they have also been crucial for the growth of design schools and their institutionalization within higher education institutions. In fact, along the modernism experience, several design and architecture schools were established or reformed with the goal of formalizing the practice-based educational approaches of applied arts schools into a codified theoretical corpus (Takayasu, 2017; Spitz, 2002). Within the Ulm school, this path was further structured into a unique vision of design as a "reflexive praxis" (Schön, 1983) able to blend practice and theory and to bridge arts and humanities with science and engineering disciplines. Since the transition to the new millennium and during the last two decades, design has been increasing in relevance and has been acknowledged as a key competence within innovation processes that can scale up companies and organizational hierarchies from being a technical function into becoming a strategic competence (Verganti, 2006; 2009); today, the so-called 'design thinking skills' have been identified as one of the key attributes of millennial leaders (Cross, 2011).

Along this path, design education has been able to embrace a continuous transformation, expanding its boundaries and exploring new domains for design practice, such as interaction, user experience, scenarios, services, strategies, etc. (Bertola and Manzini, 2004). However, the above depicted evolution has only partially addressed fashion education, often seen as a peripheral subject within the debate of design science. However, beyond luck of interest in scientific community, fashion design educators and schools have been developing themselves as a small self-referential niche within the whole design system. In fact, while design has become a prominent topic in universities, fashion education has been following a path pushed by a rapidly growing industry and an enduring demand from prospective students, usually fascinated by its cultural, social and mediatic exposure. Therefore, it has remained apart from the evolution and articulation followed by design education, too often replicating the 'arts & craft ateliers' model. This 'art-artefact centred' focus certainly addresses the strong artistic, symbolic and cultural contents that indubitably characterize fashion while simultaneously constraining the development of fashion design education from fully exploring the many fundamental disciplinary domains it involves. This approach does not properly consider the multifaceted nature of fashion that is, as with design, part of a larger and complex socio-technical system (Maldonado, 1976; Penati, 1999) in which ongoing digital transformations have the potential to completely reshape fashion into a new paradigm. However, while a systemic and multidisciplinary vision is needed to anticipate this future scenario, several fashion schools are still focused on product-centred education, very much aimed at improving students' stylistic and crafting abilities.

However, recalling the three challenges for universities introduced in the beginning and the ongoing transformation in fashion, three trajectories of change are emerging for design education in this field.

First, design as a discipline and practice that bridges art and science, humanities and technologies can gain unprecedented relevance within research and innovation processes, thus growing as a strategic function in companies and organizations (Banerjee and Ceri, 2016). Therefore, contemporary and future universities need to reshape design knowledge and learning processes to achieve a balance between high-tech innovation and a 'new humanism'. This goal requires fashion education to transfer to students not only technical skills but also critical, strategic and entrepreneurial capabilities. Therefore, the systemic dimension of ongoing technological transformations should correspond to a systemic vision of fashion in students. Consequently, a shift of fashion education from being uniquely product-centred to embracing multidisciplinary domains of knowledge is required to enable design professionals to envision their interrelation with all other functions and take full advantage of the potential of technological innovations.

Second, the need for reskilling human resources during their job life is increasing, and universities need to better address this task by finding new ways to cooperate with companies in co-creating educational paths and new training on job experiences. Additionally, given the accelerated obsolescence of contemporary technologies, a deeper reflection on how to incorporate them within education is required. In the fashion design practice, as technologies represent fundamental tools, domains of applications, and cognitive 'augmentations', the ways to teach and learn through and with them have to be rethought. This process should be focused on creating a strong familiarity with a broad spectrum of technologies in learners where the most important goal is to increase students' capacity to learn within the science-tech domains beyond learning specific solutions and tools. This requires a specific educational focus on training students' cognitive capacities in which the 'how' to learn becomes more important than the 'what' to learn.

Last, there is the need for academic institutions to take full responsibility to balance the knowledge polarization process that technological development has increased to the point of excluding communities and regions. They should actively commit to producing and disseminating open access knowledge and to enabling broad and diverse audiences of learners to access new Online Educational Resources (OERs). This goal requires the implementation of new educational method-

ologies and fully exploring technologies as a means for enhancing learning experiences. While fashion education has often been developed as an *élitarian* path, this trajectory of change could finally reflect the potential offered by innovation in terms of knowledge accessibility and openness.

2.5 CONCLUSIONS

Fashion schools and fashion education have long been niches of design education, often standing apart from the scientific debate on the discipline and its evolution. This isolation is possibly coming to an end, given the acknowledged impact of fashion on global economies and society and the need for it to engage, as for all other sectors, in supporting a consistent transition towards more sustainable and equitable paradigms. Contemporary technological transformations show great potential for reshaping the fashion system towards this goal by depicting innovation trajectories that can inform the entire fashion value chain. However, their implications are largely unexplored as a fully integrated model of I4.0 for fashion has not yet been implemented. Some aspects of technological applications (see, for example, big data management and AI) raise new questions and challenges for the future of jobs and professions that should be considered and guide the choices of education institutions. In particular, the learning and decision-making potential of these new applications can allow the implementation of business models where fashion brands lacking a formal design function can be established. Cases such as the online personal styling platform Stitch Fix and its movement into private label manufacturing reflect this trend. They are preconfiguring a fashion system without design by relying on AI algorithms and machine learning processes to "assemble" collections though the cut and paste of already existing design concepts based on consumer profiling and behaviours.

However, as the fashion innovator Zowie Broach has stated, platforms designing by AI may fall into a form of the Pavlovian paradox. They could result in the progressive homologation of products by replicating basic human chemistry by reducing consumer behaviours to algorithms that process already existing creative ideas while leaving very little room for new ideas to be introduced (Rejcek, 2019). This scenario will certainly leave very little space for creative professionals within the fashion business to anticipate a progressive impoverishment of fashion cultural and creative contents in the medium long term. A way to avoid this possible near future can be found by empowering fashion design professionals with great familiarity with technologies, their potential and their different application domains across the entire fashion value chain. This means a new commitment of fashion education to training creatives to become augmented professionals empowered by technologies and not driven by them. Only thorough a redesign of the contents, processes and reach of fashion education can this goal be achieved. The conviction is that design thinking, fuelled by AI insights, should return back to the very centre of the fashion cycle as an essential creative engine real-time informed about the impacts, actions and reactions of its surrounding cyberphysical ecosystem.

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