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CONTENTS

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DESIGN CULTURE(S) | CUMULUS ROMA 2021
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Fashion-Tech Revolution: Future Frontiers from Products to Processes

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Abstract | The fashion industry is a highly pluralistic and diversified context in which material and intangible products, cultural capital and human resources merge together. As the outcome of a complex integration process among different methodologies and areas, fashion contributes to a new reading of the cultural changes which shape our present. By drawing on various codes fashion is capable of generating a narrative which bestows meaning on the relationship between references, materials, technologies, products and processes. Given the need to rise to modernity's challenges and to be innovative, the forms of cross-fertilisation in the contemporary world are becoming ever more daring, while the number of disciplines involved is steadily growing, and the skills required are becoming increasingly specialised.
Nowadays, the fashion system is linked to technological progress. Fashion-Tech sector is originated in the interplay among fashion design and digital technologies and is a special disciplinary niche, as it is marked by elements which are unprecedented in history in terms of revolutionary impact. This process of hybridisation has opened up new possibilities in terms of innovation, and it has generated products and services with enhanced performances, whereas technological advancements have been given the chance to enter consumers' lives and bring them innovation. From design to retail, from product to communication, fashion and technology are interconnected and the shift from craft to industrial production, from an analogue dimension to a digital one involves not only all stages of the production process, improving them and making them quicker and more efficient, but also the design practice, changing its meaning and purpose.
The paper aims to trace and define the revolution taking place within the fashion world, those avant-garde movements which are experimentally operating on the boundaries of different disciplines, describing realities that are sometimes in contrast with the traditional practice. In particular the research investigates how these dimensions, resulting from the intersection between fashion and technological progress, are impacting on human beings, on their relationships with the garments, with their bodies, with the environment and with other people. The paper will analyse the changes induced by the fourth industrial revolution in the field of fashion and the impacts on processes, products and languages.

Moreover, it will analyse the technologies currently employed in the fashion landscape, along with their possible applications in future scenarios, referring to the most relevant case studies in the field. Cases will be introduced combined into clusters, according to the subject areas involved, that represents Fashion-Tech innovation tracks:

- Artificial second skin: body equipment with embedded sensors able to monitor human body parameters that are critical for healthcare;
- Hyper-body: products are becoming increasingly connected with the body, becoming part of it;
- Fashion-Tech takes care: sustainability – intended as efficiency, recyclability, transparency, mission orientation and ethical upgrades – can cover the entire fashion supply chain;
- Physical avatars: digital beauty in real layers.

These are not intended as market trends, but rather trajectories, at a different stage of development, orienting the design practice within the Fashion-Tech field. They result from observation, analysis and interpretation of emerging issues in the Fashion-Tech context, conducted by desk research.

The paper concludes with a reflection on the role of design in guiding technological innovation, highlighting how fashion design, within the Fashion-Tech paradigm, can accomplish, or at least offer, the possibility of bringing the results of the most daring scientific progress closer to a human and tolerable dimension.

KEYWORDS | FASHION-TECH, HYBRIDISATION, DISRUPTION

1. Introduction

> "The avant-garde is the symptom of a new situation ... The arts of our century are characterized by the tendency to move towards borderline areas where each art touches the boundaries of the other, often invading its territory." (Spatola, 1969)

The worlds of design and fashion are inextricably linked to the temporal variable. Indeed, the historical context integrally and intimately defines objects: not only does it determine their reason for existing in relation to needs and functionality, but it influences the stylistic, material and technical choices.

The complexity of the fashion sector, its intrinsic and communicative value, and its relationship with time can be well exemplified through the linguistic paradigm.

Clothes, like words, cannot exclude the comparison with time. In linguistics, the sign—the word—is formed by the arbitrary union of a signifier and a meaning (Ferdinand de Saussure, 1979). The signifier, or expression (Hjelmslev, 1991), can be a sound—in the oral sign—, or a handwriting—in the written sign—. The meaning instead is the content, which the sound or handwriting wants to convey, and the concept embodying the mental notion of an object. Meaning makes it possible to understand or express the sense, value or content of a sign. In communication, the sign has a dual function: one of a referential type, that is to tell something about the world; the other one is an aesthetic one—to communicate something self-related.

Like words, objects can also be traced back to this model. They have a tangible dimension which can be experienced through senses. They have also an intangible dimension of content, a referential meaning which refers to reality. Lastly there is an aesthetic meaning that refers to imagination, more or less similar or dissimilar to the representation of reality. The link that binds meaning and signifier is not natural and necessary, but arbitrary, as a cultural product that exists in a certain historical and geographical moment.

It is precisely in this arbitrariness, in this mutual bond between the parties of which the space-time component is a fundamental variable, where the concept of 'contemporary' resides.

In the world of design, we can define 'contemporary' not only as what has been designed and produced in the present time, but also as what is aware of being contemporary, therefore able to fully express the *Zeitgeist*, the spirit of the time (Blumer, 1969; Vinken, 2005): the collective taste, the general moral, ideal and cultural climate that characterises a particular historical period. Therefore, only some of the objects produced and made in the current context can be considered in all respects contemporary: the fact of being able to trace their genesis back to the present time is therefore a necessary but not sufficient requirement to be defined as such.

Clothes, like other categories of artefacts, are balancing a dualism of difficult reconciliation: on the one hand the cyclical re-proposition of tradition, its enhancement and the maintenance of ties with the past, on the other the push towards innovation, the search for a language compatible with the complexity of the present and the ongoing digital revolution. The paper is

particularly interested in analysing those Avant-guard (Szabolcsi, 1971) realities breaking the cyclical re-proposition of tradition, instead taking new directions to explore other territories and generate innovation, proposing not only a new aesthetic, but also a new vision of the world. But where do they head?

2. Hybridisation and Innovation

> "Who are we, who is each one of us, if not a combination of experiences, information, books we have read, things imagined? Each life is an encyclopaedia, a library, an inventory of objects, a series of styles, and everything can be constantly shuffled and reordered in every way conceivable." (Italo Calvino, 1988)

In his Six Memos for the New Millennium, Italo Calvino (1988) listed multiplicity among the six values that were to underlie the new millennium's literature. He envisaged the novel of the future as a large network in which different kinds of knowledge and diverse codes could generate a new and multifaceted vision of reality. The multiplicity value anticipates aspects which were subsequently to characterise both the internet and the structure of unsolvable complexity inherent in the contemporary world, a 'system of systems' based on integrated links and the coexistence of diverse elements which inform everything (Gadda, 2007).

Indeed, the world nowadays is becoming increasingly complex and interconnected; thus, the challenges of the modern times require the cooperation of various actors who avail themselves of different types of knowledge and skills, thereby integrating them and making them complementary. Our present is propelled forward by rapid changes which have affected every area of knowledge. In the meantime, the vast availability of information has blurred our perception of points of reference once embedded in our history, such as the analytical, linguistic and cultural ones.

In a context such as the present one, a dialogical approach shifts an individual and partial perspective to a choral, inclusive one, and may therefore enable the creation of shared and integrated solutions based on multilateral participation.

The boundaries between various branches of knowledge are not closed, but rather allow for constant infringements, and in fact present themselves as areas open to contamination and mediation (Lozupone, 2015). Indeed, modern disciplines are best seen as a complex interaction (Pizzocaro in Bertola & Manzini, 2004) among a plurality of systems (Von Bertalanffy, 1971): the various empirical sciences may therefore be reduced to conceptual models, each of which relies on interdependent elements that intersect one another.

The reasons behind such hybridisation, or cross-fertilisation, among different branches of knowledge with little in common are numerous. The first of these is the possibility of

generating innovative solutions, as knowledge transfer is indispensable to give rise to new ideas.

This blend among diverse fields has led to noticeable innovations across a number of them. Therefore, in a contemporary perspective, the ability to innovate appears to be largely dependent on various forms of cooperation among numerous areas of knowledge.

Fashion as a discipline has always been characterised by the intertwining of complex trajectories based on thematic references, borrowed methodologies and the appropriation of various unrelated fields of expertise, with the clear aim of generating innovation.

In the course of history, fashion and technological advances have often influenced one another. This process of hybridisation has opened new possibilities for fashion in terms of innovation, and has generated products and services with enhanced performances, whereas technological inventions have been given the chance to enter consumers' lives and bring innovation to them.

The fashion system is entirely affected by technological progress nowadays. Consequently, the Fashion-Tech sector, which originated in the interplay between fashion design and digital technologies, is a special disciplinary niche in the contemporary world, as it is marked by elements which are unprecedented in history in terms of revolutionary impact. Indeed, digital technologies have wholly pervaded the fashion system in its processes and products, have altered the DNA of traditional paradigms, and have changed the role of the actors involved (Testa, 2019). The interplay of various sectors is attracting a growing number of actors and businesses both from the fashion and the technology sector.

The introduction of digital technologies and ICT has marked a revolution in the fashion system (Testa, 2020). This modern revolution has led to more flexibility in the classic design paradigms, especially those concerning processes, codes and materials, and has mellowed former dichotomies into a seamless spectrum. Natural elements and man-made materials, analogue and digital technologies, standardisation and customisation, the artisan's and the engineer's approach, the outward appearance and the essence, the shape and the function, have all ended up coexisting in this context, and have merged with one another.

Today the fashion industry is a highly complex pluralistic and diversified organism in which material and immaterial products, cultural capital and human resources merge together. As the outcome of a complex integration process among different methodologies and areas, fashion contributes to a new reading of the cultural changes which shape our present, and by drawing on various codes it is capable of generating a narrative which bestows meaning on the relationship between references, materials, technologies, products and processes. Given the need to rise to modernity's challenges and to be innovative, the forms of cross-fertilisation in the contemporary world are becoming ever more daring, while the number of sectors involved is steadily growing, and the skills required are becoming increasingly specialised. Fashion's boundaries are open to the boldest forms of research and experimentation. They are the result of the interplay and mutual integration of highly diversified and specialised fields, which

range from medicine to aeronautics, from engineering to city planning, and from biology to cosmetics. It is these mergers which supply the lifeblood of creativity and innovation. Contemporary fashion designers are forced to operate on more levels in increasingly complex contexts, and to harmonise diverse elements which are in contrast if not in outright diametrical opposition. They therefore show a shared inclination to a high degree of flexibility which conjugates the cross-fertilisation of different kinds of knowledge and know-how and experience a similar need to experiment materially and to reach a developed vision of the technology they apply. Such modus operandi strives to seek and define original scenarios and presupposes a special ability in audaciously stretching the designers' initiatives beyond the comfort zone, thereby challenging and breaking the limitations derived from traditional paradigms such as matter, codes, and processes (Cappellieri, Tenuta, Testa 2018).

3. Future Scenarios for Fashion-Tech

3.1 Methodology

The following part of the paper will address the peaks of innovation and will describe future scenarios for Fashion embracing the digital shift through the identification of future possible directions in regard to new Fashion-Tech products, consumption habits, markets conducted with the scope of evaluating and identifying opportunities and requirements for development of main topics within the areas of Fashion-Tech.

These scenarios may be referred as 'Design Orienting Scenarios' (Jegou and Manzini, 2000) as they allow the exploration and description of promising innovations involving a set of relevant actors. The scenarios are then visualized through a Cartesian coordinate plane, producing a 'Design Plan'—design directions for the development and refinement of innovative body equipment in the field of Fashion-Tech—.

Starting from the idea that a trend is a direction of movement or change in an observed value (Thomsett, 2015), information is the common denominator among all the emerging future directions that are described in the following sections. These are not intended as market trends, but trajectories, at a different stage of development, orienting the design practice within the Fashion-Tech field. They result from observation, analysis and interpretation of emerging issues in the Fashion-Tech context.

This process proposed by Jegou and Manzini (2000) was particularly useful as it helped us approaching in a systematic, coherent and organised way a complex situation with a large quantity of variables. The followed process started with a desk research, with an overview of the state of the art in Fashion-Tech through literature search and review, case studies analysis and interviews.

We then identified main macro trends within the field of interest. A macro-trend can be defined as a change in the context of the current system that may have a potential effect on its

development (Manzini et al. 2009). For the field of Fashion-Tech we found as a relevant and discriminating element the degree of interactivity of a product (autonomous interaction/controlled interaction) and its scope in relationship with the body (functional/expressive).

It was created a Cartesian coordinate plane according to the polarities:

- the scope on the abscissa axis: on one side functional body equipment and on the other one expressive body equipment;
- the degree of interactivity on the ordinate, based on autonomous interaction and controlled interaction.

Lastly, we used the Cartesian coordinate plane to map the case studies and we built different alternative scenarios exploring potential reconfigurations of the current fashion system. The scenario building methodology we followed made use of a polarity-based approach, represented within a Cartesian coordinate plane. Polarities show possible variations along one dimension of a piece of body equipment, between opposite directions.

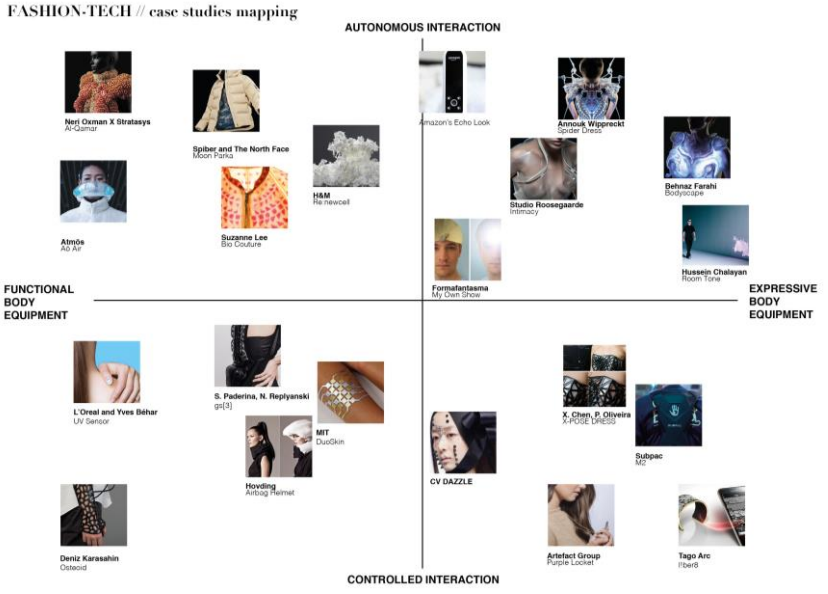

Figure 1. Fashion-Tech Design Plan, case studies mapping. Source: Authors.

3.2 The Four Macro Areas

Four macro areas emerged from the Design Plan methodology that may represent a direction of future development and potential applications of the products for the Fashion-Tech.

The four scenarios are:

1. Artificial Second Skin: body equipment with embedded sensors is able to monitor human body parameters that are critical for healthcare
2. Hyper-Body: products are becoming increasingly connected with the body, becoming part of it
3. Fashion-Tech Takes Care: sustainability – intended as efficiency, recyclability, transparency and ethical upgrades – can cover the entire fashion supply chain
4. Physical Avatars: digital beauty in real layers

For each Fashion-Tech scenario, most of the products, technologies, fabrics or techniques come from worlds apparently far from that of fashion and are only the result of the meeting of different disciplines and fields. Medicine, architecture, gaming, robotics and automotive are just some of the areas where most of the innovations we are seeing are being implemented.

The examples contained in the following paragraphs are presented in an order that is not intended to highlight the state of diffusion, marketing, or development process of the product, but to picture and highlight general common trends, the existence of some avant-garde sectors, generated by contamination and integration with areas other than fashion. It is in fact a transversal research towards the approach to innovation in the field of fashion.

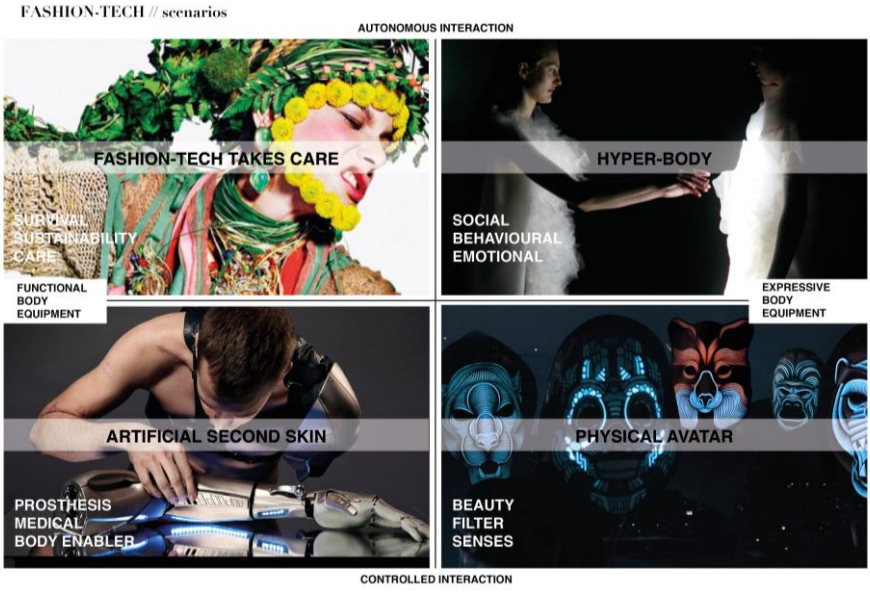

Figure 2. Fashion-Tech Design Plan, scenarios. Source: Authors.

3.2.1 Artificial Second Skin

The first scenario concerns body equipment behaving like a second skin, from one side monitoring or intervening on body parameters and on the other side acting as body prostheses to control external environments or smart devices.

It features products whose interaction activation is controlled: they can be activated either by the environment or by the users, enabling them of enhancing their performances, opening the possibilities of spreading new behaviours. For this reason, this category of body equipment is mainly purely functional.

While health and wellbeing products had previously been focused on providing information on the users' vital signals for a quantified self to improve lifestyle and control it, wearables and smart textiles with embedded sensors can monitor physiological, neurological and body kinematic parameters, critical for healthcare (Cho, 2010). Body signs, such as heart rate, respiration and motion patterns, can provide data to detect behavioural changes and health risks, diagnosing issues at early stages (McCann & Bryson, 2009; Cho, 2010). Fashion and product designers, and textile, electronics and material engineers are the main professionals involved in this first macro area. It is a mature and marketable scenario, that involves robotic, automotive, military and medicine fields.

Within the medical field, GS[3], designed by Snezhana Paderina and Nikita Replyanski, is a graduated spine support system providing dynamic back support. It is addressed to patients suffering from medical conditions, which cause joint hypermobility and chronic musculoskeletal issues requiring daily spinal support. Using data assessed by an integrated neural network, the lightweight cable mechanism of the graduated spine support system can easily and precisely be adjusted to the wearer's rigidity and support level. Within the same field, VTT Technical Research Centre is interested in creating wearable sensors and technologies to understand human movements and behaviours, while CCT Group is developing protection sensors and actuators, artificial muscles and second skin interfaces.

Moving to the field of safety, the main target group for protective wearables is mostly sick or elder people, who are statistically not highly familiar to digital technology. This instead may be helpful to predict possible future accidents or health problems. According to a study published in Smart Clothing Technology and Applications, people in general are keener in welcoming in their daily body equipment smart items that would satisfy physiological and safety issues (Cho, 2010), which are placed at the base of the Maslow's pyramid of human needs.

Thus, the need for protective garments is further proven. Protection is not only connected with monitoring the body but also with safety. Hövding 3 is an airbag for cyclists that is worn around the neck such as a collar. In the event of an accident, the airbag inflates and covers head and neck as a protective hood. Sensors inside the collar read the cyclist's movement pattern 200 times per second. In the event of an accident, the airbag inflates in 0.1 second.

The UV sensor by L'Oréal and Yves Béharto fits into body equipment designed with safety purposes, as it protects the wearer against melanoma. It is a small UV Sense device which works without the need for a battery: its dimensions are so small that it is possible to be worn on a nail. The device tracks sun exposure, as a way of lowering the risk of skin cancer.

Finally, the last case study deals with a piece of body equipment directly applied on the skin. Designed by MIT Media Lab, DuoSkin is a fabrication process that enables users to create customized functional devices which can be attached directly on their skin, as metallic jewellery-like temporary tattoos. Using gold metal leaf, a material that is cheap, skin-friendly, and robust for everyday wear, DuoSkin is designed to allow three types of on-skin interactions: sensing touch input, displaying output, and wireless communication. DuoSkin devices enable users to control their mobile devices, display information, and store information directly on the skin.

3.2.2 Hyper-Body

Hyper-body concerns body equipment designed with a high aesthetic and expressive value and not fully controlled by the user's will.

In the relationship between technology and fashion, the body plays a crucial role. While on one side technologies are becoming autonomous, contactless, wireless, on the other side products with embedded technology are becoming increasingly connected with the body and the skin, in some cases becoming part of them.

Starting from medicine, engineering and military fields, artists, fashion and textiles designers together with electronic engineers explore how to develop new body languages, through wearables and smart textiles.

Some projects are working on designing wearable items with behavioural attitudes, able to respond with a certain degree of autonomy to body or environmental stimuli. Some products are able to react thanks to the properties of the smart materials as My Own Show by Formafantasma. This head piece moves from the idea of preserving the privacy of the wearer and works against facial recognition. Hacked flashlights mounted on a golden radiating wire construction will flash as a reaction to other cameras, resulting in overexpose of the face of the wearer. The headpiece questions the thin borderline between the private and the public, and the way we daily 'sculpt' our own image on network communities.

Some other more radical projects investigate instead the capability of a garment to assume the behaviour of animals.

The Spider Dress 2.0 by Dutch designer Anouk Wipprecht, for example, well shows the power and beauty of technology when integrated into body equipment. The 3D printed item features animatronic mechanical limbs with sensors, that protect the wearer's personal space.

Conceived to respond to external factors through proximity and respiration sensors, the piece extends or retracts its limbs once the sensors are stimulated.

Another project that explores the relationship between people is Intimacy by Studio Roosegarde. These high-tech garments are made of smart e-foils able to track and respond to the wearers' life signals, such as heartbeat. The e-foils become more or less transparent based on the wearer's interactions with people, creating a sensual play of disclosure.

Within the context of project exploring the behaviour of the human body, Bodyscape focuses in particular on highlighting and enhancing the wearer's movement through light. As the wearer moves, the garment lights up thanks to embedded LEDs. The lights are controlled by a gyroscope that tracks the shoulder movements of the body. Bodyscape is not only a technologically advanced fashion item produced using 3D printing technology, but it also raises fashion to the poetic dance of light and human movement: it amplifies the performative qualities of the body in motion and creates an enchanting, illuminated choreography of the movements.

In this context of Fashion-Tech performances it is simply not possible to overlook the work of Hussein Chalayan, one of Fashion-Tech's visionary forerunners, who began experimenting with the application of wearable technology to haute-couture right from the establishment of his brand in 1994. He has amazed the public of his fashion shows with clothing that changed shape by means of microchips, dresses with countless embedded LED lights which reproduced the same effect as pixels on a screen, and tables that turned into gowns. For his SS 2017 collection he cooperated with Intel on a line of technological clothing that was showcased at Paris Fashion Week. As models moved along the catwalk, images relating to their stress levels were being projected on the wall behind them, something that was made possible by the biofeedback which the accessories they were wearing kept sending. Glasses powered by the Intel Curie module gathered biometric data from three different sensors. Combined they were able to infer stress in real-time. That data was then communicated to a belt via a Bluetooth and then translated into the visualizations displayed on the wall as the models moved down the runway.

It goes from products to services able to store data and working through artificial intelligence.

Echo Look is the device launched in 2017 by Amazon that acts as a virtual stylist giving fashion advices. It is a smart camera that reacts when the user awakens its smart soul, invoking Alexa the Echo products virtual assistant. Once the outfit is worn, Alexa is asked to take some photos in different positions and from all angles. Having collected the data, Alexa compares the outfit with other ones already stored in its database, giving a preference based on algorithms. Thanks to these smart devices Amazon can collect an infinite amount of data and information about its users extremely quickly. These data are useful to better profile consumers' tastes with ever greater precision, to propose items that we might purchase on its platform.

3.2.3 Fashion-Tech Takes Care

Sustainability goes across design, production and retail covering the entire supply chain and it is intended as efficiency, recyclability, transparency, mission orientation and ethical upgrades. Involving mainly smart textiles and digital manufacturing, the level of maturity of this trend is very high as well as its marketability. Usually the presence of technology is behind the scenes and it is managed by material and textile engineers, biologists, computer scientists and fashion and product designers.

Due to the fashion industry´s high impact on the environment, investing in technological solutions to decrease its negative effects is crucial (Forbes, 2016). While digital technologies, such as 'see-now buy now' concept or digital solutions offered by companies such as Berge and Teko Solutions can decrease waste by producing only what is in demand, involving microbiology and biotechnology into fashion to produce biodegradable garments can close the cycle of production, disposal and re-use (Seymour, 2010). Thus, some realities, such as BioCouture and Bolt Threads, are advancing sustainability working with sustainable fibres and production techniques. While BioCouture´s aim is to grow garments from bacterial cellulose (Seymour, 2010), Bolt Threads is brewing spider silk protein to then spin it into yarn (Forbes, 2016). According to Danielle Wilde, Associate Professor at the University of Southern Denmark, designers should learn from biology in order to shift their design process to more sustainable practices. On the other hand, a sustainability related issue requiring attention relates to different theoretical life spans of textiles and the electronics utilized in wearables (McCann & Bryson, 2009), which can be challenging for a workable integration of the two (Seymour, 2008).

Moon Parka, developed by Spiber together with The North Face, made from artificial spider silk, is designed to endure the harsh conditions and intense cold of the South Pole. Spiber staged a five-step innovation cycle in order to produce ever better qualities of artificial spider silk. It starts with molecular design: designing amino acid sequences, on the basis of bioinformatic analyses, that deliver better tensile strength, elasticity and heat tolerance. The second step is gene synthesis: synthesising genes that produce the desired amino acid sequences. Then, microbial fermentation. The synthesized genetic DNA is introduced into microorganisms. Test spinning can begin as soon as 10 days after gene synthesis is complete, once fermentation and refining conditions have been fine-tuned. The fourth step is spinning. The fibroin proteins produced through microbial fermentation are refined and formed into fibres. Spiber established a scalable spinning process that paves the way for mass production of artificial spider silk. Finally: prototyping. Spiber produces textiles and composites from their new materials; they assess their productivity and functionality. They feed back this data into the next generation of molecular design, after which a new cycle begins. The result of all this hard work is enormous: compared to when they started in 2008, they have dramatically increased productivity and decreased costs, bringing us to a place where large scale adoption of protein materials is finally becoming a reality.

Sustainability is becoming a trend, and this is demonstrated by the interested to the topic by the fast fashion giants. H&M group have partnered with Swedish company re:newcell, whose unique technology recycles used cotton, viscose and other cellulosic fibres into a new, more sustainable dissolving pulp. The pulp can be turned into new textile fibres and be fed into the textile production cycle. The partnership is another step towards H&Ms goal to use 100% recycled or other sustainably sourced material by 2030. Also, the birth of the first global retailer in fashion launching Gold level Cradle to Cradle (C2C) CertifiedTM T-Shirts. C&A produces in consideration of the environment, in a way that does not create excess waste, uses only safe chemicals and dyes, produced in a socially responsible way and is designed for its next life.

Sustainability also includes all those products that foresee an 'apocalyptic' vision of the world, in the event that there is no action in time with sustainable solutions.

Some products for example are designed to assist us in the act of breathing, such as Aō Air Atmōs. Consumer concerns regarding air quality are increasing on a global level due to the high levels of pollutants found in urban areas, which is seeing new products like the Aō Air Atmōs wearable air purifier be developed. The purifier works by being worn over the face and creating a light seal over the face to let the user enjoy purified air throughout the day when commuting or exercising. The unit doesn't focus on creating a tight seal around the face in order to not cause discomfort and allow the skin to breathe instead of feeling hot or constricted.

Other projects instead explore alternative territories, such as life in space or on other planets. For the future - the fourth revolution - Neri Oxman predicts the arrival of what she calls the Biological Age, in which microorganisms, living matter, and wearable micro-biomes will be designed that nourish the skin or photosynthetic buildings will be built that convert carbon into biofuel.

3.2.4. Physical Avatars: Digital Beauty in Real Layers

In the last scenario, the user-controlled product becomes a purely ornamental interface to create new digital-experiential levels within the physical world.

The body can be counterfeited as with CV Dazzle. CV Dazzle explores how fashion can be used as camouflage from face-detection technology, the first step in automated face recognition. The name is derived from a type of World War I naval camouflage called Dazzle, which used cubist-inspired designs to break apart the visual continuity of a battleship and conceal its orientation and size. Likewise, CV Dazzle uses avant-garde hairstyling and makeup designs to break apart the continuity of a face. Since facial-recognition algorithms rely on the identification and spatial relationship of key facial features, like symmetry and tonal contours, one can block detection by creating an ‘anti-face’.

In other cases, the body can be revealed according to the type and intensity of interactions.

X.pose for example deals with digital data production. Since we have already ceded control of our digital data emissions, X.pose broadcasts the wearer's data for anyone and everyone to see.

Users can directly control the aesthetics of their items, customizing them and adapting them to their taste. TagoArc is a bracelet featuring a full E Ink display that can change according to the user will. Thanks to a smartphone app it is possible to change the displayed pattern on the item an infinite number of times.

Another layer that can be created is that of memory taking a digital form. Design studio Artefact Group created a conceptual smart locket that wirelessly interacts with social networks to display a digital memento of friends or family. Intended as a benchmark for how fashion and technology can complement each other, Artefact's Purple is a proof-of-concept locket that wirelessly receives images and messages from the wearer's social networks, offering a 21st century update to the traditional keepsake. The locket is able to connect to social networks, but rather than swamping the wearer with every possible update, the user first selects the people they'd like to receive notifications from. An accompanying app enables further options like creating personalised keepsakes with filters and effects, or adding and removing people from the update list.

The added layer can also be haptic to amplify the musical experience. Subpacby M2X is a tactile transducer to be worn on the back that conveys to wearers a physical impression of sounds just as if they were in a real club.

4. Conclusions

> “As we move deeper into the twenty-first century, it becomes ever clearer that the ultimate, most intimate territory for design is not electronics, or interiors, or furniture, or the web. It is us—our own living, breathing, biological selves.” (Rick Poynor, 2013)

For a long time, digital innovation applied to body equipment has been mostly carried out by the technology industry.

Engineers and scientists have moved their research mainly in function of an improvement in terms of quantifiable performance, data and mathematical results, with the aim of pushing humanity constantly beyond its limits.

Contemporary society is markedly based on performance, on overcoming borders, breaking records, in the incessant pursuit of the myth of the super-human. The fantasy that nourishes the common imagination is that new technologies applied to the body and clothing have the aim of becoming functional prostheses capable of improving human performance and therefore, as a direct consequence, his quality of life. But is this really the case?

In this regard, the reflections of Sobchack are interesting. Through her essays, she deals to varying degrees with the theme of the 'techno-body', a personal and stringent question following the surgical amputation of one of her legs as a treatment against cancer. In her 1995 essay on computer theory, Sobchack criticizes the "delirious liberating rhetoric of technophiles" and does so from the position of someone who is "technologically enabled in the most intimate way", but who is not and does not feel, however, a cyborg. In particular, she addresses Baudrillard (1991): "(...) Unlike Baudrillard, I have not forgotten the limitations and finitude and naked capacities of my flesh – nor, more important, do I desire to disavow or escape them" (Sobchack, 2004, p.172). While not a 'technophobe', Sobchack argues that a critical emphasis on the 'lived body' is crucial to providing an ethical basis for issues relating to the intersection of technology and the body (Sobchack, 2004, p.172). This is why performance for those who live with the need to use bodily prostheses is no longer a priority, but the priority becomes the possibility of 'normality'. And this is precisely the crucial point. The theme of innovation and performance, whether or not enabled by digital technologies, is approached from a different point of view from engineers and scientists to designers. Progress has long been a monopoly of science and this has led to its being associated over time with values linked to performance and functionality.

Today, an increasing number of designers are working in the field of biological research, creating speculative and critical design projects, in an attempt to encourage the public to actively participate in the discussion of scientific advances and ethical issues surrounding them.

The growing interest in these hybridizations is evidenced by the inclusion of degree programs in design that intersect with scientific disciplines, from Design Interactions at the Royal College of Art in London, to Contextual Design at the Design Academy in Eindhoven, to the Master courses dedicated to Fashion-Tech at Politecnico di Milano.

In this territory, design and fashion have the task, or at least the possibility, to bring the results of the most daring scientific progress closer to a human and tolerable dimension.

What is urgently needed is to initiate a substantive discourse on the role and contribution of designers when collaborating with scientists and engineers.

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