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# Fashion Wearable Between Science and Design, From the Product to an Overall User Experience

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## To cite this article:

Alba Cappellieri, Nicholas Henchoz, Livia Tenuta, Susanna Testa. Fashion Wearable Between Science and Design, From the Product to an Overall User Experience. *International Journal of Literature and Arts*. Vol. 8, No. 1, 2020, pp. 12-22. doi: 10.11648/j.ijla.20200801.13

**Received:** September 17, 2019; **Accepted:** February 6, 2020; **Published:** February 14, 2020

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**Abstract:** The purpose of the research is to develop a fashion wearable design methodology that could potentially embody authenticity. The paper first indicates and analyses the limits of wearable technologies here intended not only as products, but also as a systemic and procedural dimension offered by a design-oriented approach. A market analysis and a literature review had been conducted to provide the theoretical framework needed for a practice-driven inquiry into the design process. Starting from the limits of wearables, the experimentations on the methodology to design wearable devices run by Politecnico di Milano with EPFL + ECAL Lab gather 4 workshops and 2 industrial partnerships over 3 year. The findings offer the opportunity to reinterpret the design process and the interaction that designer have with areas such as art, technology and science. They lead to redefine both the design processes concerning the very meaning of the object and the interaction between human, object and context. The results of these experiments are presented in the form of an advanced methodology to design wearables and the value of this approach leads to an emphasis of the designer's cross role and it can provide significant social and practical implications both in the academic research and in the market.

**Keywords:** Wearables, Fashion-Tech, Design, Technology, Process, Interaction, User-Experience, Methodology

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## 1. Introduction: A Snap-shot of Wearable Technologies Today

Historically fashion and accessories have served as tools to turn new technologies, such as smart fabrics or new materials, into convincing products. As a matter of fact fashion is considered as an extension of both the physical and the aesthetic body – and it has been one among the first ways technology began to enter the physical body's space [1].

Today, the fashion field is permeated by an extraordinary number of technological developments, whose main innovative features are based on their "disruptive" nature, meaning the prerogative of creating unexpected development conditions or, much more frequently, breaking the pre-existing settlements.

Wearable devices and, more in general, fashion technologies have been forecasted as the next future major trend.

“Wearables are one of the newest frontiers in the tech space”, as well as “wearable technology like the Fitbit is becoming increasingly popular and that trend is only going to increase as the technology improves” [2] and “technological innovation, or Fashion Tech, is a strategic issue for the fashion industry's future, and the arrival of technology in this universe continues to shake up codes and practices.” [3] are just some of the main reasoning around the wearable market.

Although sales tend to increase on a global scale for wearables, this picture does not look as the promised Eldorado. In 2017, the total number of devices sold (including bracelets, watches and head mounted displays) reached almost the 7.5% of the entire cell phone market with a progression of nearly 7.3%. By comparison, according to Statista, the average increase of sales between 2005 and 2015 within the smartphone market was around 35.6%, with many years scoring almost a 60% growth before approaching steady state.

The trend of digital wearables has not stopped at all and

indeed the shift from consumer gadgets to business tools keeps growing. As ABI's research points out, wearables are now in higher demand by enterprises rather than the consumer market [4]. This is also shown by the recent patents by Amazon: the company developed wearable devices able to guide employees' movements by tracking the handled products' location and giving vibrational feedback.

"Enterprise wearable device usage is continuously on the rise because more and more companies are understanding the benefits of deploying the devices to specific tasked workers," states Stephanie Lawrence, Research Analyst at ABI Research. "Return on Investment potential is continually shown, and key performance indicators are proving positive. This will continue to cause enterprise wearable shipments to rise at a higher rate than consumer wearable shipments, where the devices productivity improvement benefits do not have don't have the same impact."

Indeed, current trends seem to be very unstable among the various devices. If bracelets remained the first item for units sold, this number dramatically drop down in 2017. Matt Turk analysis shows that Jawbone went out of business, and Fitbit or GoPro stock prices considerably decreased from their 2015 or 2016. Apple seems leading watches take over, even if companies are stingy on numbers. Consumer Electronic Show 2018 (CES) didn't show signs of accelerations for wearables or revolution for mass market, including for other types of devices like head mounted display. To meet market's demand, watches are driven by electronic industry even tough companies are mostly mimicking the code of traditional watch manufacturing (Samsung, LG, Huawei; etc.). Intangible values of fashion and accessories design are barely present and initiatives from the traditional fashion industry are rare. With its connected modular watch, Tag Heuer seems to be an exception, followed in January 2018 by Skagen. Several examples, such as Jawbone Health furtherly stresses the desire of moving out of the fashion realm and find their suitable market in professional environment. Augmented reality shows similar evolutions.

The following paragraphs aim to analyse the limits of wearable technologies.

### **1.1. Limits in Wearable Market: Opportunity for the Design Field**

When asked to describe the fashion industry in a word, fashion executives mention three ahead of all others: "uncertain," "challenging," and "changing." [5]. This perception is underscore by sales figures in 2017, showing a dramatic drop for many bracelets producers, for instance. The slow growth of the global market of wearable, far from other devices like smartphones, involves different levels of limitation

1. The product: meaning both the technological components that make a product "smart" (this includes the sensors, indicators, transmitters - as well as requisite power sources - that are layered into a physical product to add functionality) and the shell that will contain the hardware.

2. The experience: the product with the suite of apps, services and interfaces that the user interacts with the interfaces may be on the wearable itself (as in a full-display watch) or synched to a device (as with a fitness tracker).

### **1.2. The Product**

Besides the ones belonging to the category of fitness tracker, yet still aimed to be included in the ready-to-wear sector, Fashion Tech products currently on the market are struggling to achieve satisfying results.

As the need for complex, differentiated use cases for wearable devices grows, size and weight don't match expectations for specific use, such as 130g smart watches meant to be used while running. A recent study from the User Experience Strategies (UXS) service at Strategy Analytics "UXS Technology Planning Report: Wearables", investigating the needs, behaviours and expectations of consumers regarding wearable devices, has found that hardware design is one of the most obstructive factors for wearable devices because it inhibits what they can do.

Wearable devices need to meet demands in terms of size, power consumption, safety, security and wireless communication. In addition, they must also be convenient, comfortable, unobtrusive, and in many cases "fashionable".

While the first generation of wearable devices often showed limited communication capabilities, such as for example the Bluetooth link to a smartphone, the newer emerging generation of these products is an integral and seamless part of the Internet of Things.

Among the main technical limits of wearable technologies, the most significant one is the duration of batteries. A fresh batch of growth predictions on wearables has once again highlighted the burning question of power usage.

However, the power/performance profile for wearables remains much lower than those for smartphones because wearables, being small, can only use small batteries. Bigger batteries tend to reduce the wearability and the comfort of the final product and increase design and aesthetics constraints in terms of size and shapes. Most wearables and smart watches available on the market has a battery life of 1-2 days.

Therefore, one of the major efforts today is reducing the battery size, increasing its efficiency and more in general finding ways to easily power them.

### **1.3. The Experience**

The past has taught us that the most successful products with integrated technology, from mobile telephones to music players, were intuitive, fashionable and human.

The first goal that wearables should achieve, as a matter of fact, is usability: they need to adapt to movements to such an extent that they do not make the technology perceptible. In the book "The Design of Everyday Things" Donald A. Norman identifies the principles of good design. Some of the most important ones seem to be providing the user with a good conceptual model for understanding the object, highlighting the

parts to be used and clarifying how to do it, using spontaneous mapping, creating analogies with the natural behaviours and giving feedbacks on the performed tasks. Henchoz suggests three typologies of designing for Augmented Reality: hiding the technology, making it super normal (i.e. inducing a sentiment of essence of normality), divert perception through introduction of well-known references.

All these considerations lead to a perception of simplicity. This simplicity is the key to successful design because “simplifying means trying to solve the problem eliminating all that is unnecessary to the achievement of the functions [...] it is difficult work and it requires a lot of creativity” [6].

And yet simplifying is not so easy when it comes to technology because this is itself very complex, with its sizes, limits and rules. The designer has to be able to engineer the object’s functions and user interaction in the most natural possible way. Many products on the market today exploit the user’s natural gestures. This is the case of Neyya, a ring that enables the wearer to scroll presentations, take pictures and control videos, calls or messages through the natural movements of the hands. Despite being much less refined in its aesthetics, O2upcycle is a smart glove that creates a connection with the phone. The user can pick up a call by reproducing the “telephone receiver” gesture, approaching the hand to the ear. After being repeated for so long, these simple gestures have become part of people’s everyday habits and can now simplify the usability of objects when integrated in such behaviours. When users learn something very well and this pervades their everyday lives, they stop having the impression that they are making an effort [7]. This phenomenon is called ‘compiling’ by Herb Simon, ‘visual invariants’ by the philosopher Michael Polanyi, and it essentially defends the importance of the non-invasive perception of technology.

Previous analysis suggests that the limits of FashionTech products addressed to the consumer market can be traced back to a lack in the structure of the realities operating in the sector, which seem to struggle to evenly manage all the different aspects of the project. The resulting objects are closer to prototypes rather than to products being ready for market production. The analysis clearly shows the difficulty of moving from prototypes to serial products: they are made on demand, with consequently very high costs, not sustainable in the field of ready-to-wear. Such products do not often follow seasonality and the logic of the fashion system as they have not been developed as a part of a collection.

Starting from a wearables market analysis, we concluded that limits can not only be technical, material or formal as they also concern the design process, intended as the entire user experience. What is still lacking is a shared methodology among the different actors involved.

The main objective of our research was to define a methodology able to combine the processes of fashion design and the engineering approach. This would satisfy in a more general way the market request with more versatile professionals able to control an emerging topic (i.e. wearable technologies), developing competences to design innovative products.

Such products are innovative for their ability to improve the experience of the user and at the same time to be effective on the side of performances and aesthetics [8].

Within the field of fashion technology, fashion design and engineering methods are currently applied alternately or in an imbalanced way. This result shows a lack of integration and dialogue between the two fields. This has significant impact on the relationship between form and function of a product, and it generates a negative or misperceived user experience, while creating experiences is crucial for launching a successful product on the market today.

## 2. Design Methodology for Wearables

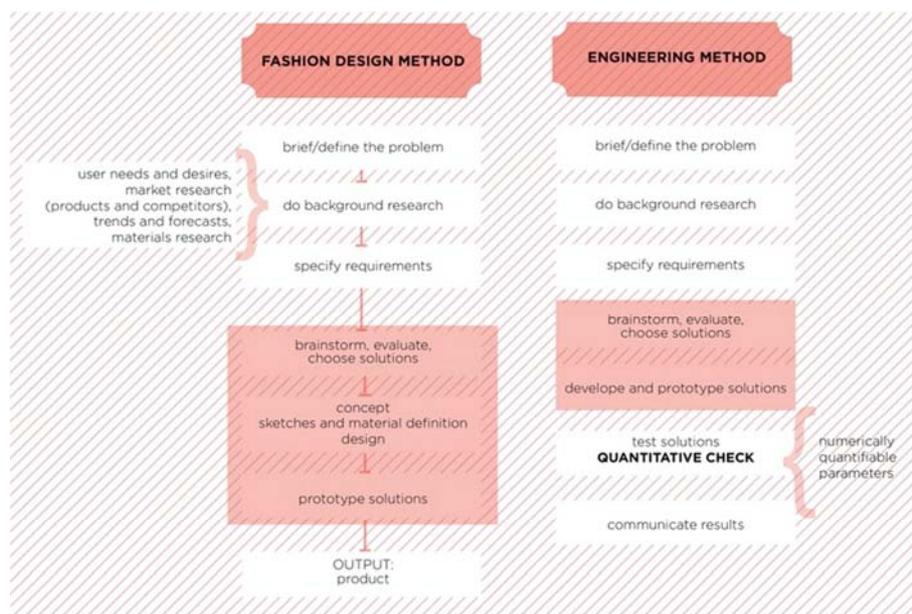
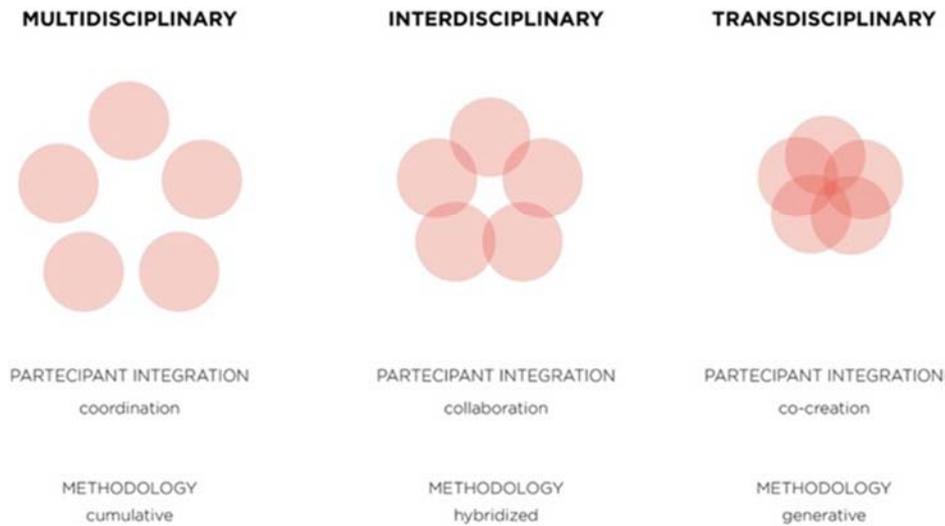


Figure 1. Comparing Fashion Design and Engineering Methods.

## 2.1. Research Methods



**Figure 2.** Methodologies and approach used to test applied research experiments.

To achieve the goal of creating a design methodology dedicated to FashionTech, the methods used belonged to the field of applied research, conducted through an analysis of case studies and pilot workshops participant observation.

With this aim we tested the application of three different approaches [9]:

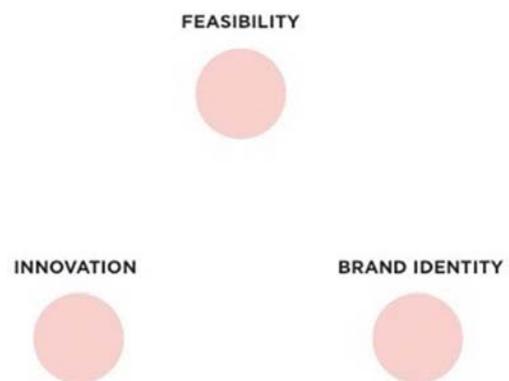
1. A multidisciplinary approach where the different actors work in coordination through a cumulative methodology (which is the sum of every single method) that is able to merge the experiences of each participant;
2. An interdisciplinary approach based on a deeper collaboration among the actors, generating a hybrid methodology;
3. A trans-disciplinary approach, which is at our eyes the most effective, where the participants work together and share knowledge and processes, in a continuous exchange along the steps, therefore creating a generative methodology.

The success of the three methodologies was tested in a qualitative way according to the following parameters:

1. The technical and technological feasibility in terms of performances, price, industrial development;
2. The innovation degree (here intended as the capability to generate new contents);
3. The brand identity for the coherence to the aesthetics of the client company.

We also introduced in the last workshop as well as in one of the partnership the notion of user experience design. User experience has a blurry definition in literature. We define it here as the full set of devices and services delivering the value proposition. This definition is inspired by Osterwalder and Pigneur's approach [10] to value proposition as "statements of benefits that are delivered by the firm to its external constituencies". They include products, services and complementary value-added services. This notion of services is instrumental in behavioural changes as it can also provide a way to disseminate cognitive content and awareness about the use of

a radical innovation. Such principles developed by Baird and Fisher can be applied to provide knowledge on new practices, meanings and products: "Social networking media engages the user in the content and allows them to be included as an active participant as they construct a learning landscape rooted in social interaction, knowledge exchange, and optimum cognitive development with their peers." The focus of these authors on Neo-Millennial users can be extended to inclusive design of full user experience by using new design practices developed by Henchoz and Mirande [11], involving the idea of essence of normality in disruptive innovation, coined as Super Normality by the designers Naoto Fukasawa and Jasper Morrison [12]. Prototyping and understanding of user experience impact are crucial elements as they might bring unexpected results. Redström stated that there will always be, to various degrees, a difference between the intended use that governs the design process and the eventual use of the resulting design [13]. He underlines the importance to create designs which allow such a shift. However, to take advantage of these evolutions in the user experience and build sustainable proposition, evaluation must bring an understanding of user perception and behaviour, like the chronogram project showed.



**Figure 3.** Parameters to test the methodology.

## 2.2. Experimental Work

Our research takes advantage of several experimentations carried out between the Politecnico di Milano and the EPFL+ECAL Lab. On the one hand, a series of workshop, led mostly in one week with a high number of young designers, ranging between 20 to 52. Due to short timing, these experiments are limited in terms of research practices, yet are able to offer a high number of propositions. On the other hand, industrial research partnerships offer in-depth investigation on specific topics. These experimental works and their outputs regarding FashionTech design methodology are summarized in the following paragraphs.

Specifically:

- A. Workshop series with the aim to test different design approaches (multidisciplinary, interdisciplinary and transdisciplinary) and working groups:
  1. Fashion design approach
  2. Fashion design integrating technological innovation
  3. Fashion design and engineering co-creation
  4. Full user experience approach
- B. Projects to move from the academic field to the market:
  1. Baraka: Product Methodology
  2. Chronogram: User perception

### 2.2.1. Workshop 1: Fashion Design Approach

The workshop was focused on a fashion design practice, but with a turn toward the user experience as it includes scenario creation.

This first workshop involved a fashion brand as a client, a product and interaction expert as a support and 20 young fashion designers who were asked to develop the project. The brief by the company consisted in integrating innovative technology in the field of eyewear.

The process was conducted applying the traditional steps of fashion design methodology: from the launch of the brief by the company, through the research around users' needs and existent products in terms of technology and fashion products so to define and develop the concept.

The main results obtained from this workshop concerned the preliminary phases of the design process, such as the idea to start from a specific target or environment with well-defined features to then extend the use of the product to a wider target. Moreover, a new step is added into the fashion design process: the phase of the scenario definition, describing not only a need but a specific and future context of use for the product.

The brand appreciated the outcomes in terms of innovation but did not consider the issues related to the technical aspects of the products in terms of feasibility since the designers did not have proper skills in digital technologies.

Learning WS1: The scenario definition opens the potential of the technology towards new meanings. But absence of engineering skills blocks the progress just after preliminary ideas.

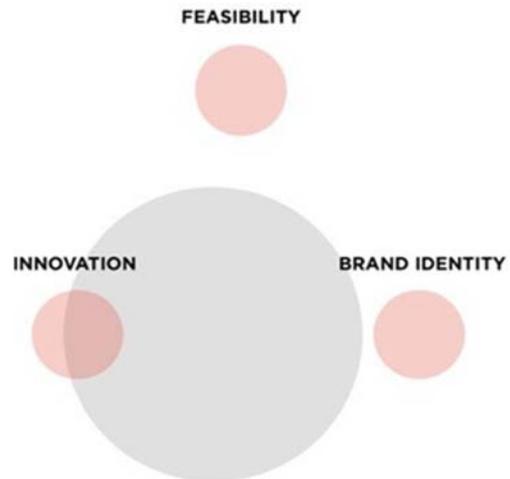


Figure 4. Evaluation of the Workshop 1 outcomes.

### 2.2.2. Workshop 2: Fashion Design Integrating Technology

The workshop asked young designers to include in their work engineering issues to come up with full perspectives of innovations.

Starting from the experience of the first workshop, where the major issue arose was related to a lack in the technological skills, a company focusing on digital technologies (ST Microelectronics) and a technology expert, together with a fashion company (Yamamay) and smart textiles expert, to support the young fashion designers in the projects' development were involved.

The goal of this second workshop was to develop a smart underwear collection, according to the aesthetics and the codes of the fashion company.

Since it was identified as crucial in the previous workshop, the scenario definition phase was included in the methodology. Designers were asked to develop a storyboard to better understand, define and describe the possible experiences they wanted to address and that they identified future trends in the wearable technology market.

The different actors were involved in all the phases of the methodology, but the reviews were alternated.

The consequences of including a technology expert and a company generated chaos along the steps because young designers had to alternate different approaches without integrating them.

Moreover, the role of designers all along the process was unclear: they were asked to solve problems related to technological issues even though they lacked skills in that field and their work should have only focused on design aspects.

Learning WS2: FashionTech projects should source professionals from different fields and should be able to combine their skills, sharing knowledge and methodologies along the process.

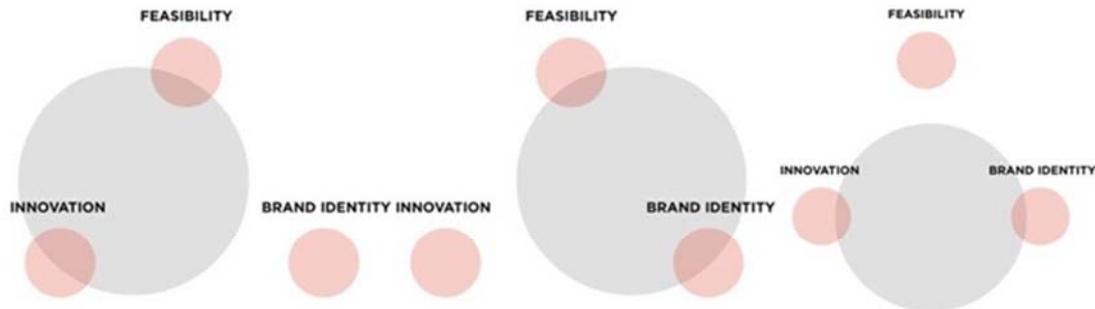


Figure 5. Evaluation of the Workshop 2 outcomes.

### 2.2.3. Workshop 3: Fashion Design and Engineering Co-creation

Young designers and engineers were asked to work together, following a common methodology to define their way to interact.

From the results of the two experimental workshops, in combination with the analysis of case studies taken from the market, it's arguable to assess that contemporary technology and start-up companies are successful examples in the field of wearable technologies. In fact, technology companies' aesthetics is already linked to technological components, while start-ups' s brand identity is associated to an aesthetic that is able to include and be coherent to the functionality brought by technology since their establishment.

So, for the third workshop it was decided workshop promoters had to step back and act independently from the companies. A pilot brief was launched to analyse possible shared methodologies where designers and technology experts had to share the design process from the concept to the communication.

The workshop was conducted by three groups. Each group was composed by a designer and an engineer that had to design a smart bag collection featuring embedded technology and had to work together along every single step.

Even though the brief was the same for all the participants the outputs were completely different, not only in terms of aesthetics but also in terms of functions and interactions.

When it comes to the products conceived, one of the main results consisted in the successful integration between technology and fashion. Fashion becomes a mean to communicate what technology does and vice versa, so the problem of form and function, explained in the first part of the paper, was solved. Regarding the process, the two actors shared the same methodology along every single step: modifying, adjusting and implementing it. The groups decided to include users to collect information and to informally test the project from the idea to the prototype even though they were not specifically asked to.

Learning WS3: In this case, all the projects meet the standards for what it concerns both feasibility and innovation; technology and meaning converge toward a satisfying product. Relationship between project contributors gets more productive.

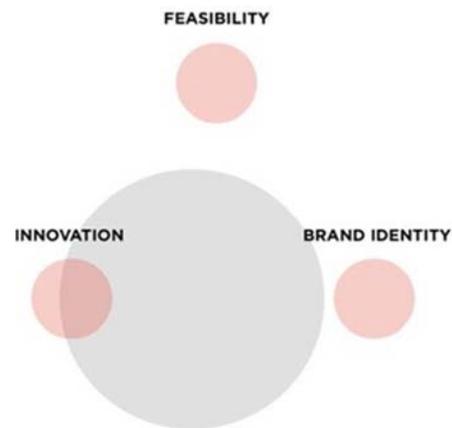


Figure 6. Evaluation of the Workshop 3 outcomes.

### 2.2.4. Workshop 4: Full User Experience Approach

Fashion designer were asked to design a full user experience, having access to engineering expertise to simulate co-creation process.

The participants' assignment was to explore how to take advantage of embedded. Several devices have shown interest of wide audiences for new ways to take pictures, like head mounted camera, instant camera, drones, etc. Go Pro sales, for instance, rose from \$ 64 Mil in 2010 to over \$ 1.6 bn five years later.

Engineering perspectives were brought through a set of components, technological description, and integration constrains. Designers were asked to look beyond the camera itself and dig in the numerous dimensions of what a camera induces. The relation between the person holding the camera and the one pictured is impacted by the act of taking a photo: images in the heat of the moment, posed scenes or stolen actions do not have the same meaning. The way they are consulted and shared also affect the relation.

In consequence, participants were not asked to design just an accessory including a camera, but to develop a full user experience by the following several steps: the first was to define a context of use, including some personas, and the values provided by the experience. Secondly, to write a full scenario of use, from the first idea of taking the picture until the images are, shared, watched and stored. Third to pinpoint the elements needed to create this experience: wearables including the camera, interface of the camera, interface to browse and share pictures, charger, etc. To turn this scenario

into reality, the fourth step requested to gather a mood board and, start to create all the elements needed to design the experience for the final step.

Due to the number of tasks required per proposition, participants were asked to group and form 6 teams. The initial excitement of a new type of challenge led to difficult times: most of the group got lost in the complexity of the challenge after Day 2. But eventually 5 groups out of 6 came out with full solutions. One dug into the idea of a hand mounted camera, using the gesture to control the device, but also to interact with the people photographed. The movement of the hand combines with a wearable to mediate new interactions between people. The second group explored the multiplicity of point of views, playing with multiple attach points, including a new back pack, and a hood. The third one focused on a hood with new sensors to control in a new way the camera. The initial fear of complexity turned into the capacity to think unexpected ways to use the camera, to provide a coherence between all the items included and the defined values, expressed visually in the mood board.

Learning WS4: This approach put the fashion designer at the core of the radical innovation process by creating new meanings. His work led to more than new objects or aesthetics: it generated proposition of new practices, new social rituals. It provides pragmatic perspectives with the emergence of new typologies of devices, new forms of expression.

In parallel to short experimentation through workshops, it was possible to take advantage of two long term research partnerships done in collaboration with industrial players.

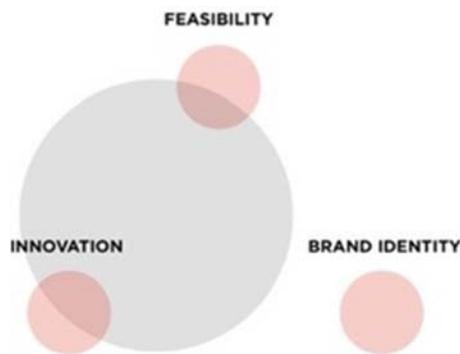


Figure 7. Evaluation of the Workshop 4 outcomes.

### 2.2.5. Partnership 1: Barakà, Product Methodology

The first partnership concerned the creation of a connected quantified-self bracelets for Barakà, an Italian company that caters to a male audience, based on jewellery references by applying a co-creation methodology between fashion designer and the engineer's technology developed.

The research was organized in four phases: brand study, encompassing formal and material aspects, product type and target audience hallmarks; market analysis and potential competitors; identification of existing technologies that could be combined with jewellery; development of a collection that includes scenarios for business as well for leisure.

The brief was to create a collection of technological

jewellery for a businessman over 35. The collection had to include mainly small size and precious bracelets which have not the appearance of a gadget.

Brand and market analysis followed. Also, available technologies on the market were investigated and divided into three categories to simplify the approach to technology: input, output and data transmission.

A separate and much deeper research was instead done for batteries that, as we have seen, represent the biggest limit in terms of size and duration.

Based on existing technologies three possible scenarios of use have been shown:

1. Bracelet>smartphone>bracelet: the bracelet is the tool that receives inputs from the environment or from the body, transmits the data to the smartphone that reworks them and sends the output to the bracelet. For example. The jewel monitors the heartbeat, the mobile phone stores the received data, records that the beat is regular and sends the signal to the bracelet that through a sound, a vibration or a light signal, communicates information to the user.
2. Bracelet>smartphone: the bracelet is the input to activate a function on your smartphone. For example, by contacting the bracelet and the smartphone you have access to private data.
3. Smartphone>bracelet: the phone receives the input and the output is displayed on the bracelet. For example, the user receives a call on the smartphone and the signal is also sent to the wearable device.

Based on the analysis a collection in which all the products had common characteristics was designed. The part containing the technology can be easily removed and replaced to be updated directly in Barakà boutiques, making the user-brand connection increasingly closer. All scenarios rely Barakà app that alerts the user when a new product and latest updates are released, events are organized or if the user is close to Barakà boutique. All jewels are thought not to have a seasonal duration but to resist the passage of time, be upgraded and customized according to the tastes, but always following the brand's aesthetic.

From the direct experience of the realisation of the design, there emerged some difficulties in terms of the development of miniaturised technology on a small scale.

Learning P1: Although the product didn't reach the market as it required more investment to solve miniaturization challenges, the process led to a more productive relation, a well define product, and a clarification of the roles and expertise.

### 2.2.6. Partnership 2: Exploration of Full User Experience Around Head Mounded Display and VR for Luxury Environments

The Chronogram project, aimed to take advantage of head mounted display and virtual reality to provide, in the company's context a new experience with its heritage: Vacheron Constantin has never stopped to produce watches since 1755. It has provided many world premieres in the

history of watchmaking, like the jumping hours watch in 1824 or in 2015, the most complex watch ever made. The heritage department has more than 350 linear meters of archives retracing these 263 years of the history of watchmaking. But how these tons of paper could be turned into convincing user experience? Transforming these old papers into a contemporary informational system was dealt between the Digital Humanity Laboratory of EPFL and the Heritage Department of the Manufacture. EPFL+ECAL Lab had the mission to turn the digitized archives into a convincing user experience. Virtual reality was selected for its ability to provide a global vision of the full heritage, and empower the user to travel in this world of documents. It meant to introduce wearable, i.e. Head Mounted Display at the core of the user experience. But the use of the available devices, mostly designed for gaming, in a luxury environment has been identified as a key challenge towards adoption. The EPFL+ECAL Lab decided to revise the typology of this wearable. A first workshop was performed at the Lab with product designers. Combining a study of existing devices and new direction emerging from the designers, three typologies for HMD were defined: materials and craftsmanship, protection device inspired by fencing masks, and freedom related to touristic binoculars.

The designers involved, under the leadership of Nicolas Lemoigne, managed to build with the lab engineers fully functional prototypes and successfully integrated them in the final scenography. The lab has then conducted a quantitative test with 60 users and qualitative observations with more than 200 people from Europe, Asia and USA, in various locations. Quantitative test showed that redesigned HMD increased the perception of content's credibility. They were also perceived as more comfortable by the users, although additional manufacturing, weight and materials introduced stronger pressure points and limited adaptability for our prototype. The redesigned HMD was judged as comfortable as the original model, although it was not the case physically due to some compromised force by additional manufacturing, weight and materials. Observations with the final scenography and virtual environment, designed by Marius Aeberli and the Lab engineers, showed a focus of users on the content, extended consultation time and trustworthiness. Showed for the first time in 2015, the Chronogram experience continues to travel around the world, hitting the Art Summit 2018 in Verbier, and the Mexico, as World design Capital, the same year. It will be extended in 2019.

Learning P2: This partnership proposes two observation: first combining a design looking for new meaning with a quantitative and qualitative knowledge of user perception lead to sustainable proposition. Secondly, the result is linked to a full user experience approach where content, device, service and technology provide a coherent proposition.

### 2.3. Results

The result of different outputs as well as the feedback from the companies showed the difficulty of satisfying all of the three parameters. The high grade of integration of fashion and

technology with good results in terms of feasibility and innovation leads to an aesthetics that reflects the function of the product, clashing with the image the brand intended to deliver. Indeed, when the traditional image of the brand is satisfied and it is technically implementable, there is not a strong impact on innovation. The latter case is very close to first pilot workshop; therefore, the brand's identity was fully respected and the project describes innovative scenarios, yet technologies are still too experimental - immature or expensive - for an industrial production.

The results obtained from the market investigation showed a significant deficiency when it comes to integrating technology into fashion products, revealing flaws that also affect the process.

To reach a satisfying integration of the different components it is necessary to review the methodology as well as the role of the professionals involved in the process. This renewed methodology should be able to connect and combine the process of design to the one of IT, dwindling the boundaries between creativity and the scientific method.

FashionTech is the meeting point of fashion, industrial design and IT: aesthetics, comfort, the centrality of the user's role and usability should be applied to the sector of electronics and digital technologies, where the inventions and the progress in terms of multi-functionality and performances, dimensions and cost, represent the driving forces. The complexity of languages and the heterogeneity of the actors gravitating around the world of fashion technology entail the necessity of creating a code that better connects the various areas involved, creating synergies among the processes while facilitating the transition from invention to innovation through design.

Indeed, the difference between invention and innovation is subtle yet important. The invention, generated in the scientific field, creates a set of possibilities that are applicable in the consumer market. Therefore 'innovation' is an applied invention, as it produces an impact on the market; invention is about creating something new, while innovation introduces the concept of 'use' of an idea or a method; an invention is often a 'thing', while an innovation is an invention that causes changes in the behaviours or in the interactions.

Wearable technologies, today, represent a real opportunity for the market to generate new behaviours, new interactions and methods, for companies to innovate thanks to the inventive component typical of the world of engineering and the value-driven nature of fashion design.

To better understand how to facilitate this transition, the two methods involved in the field of wearable design were analysed: one mainly focused on creating inventions while the other aimed at driving innovation. Comparing the phases that define the two methods (on one side the one used to design fashion objects and on the other side the one aimed at designing engineering products) may be useful.

The main differences mostly concern the initial phase: if engineering starts from an accurate scientific market research based on mainly technical specifications, the preliminary phase of fashion design focuses on the analysis of trends and

on an investigation about the users’ needs and desires.

Despite the differences between the fields, both methodologies are substantiated by a double common nature: a mainly creative character and a logic one, oriented to scientific strictness.

However, the integration of the two methodologies does not occur in a symmetric way, but it is consequential, causing an undeniable difficulty in interpenetration between the fashion field and the digital domain. This has an impact on the aesthetics and on the functional features of the product, on the

relation between form and function and on the user experience. The latter today represents a fundamental discriminating factor for the success of the product.

Even though this method is widely used either in the academic field and in the market, in the context of wearable technologies, we realized that this method was not adequate to reach fully satisfying results. That is why it was necessary to define a specific method that can better connect and to create synergies between the processes of fashion and the ones involving digital technologies.

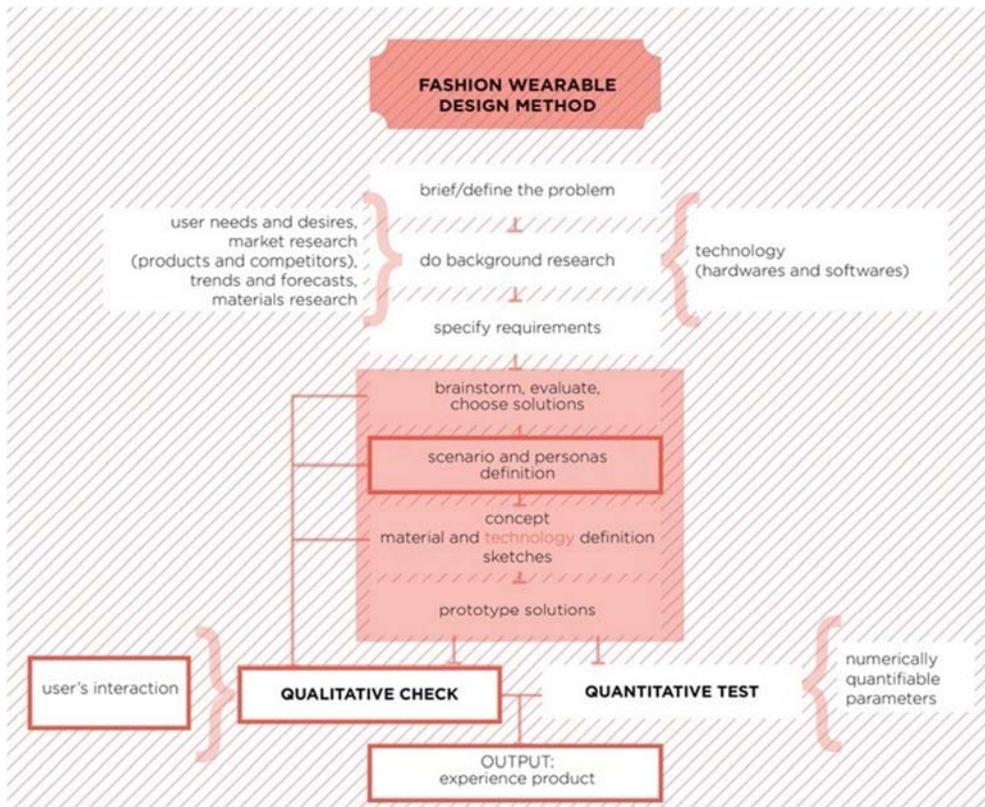


Figure 8. Fashion Wearable Design Method.

### 3. Proposal of a Methodology Based on a Scientific Method and a Creative Process for Wearable Technologies

The experiments mentioned above led us to develop and trace a hybrid methodology that merges some elements of the fashion design method and of the engineering one.

Fashion wearable design method, as called, is a mix of the two different approaches, starting from the definition of the problem, going through a background research that explores both the user needs and desires, the fashion market research, trends and innovative and existent technologies ready for the industrial production.

After the requirements’ definition, the creative part takes place: the phase of brainstorming is followed by a new step which is the definition of a specific and future scenario. Here the product is the main character, becoming the point of connection among the user, the environment and other objects.

This phase leads to the definition of the concept and the implementation of the product.

To the quantitative check, typical of the engineering method, it was added also a qualitative evaluation, to test the user interaction through experience and “emotional” measurement of the relationship between the user and the product.

All these steps have to be managed by both designers and technology professionals to achieve successful output, merging and contaminating their skills. UX professionals should be involved to ensure a good understanding of the different parameters influencing the user perception and how they impact the experience.

This paper proposes alternative prospects for the traditional fashion design process. The methodological proposal is a starting point for optimizing the design of wearable technologies. This new method calls into question the models used until now both in the training of professional figures in the academic field and in the internal organization of companies now involved in FashionTech. If, as we believe,

FashionTech represents a real opportunity for the future of fashion, it is worth asking ourselves how to reorganize educational models, which specialized professional figures to integrate, how to facilitate dialogue and integration of different professions.

If on the one hand this involves a complete revision of the existing, on the other hand it represents an opportunity for success, and it can promote and foster interdisciplinary knowledge.

## 4. Conclusion

Technology tends to disrupt everything: from the economic and manufacturing models to the way creativity is conceived. "But the real challenge lies in the connection between innovations brought about by new technologies and traditional methods. High-tech products must also be fashion products, embodying a sensory appeal, an emotion and therefore a desirability. You have to use technology but also transcend it." [3].

In this paper we synthesize the current literature on fashion technologies, specifically wearables, to face their limits. To understand how these limits could be overtaken, a proposal of methodology is presented as result of practical experimentations.

There exist some limitations to such work. For instance, this study was based mostly on qualitative analysis and involved specific groups of participants. Therefore, the findings may not be generalizable.

This work has the following primary contributions: the importance of the integration between science and creativity both in terms of knowledge and process was underlined; (2) a good methodology towards the wearables field is not addressed only to designing the physical device but it takes care of the full user experience; (3) it was pointed to the potential of generating knowledge and original concepts involving fashion design and science.

This suggests that design involvement in FashionTech should work on two time frames: one for creating sustainable radical innovations, requiring a capacity to generate knowledge, which introduces a scientific time scale, and the other one, shorter, based on the collection principle, which fuels the proposition with social, cultural and aesthetics trends, to fit in the daily life of users.

Such perspective differs from the technological- and device-oriented focus by examining the potentiality of a design driven approach.

Future studies will investigate the possibility to apply and share this methodology in different contexts to register, analyse and measure other results.

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