

The Significance of Emotional and Sustainable Values in Smart Clothing

Dragana Rikanovic

Kunstuniversität Linz, Austria

Christiane Luible-Bär

Kunstuniversität Linz, Austria

Abstract

In the past, numerous examples of garments with integrated electronics have been developed in research, artistic, as well as commercial contexts. Despite continuous technological advancements within e-textiles, there are few examples of smart products that work as fashion items and that have led to a lasting and satisfactory commercial use. The reason for this can be found in the fact that wearable technology products focus on problem-solving by using reason and targeting the wearer from a user rather than a human perspective. This approach results in clothing that lacks intuitive and emotional expression, as well as distinct design identity. To develop clothes with integrated electronics that blend fashion and technology with emotional and sustainable values, it became apparent in this research that standard methods of fashion and common methods of technology contradict one another. With the aim to harmonize these two approaches a new concept-driven collaboration methodology based on emotional and sustainable/ethical values has been developed. In the realization of this research, an extended desktop-research and literature review was conducted. The newly developed method was tested in teaching with students, as well as with a group of experts from a wide variety of identified relevant fields. By combining designer's visual sense and sensibility with engineer's technical and scientific expertise, as well as additional experts with sustainability, design communication, anthropology and sociology background at the beginning of the R&D phase, new thought processes could be started that lead to more meaningful smart objects.

Keywords: wearables, fashion, technology, sustainability, participatory method, art-tech collaboration, concept-driven collaboration, emotional design.

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Corresponding author's email:
dragana.rikanovic@kunstuni-linz.at

1. Introduction

In the past, numerous examples of garments with integrated electronics have been developed in research, artistic or commercial contexts. Designers who have worked on these fields, worked on various smart garment function concepts. While some continued to explore the possibility of artistic, emotional and identity expression through the application of smart fabrics/e-textiles, others have shown increasing interests in the performance, functionality and practicality of those and their application - working on usability and experience design (Parkes, 2016).

Initially, wearable technology was seen as having great potential to revolutionize the fashion industry. So far, however, despite continuous technological advancements within e-textiles, there are few examples of smart products that work as fashion items and that have led to a lasting and satisfactory use. "The enthusiasm for Wearable Technology is reflected in the fact that one in ten Americans own such a device. Unfortunately, the same research shows that one third of these consumers stopped using their product within six months." (O'Mahony and Gwilt, 2016) Customers do not necessarily anticipate, or demand items made with wearable technology. Aside from technical, production, distribution, and financial difficulties that may arise when placing smart fashion items on the market, one of the essential challenges is to determine what it takes to convince the wearer not only to buy a smart fashion product but to keep wearing it. Wearable technology products tend to focus on problem-solving by using reason and targeting the wearer from a user rather than a human perspective. This approach often results in clothing that lacks intuitive and emotional expression, as well as distinct design identity while mainly promoting the sensation behind the technological inventions. In theory, wearable technology seems to be pushing radical new meanings in clothing and accessories while it has been rather focusing on technology push than "design-driven innovation - radical innovation of meanings that goes beyond the mere technological function and that is grounded in culture and relations." (Verganti, 2009) Toussaint stresses the importance of being careful not to become entrapped in technology push, where we are anxious to design another new prototype to solve societal problems. (Toussaint, 2019) It is essential to recognize that while wearable technology has the potential to improve our performance and emotional and physical well-being, it still requires a responsible approach. We need to gain a greater understanding of the following questions before discussing HOW to integrate technology into textiles, clothing, and accessories:

1. Why have technology in clothing and accessories in the first place?
2. Where can the integration be most useful, and how would it affect the experience of a wearer with a smart fashion product in terms of intuitive interaction, emotional connection, as well as visual identity? Therefore, our research has been motivated by the question of how to develop clothing with integrated electronics, as well as interactive and hybrid garments that convey emotional and sustainable values, instead of another 'proof of concept' from a technological standpoint.

2. Existing Innovation Approaches and Categories of Smart Fashion Products

The innovation expert Roberto Verganti writes in his book *Design-Driven Innovation: Redefining Competition by Radically Innovating What Things Mean* about the fact that innovation studies have primarily focused on two strategies, radical innovation pushed by technology or incremental innovation pulled by the market e.g., user-centered innovation. He introduces a third strategy - design driven innovation as a radical innovation of meanings. According to Verganti, innovations driven by design do not originate in the market, they create them. Instead of pushing new technologies, they push radically new meanings. Having the ability to take the vision about possible breakthrough meanings and product languages and convey it to customers. Although the new meanings were not requested, when they were experienced, it was usually love at first sight for the customers. (Verganti, 2009)

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By taking into consideration the current fashion system and its social and environmental issues, we investigated the market potential of integrated technological developments in wearable items through desktop research on already launched smart clothing and jewelry on the international market within the last decade - their success so far. “While wearable technology is usually associated with devices and gadgets, textiles are primarily about fibers and functionality of their characteristics. The convergence of these two leads to the next stage which is representing interactivity in the textiles and to so-called smart/e-textiles. In other words, we can make the garments sense, react, and interact.” (Parkes, 2016)

Incorporating smart function into fabrics, garments, accessories, and jewelry creates a whole new category regarding their function and experience. Wearable technology is redefining the meaning of clothing. Our relationship with clothing is being redefined, as well as the exchange within the social and cultural environment. The following categories in terms of smart functions / smart product’s experiences that have reached the market have been identified (Table 1):

Category	Purpose	Examples
1st Category:	As efficiency/management/ organization tool attempting to solve practicality issues in everyday life while diminishing the use of smartphones and screen time as well as reducing the amount	- Levi's® Trucker Jacket with Jacquard by Google, launched 2017, US - Ringly Smart Jewelry, (Cat.1&2) launched 2015, US (closed 2018)

	of information traffic while still staying informed and connected.	
2nd Category:	PERFORMANCE and HEALTH MONITORING in Sportswear, Underwear & Jewellery, Biometric SmartWear / Biometric SmartJewellery, Biometric tracking = gives information about the wearer their emotional and physical wellbeing or their performance and everyday activities in order to predict and improve those.	<ul style="list-style-type: none"> - <i>Emglare</i> Smart Clothes with built-in ECG and heart rate measurement, launched 2018 - <i>Prevayl</i> SmartWear™, Luxe Smart Sportswear, launched 2019, UK - <i>WiseWear</i> Smart Jewelry, launched 2016, US (closed 2018)
3rd Category:	Focuses on the environment to protect the wearer. The data is collected and evaluated from the wearer's surroundings, not from the wearer themselves. Smart clothing alerts the wearer about the danger in the environment.	- <i>Spinali Design</i> , Smart Swimwear, launched 2015, France
4th Category:	Technology used to enhance the creative process as well as for social good while enticing the wearer into the augmented world - experimental, expressive, playful	- <i>CuteCircuit</i> , Interactive fashion, Haute Couture, Ready to Wear, 'Mirror Handbag', 'Soundshirt'
5th Category:	Technology, as digital ID card used in garments for information purposes about the garment itself, to ensure the integrity and authenticity of the products throughout their lifecycle, in manufacturing and retail (improving supply chain performance and inventory management) while driving consumer engagement.	<p>"Clothing digital ID card 'The Janela Smart Products Platform', powered by Avery Dennison Retail Branding And Information Solutions (RBIS)</p> <p>and <i>EVERYTHNG</i> - IoT Smart Products Platform Pioneer - '#BornDigital'</p> <p>Ralph Lauren's Digital Product IDs. – 2019, US - "one of the first brands to adopt digital identity technology on a large scale."</p>

Sub-category:	Digital ID card as a pass to exclusive experiences.	- <i>Rochambeau in collaboration. with Avery Dennison & EVERYTHNG</i> The Bright BMBR Smart Bomber Jacket, 2016, US
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Table 1: 5 categories of smart functions /smart products that have reached the market

To date, the wearables market has been dominated by smartwatches like the Apple Watch and activity trackers like Fitbit which additionally fall into 1st and 2nd category.

Based on Verganti's findings, executives usually think of design and designers either from a traditional - styling perspective where a designer is asked to make things look beautiful or from a user-centered perspective. Often, both are used as ways to distinguish a company from its competitors. However, by implementing these practices across all companies, they are losing their differentiation power because those approaches are better used for incremental innovation. When it comes to radical innovation, different expertise is required - the one of 'radical researchers' which are "experts who envision and investigate new product meanings through a broader, in-depth exploration of the evolution of society, culture, and technology. These experts may be among others, Designers." (Verganti, 2009)

All categories strive to achieve a 'personalized relationship' between the wearer and the garment as well as the wearer and the brand. In most cases, as soon as a wearable is introduced onto the market, the initial excitement and sensation seem to wear off rather quickly, and there is very little new information related to their success beyond the launch period, except there is an announcement of a company's closer resulting in wearables discontinuation e.g., *Ringley* and *WiseWear* Smart Jewelry - both have been discontinued since 2018. There is a notable trend that most tech companies usually keep focusing on developing technology and less on the design and emotional and embodied aspects of their products. Design is very often used as a 'cosmetic tool' that is supposed to show off or hide technological innovation rather than understanding the wearer on an emotional and personal level.

When it comes to reaching the wearer based on smart product's reviews, there is still some disbalance between the founder's initial enthusiasm and intentions versus smart product's commercial success and observers' and consumers' reactions as well as skepticism and criticism. Most observers question the need for technology in garments at all. Followed by concerns about privacy, data, and health issues as well as sustainability concerns. Wearers are more open and receptive but there are still some practicalities, expectations vs. reality issues.

Cognitive scientist Don Norman who used to ignore emotions in his previous work and rather address utility, usability, function, and form, all in a logical way (Norman, 2005) argues in his book *Emotional Design - Why we love, or hate everyday things* that “there’s a strong emotional component to how products are designed and put to use” and “that the emotional side of design may be more critical to product’s success than its practical” (Norman, 2005). He is “not just talking about the emotions but the affect - general term for the judgmental system, whether conscious or subconscious, while emotions is conscious experience of affect” (Norman, 2005). What contributed to the change of his mind were scientific advances in the study of the brain and recognition of how emotion and cognition are deeply interwoven as well as the value of emotions in our everyday life (Norman, 2003). What is fascinating is that he makes a very interesting analogy between his scientific self and his personal self. While as a scientist he used to ignore aesthetics and emotions and concentrated mainly on cognition, in his personal life he loved “visiting art galleries, playing music and was proud of his architect-designed home”. He goes on with the example of the use of color monitors for computers to describe how early in his career he was surprised and challenged by the notion of his reasoning telling him that color was unimportant, but his emotional reaction told him otherwise. He then admitted that obviously color was fulfilling some need but one that it couldn’t be measured (Norman, 2005). Norman emphasizes the importance of the three levels of design, visceral, behavioral and reflective, and that if any design is to reach a user successfully, it must take into account more than just what users need, but must also address our minds by taking into account our visceral reactions, as well as our behavioral choices, and on the reflective level - our stories about ourselves we wish to convey to others through our lives. (Norman, 2005)

3. Intersection of Fashion, Technology and Sustainability

Applying the contribution of Norman and Verganti to Fashion-Tech projects it becomes apparent that the role of the designer and the nature of the collaboration process in wearable tech needs to be redefined. What usually happens in the collaboration process is that the visceral (appearance) level of design is attributed to the designer and fashion at a later stage of the wearables' development process. In most cases, the behavioral level (function, understandability, usability) is focused on technology and the user, while the importance of the reflective level (message, culture, meaning of the product or its use) is often overlooked. It is hard to bring all three levels in harmony within the collaboration process of smart clothing. Rather, it is a more complicated process, and it requires an inclusive and intuitive approach from the initial R & D phase of the smart product's meaning and life cycle - it requires ‘concept-driven collaboration’.

So far, most of the wearable technology products did not manage to have a lasting impact, especially, when it comes to our everyday life. A closer look reveals what wearable tech products are usually missing:

1. Responsible smart function concept - Technology as intuitive as possible in terms of ideation,

implementation, and usability.

2. Smart product's end-of-life cycle (EOL) - Not taking sustainability and circularity into consideration when choosing materials and electronics.
3. Smart product's distinctive visual identity
4. Designer's sensibility - Personal expression, emotions, and intuition

3.1. Invention of the Concept of a Responsible Smart Object of Desire

The Fashion industry's increased competitive behavior since the beginning of the 21st century has led to overproduction and overconsumption, loss of quality and value in clothing which resulted in major environmental and social issues. At the same time, continuous technological advancements within e-textiles and wearable technologies have been driven by technology with little or no attention to sustainability and circularity aspects when it comes to choosing materials and electronics as well as to a smart product's deeper meaning that goes beyond the mere technological function such as product's emotional, intuitive, and sensorial appeal. With the rise of sustainability and circularity within the fashion industry pre-pandemic and especially since the pandemic in 2020, wearable technology cannot continue to ignore the current status quo since wearer's expectations have risen in terms of ethical values of clothing. In our approach to the design and development process of new textiles it is not enough only to be conscious of the existing social and environmental issues but to take responsibility from the start and incorporate waste prevention measures early on. Fashion, technology, and sustainability are inherently different in their respective fields, while coming together in a wearable form. The question arises, what happens when fashion and technology meet in a wearable form while taking sustainable values into consideration? In seeking the answers, we examined each area separately regarding their definition, their key characteristics, and values.

Primarily, looking into their non-similarities followed by positive and negative similarities.

"Fashion is a form of self-expression and autonomy at a particular period and place and in a specific context, of clothing, footwear, lifestyle, accessories, makeup, hairstyle, and body posture." (Kaiser, 2019) Looking at the commercial aspects of fashion, fashion is primarily perceived visually and is evaluated on its visual appeal and the newest trends promoted by the fashion industry and media which is why fashion can also be attributed as frivolous rather than a necessity. Nowadays, the branding, a bare price tag, as a single measure - takes over - disregarding product's emotional value, quality, and longevity. The product longevity is very often planned solely in favor of frequent consumption. When introducing novel technologies and processes in clothing it is essential to understand the values that are worth sustaining. These values are reflected in culture and fashion's artisanal power, such as creative vision, craftsmanship, attention to detail, the expressive, emotional, and empowering side of fashion that speaks to people's desires and goes beyond the functional and practical aspects, even in functional clothing. "We like attractive things because of the way they make us feel." (Norman, 2005) Aesthetic appeal in a garment is a sensorial experience that can be

divided into a visual one including color, texture, pattern, design lines, proportions, shape, etc., as well as a haptic one which is about material aesthetics, that goes beyond visual appeal and relates to material experience on the skin. Hence, fabrics and garments are associated with flexibility and softness - also experienced as a second skin. "Fashion is embodied, it does not exist without a body." (v. Dongen, 2019). Dongen's book discusses the significance of the concept of material aesthetics regarding technology, from the design process to the embodied wearer's experience of wearable technology. (v. Dongen, 2019) Otto von Busch goes even further and places fashion under the skin located in the form of an energy in our bodies. Fashion in its energy form is "not a thing, but it is a place you go, an emotional space you enter inside yourself and another." It makes us feel alive and empowered, while funneled through the fabricated commodities of the fashion system, the energy flow becomes stagnant and we become anxious of the emotions evoked by fashion, we fear the judgments and responses by others. (Busch, 2018)

In fashion the approach to problem-solving is rather through intuitive thinking. "Intuitive thinking is a type of thinking and a decision-making process that relies on instinctive understanding and feeling." (Brilliantio, 2022)

The term technology can be explained in different ways and there are different nuances regarding its precise meaning. It could be simply explained as the sum of techniques, skills, methods, and processes used in the production of goods or services or in the accomplishment of objectives, such as scientific investigation. (Wiki, 2022) Other sources define technology as science or knowledge put into practical use to solve problems or invent useful tools. However, technological developments of the different technical disciplines have in common that they are developed with a very specific, previously well-defined goal. To achieve the goal, usually important expertise in a certain field rather than intuition or emotion is needed. Therefore, the role of technology is, hence, associated with its functional aspect and evaluated based on its effectiveness. New technology is important as it can make tasks easier, solve many problems of mankind, save lives, it could to some extent make the world better.

(digitaledenz) Scientific technical knowledge, facts and data are at the heart of technology when it comes to problem-solving and using analytical, strategic and/or logical thinking. Technology is associated with rigidity and hardness - products that are not in constant proximity to the body but that are effective, efficient, smart, and interactive. However, "when we wear, rather than just carry, or use technology, it becomes imbued with 'fashion aspects' such as social visibility, identity, and self-expression." (Toussaint, 2019) With regards to negative aspects of fashion and technology, both industries struggle with short-term vision, throw-away mentality, and sustainability issues.

Those can only be resolved with the help of sustainable solutions. The most common definition of sustainability comes from the 1987 Brundtland Commission report for the United Nations. It defines the concept as 'meeting the needs of the present without compromising the ability of future generations to meet their own needs.'

The idea is often broken down into three pillars: economic, environmental, and social—also known informally as profits, planet, and people. In the broadest possible sense, sustainability refers to the ability of something to maintain or sustain itself over time. (Sciencedirect, 2022) (Investopedia, 2022)

Sustainability is not only tackling environmental issues when it comes to fashion and its design and production process. The new value chain includes social, ecological, economical, and cultural responsibility, while considering fashion’s tactile, visual, embodied, and emotional side.

Based on the core characteristics and values of fashion, technology, and sustainability when all three intersect, we refer to a *responsible smart object of desire* in the field of wearable technology (smart clothing & accessories). People want more in clothing and accessories than a technological function whether function is what they need. What wearables have been missing so far is a responsible *smart object of desire*.

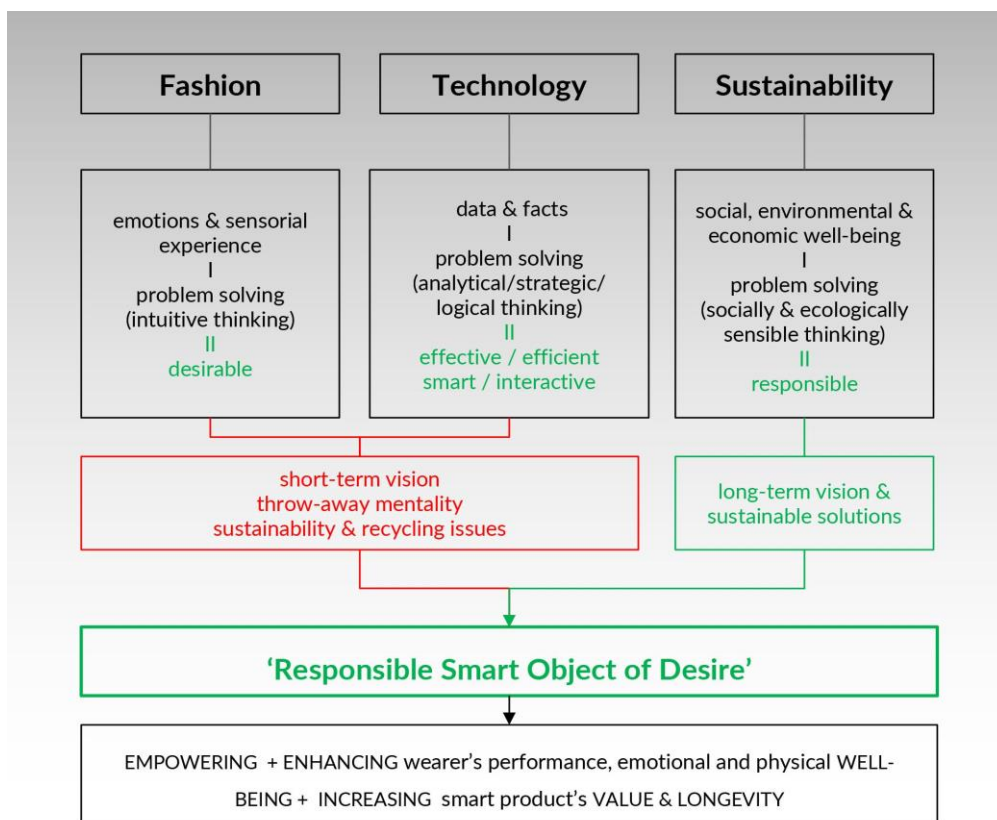


Figure 1: Scheme of the INTERSECTION of fashion, technology, and sustainability

Through the lens of a *responsible smart object of desire*, fashion, technology, and sustainability come together in a wearable form, empowering, and enhancing wearers' performance, emotional, and physical well-being, as well as increasing the value and longevity of smart products.

3.1.1. Balancing Wearer's Needs and Wants

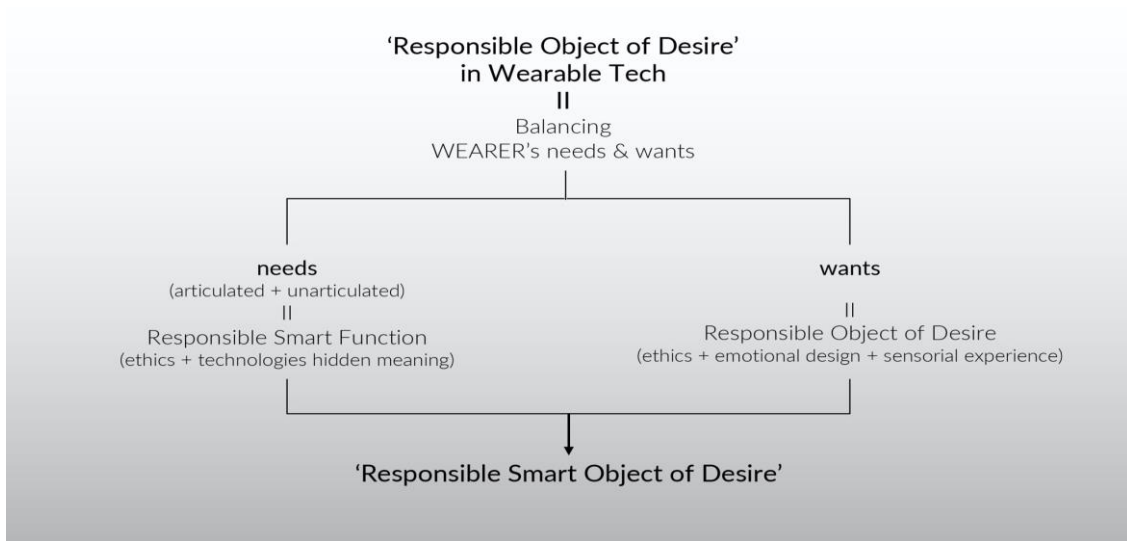


Figure 2: IMPORTANT ASPECTS of a 'responsible smart object of desire' concept

"The distinction between the terms NEEDS and WANTS is a traditional way of describing the difference between what is truly necessary for a person's activities vs. what a person asks for. NEEDS are determined by the task while WANTS are determined by culture, by advertising, by the way one views oneself and one's self-image. Wants can often be more powerful than needs in determining the success of a product." (Norman, 2005)

Wearer's unarticulated needs must be taken into consideration in addition to their articulated needs when designing smart clothing and accessories. "Articulated needs are those needs that a customer can readily verbalize, if asked appropriately. Unarticulated needs are needs that customers cannot easily verbalize." (Kenan, 2022)

Understanding end-user unmet and unarticulated needs is where the real challenge is – 'to discover real needs that even the people who need them cannot yet articulate'. (Norman, 2005)

While Norman sees it as a design challenge, in design-driven innovation Verganti is placing the challenge already at the R & D process for meaning that is happening before the design and development process. Based on personal design experience, both stages are relevant and contribute greatly to identifying the wearer beyond their true needs. The R & D process for meanings in design-driven innovation is not only designer-centric. It is based on a 'collective research laboratory' and 'steps back from a user and takes a broader perspective while exploring the context in which people live is evolving, both in sociocultural terms and in technical terms.' (Verganti, 2009) Designer role gets more centric at the design and development process where both, Verganti and Norman, suggest that in discovering and understanding a user's unmet

needs it 'requires careful observation in their natural environment' and envisioning what the user could be missing in a product but is not aware of - the moment where not only designer's problem-solving skills are required but the deeper understanding of a designer role.

3.1.2. 'Quiescent' Meaning of Technology vs Hidden Meaning of Designer Role

Verganti defines 'the interplay between technology-push and design-driven innovation - when the radical innovation of technologies and radical innovation of meanings are closely entangled - as technology epiphany'. He argues that new technologies, if used in a creative way, often hide a more powerful, deeper meaning that he calls 'quiescent' meaning and that it goes beyond technology's functional purpose.

In relation to wearable tech, technology, designer as well as engineer role is often seen as a 'tool' to implement a certain function or 'cosmetics' (a word very often used to describe designer's function within the design and development process) into a product while the hidden meaning is usually overseen. Therefore, it is difficult to achieve useful functional as well as intuitive and emotional responses to human needs and wants, while creating and offering new experiences to the wearer.

The hidden meaning of a designer role during the design concept and inspiration stage in wearable tech is to understand and predict what the wearer wants and needs before they even realize it. That doesn't mean as a designer to ignore the wearer's articulated needs and wants. It means not only having a vision but also feeling it as well as having extended understanding of culture, society, and the human body - being able through your own emotions and intuition to feel the design and to communicate it in such a way to evoke emotions through it, and to a certain extent to anticipate long lasting emotional feelings in the wearer towards the smart fashion product. When it comes to true long-lasting emotional feelings towards a product, they take time to develop and come from the user's sustained interaction with the product. Here, the object's history of interaction, its associations, and the memories it evokes are crucial (Norman, 2005).

3.1.2.

1. Practical vs. Emotional Creativity

The traditional role of the designer as a creative has experienced major shift already within the fast fashion environment where the designer role has been seen as 'practical' and as a 'tool' in favor to reach high volumes and profits, which has led to, not only products' identity loss, but also, loss of quality and value. Emotions inspire creativity and creativity creates emotional connection with people.

Most wearable tech projects focus solely on problem solving design, that is usually based on using reason rather than taking into consideration designer's sensibility, intuitive and emotional expression, which usually

results in clothing that is lacking design identity and primarily promoting technology and services behind it. While the designer role will continue to transform with the emergence of new technologies within multidisciplinary environments it is vital to avoid previous mistakes and to recognize: designer's creative expression, emotions, and intuition have a significant impact on the distinguishing character of a design.

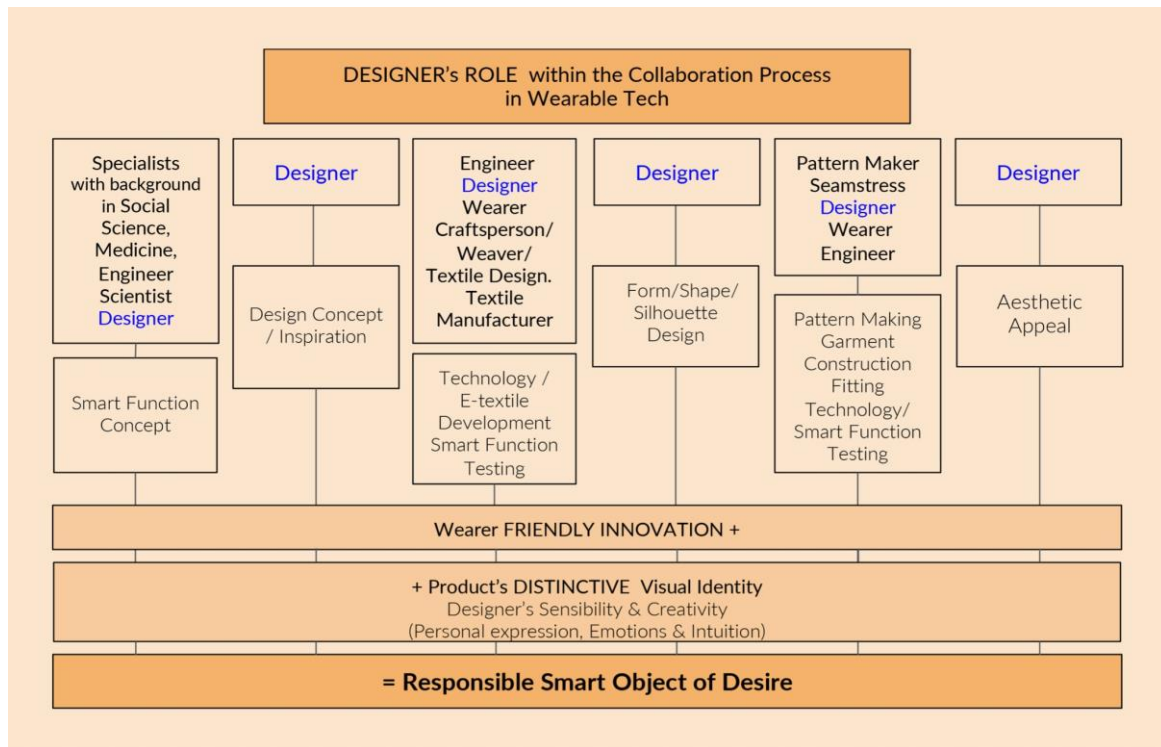


Figure 3: Designer's role within the collaboration process in Wearable Tech

In wearable tech, R & D relates to the development of smart function concept / smart product's experience, which happens before design and development. There the designer role is not centric.

The designer is the researcher like all the other participants. It is critical to involve all participants from the start so that a common language can be developed. At the following stage - design concept and inspiration, the designer role becomes more centric and continues to play an important role throughout the development process.

The design approach in wearable tech has a lot to do with the terminology. The design and development processes in fashion, technology, and sustainability differ in several ways - not just when it comes to their goals, products, or practices, but also to the language used during those processes. During the co-creation and other collaborative processes, it can be difficult to understand each other's point of view when it comes to needs and experimentation, even if everyone thinks they are speaking the same language. Certain terms

always need to be explained first to create better understanding between the teams and ensure that other areas do not ignore how design affects our emotions and senses.

3.1.3. How to merge a radical innovation of technology and meanings in wearable tech at the initial

R & D stage?

In wearable tech, the R & D process can help these products successfully reach the wearer and encourage them to fall in love with the smart products in the long run as well as open new markets in the fashion industry. However, the difficulty here is to better merge a 'radical innovation of technology and meanings.' Merging innovation and meaning in wearable tech while putting emphasis on:

- Allowing a more intuitive approach to the development process
- Strengthen the role and importance of designer's sensibility (personal expression, emotions, and intuition) within the development process
- Bridging the gap between initial R&D stage and the wearer
- Identifying the wearer beyond their articulated needs through the lens of a *responsible smart object of desire*

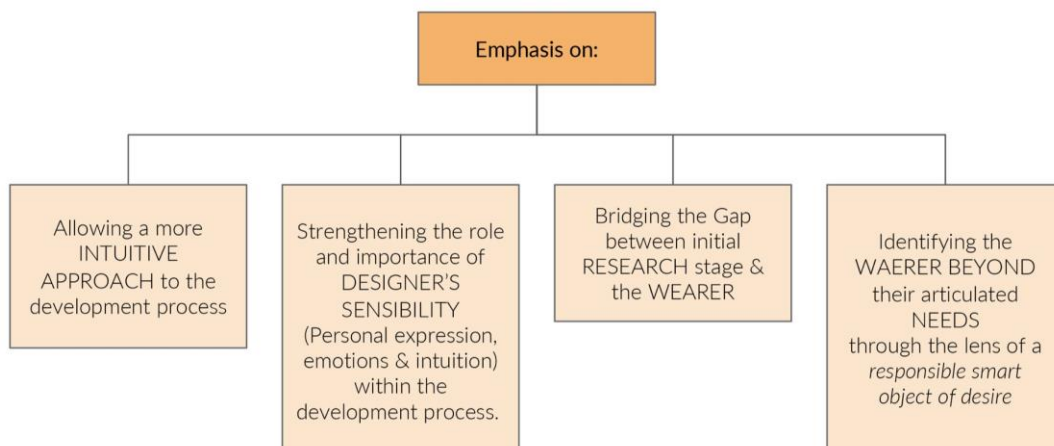


Figure 4: MERGING of INNOVATION and MEANING in wearable tech

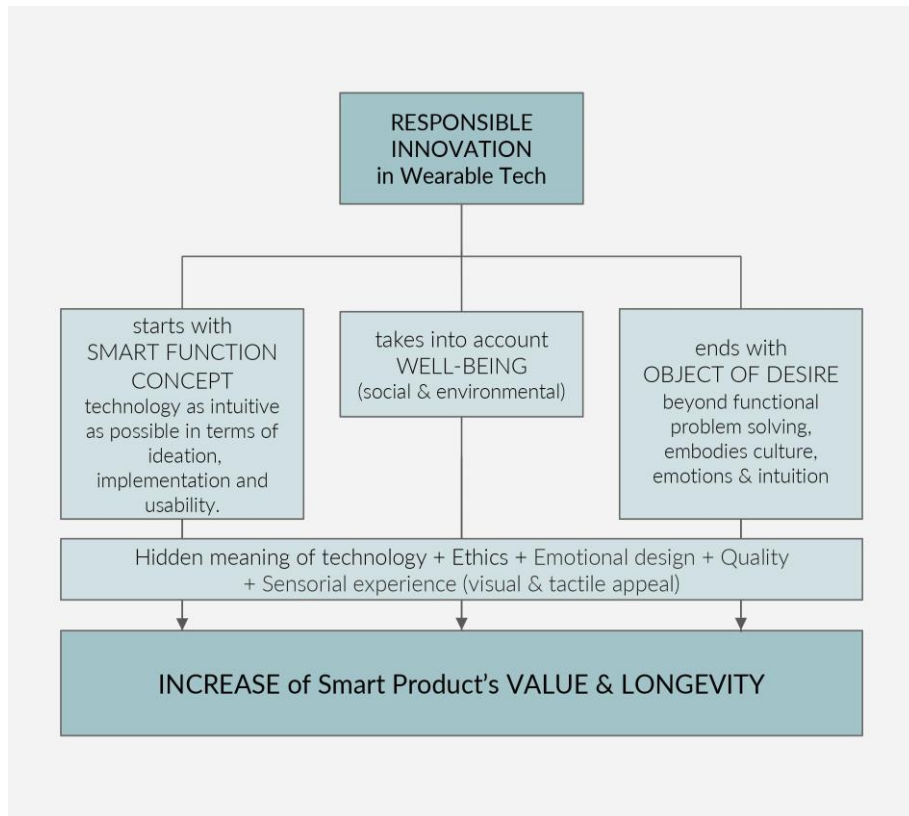


Figure 5: How to increase a smart product's value and longevity

"If you create something that is 'sustainable' and is not attractive and designed well in itself, you are kind of creating a 'nothing product'." (McCartney, 2021) Style, function, and substance (meaning) should be coherent to increase smart product's value and longevity.

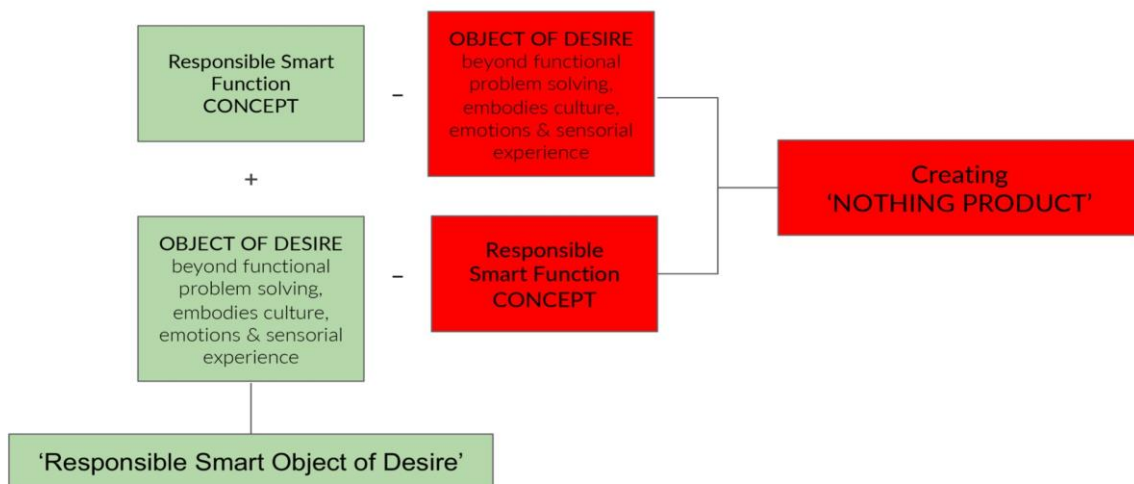


Figure 6: Creating a 'Nothing Product' in Wearable Tech

3.2. Concept-Driven Collaboration Method Development

To develop clothes with integrated electronics that blend fashion and technology with emotional and sustainable values, it became apparent that standard methods of fashion and common methods of technology contradict one another. From a fashion perspective, technology constitutes a new functional design element that must be introduced at the right moment in the design process. From a technology point of view, important emotional and sustainability aspects of fashion and body must be considered, which is not automatically the case in problem-solving processes. With the aim to harmonize these two approaches we concluded that a new methodology development would be required and that a collaboration between an engineer, scientist, and designer from the initial R & D stage of a wearable, represents the most suitable way to develop smart fashion products that are not only accepted by the market but also valued by the wearer over the long run. The meaning of the smart fashion product starts with the R & D process and ends with the wearer and wearer's interpretation. The problem is that technology as well as the designer and engineer role are very often seen as a 'tool' and used to implement a technological or aesthetic function into a product while their hidden meaning is usually ignored. Therefore, it is difficult to achieve useful functional as well as intuitive and emotional responses to human needs and wants, while creating and offering new experiences to the wearer. If involved and implemented correctly at the initial stage of R&D and throughout the design and development process, we can give a deeper meaning to a wearable product and reach the wearer not only on a functional level but on a personal and emotional level. What wearable tech design and development process is usually missing is a collaboration with specialists from varied backgrounds from the initial R & D (conception phase for meaning in the smart fashion product's life cycle) and common terminology understanding that is concept/vision-driven for all specialists involved. The main goal of the newly developed concept-driven terminology and collaboration method is to allow the creation of a conceptual framework that is based on emotional and sustainable values as a starting point rather than on function and problem-solving thus stimulating a thought process change already at the R & D stage in wearable tech.

A first collaboration format has been developed, which was tested in teaching and refined in the form of a workshop with specialists of different backgrounds. By combining designer's visual sense and sensibility with engineer's and scientist's technical and scientific expertise, as well as additional specialists with sustainability, circularity, social science and design communication background at the beginning of the R & D phase, we expected novel thought processes and meaningful smart object ideas to emerge, which carry sustainable values and emotions.

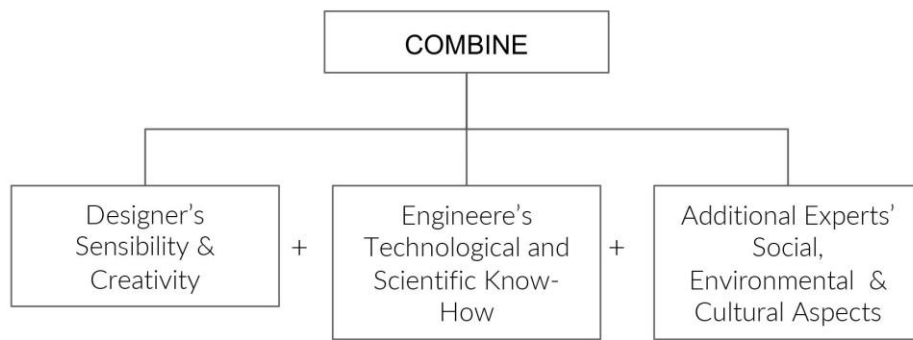


Figure 7: Combining experts' know-how

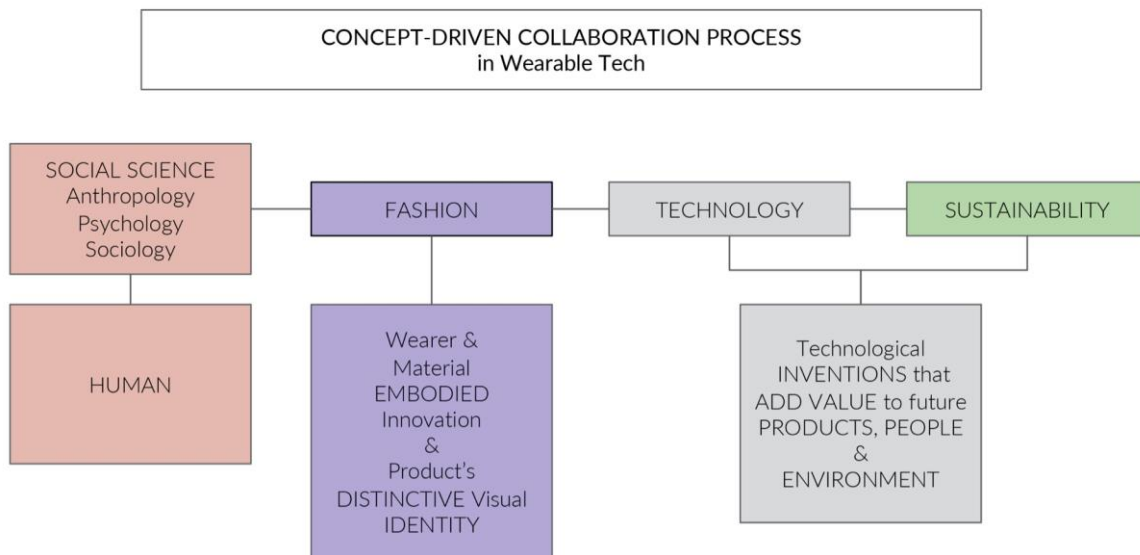


Figure 8: Concept-driven collaboration process in Wearable Tech

The concept-driven collaboration process in wearable tech recognizes the complexity of the relationship between smart fashion products and the wearer and understands that the development of 'smart function concept' should not be happening exclusively between technology and fashion. Although the concept of the human-centered design is not a new one what is novel about concept-driven collaboration method in wearable tech is that it acknowledges that in order to have a responsible approach to the innovation and to gain better understanding about people's needs and wants when it comes to wearables, additional specialists from social science and sustainability are needed (all categories), as well as from other fields, depending on existing and future categories (e.g. medicine, sports - 2nd category).

3.3 Workshop

In designing the workshop, the main question was, how to merge a radical innovation of technology and meanings in wearable tech at the initial R & D stage.

In the development of the methodology, the following two points have emerged as central:

1. The invention of the concept of a 'Responsible Smart Object of Desire'
2. The 'Concept-Driven Collaboration Method' development

Next, these two aspects were implemented into a workshop format that allows a group of experts of different fields to be involved in the initial R & D stage about wearable products.

We conducted a two days' workshop with the aim to test and refine both concepts with specialists with different areas of expertise: - Unisex fashion design and sustainability

- Fashion design and technology (research and practice)
- Science and sustainability
- Anthropology
- Sociology, fashion theory and culture critique
- Curation and fashion communication

Furthermore, with the workshop format, we intended to enable a more intuitive approach to developing smart function concepts, bridge the gap between the R&D phase and the wearer by introducing a methodology that stimulates the thought process change in problem-solving design in wearable tech, and finally, identify the wearer beyond their articulated needs through the lens of a *responsible smart object of desire*.

First day of the workshop process had a lot to do with terminology awareness and generating a deeper insight into key terms as well as creating an environment of discourse, listening and understanding between the participants.

We started the workshop with the exploration of the key terms' 'wearer' - 'consumer' - 'user' - 'human'. The purpose of this study was to determine what each participant associated with these terms and to give a depth to each term through a different expert's point of view.

When looked through the lens of concept-driven collaboration method following characteristics were attributed to the 'wearer': wardrobes, styling, feedback, message, communication, enrichment,

comfort, body, belonging, empowerment, 'phygital', sensing individual,

body-ownership, augmentation, surface, target group, culture/identity,
acceptable, choice, co-creation, change, design, esthetic, comfort

‘consumer’: customer, status, excess, 20th century capitalism, passive consumption,
warranty, business model, values, profit/capitalism,
expression/communication, identity, pleasure, to consume, temporality,
privilege, behavior, revenue, status, exclusivity, capitalism, by less,
affordable, guarantee

‘user’: Silicon Valley jargon, addiction to availability, fashion media/PR/marketing
function, user manual, technology, object of investigation, A-gender,
dis/ability, influences/appropriates, interaction, software, user friendliness,
data security, protection

‘human’: body, couture/tailored/personal, itchy/tight/loose/fitting, with flaws and
weaknesses (“to be human” = to make mistakes), responsibility, conscience,
basic needs, basic drives, empowerment, society, love, humor, identity,
performativity, community, sensing body, socially conditioning individual,
social being, user/customer/wearer, body-ily/identity, culture, human
condition, empathy, analogue/digital, desire, senses, health, needs, fragile

Our next exercise involved exploring and defining fashion, technology, and sustainability - participants’ personal understanding of the three fields. Based on individual input into each field fashion was most associated with identity expression, communication, individual empowerment, also asked whether fashion can be empowering to a community, while technology was seen as having potential to enhance human experience but also can represent a risk to those, last but not least, sustainability as being considerate of society and resources, but also questioned as to whether or not the idea that sustainability is in no way harmful is not an idealistic one.

After the terminology awareness exercises, participants have been asked to practice ‘active listening’ in pairs, while one is listening, the other is explaining how they understand their role as a designer, scientist,

anthropologist, etc. The goal of the exercise was to listen to each expert's deeper meaning of their roles, to minimize preconceived ideas while reflecting on their own roles within a collaborative setting.

Subsequently we moved on with the brief exploration of the term 'desire'.

It stirred mainly positive associations such as: sensual, body, feeling, doing good, purpose, basic needs recognized = belonging, anticipating experience, emotions, happiness, bliss, not having to worry.

Moving from 'desire' we asked participants to investigate possible 'needs' and 'wants' as well as 'functions', 'areas of application' and 'ideas' regarding a wearable.

Under 'needs' following findings were identified: product's sustainable and sensorial aspects, data protection and safety. While 'wants' also emphasized privacy, data protection and safety, they also were identified as enriching human and bodily experience, stress reduction, having easy, intuitive, and playful interaction.

The ideas generated through 'needs' and 'wants' had more group harmonized, authentic, emotional and intuitive approach to problem-solving and felt more connected to the human and human experience while the ones coming from 'function' (e.g. protection related functions in case of emergencies or accidents, implemented in job/work related tasks that usually requires too many buttons & screens, cleaning polluted air), 'areas of application' (e.g. travel, sports, toy-industry, mental health) and 'ideas' (e.g. smart garment that makes the user feel 'smart', community for wearables, beautiful colorways) were mainly problem-solving oriented individual requests and lacked group harmony.

The second day started with a group task and the scenario of a *responsible smart object of desire* concerning "well-being". How could a *responsible smart object of desire* look and feel like concerning the wearer's well-being? Participants were asked to work on a mood board in that matter.

In addition to examining what ideas responsible smart objects of desire would generate, we were interested in testing the dynamics within the group. Would the group harmony persist? Would someone take the lead and if so who and how would it affect the result of the task given?

By the end of the second day 'responsible smart object of desire concerning well-being' was identified as fluid, soft, calming, transparent, organic, changing in temperature, not too small, oversized, modular/iron on/customizable, intimate, addressing chronic pain and body movement.

What we found interesting was at some point of the concept-driven collaboration process some of the experts switched strongly into the role of the wearer and user, which contributed to a group dynamic change and resulted in an individual request rather than a collective smart product's concept generation.

4. Conclusion

Our research demonstrates why existing wearables do not work, why users do not use them for longer periods of time. We have shown when the values and characteristics of fashion, technology, and sustainability intersect, we refer to a *responsible smart object of desire* in the field of wearable technology. Additionally, we discussed the importance of terminology and a new approach to the development of smart clothing, and we propose a concept-driven method that develops more meaningful products because they put people at the center, not technology.

Subsequently, we tested these during a workshop. Because so many terms had to be clarified, we did not get as far as we had hoped with the smart function concept creation in two days, which only confirms the need to create a common language understanding in collaborative processes.

Hereby, we have highlighted and sharpened the important role of the designer in the development phase of smart clothing.

Next, further workshops should be conducted to clarify other roles in the process, allowing us to develop future objects that are meaningful. This is an inevitable development, especially in terms of sustainability. Regarding sustainability, we need to look not only at material streams and the role of society, but also at new approaches, and here we have contributed in the right direction.

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