

Research on the Practice of Design Thinking in Fashion Design Empowered by Wearable Technology

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Abstract: How wearable technology is changing the application of design thinking in fashion design: an exploratory study. Rather than viewing wearable technology as an addition to clothing, this paper believes that it is changing the very logic of fashion design by putting forward new requirements for interaction, data responsiveness, material integration and cross-disciplinary cooperation. Based on research in design thinking, wearable technology, smart clothing and fashion innovation, this essay explores how human-centred inquiry, prototyping, systems thinking and iterative testing are applied to interactive products for clothing. It further presents eight practical paths for wearable technology to promote fashion design, including building user-centric scenarios and material-technology co-design, as well as cross-disciplinary cooperation and post-use reflection. This paper proposes that the applications of wearable technology in fashion design aim to offer new designs and different visual styles, as well as to provide functions, embodied interactions, and extended-life user experiences.

Keywords: Wearable technology; fashion design; design thinking; smart clothing; interactive garments; user-centered design.

1. Introduction

Wearable technology is starting to enter contemporary culture in recent years. With the availability of sensors, conductive materials, embedded electronics and responsive interfaces for clothing and accessories now, the concept of fashion design is changing. Now it also has interaction, performance, usability, maintenance and data communication through the body. Thus, the scope of fashion design has been expanded beyond aesthetics, and new conditions for design practice have been created.

At the same time, wearable technology does not spontaneously generate new fashion. A garment with electronics may be cumbersome, fragile, unappealing, or out of touch with what people need. Therefore, the problem is not how to add technology to clothes; rather, it is how design thinking can be used to guide the integration of technology, fashion and use. Now that clothing has become an intelligent system, the design process needs to consider embodiment, comfort, expression, care and user experience in more complex ways than traditional clothing development.

This paper studies wearable technology in fashion design through the concept of design thinking. Wearable technology can be used more effectively to promote the development of fashion design through a human-centred, iterative, and interdisciplinary design process, rather than being applied as a technical addition after the fact. Based on this, the paper reviews the concept of design thinking in relation to wearable fashion, analyzes major practical tensions in the design process, and proposes a path for strengthening the practice of design thinking in fashion design empowered by wearable technology.

2. Design Thinking and the Transformation of Fashion Design

Any discussion of design thinking in wearable fashion should start with the general idea of design thinking. Rowe's first paper on design thinking proposed that design should be carried out as an orderly investigation process rather than an

intuitive one, and showed how designers can proceed through problem definition, choice selection and repetition [1]. Later, Brown put forward the concept of design thinking to address innovation by considering people first, then exploring ideas, building models and finally testing these based on actual needs and life [2]. Together, the above formulations provide strong conceptual support for the study of wearable fashion and require integrating aesthetics with functions.

Wearable technology also adds to this design context. Seymour believes that fashionable technology is the result of the meeting point for design, fashion, science and technology; thus, clothing has become a platform for communication, sensing and interaction rather than just a way to express style [3]. Fletcher's work on sustainable fashion and textiles has also shown that design decisions need to be considered in the context of the whole system of production, use and lifecycle impact [4]. The system's perspective is also increasingly needed for wearable fashion to address problems such as the long-term durability and energy consumption of electronics, as well as repair and disposal after use.

The same change can be found in the technology papers for smart clothes. McCann and Bryson propose smart clothing and wearable technology as an interdisciplinary field for design and development that spans from fibre and fabric selection to product release and end-user needs [5]. Quinn believes that the future of textiles will be new relationships among fashion, design and technology; therefore, material intelligence and conceptual experiments will alter the conception of clothing [6]. The above studies have shown that wearable technology is also adding to the tools in a fashion designer's kit. It changes the object of design from a fixed garment to an interactive system on the body.

The changes have methodological consequences. With the addition of interaction, design can no longer be solely based on form and symbolism. The stages should be users' behaviour, sensory feedback, technological reliability and situational context. Design thinking is suitable for this purpose because it treats design problems as open-ended, iterative and relational rather than as linear styling problems. Therefore, wearable technology has given new functions to

fashion design and required richer modes of inquiry in materials, interfaces and embodied experience.

It will also change the organisation of knowledge in the design studio. Traditional fashion design can generally be carried out in a relatively regular order: trend research, concept creation, material and pattern selection, sampling, refinement of aesthetics, etc. Wearable design interrupts sequence because technology-related decisions affect the clothing at an early stage. Change in battery size alters the shape; adjust seam positions based on interface logic; determine fitting method according to sensor location. Thus, wearable technology is not only adding extra restrictions. It can thus be organised more rationally and is subject to iteration.

3. Practical Tensions in Design Thinking for Wearable Fashion

First, there is a problem of reconciling aesthetics and functions in practice. Traditional fashion design generally focuses on silhouette, proportion, texture of materials and symbolic expression; wearable technology often needs to be non-soft, flexible and visually harmonious. Norman's studies of daily life design show that good design needs to be convenient to use, easy to understand, and pleasant; otherwise, it will be useless [7]. Therefore, only a certain level of technology is insufficient for wearable fashion. If the clothing is too conspicuous, impractical or visually messy, it will not be acceptable to the public.

Secondly, the materials and technology do not match. Seymour and Guler, Gannon and Sicchio have shown that in the design of wearable products, one needs to consider how electronics, conductive pathways, textile structures and fabrication methods work together [3, 8]. Most digital products are not subject to bending, movement, washing and aging of the body. Therefore, at the beginning of the design process, material behaviour must be considered to avoid problems with styling later on. This will not split the workflow of concepts, construction and techniques too rigidly.

A third tension is the problem of innovation-commercialisation. Dunne lists deficiencies in functions, production feasibility and development practices that restrict the commercialisation of smart clothing [9]. Therefore, the scope of application for Design Thinking in wearable fashion needs to be expanded beyond demonstration and proof-of-concept. Repeatedly test the comfort, reliability, care and daily applicability of it. Without the above extended test logic, wearable garments will remain display items and not practical designs.

The fourth is the body as both a platform and a fluctuating environment. According to Fairclough's discussion of physiological computing, technologies that engage with the state of the body are dynamic feedback systems connecting users and computational systems [10]. This makes the design requirement ambiguous; the clothing does not just cover the body, but also perceives and responds to changes in the body. Therefore, in design, we should consider privacy, embodiment, affect and context of use, and not assume that technological responsiveness is inherently good.

Finally, there is a conflict between newness and enduring value. Fletcher's systems-oriented system of fashion design proposes that innovation should not be based solely on newness but also on its effects in use, maintenance and disposal [4]. Ryan considers wearable technology to be a type

of dress discourse in which technological interfaces modify embodiment, identity and expression [11]. Expand the application scope of design thinking. The most successful innovations in wearable fashion are not necessarily high-tech products; instead, they integrate function, desire, durability, and a sense of meaning for users into a single experience.

The above problems show that wearable fashion is not merely a combination of fashion and hardware. It is a difficult design problem, and the goal is to achieve all of them simultaneously. Designers need to decide whether to show the technology or hide it, how expressive interaction should be or how discreet, and how far customisation can go before it becomes difficult to manufacture. These choices are also not technical but rather aesthetic. They are design thinking questions because they require reframing problems rather than addressing pre-determined ones.

4. Practice Pathways for Design Thinking Empowered by Wearable Technology

If wearable technology is to serve the purpose of advancing fashion design, then design thinking should be used as an organised system of application rather than a mere idea. The first is a user-centric scenario construction path. Brown's idea of design thinking is based on the people's needs for innovation [2], and Norman also focuses on understanding the actual circumstances in which things are used [7]. Wearable fashion should start by considering who will wear the product, when they will use it, what body and emotional needs are being met, and what environmental conditions apply, rather than starting with a list of available technologies.

The second way is material-technology co-design. McCann and Bryson indicate that the design of smart clothing extends to fibre and textile choices, as well as system integration and product release [5]. Guler, Gannon and Sicchio have also pointed out that the two are intertwined and should not be dealt with separately [8]. Fashion designers need to work closely with engineers, textile specialists and interaction designers in an early stage to determine the materials, circuit locations, seam construction, flexibility and maintenance of clothes.

The third way is iterative prototyping at multiple levels of performance. Rowe's account of design inquiry and Brown's focus on prototyping both support the idea that design is a process of exploring what can be achieved through testing, rather than improving a fixed idea from the outset [1, 2]. The prototypes in wearable fashion need to be judged on appearance, comfort and technology, as well as user experience. Designers should consider the following in their Design: fit, mobility, interface legibility, sensor reliability, battery placement, user comfort and emotional response. Extend the prototyping logic to prevent the attractive idea from failing in practice.

The fourth way is learning by doing. Dunne's discussion of commercialisation barriers indicates that, in light of functional requirements, manufacturing and development practices, etc., smart clothing must be evaluated beyond proof-of-concept performance [9]. Ryan's analysis also proposes that the assessment of wearable technology should be based on its embodied and cultural connotations, rather than on how technologically advanced it is [11]. Therefore, the design thinking process in this area should consider evaluation factors such as wearability, learning curve,

repairability, social acceptability and long-term value for users. A design enabled by wearable technology succeeds when it creates an experience people are eager to live in, rather than merely being an object of admiration for a short time.

The fifth way is the integration of sustainability-oriented design. Fletcher proposes that, in light of the life-cycle impact and user behaviour of systems, fashion design should be revised [4]. Wearable technology adds to the severity of the problem because clothes with electronic components are difficult to repair, recycle or dismantle. Design Thinking should therefore incorporate questions of modularity, repairability, charging behaviour, product lifespan and disposal at the start, rather than adding them on later.

The sixth way is to redefine the concept of a designer. Quinn and Seymour are in agreement that nowadays, most fashion designs are quite cross-disciplinary and incorporate various new materials, interaction designs and concepts of narrative [3-6]. Therefore, the wearable fashion designer is no longer just a stylist or a form-maker; they have become mediators of body, technology, craft and system experience. One of the first manifestations of design thinking in wearable technology is the expansion of the role of designers, who are now required to think relationally, experiment more freely and take greater responsibility.

The seventh way is communication-oriented cooperation during the design period. Wearable fashion projects often fail not due to a lack of talent among the team members, but because the designer, engineer and maker use different vocabularies and criteria for success. Design thinking can help reduce the above gap by creating feasible cooperation scenarios with prototypes and user journeys. When a garment is shown in terms of how it will be worn, moved, washed, repaired and perceived, interdisciplinary cooperation can be realised more easily. Wearable fashion is also subject to the same problems; thus, the whole user experience will be negatively affected.

For communication-oriented cooperation, joint checkpoints can be established at the concept, material, prototype, wear-test and so on, in various stages of the project. At all checkpoints, the designers, engineers and textile specialists should use the same set of criteria to evaluate the same piece of clothing for comfort, visual consistency, technical feasibility, ease of care and suitability for its purpose. Thus, the aesthetic sense will not be detached from circuit design or software operation. It can also show problems in the early stages of construction or modification without a large cost. Shared documents, annotated prototypes and short user-test records can also help to keep the reason for design selection and improve coordination in the next round.

An eighth way is post-use reflection. Many fashion design processes focus too much on development before release and pay little attention to what occurs after the product is used daily. Wearable technology requires a retrospective examination after use because the garment has been exposed to sweat, washing, seasonal changes, irregular use by different individuals, and frequent updates to software and device ecosystems. Designers can learn from the above cases of failure, non-use, adaptation and user modifications. This kind of feedback extends design thinking beyond studio innovation and continuously adds to the body of knowledge for wearability.

Record one's emotions after using it as well. Designers can see where users stop using a certain function, how often the

clothes need to be washed or repaired, whether they follow the washing instructions, and which parts are removed, covered or modified by users. Therefore, this will not lead to good use by the public. They can also inform the following decisions on modular construction, replaceable electronics, software updates and product life cycles. Use, non-use, breakdown and modification can all be regarded as design references to improve both the clothing and the development process. Wearable technology is thus incorporated into the continuous learning cycle and is no longer a standalone new feature released at the time of launch.

Together, these paths suggest that wearable technology is not about building a future for clothes but rather a way to motivate further study in fashion design. Designers need to integrate beauty with practicality, materials and interactions, and innovation that will last. If design thinking is applied in this way, wearable technology will serve as a driving force for the modification of the fashion design process rather than just adding electronic elements to it. Therefore, for wearable fashion, teaching and research should be conducted through process-based experimentation rather than solely by technology demonstrations. The educational and professional values of the field are in how to train designers with a system-stakeholder-future perspective.

5. Conclusion

Wearable technology has changed how modern fashion is designed at the same time. Change garments from static visual products to interactive systems that need to be designed for use, movement, interpretation and technical performance. Thus, the actual value of wearable technology may be to provide fashion designers with new tools for more extensive and difficult design problems, rather than new functions or an advanced form.

Design thinking can be applied to address the problem mentioned above in the following way. Through human-centred inquiry, the system will be understood; material-technology integration and iterative prototyping/experience-based evaluation will be used to transform fashion design into profound innovations driven by wearable technology. Tension between aesthetics and function, novelty and sustainability, or concept and commercialisation are not reasons to avoid. Therefore, design thinking will be employed in this design.

In light of this, wearable technology is empowering the design of fashion by expanding the capabilities and creative spaces for clothing. Develop the application of fashion through embodied interaction, interdisciplinary collaboration and responsible innovation, and break away from visual concepts. Therefore, the application of design thinking in the future development of fashion design for wearable technology is expected to be quite prominent.

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