Interactive Textiles: An Interdisciplinary Design Approach

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Abstract

With the advancement of scientific knowledge and evolving demands of consumers, there is a growing need for products which enable the seamless integration of technology into daily environments. Due to their tactile familiarity, interactive textiles with embedded technology can be found in a wide range of products, from fashion to interiors. Both aesthetics and functionality are critical to the creation of such smart textiles. Although the fundamental approach for design and technology may differ, the integration of both distinct areas will be mutually supportive and beneficial to the end product. Conventionally, design practitioners are more concerned with the concept and aesthetics while scientists are focused at showcasing the technical advancements. An interdisciplinary approach will aid the development of products which possess both aesthetics and functionality. This paper aims to study how interactive textiles have been applied within the contexts of healthcare, fashion and interior design. The research will analyze how scientists and designers approach the design process. The researcher's own design practice in photonic textiles will be investigated as the main case study. It synthesizes design and technology approaches to develop an inter-disciplinary design framework for photonic textiles. This paper seeks to make a contribution towards existing knowledge about the creative design process of interactive textiles.

Keywords : *Design, Technology, Interactive Textiles.*

Introduction

Interactive textiles are textiles which interact with the environment and users. The interactivity is often aided by the embedded technology, in the form of sensors, electronics and computing components within the textiles, enabling technology to be more portable and accessible in daily environments.

Interactive textiles have been utilized in diverse contexts, for various purposes ranging from functional to aesthetical; however, they all focus on a common goal of improving the user's quality of life. Interactive textiles had been developed for a wide range of purposes such as functional healthcare applications, aesthetical designs for fashion and, as an interactive platform between the environment and the user in interior design.

Applications of Interactive Textiles

Healthcare

Population growth in developing countries and the aging populations of developed countries had led to a global demand for healthcare services. Healthcare is currently one of the world's largest industries (Fisher, 2006). There is an emerging need for healthcare products which can help users monitor their health in an unobtrusive and efficient manner.

Medical monitors have benefited from technological advances in the fields of wireless communication, processing, and power sources. These advances have made possible the miniaturization and prolonged operating times of medical monitors as well as their global integration into medical systems. Interactive textiles within the healthcare domain serve an important function, they are capable of recording physiological, neurological and body kinematic parameters which are crucial for healthcare and health provision (De Rossi, Lorussi, Mazzoldi, Orsini & Scilingo, 2000). They can provide physicians with data to detect and manage health risks, diagnosis at an early stage, recommend treatment, and make professional decisions based on objective information (Lymberis & Olsson, 2003). As indicated by Park & Jayaraman (2003) with De Rossi et al (2003), many interactive textile applications incorporate sensors and processing units into garments.

One prominent example is the MyHeart project (Fig.1), which developed smart clothing using technology embedded interactive textiles (Luprano, Sola, Dasen, Koller & Chetelat, 2006). The underlying concept relies on the use of tiny conductive wires knitted like normal textile yarns. The wearable system is very comfortable for the user, no wireless modules are needed for the sensors and the whole system needs only one centralized on-body power supply, thus resulting in significant decrease of the overall system's size. One main device is used to control and synchronize the power supply for all the on-body components. The developed textile-sensors include an ECG and an activity sensor. The embedded technology is easily accepted by users when they are integrated into wearable sensing interfaces which monitor the user without interrupting their daily activities.

Fig.1: MyHeart T-Shirt

Fashion

Besides serving functional purposes, interactive textiles have also found a niche within a fashion context. Interactive textiles are expressive and customizable thus serve as a valuable communicative platform between wearer and viewers. This is especially evident in the works created by CuteCircuit, a company formed by Francesca Rosella and Ryan Genz (Black, 2010). As both Rosella and Genz had training in both fashion and interaction design, both are keen to develop interactive products which possess good quality design and convey positive emotions.

As observed by Seymour (2008), CuteCircuit's KineticDress (Fig. 2) is an emotionally responsive garment. The electroluminescent embroidery on the surface of the dress is connected to the embedded sensors within the fabric of the garment. The sensors capture the wearer's movements and the luminescence of the embroidery will reflect the wearer's movements and interactivity with others. The designers liken wearable technology as a flowing interface which allows people and environments to connect (Black, 2010).Conventional clothing are passive and reliant on the viewer to interpret the message in which the wearer and the outfit emotes. In contrast, interactive textiles and clothing can actively react to pre-determined stimuli and evoke messages between the product and the viewer.

Fig. 2: KineticDress

Interior Design

Marshall-Johnson's (2009) research indicates that consumers want homes which adapt and allow them to manage their space efficiently as their needs evolve. There are emerging needs for sustainable products which can enable people to modify their living spaces according to their evolving lifestyles without wasteful disposal of materials. Interactive textiles, with their ability to adapt and customize ambience and interiors will help users to maximize the functionality of their fixed living spaces without the need to resort to intrusive renovations and wasteful disposal of building wastes.

Blumen, (Fig.3) developed by Loop.pH, is a light-kinetic textile based room divider created with electroluminescent technology, the surface print can react to various stimuli based on the embedded sensors to create a luminescent glow in the textile print (Ritter, 2007). The floral patterns on the dividers are printed onto the base fabric using electroluminescent ink and each motif is individually supplied with current using thin electric wires in a contrasting color to the floral print. The printed pattern luminance when current is supplied via thin electrical wires which ornamentally surround each pattern. The pattern can thus be controlled by the user who selects the individual patterns that they will like to illuminate by supplying the current. The ambience and decorative patterns within the environment can be easily adapted to the individual's preference without the need for intrusive renovations.

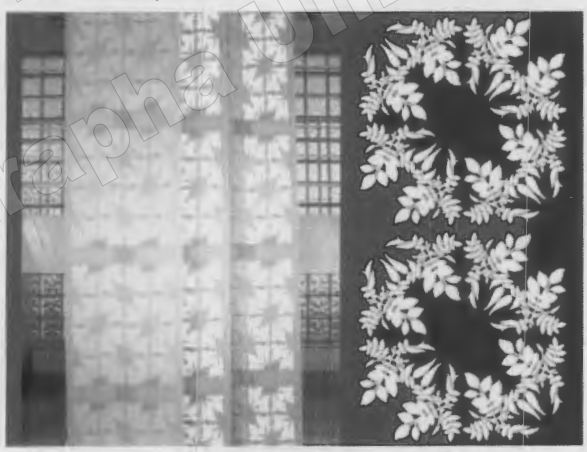

Fig.3: Blumen

Design Methodology

As evinced by the examples cited, interactive textiles serve an important role in many different areas. Many of the existing research on interactive textiles had been conducted by scientists who are focused on enabling technologies. Showcasing the functionality of

the technology had often led to neglecting the creative design aspects of the interactive textiles product. On the other hand, designers also face challenges when embedding technology into design. Conventional design is a matter of mixing known elements in new and exciting ways in order to create fresh combinations and creations. The main factors for consideration in design are theme, shape, color, proportion and texture. However, the development of interactive textiles and relevant products cannot be reliant on a conventional design approach as the consideration of wearability, functionality and technology constitutes key factors to make a user-friendly product for the user. The emergence of conductive and electronic materials demands a greater collaboration between scientists, technologists and designers when creating interactive textiles. Fashion design and technology are established fields of their own, and it is difficult to communicate or adopt the others' work methods (Seymour, 2008). There are gaps between disciplines, which can handicap the usability of interactive textiles.

Technology Led Creative Process.

McCaan, Hurford and Martin (2005) proposed the "Critical Path" (Fig.4), as a design tool, to guide the design research and development process in the application of smart technologies. As illustrated in the „Critical Path", the process includes identification of end-user needs, fiber and fabric development, integration of technology into the interactive textiles and subsequent production and distribution of the interactive textile product. The process is very systematic, with one consideration factor leading to the next. The leading factors for consideration in this approach are the materials which possess the showcased technology and the end user requirements. This proposed process shows little reflection on the creative design and the aesthetics of the product.

In the design of interactive textiles and garments, Dunne, Ashdown and Smythe (2005) have been aware that designers require guidance in the enquiry into the breadth and significance of the technological issues. Researchers found it challenging to demonstrate the different work approaches of technology and design (Aruyatum & Holland, 2003). Thus, a new product design model is needed to improve greater understanding about the nature of each discipline and strengthen communications within the collaborative teams.

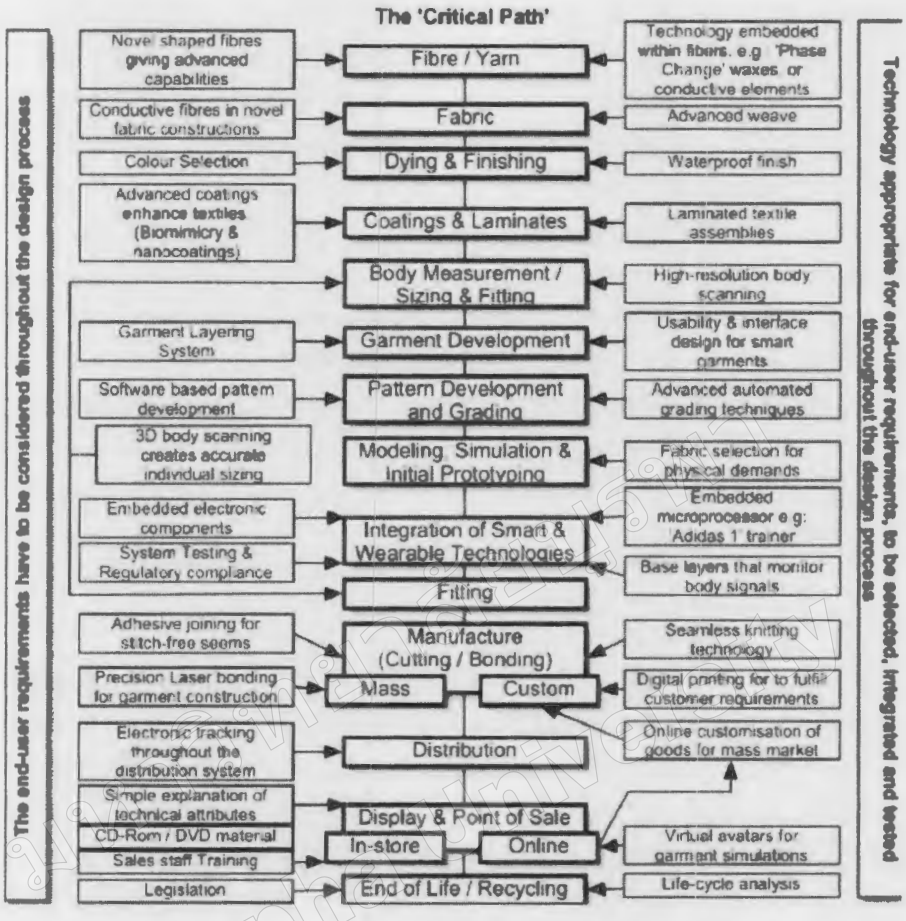

Fig. 4: The Critical Path

Designer's Creative Process.

In contrast to a technology led design process conducted by scientists, whereby the design works around the technology, the designer's process is often thematic or influenced by creative inspiration. Tan's (2005) research, highlights that the design practitioner's process often stems from conceptual inspiration which helps the designer to focus on viable design forms, styles and materials. The design process is often experimental and evolutionary, the cyclic nature allows the designer to reflect on the experiments and refine the designs during the process (Fig.5).

Although the design process is unique to each practitioner, it is evident that the reflective process is vital to the development of original creations. Innovations and aesthetics refinement can be developed from the serendipitous nature of the creative experiments. The

process is not planned to finite details in fact the designer is encouraged to freely move forwards and backwards during the process to further improve the design.

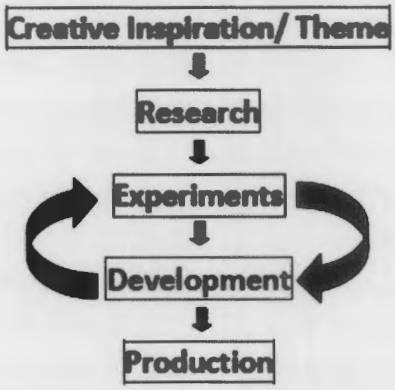

Fig.5: The Designer's Process

Case Study: Design Process of Photonic Textiles

As highlighted by the technology led and designer's creative process, there are gaps which need to be addressed when they are utilized to develop interactive textiles. It is important to incorporate both technological function and aesthetics. This case study will investigate the creative process utilized by the author and her research group which consists of both designers and scientists. The research group synthesized both technology and design approaches to develop a small collection of interactive textiles for interior purposes, entitled Chinois Photonics (Fig.6). The collection consists of cushions and textile room dividers.

Fig.6: Chinois Photonics

The creative inspiration for Chinois Photonics was derived from Neolithic Chinese earthenware (Fig.7) and the showcased technology will feature photonic textiles. Both the design inspiration and technology were considered as parallel factors at the beginning of the process. Subsequent research on the physical shape, form, texture and surface pattern of the ancient pottery was interpreted with a contemporary perspective and introduced into the interactive textiles as the surface print; form and base material and initial designs of the final prototypes were drafted. Viable photonic fibers and yarn were selected based on their ability to transmit light and tactile quality, which were woven into photonic textiles. Light Emitting Diodes (LEDs) were coupled with the photonic fibers to allow light to be transmitted and illuminate the textile.

Laser engraving experiments were conducted on the photonic textiles to enable the emission of light from the lateral surface of the fibres. Surface printing and embroidery experiments were also conducted on the interactive textiles to further enhance the aesthetic design and tactile texture. The results of the experiments influenced the designs and vice versa. Both the designs and experiments worked in tandem which helps to refine and enhance the final design.

The process (Fig.8) integrates technological concerns with the cyclic reflective motion of the designer's process to create interactive textiles which possess both technological functions and aesthetic considerations. At each phase of the process, research members were able to address emerging design and technological concerns and exchange ideas. The research group was able to work flexibly between the different phases to adapt the developments, designs, materials and experiments in a systematic manner, to further improve the final product. Being able to move forwards and backwards within the process had allowed the researchers to have more opportunities to consider more design and technological concerns and requirements. Incorporating considerations from both perspectives had enabled the incongruous partnership of scientific knowledge and design processes to be mutually supportive in the creation of well rounded design products.

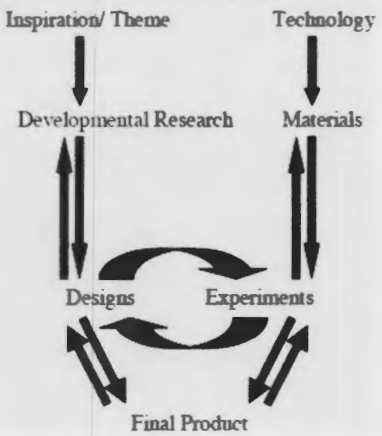

Fig.8: Design framework proposed by research group.

The final prototypes could be presented in both lit and dark environments (Fig.9a &b). The photonic textile is highly interactive as it allows the user to adapt the emitted colors according to preference. The emitted colors can be adjusted to create different ambience and be used as a communicative tool amongst users. The embroidered texture and surface print serves as aesthetic decoration when the technology is not in use. This is in contrast to many interactive textile products which often do not serve any aesthetic purpose when the technology is not engaged.

Fig. 9a & b: Chinois Photonics in both lit and dark environments.

Conclusion

The results of this paper demonstrate that interactive textiles have many viable applications within varied contexts. The seamless integration of technology improves the functionality of healthcare products, aesthetics of fashion products and creates new adaptive and communicative platforms in interior products and therefore serves as products which enhance the overall quality of life. The research indicates the adoption of only the scientist's or designer's approach will have a tendency to develop products which does not fully consider the creative design and technological requirements. The research group had successfully developed an interdisciplinary framework which is both systematic and reflective in aid of developing well rounded interactive textiles and products which are both sustainable and will enhance quality of life.

Acknowledgements

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