Bai, Z.-., & Tan, J. (2016). Photonic Textile Design Practice: a case study. The Fiber Society's Spring 2016 Conference, Textile Innovations - Opportunities and Challenges, University of Haute Alsace, Mulhouse, France, 25-27 May 2016.

Photonic Textile Design Practice: A Case Study

Zi-qian Bai [1], Jeanne Tan [2]
[1]Shanghai International College of Fashion and Innovation, Donghua University, China
[2] Institute of Textiles and Clothing, The Hong Kong Polytechnic University, Hong Kong
vera.bai @dhu.edu.cn

INTRODUCTION

POFs (Polymer Optical Fibers) have been widely utilized in innovative photonic textile and fashion design, due to its compatibility to textile processing. When coupled with light source, POF fabric can emit light if the cladding of POF is partially damaged by chemical corrosion, mechanical abrasion, laser engraving, etc (Daum et al.; Endruweit, Long and Johnson). In contrast to the never-changing color of conventional textiles, the POFs in the photonic textile can be connected to different Light Emitting Diodes (LEDs) sources to transform the textile color to adapt to the user's preference. With the integration of sensors, the photonic textiles can detect and respond to the stimuli from the users, and therefore promote interaction between textiles/user, and user/user (Bai and Tan; Bai et al.; Bai, Tan and Tao). The developing process of interactive photonic textile involves technology implementation, engineering techniques and design, which makes developing a user-friendly product a big challenge. Conventional technology-driven development of smart photonic textiles lacks the considerations from a designer's standpoint. The objective of this research is to address some issues during the design and development process by taking a developed photonic textiles prototype as a case study. How to bridge the gaps between different disciplines are discussed.

CASE STUDY

One piece of illuminating creation based on POF fabric has been developed. During the development process, it is found that technology-centered development approach does not necessarily yield a prototype with satisfactory user experience. The main issues are discussed below.

1. FASHION VS FUNCTION

Design and development of interactive photonic textiles require knowledge from multiple areas (design, textiles, wearable electronics, sensor, etc). During this multi-disciplinary design process, the designer should understand the knowledge of technical parts. How to communicate with technical experts and engineers is a big challenge to designers, since the language the designer uses is very different from the language the engineer uses. Discussions should be carried out during the whole design process between different parties (Figure 1).

Figure 1 Discussion between designer and engineer during the design process

Smart textiles are always developed by technical researchers, who concern more about the technology and function. There is a lack of consideration about the appearance, aesthetics and comfort of the prototype, which significantly influence the usability of the end product. Therefore, the development of interactive photonic textiles must combine technology and design, fashion and function. The designer and engineer must work closely to continuously refine the prototype until the preset requirements from both functional and aesthetic points of view are met.

2. UNOBTRUSIVE DESIGN

One of the main challenges in development of POF textiles is how to integrate POFs and LEDs into fabrics without interfering much with the user, while still maintain the desired illuminating effect. Especially in smart clothing application, as the POF fabric is worn next to skin, the integrated electronic components must be safe, less-bulky, comfortable, easy care and fashionable as well.

Conventional method to couple LEDs to POFs is to attach LEDs to the ends of a group of POFs by transparent glue. The glue needs to be solidified using ultraviolet radiation to ensure the fixation. Due to the size of LED, only a small amount of POFs can be coupled to one LED. This makes the coupling procedure a time-consuming and labor-intensive process. Experiments in this study indicate that the utilization of cable glands significantly reduces the time required for POFs coupling compared to the Ultraviolet bonding technique. This technique involves the use of a customized

coupler based on a cable gland. A Tri-color LED is fixed inside the coupler, and is connected to PCB via wires. A bundle of POFs is inserted into the coupler, and then is fastened by the cable gland without the fussy gluing and curing process. This technique is labor efficient and produces bright illumination. The developed prototype uses less LEDs and wires, is less bulky, and therefore imposes less impact to the wearer.

3. USER EXPERIENCE

Previous study on smart textiles and clothing focused mainly on the technology development. Experiments are always designed to test the functional performance of the prototypes. However, very few studies have been conducted to research the user experience of the prototype, and how to use the feedback from users to refine the design.

In this research, when a prototype is finished, surveys are conducted to obtain the feedback from users. Each performance is given a numerical grade from 1 (very unsatisfactory) to 7 (very satisfactory). The overall grade is obtained by taking average of the grades from all subjects. Results from surveys provide valuable directions for further refinement of the prototypes (Figure 2).

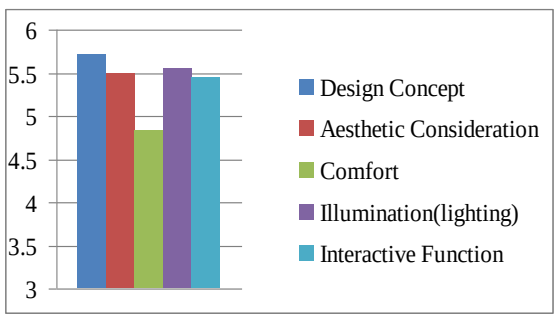

Figure 2 Numerical grades

4. INPERFECTION IS PEFECT

In the creation developed in this research, the POF fabric is engraved by laser to achieve an illuminating effect. During laser engraving, due to the wrong setting, some POFs are over-burned. Therefore more light emit from the over-burned area than other areas, and this makes the over-burned area lighter than other areas (Figure 3). From a technological point of view, the over-burned area is a consequence of wrong setting and failed treatment. However, from a designer's viewpoint, this creates a unique appearance and illuminating effect, which is acceptable. The development process is rather design-driven than technology-driven.

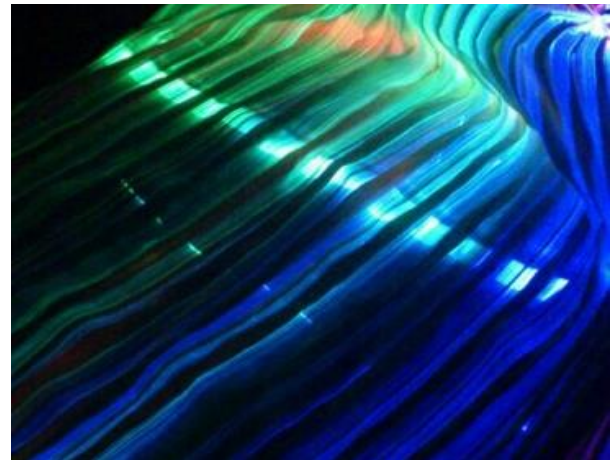

Figure 3 Illuminating fabric

CONCLUSION

The challenges in the development of smart photonic textiles are discussed. It is concluded that:

1) In order to create user-friendly smart photonic textiles prototype, the design process needs to combine fashion and function, design and technology.
2) Research on smart photonic textiles needs to consider the needs and feedback of end users. Unobtrusive design can satisfy the user physically and psychologically in terms of minimizing the impact on the users. Surveys also offer a useful tool to collect the feedback from the users to further improve the prototypes.
3) Development of smart photonic textiles is not only driven by technology, but also driven by design.

KEYWORDS

Fashion Design, Photonic Textiles, POFs

REFERENCES

Bai, Z. Q., J. Tan, and X. M. Tao. "Surface Printing and Photonic Fibers for Interactive Interior Textiles." The Fiber Society 2011 Spring Conference. 2011. .

Bai, Z.Q., and J. Tan. "Innovative Design of Polymeric Optical Fiber Fabric for Interior Textiles." Research journal of textile and apparel 17.2 (2013): 10-15.

Bai, Z.Q., et al. "Enhancing the Functionality of Traditional Interior Textiles with Integration of Optical Fibers." Research journal of textile and apparel 16.4 (2012): 31-38.

Daum, W., et al. Pof Polymer Optical Fibers for Data Communication. Berlin: Springer, 2002.

Endruweit, A., A. C. Long, and M. S. Johnson. "Textile Composites with Integrated Optical Fibres: Quantification of the Influence of Single and Multiple Fibre Bends on the Light Transmission Using a Monte Carlo Ray-Tracing Method." Smart Materials & Structures 17.1 (2008).