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CraftTech: hybrid frameworks for textile-based practice

Abstract

Growth in wearable technology is forecasted to grow from \$30bn to \$160bn over the next 10 years,¹ suggesting consumers' need and demand for smart wearables will be high. Smart apparel is not new, over the past decades, various technologies had been applied onto apparel, however most have received limited acceptance. In many existing products, the technology is applied as an add-on function onto garments creating obtrusive designs which are challenging to maintain in everyday lives. As noted by Dunne,² existing products tend to be a culmination of apparel and technology practices instead of an integration of both. In contrast to fast evolving technologies, the fundamentals of creating and constructing a garment have remained the same since the invention of the sewing machine in the 1800s.

Using the data collected from a collaborative workshop between the Institute of Textiles & Clothing (ITC), The Hong Kong Polytechnic University (HKPolyU) and The Royal College of Art (RCA), this paper reports on the development of a hybrid design framework utilising interdisciplinary approaches to smart materials, methods and techniques to bridge the gap between design technologies. With a common focus on praxis, the teams tested, challenged and extended the affordances of polymeric optical fibre through experimental iteration, failure and reiteration.

Keywords: wearable technology, craft, photonic fibres, interdisciplinary practice, textiles

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Introduction

The fast-evolving nature of contemporary lifestyles means an increasing demand for smart materials that can adapt to the changing needs of consumers. While the market for smart materials is forecast to be worth USD \$80 billion by 2020,¹ to date there has been little research on fundamental design processes for smart materials. Studies focus on technical application and functionality but neglect the integral development process. The tendency to skew research and development towards a technology focus might have resulted in unsuitable products that are not readily adopted by the mass market. As noted by Dunne,² many existing smart wearables show little regard for aesthetics and are inconvenient to maintain, so consumers are unlikely to utilise them in their everyday lives.

Within the context of smart textiles, it is important to note that while technology is relatively new, and indeed, constantly updating and evolving, the methods for textile making and construction have fundamentally remained unchanged since the mechanisation of sewing and the introduction of weaving looms in the 1800s. There has been little discussion about how fashion and textile techniques accommodate technological functions in their components and how the technology affects the ways that smart materials are designed and created.

How do distinct design approaches influence the development of smart materials and how, in turn, does new technologies influence textile design processes? This is the question investigated through two research workshops in Hong Kong and London on hybrid design processes for smart photonic materials. A focus on technology has meant that design processes in smart materials are under researched,

and their importance to creating products that are useable, useful and desirable, is undervalued.

This paper reports on a project utilising photonic textiles and polymeric optical fibres (POFs) as mediums to explore hybrid design frameworks that utilise interdisciplinary approaches. The process of 'making' is critical to this practice based research and illustrates the necessity for craft skills and knowledge in the wearable technology landscape. It involves explicitly studying the practitioner's perspective when synergising design and technology. CraftTech resets the balance and, in doing so, reveals the primacy of making in interdisciplinary design practice.

Creating a framework for hybrid textile practice

Based on two international workshops, one held in Hong Kong at the Hong Kong Polytechnic University and the other in London, at the Royal College of Art, the project set out to investigate the following:

- How practitioners from different disciplines develop hybrid design processes to design smart materials and products.
- How hybrid approaches will bridge the gap between traditional craft and technology.
- How design and technology can be integrated within a physical artifact to develop alternative communication platforms.

As a discipline, Textiles is concerned with the materiality of our lives. The skills and knowledge base that the creative textile practitioner develops through a constant dialogue with materials and making enables the development of a unique materials language

that is simultaneously technical and poetic. The more sophisticated and nuanced this individual language is directly correlates with the capacity to produce more complex, nuanced and multi-dimensional material responses to the challenges of our 21st century society. Igoe describes the Textile practitioner as an agent of tactile and visual experience whose outputs are earnestly functional and elaborately decorative at the same time.³

The design process is often unique to each practitioner. Often mistaken as being led by intuition, detailed studies of the process often reveal a systematic exploration of conceptual inspirations and practical skills.⁴ Practitioners in different disciplines can have different approaches and motivations, but they have a common objective to create an ideal design.

This collaborative research explored the design practice process via the mediums of photonic textiles and polymeric optical fibres (POFs). Photonic textiles are illuminative fabrics woven from POFs and textile based yarns. The design and handle of the material is dependent on the weave, surface treatment and composition. Conventionally, POF transmits light from one end to the other through the core of the fibre with light emitting at the tip. It possesses three layers, with light guided through the core layer following the law of total reflection at the boundary between the core and the first sheath. The second sheath has anti-bending and color modulation functions achieved via different reflective indexes and optic gain materials. Light can be transmitted from the lateral side of the fibre when the surface cladding is damaged by thermal, physical and chemical treatments thus allowing light to escape from the core. POFs are brittle and thus susceptible to breaking when abruptly bent. Light is emitted from the breakage point and hinders the continuous flow of light within the core of the fibre.

For the POF to illuminate, it requires light and power sources. Light Emitting Diodes (LEDs) are used because they are light, safe and energy efficient. The POFs are carriers of light, and the colour of the illumination depends on the colour emitted from the light source. The light sources are connected to a motherboard with incorporated programs. Integrated sensors or remote controls enable the interactivity of the textiles. Interactive POF textiles can be powered by conventional batteries or flexible batteries, or can be directly plugged into a power source.

The research experiments were conducted with 0.25 mm and 0.75 mm POFs made from Poly Methyl Methacrylate (PMMA), a strong and transparent thermoplastic. Research has shown that such POFs yielded positive flexibility and tactility.

POF is an interesting material to challenge. At first glance, assumptions can be made as to how to handle this material based on previous experience with monofilament yarns, and the participants' initial material experiments supported this position. However, on closer inspection and engagement, other technical properties and considerations came to the fore, such as the fragility of the material, the negative impact of heat and excessive bending or fracture, all of which affect the light emitting properties. Of course, these challenges can also offer creative opportunities, many of which are demonstrated within the project. The added layer of working with light as a material posed an interesting dimension to the scope of these materials-led experiments. Light as a material is ephemeral and intangible, yet the POF filament provides a tangible base for exploration. The technical realities associated with working successfully with POF had to be

learnt and factored in to each piece of work. Expert help was on hand throughout the workshop to assist the students, accelerate their learning and help with technical problem solving.

Collaborative methodologies and mechanisms of delivery

Hong Kong design practice

The Hong Kong workshop took place during 11-15 September 2017. The group of eight practitioners included Dr Jeanne Tan (Smart textile Designer), Flora McLean (Accessories Designer), Dr Wang Faming (Textile Technologist), Kurt Ho (Menswear Designer), Nelson Leung (Menswear Designer), Miu Wong (Fashion Designer), Carrie Ge (Textile Weaver) and Heeyoung Kim (Material Designer).

McLean is an accessory designer inspired by Bauhaus imagery and focused on the use of POFs as a material to create structure and form. Wang developed his initial ideas through identification of user problems. The fashion designers Ho, Leung and Wong were interested in constructing silhouettes and exploring construction methods with the POF textiles. With their textile backgrounds, Tan, Ge and Kim started their design process by conceiving prototype ideas that require the use of textiles. The collective design considerations of the designers were the fibre, form, end user and tactility.

Fibre

The practitioners experimented with the fibres to create reflection and encasement effects. POFs were juxtaposed with acrylic to reflect light, thus enabling increased illumination and a means to create illumination via the manipulation of the reflective surfaces. They developed smart materials that are self-contained without relying on cumbersome external components. Experiments were conducted to develop encasements of POF textiles and components. Plastic materials were molded to create pods to contain fibers via sewing and ultrasonic welding.

Form

Research on POF textile design has focused on creating textile structures via weaves. This research fills a gap by experimenting with heat molding to create alternative structures and forms. The heat and pressure from the mold physically damaged the cladding of the fibres, thus creating a ring of illumination around the molded shape. The experiment found an alternative way to create uniform illumination effects (Figure 1).

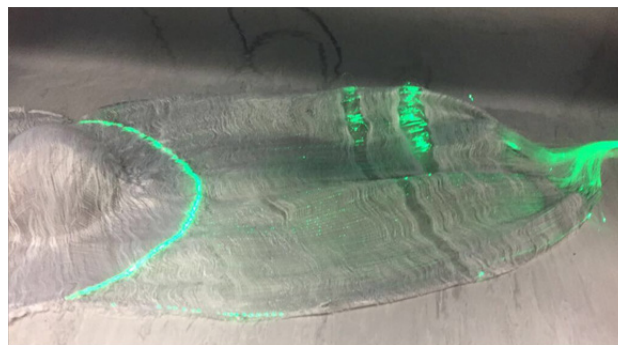


Figure 1 Research on POF textile design has focused on creating textile structures via weaves.

End user

A challenge driven approach requires the identification of potential users and problems to develop a solution via design. The product driven approach is practical and ensures the validity of the experiments and process. One of the challenges identified was to aid people with dementia to communicate via interactive sensory games. The objective of the experiment was to develop sensor integrated POF textiles with textures to encourage potential users to interact with the product.

Tactility

To increase texture on the POF textiles, surface embellishment experiments were conducted using the Tajima industrial embellishment machine. The embellishments were in the form of embroidery, sequins and beads. Of the experiment products, the embroidery sample was the most viable and the practitioners explored possibilities for component encasement within the embroidery (Figure 2).



Figure 2 POF textiles, surface embellishment experiments were conducted using the Tajima industrial embellishment machine.

UK design practice

The London workshop took place during 23-27 November 2017 at the Royal College of Art. The group consisted of 23 practitioners with diverse backgrounds in engineering, architecture, fashion design, textile design, and computer science and service design. Smart textiles practitioners Dr Jeanne Tan, Anne Toomey, Sarah Taylor and Dr Sara Robertson supported the workshop.

At the start of the RCA workshop the participants were asked to arrive with a selection of visual references and background research on using POF. This collective 'mood board' provided a base from which to cluster the thinking of the participants into like-minded groups and provided the clues to identify initial concept areas for each group to develop. The practitioners were divided into five groups based on their initial inspirations and ideas. The groups were Deployable Light, Playful Surface, Assistive Healthcare, 3D Objects and Interactive Space (Figure 3).



Figure 3 The group consisted of 23 practitioners with diverse backgrounds in engineering, architecture, fashion design, textile design, and computer science and service design.

Deployable light

The objective of this group was to develop a flexible lighting system. The first experiments were conducted with paper to explore how POF can be integrated across folded seams within a retractable structure. Further experiments were conducted with paper and mirrored acrylic to develop maximum illumination with limited power reliance.

Playful surface

The design objective for this group was to develop an interactive communication platform that would utilise the POFs to transmit messages to users. Initial experiments involved hand etching and singular messages. Further developments involved laser etching and two messages illuminated via alternate light sources. The flexible POF panel can be applied onto clothing to transform conventionally passive clothing into interactive platforms (Figure 4).

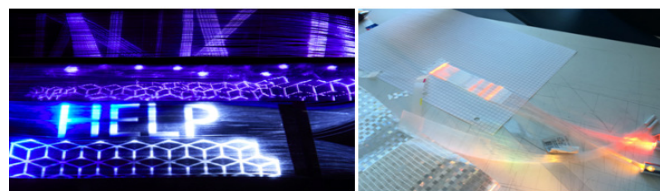


Figure 4 The flexible POF panel can be applied onto clothing to transform conventionally passive clothing into interactive platforms

Assistive healthcare

Creating an interactive music learning aid was the design challenge for this group. The intention was to develop an illuminative glove that teaches finger movements to piano learners. The design could be used by individuals who are re-learning motor skills due to illness or accidents. It was important for the material to be stretchable to accommodate movement. The group experimented with POF fabric construction via weave and knit. Innovations were achieved by integrating the POFs by inlaying the fibres horizontally. This method allows the fibres to be integrated into the knit without subjecting it to abrupt bends. Further experiments were conducted to address the resultant fibre bunching after stretching.

Craft

Using traditional basketry and crochet craft techniques, this group of designers developed structured and soft three-dimensional forms. POFs were juxtaposed with metal and textile based fibres to create organic shapes. POF research to date has relied on cutting and sewing POF textiles to create three-dimensional forms, but each panel can require additional components thus introducing obtrusive technology. The craft approach enabled the practitioners to address the existing research gap by developing seamless POF structures that require fewer components.

Interactive space

The design aim of this group was to utilise POFs to create a responsive environment. They sought to develop a material with POF as an integral part of its architectural structure. The design challenge inspired the group to experiment with casting silicon and resin to create structural definition in POFs and POF textiles.

Discussion: hybrid design processes

The design processes studied in the two workshops were not pre-determined. The practitioners involved in each study led the processes. The Hong Kong case study involved a reflective design process with an emphasis on material experiments. It involved five major phases: visual inspiration, material experiments, reflection, application and scenario building. This process was very similar to a conventional textile and fashion design process where the emphasis is on development of the material and form. Design innovation was visually driven and based on the curiosity of the medium. The production process was quick and had a particular focus on proposing and creating wearable form.

The UK case study involved a design process driven by product concept. The UK process comprised 6 phases: defining product concept, material immersion, material development, material prototyping, scenario building and final prototype proposal. The material immersion phase involved knowledge transfer of material characteristics and demonstrations of material construction and treatment by Tan and Taylor. The conceptualisation of the products was based on design problems without user specifications. The design motivation was challenge driven.

The case studies showed that regardless of design motivation, material development is crucial to the design process (Figure 5). Practitioners of different disciplines create innovation within their medium of choice such as fibre, textile, electronics and silicon.

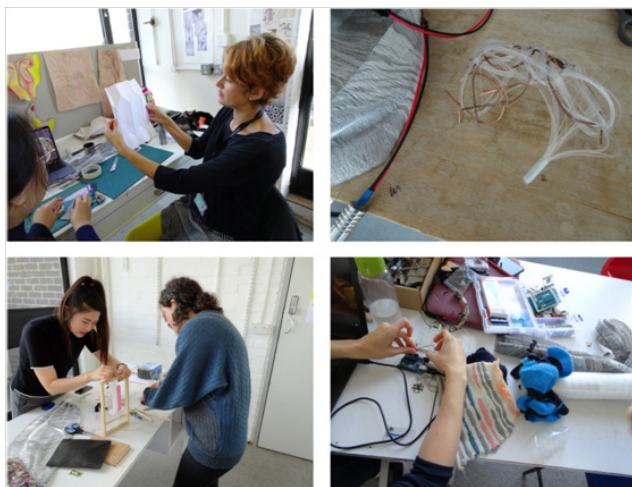


Figure 5 The case studies showed that regardless of design motivation, material development is crucial to the design process.

Practitioner diversity

Both case studies involved practitioners from multiple disciplines. The case studies indicate that disciplinary diversity of practitioners directly affects the process. The multiple perspectives and expertise of the practitioners provided a vibrant environment for experimentation. The hands on practice provided immediate design aesthetic and functionality feedback to the practitioners, enabling a continually evolving reflective process.

Process adaptability and evolution

The two case studies indicate that the practitioners conducted

research that was either:

- i. Driven by material curiosity; or
- ii. Challenge driven.

Practitioners belonging to the first group focused on creating innovation by transforming the material to be applied on potential products. The latter group focused on problem solving: they adapted the materials to accommodate the needs of the proposed design. The flexibility of the evolutionary process allowed the practitioners to address different design considerations in tandem.

Impact and summary

This research documents the exploration of interdisciplinary design processes for designing smart materials and products in Hong Kong and the United Kingdom. The research involved practitioners from different countries and disciplines. The research highlights the reflective and evolutionary nature of design practice and its contribution to the creation of smart materials. This research has:

- a. Built an understanding of how hybrid frameworks contribute to the design of smart materials and products
- b. Established reference points within design discourse and reflected on how practice contributes to design research.

The project formed an exhibition, 'CraftTech', held at two locations, The Hong Kong Museum of Medical Sciences, Hong Kong, in March 2018 and the Edinburgh College of Art, Scotland, in April 2018.

The research shows how a wide range of insights and expertise from different disciplines contributes to the development of innovative designs. The process requires a balance of concepts, methods and techniques from different perspectives. Flexibility allows the practitioners to refine the designs by incorporating new findings from their practice.

We maintain that the exploitation of craft practice and knowledge is essential to realise the potential of the smart wearables market. Moreover, we suggest that this hybrid approach can form the basis of exploratory work into yet unknown materials as the fundamental framework is applicable to many types of materials and scenarios.

Building on rich data (in the form of research, material innovation and frameworks) gathered from the case studies, the next phase of the research would explore the development of physical artifacts as communication and sensory platforms. The continuous research of the fundamental hybrid design frameworks will contribute to the sustainable development of innovative smart materials.⁵⁻⁷

Conclusion

Collaboration between experts in diverse disciplines fuels experimentation and innovation, as CraftTech reveals. The project brought together two institutions, The Hong Kong Polytechnic University and the Royal College of Art, and interdisciplinary teams comprising practitioners from diverse backgrounds, spanning electronic engineering, fashion design, smart textile design, textiles technology, weaving and material design.

Distinct but complementary design processes emerged in the two workshops: one focused on development of material and form, the

other driven by product concept. The array of tactics employed by the research teams, from open-ended, curiosity-led experimentation to a challenge-driven approach focused on solutions for potential end users, reflects the diversity of their backgrounds. What united these diverse approaches was a hands-on concern with material experimentation, central to the design process.

The teams also had in common a focus on praxis or what Toomey refers to as ‘thinking through making’. It is through experimental iteration, failure and reiteration that the affordances of smart materials are best tested, challenged and extended. Similarly, it is through praxis, through the lived experience of working together, that practitioners from diverse design and technology backgrounds exercise and build essential skills and common languages for collaborative practice.

There is an apparent paradox in the term ‘CraftTech’: in contemporary discourse, craft is often set in opposition to technology. Yet there is increasing recognition of, and evidence for, how craft techniques stimulate innovation in science, technology and engineering. This body of work is an exemplar of the potential for the material-driven approach to innovation identified by KPMG in their 2016 research report, *Innovation through Craft: Opportunities for Growth*. That report identified a number of characteristics of craft processes that in combination with technology fuel new breakthroughs. Each of these qualities—a problem-solving mindset, experimental approach, deep material specialism, and a human, empathic sensibility—is manifested in the research showcased here.

Just as polymeric optical fibres give structure to light, that most intangible of materials, this research gives structure and visibility to intangible processes of design and collaboration. If we are to address ‘wicked problems’—those intractable design, health and social challenges that cannot be resolved by any single discipline alone—we need practitioners who combine deep expertise in their field with an ability to bridge disciplines to collaborate effectively in interdisciplinary teams. And, as CraftTech reveals, if we are to

understand and fully exploit the potential of smart materials, we need designers who are deeply conversant with making and thus grasp the deep interdependence of material and process.

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Conflict of interest

Authors declare there is no conflict of interest in publishing the article.

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