CRAFTTECH

HYBRID FRAMEWORKS FOR SMART PHOTONIC MATERIALS

Dr Jeanne Tan & Anne Toomey

Research Team

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FOREWORD

CraftTech sees a collaboration between Dr Jeanne Tan and Anne Toomey; it brings together their research in smart textiles and Design-STEM practice. The research proposes a hybrid approach for sustainable design frameworks that can adapt to changing technology and user needs.

As consumers demand more seamless experiences, they seek sustainable smart materials for everyday solutions rather than novelty gimmicks. It is exciting to see their paradigm shift to seek innovation within tradition instead of technology.

Based on the design practice of 27 practitioners, this insightful study demonstrated how craft integrated practice allows flexible problem solving via first-hand experience. Juxtaposing tradition-based craft with advanced technology may seem incongruous however; both share common values in originality, quality and creativity. Interdisciplinary experimentations enabled practitioners to challenge and push the boundaries of textile materiality.

Against a research landscape that primarily focuses on the final product, Their research had represented smart material design from the neglected yet vital perspective of the design practitioner. In this rigorous investigation, Dr JeanneTan and Anne Toomey had successfully demonstrated hybrid design frameworks bridging the gap between craft and technology. They have contributed new knowledge and alternative perspectives to the design fundamentals of smart materials.

CraftTech is a tangible asset not only to the artistic realm, but it is also an in-depth study that contributes to our daily life. This investigative journey evokes our interest in the creation of new materials, transcending the boundary between art and technology.

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EXHIBITION REVIEW

How do distinct design approaches influence development of smart materials and how, in turn, do new technologies influence textile design processes? This is the question that Dr Jeanne Tan and her collaborators set out to investigate 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 underresearched, and their importance to creating products that are useable, useful and desirable, is undervalued. CraftTech resets the balance and, in doing so, reveals the primacy of making in interdisciplinary design practice.

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 'thinking through making', as Anne Toomey puts it elsewhere in this publication. 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 – are 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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INTRODUCTION

CRAFTTECH

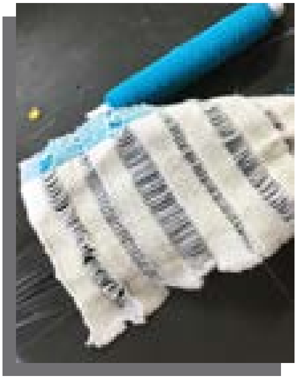
HYBRID FRAMEWORKS FOR SMART PHOTONIC MATERIALS

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 (Housely, 2016), 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 (2015), 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, 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.

Utilising photonic textiles and polymeric optical fibres (POFs) as mediums, this research explores hybrid design frameworks that utilise interdisciplinary approaches. The process of 'making' is critical to this practice based research. It involves explicitly studying the practitioner's perspective when synergising design and technology.

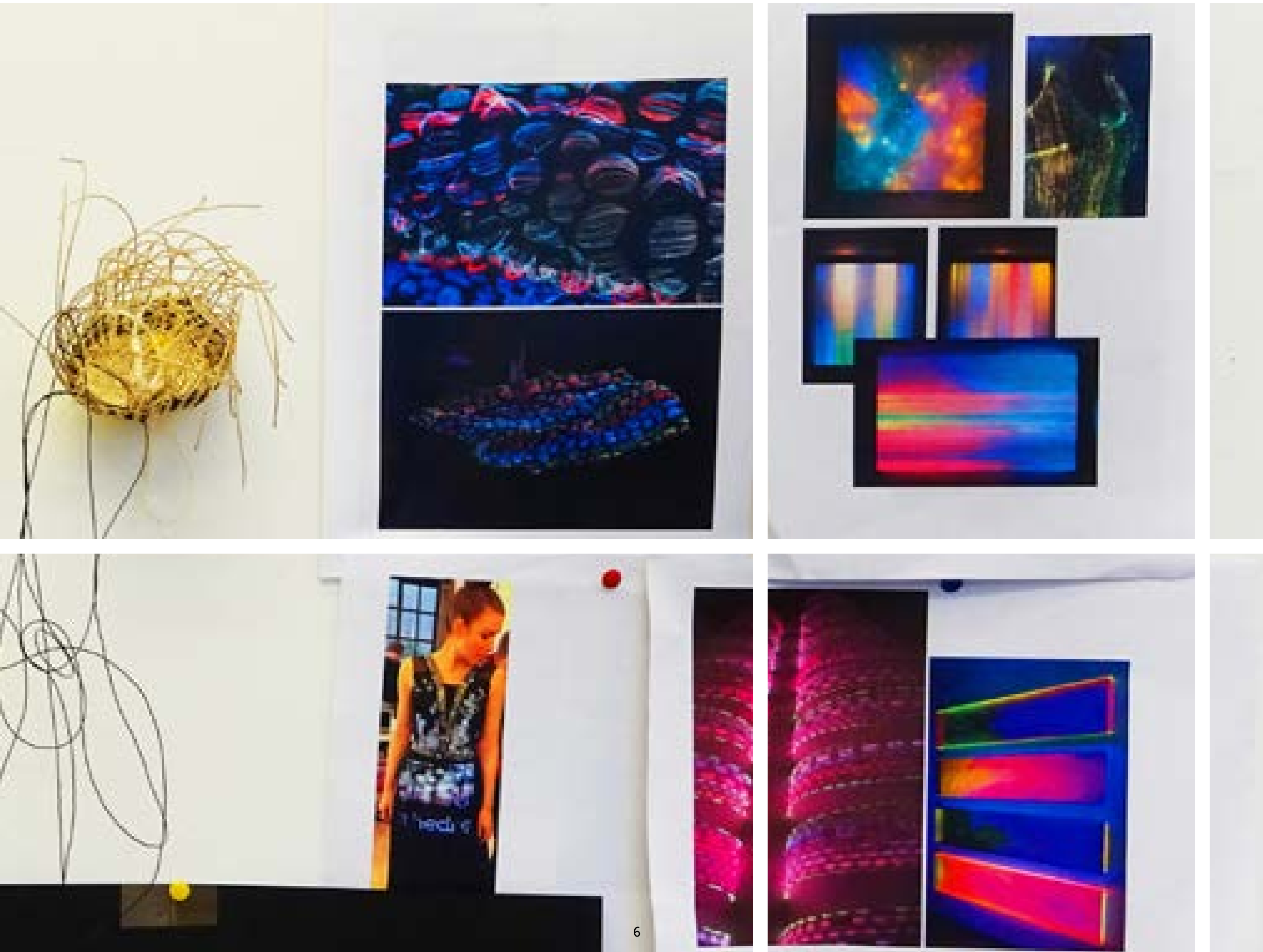
This book and exhibition are part of a body of work (comprising publications, exhibitions, sketchbooks and videos) that explores how interdisciplinary design processes affect the creation of smart materials that are used as alternative communication platforms. The showcased research is based on studies conducted in two international collaborative workshops that brought together practitioners across many disciplines (textiles, fashion, millinery, electronic engineering and textile technology) to experiment, develop and create. The research investigates how hybrid design processes adapt, refine and improve new technology and vice versa. This research documents and studies the balance of interdisciplinary methods and processes via design practice conducted in two workshops at the Institute of Textiles and Clothing, Hong Kong Polytechnic University and the Royal College of Art in London on 11-15 September 2017 and 24-27 November 2017, respectively.



RESEARCH QUESTIONS

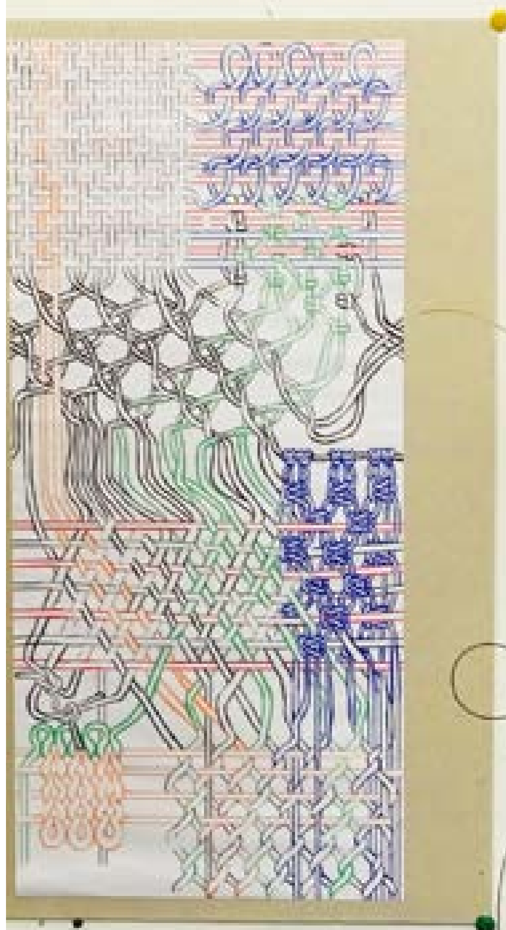
The research sets out to investigate:

- 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.



PRACTICE
BASED RESEARCH

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 (Tan, 2009). Practitioners in different disciplines can have different approaches and motivations, but they have a common objective to create an ideal design.

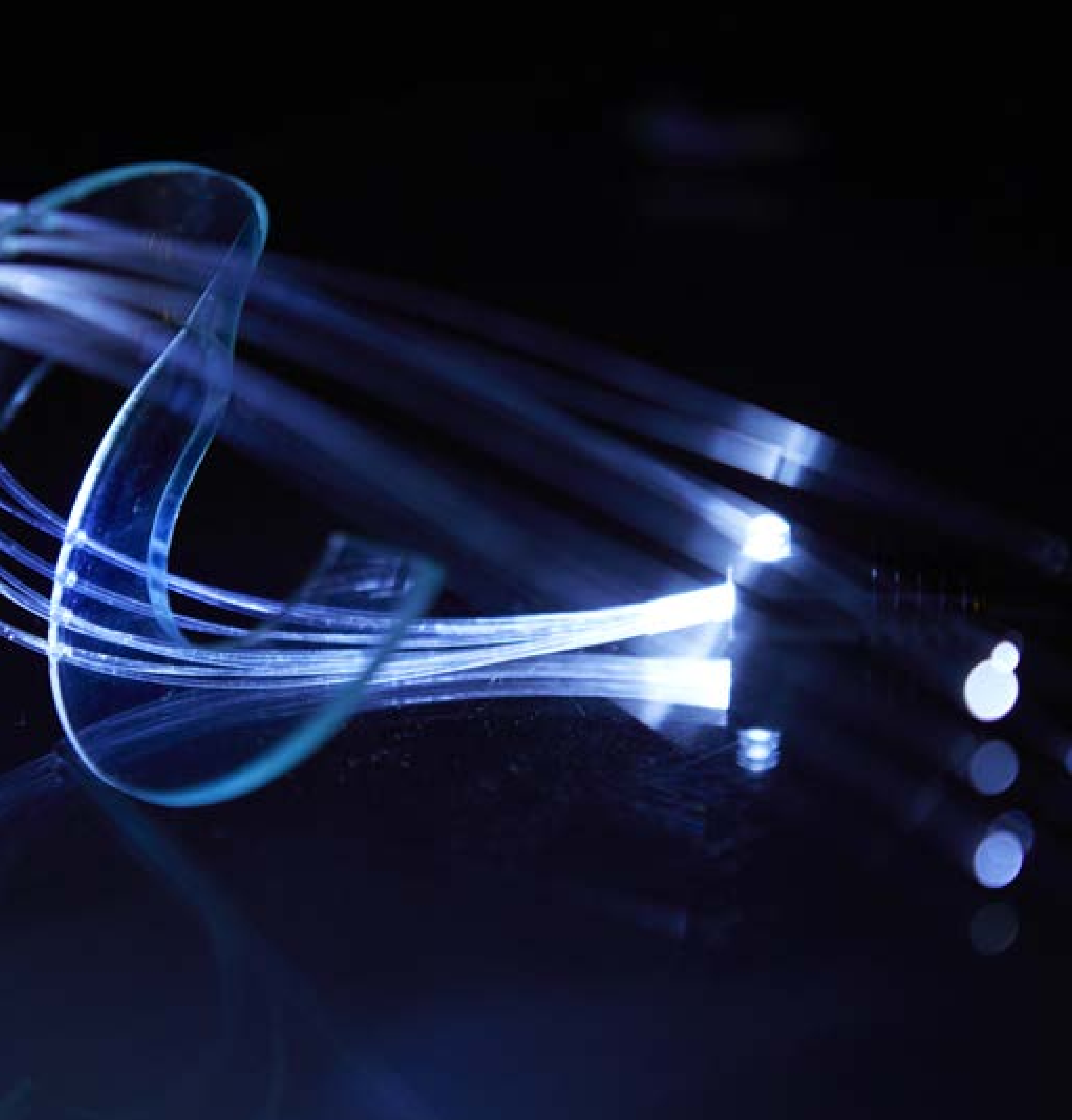


PHOTONIC MATERIALS:
POLYMERIC OPTICAL FIBRES (POF)

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.

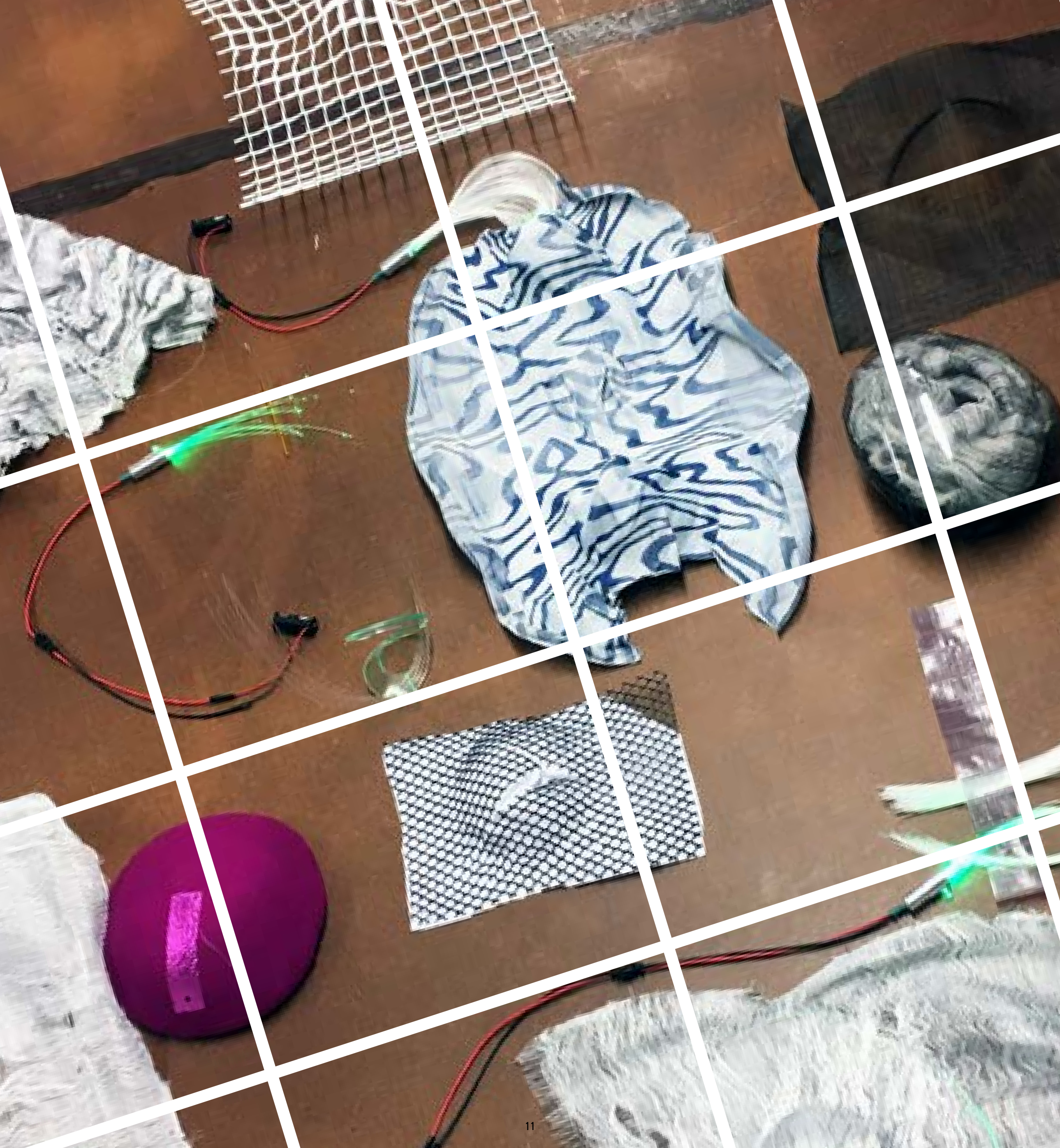
The research experiments were conducted with 0.25 mm and 0.75 mm POFs made from Poly Methyl Methacrylate (PMMA), a strong and transparent thermoplastic. Research has shown that such POFs yielded positive flexibility and tactility.



HONG KONG
DESIGN PRACTICE

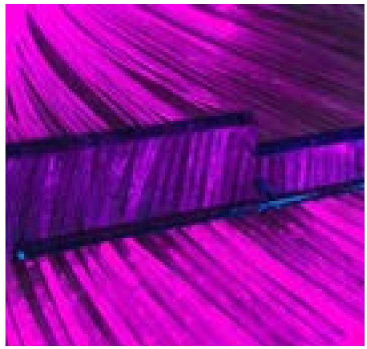
The Hong Kong workshop took place during 11-15 September 2017. The group of eight practitioners included Dr Jeanne Tan (Smart textile Designer), Flora McLean (Accessories Designer), Dr Wang Faming (Textile Technologist), Kurt Ho (Menswear Designer), Nelson Leung (Menswear Designer), Miu Wong (Fashion 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 moulded to create pods to contain fibers via sewing and ultrasonic welding.



FORM

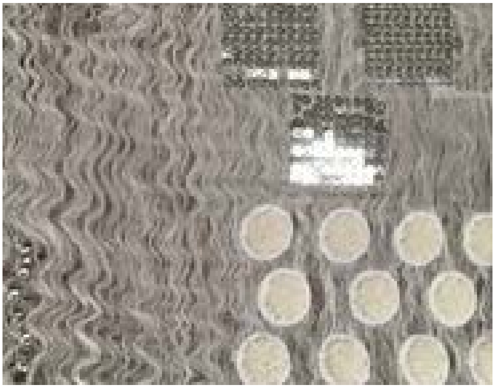
Research on POF textile design has focused on creating textile structures via weaves. This research fills a gap by experimenting with heat moulding to create alternative structures and forms. The heat and pressure from the mould physically damaged the cladding of the fibres, thus creating a ring of illumination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

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.

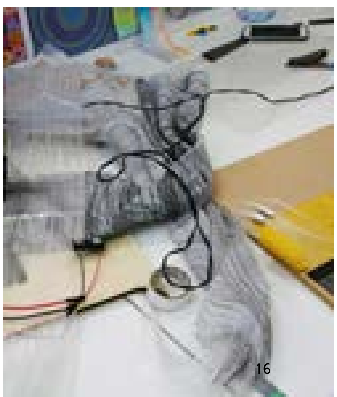
TACTILITY

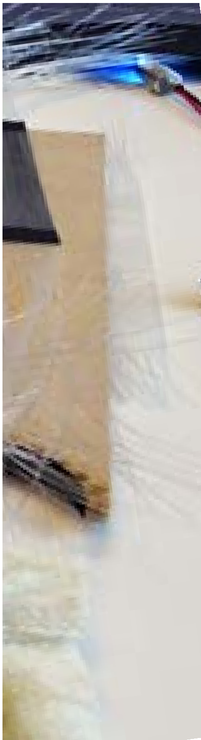
To increase texture on the POF textiles, surface embellishment experiments were conducted using the Tajima industrial embellishment machine. The embellishments were in the form of embroidery, sequins and beads. Of the experiment products, the embroidery sample was the most viable and the practitioners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



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, computer science and service design. Smart textiles practitioners Dr Jeanne Tan, Anne Toomey, Sarah Taylor and Dr Sara Robertson supported the workshop. 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.



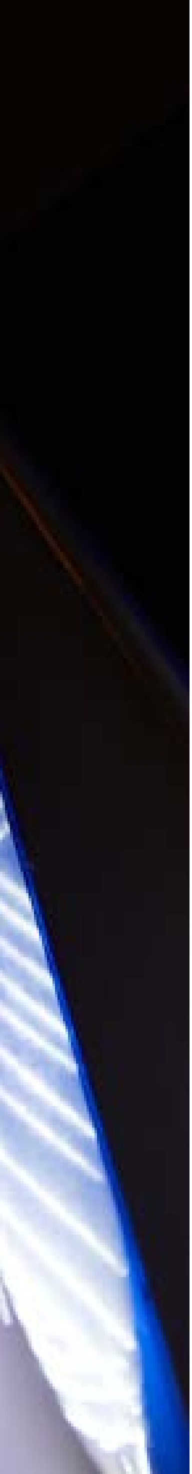


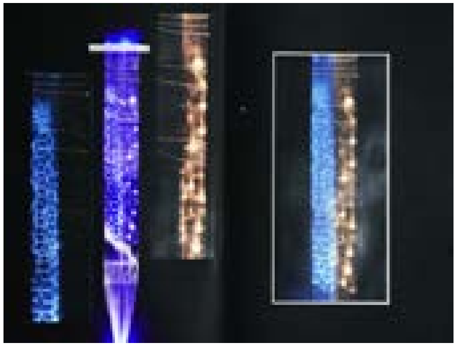
DEPLOYABLE LIGHT

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

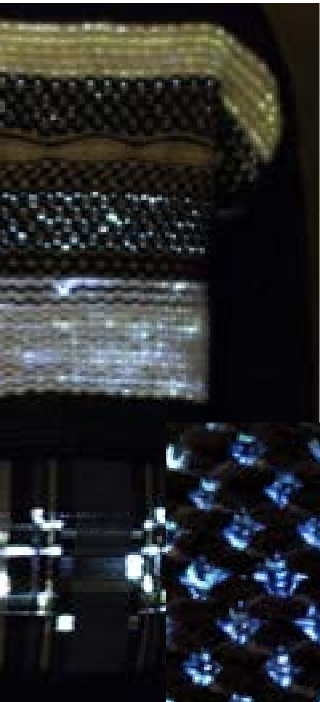
The design objective for this group was to develop an interactive communication platform that would utilise the POFs to transmit messages to users. Initial experiments involved hand etching and singular messages. Further developments involved laser etching and two messages illuminated via alternate light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





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.

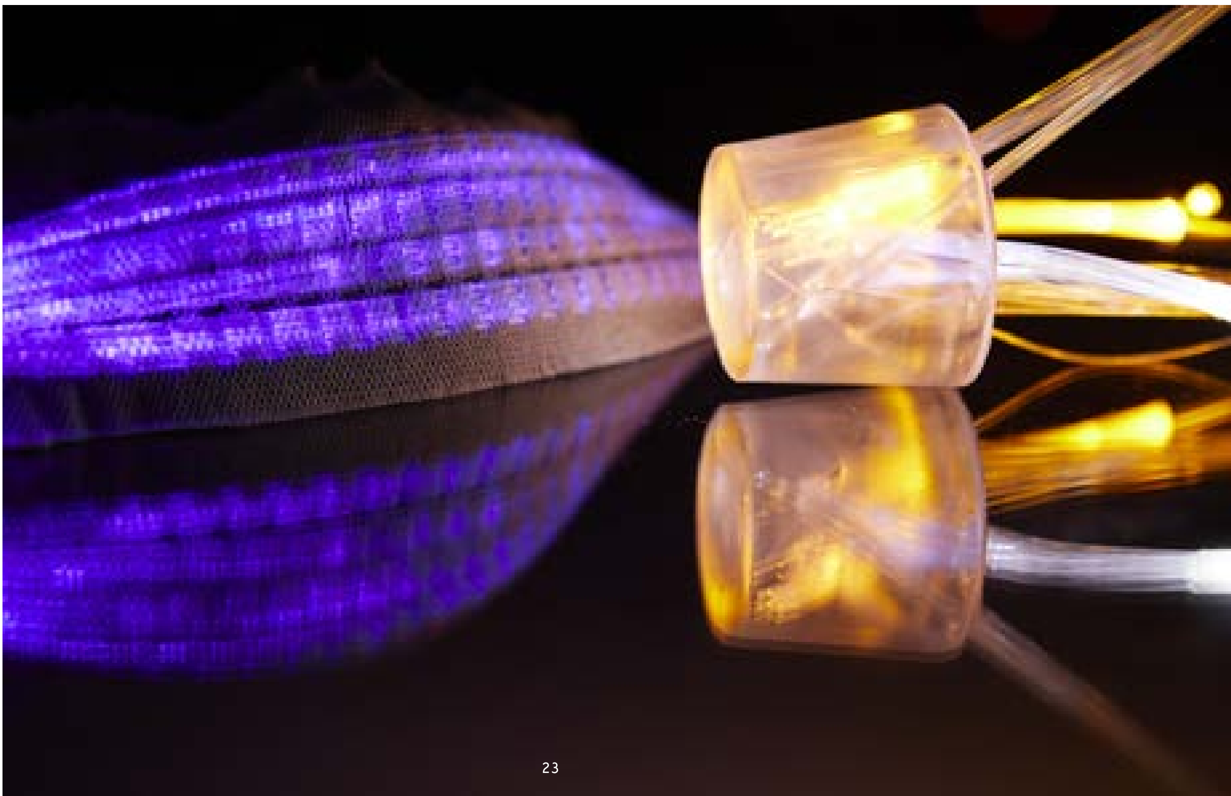


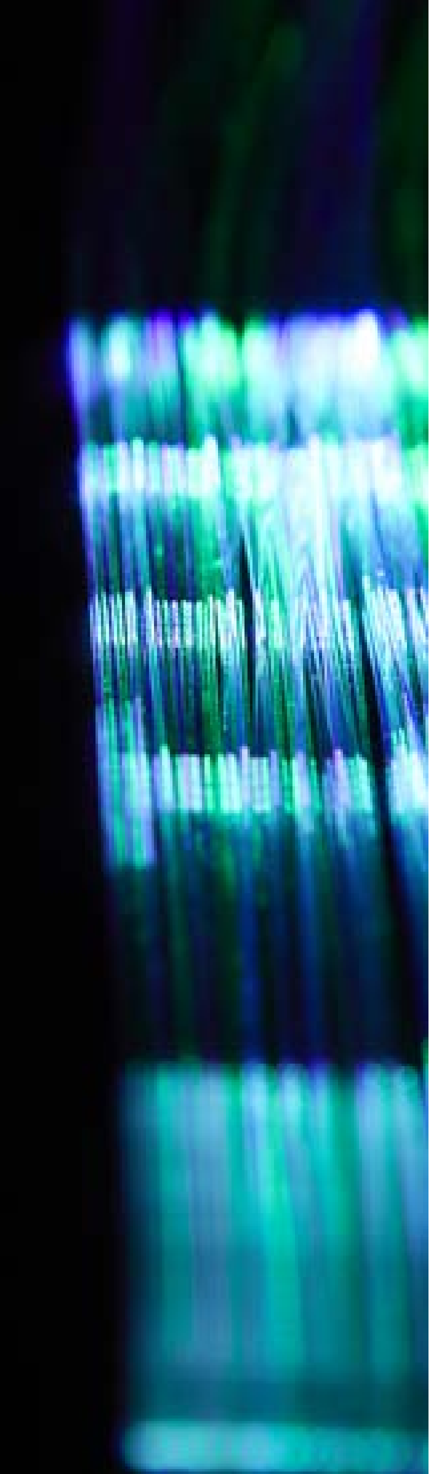
CRAFT

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.





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 (Fig.1). 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 (Fig.2). 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. Practitioners of different disciplines create innovation within their medium of choice such as fibre, textile, electronics and silicon.

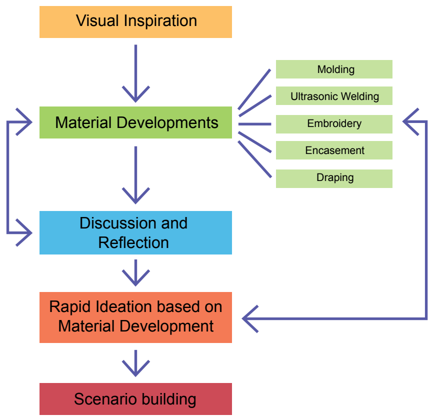


Fig. 1 Hong Kong Case Study Design Process

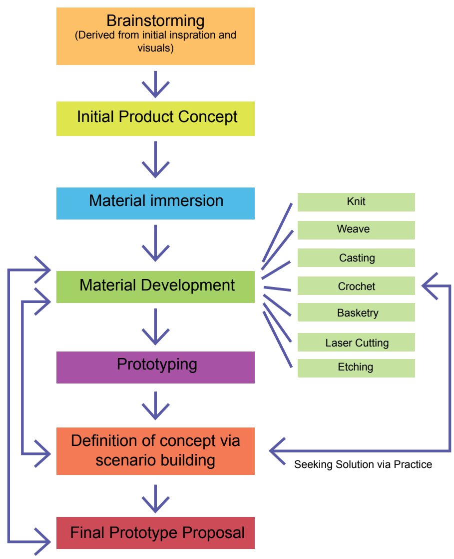


Fig. 2 UK Case Study Design Process

PRACTITIONER DIVERSITY

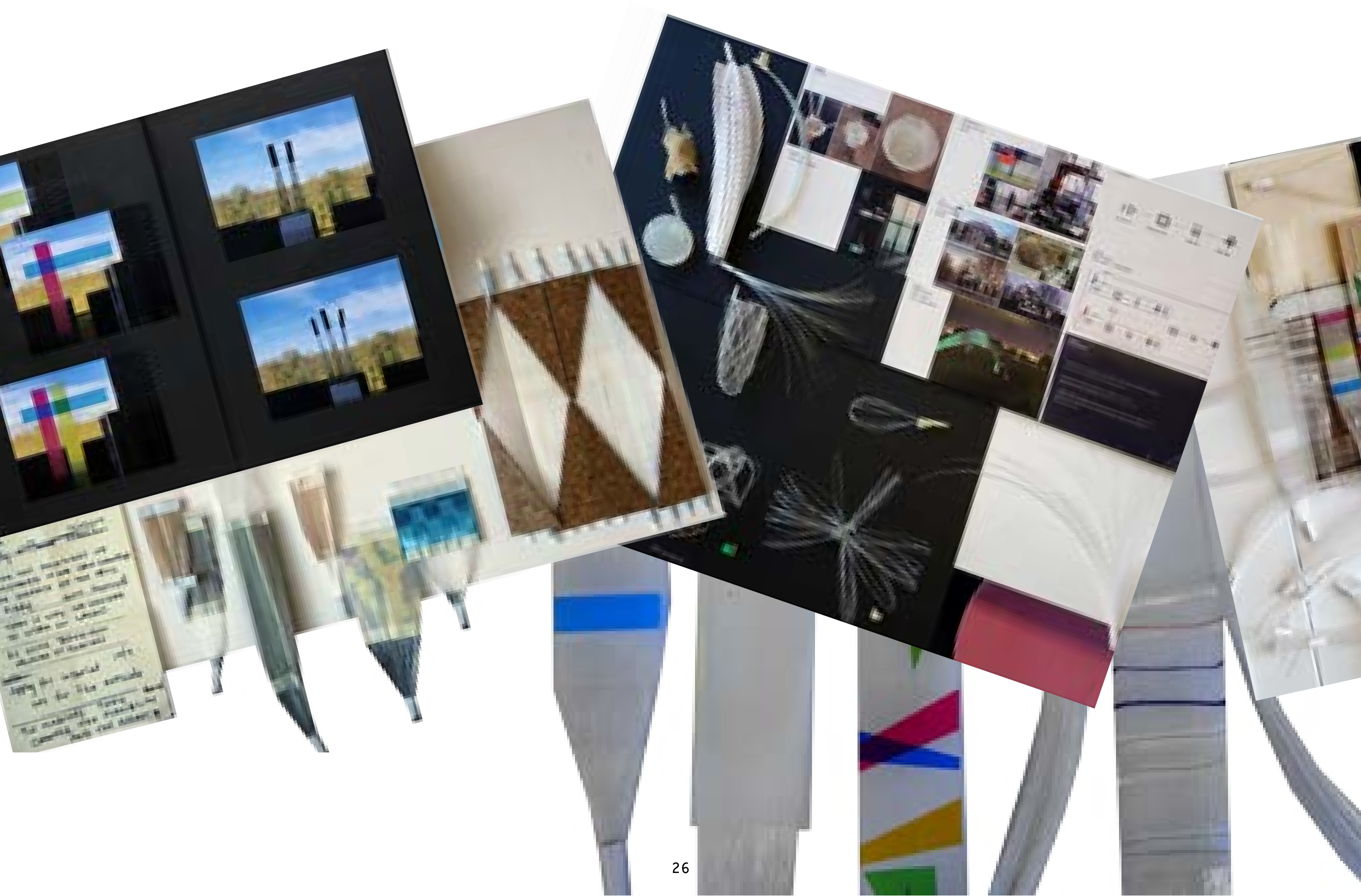
Both case studies involved practitioners from multiple disciplines. The case studies indicate that disciplinary diversity of practitioners directly affects the process. The multiple perspectives and expertise of the practitioners provided a vibrant environment for experimentation. The hands on practice 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:

- Driven by material curiosity; or
- 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:

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

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.

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.

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A TEXTILE APPROACH
THINKING THROUGH MAKING

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. This description is extremely appropriate for the work undertaken in this collaboration.

Advances developed in science, technology, engineering and maths (STEM) subjects offer opportunities for designers to innovate and realise products with advanced, enhanced and engineered properties and functionalities. In turn, these advanced characteristics are becoming increasingly necessary as resources become ever more strained through 21st century demands, such as ageing populations, connected communities, depleting raw materials, waste management and energy supply. We need to make things that are smarter, make our lives easier, better and simpler. The products of tomorrow need to do more with less. The issue for the next generation of designers is how to maximize the potential for exploiting opportunities offered by STEM developments and how best to enable designers to strengthen their position within the innovation ecosystem. We need designers able to navigate emerging developments from the STEM community to a level that enables understanding and knowledge of the new material properties, the skill set to facilitate absorption into the design 'toolbox' and the agility to identify, manage and contextualise innovation opportunities emerging from STEM developments. In doing so, we begin to outline a new design led approach to STEM innovation and begin to redefine studio culture for the 21st century.

There are many different approaches to design across the spectrum of design disciplines and it is important to note that not all enquiry and innovation starts with a brainstorming workshop, is needs driven or problem solving. Of equal value are more curiosity-led discoveries where the end goal is completely unknown at the start of the journey. With regard to creative textiles practice, this open ended, more speculative approach using materials-led experimentation uses established craft skills and knowledge as a point of departure to familiarise the participants with an unfamiliar material.

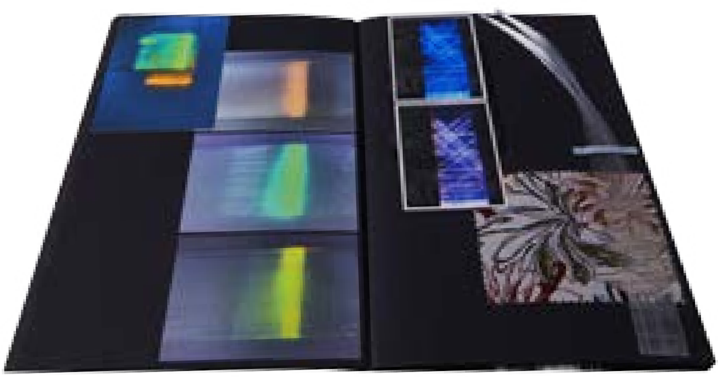

HELP

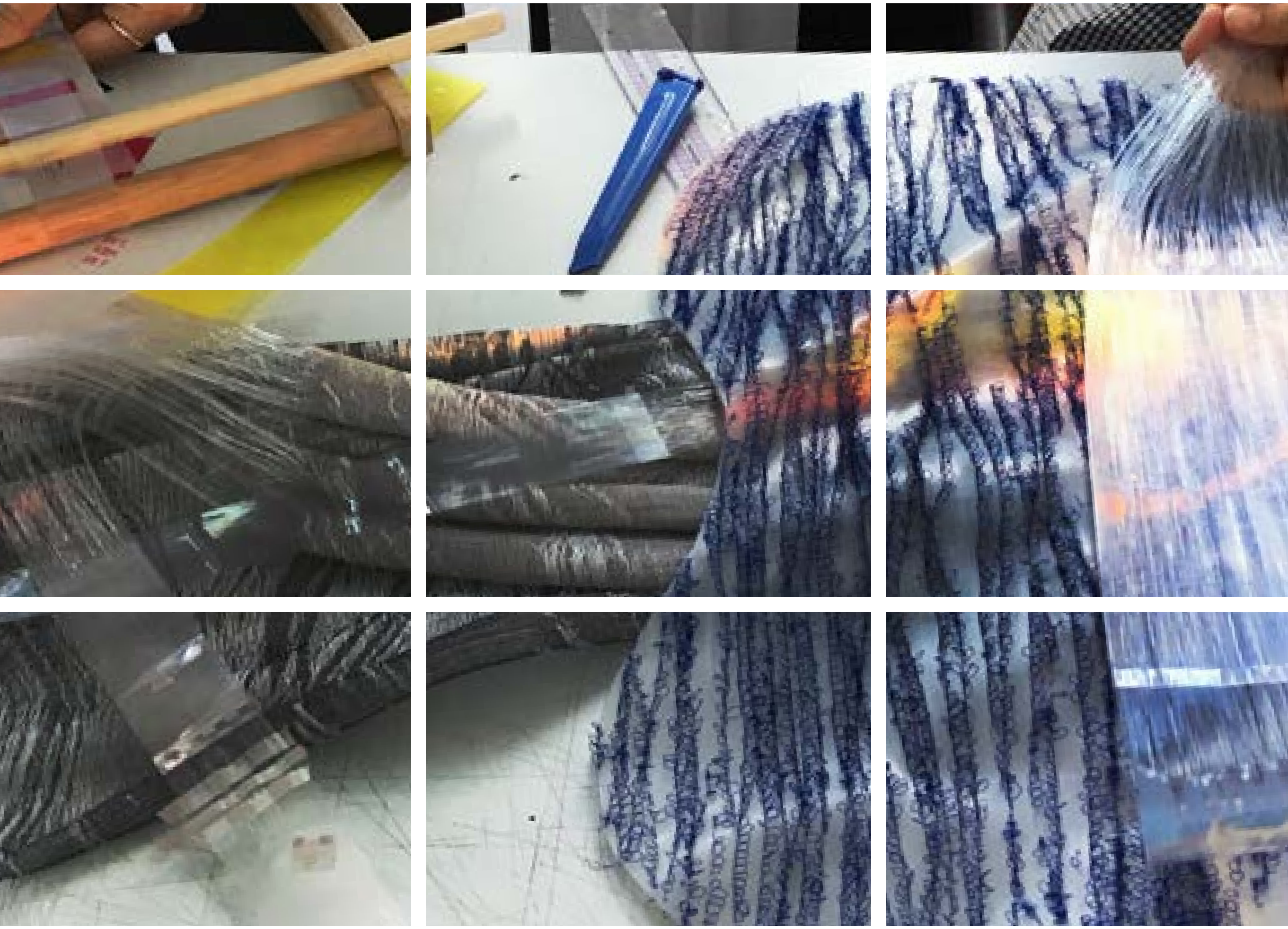
A CASE STUDY
ON WORKING WITH POF

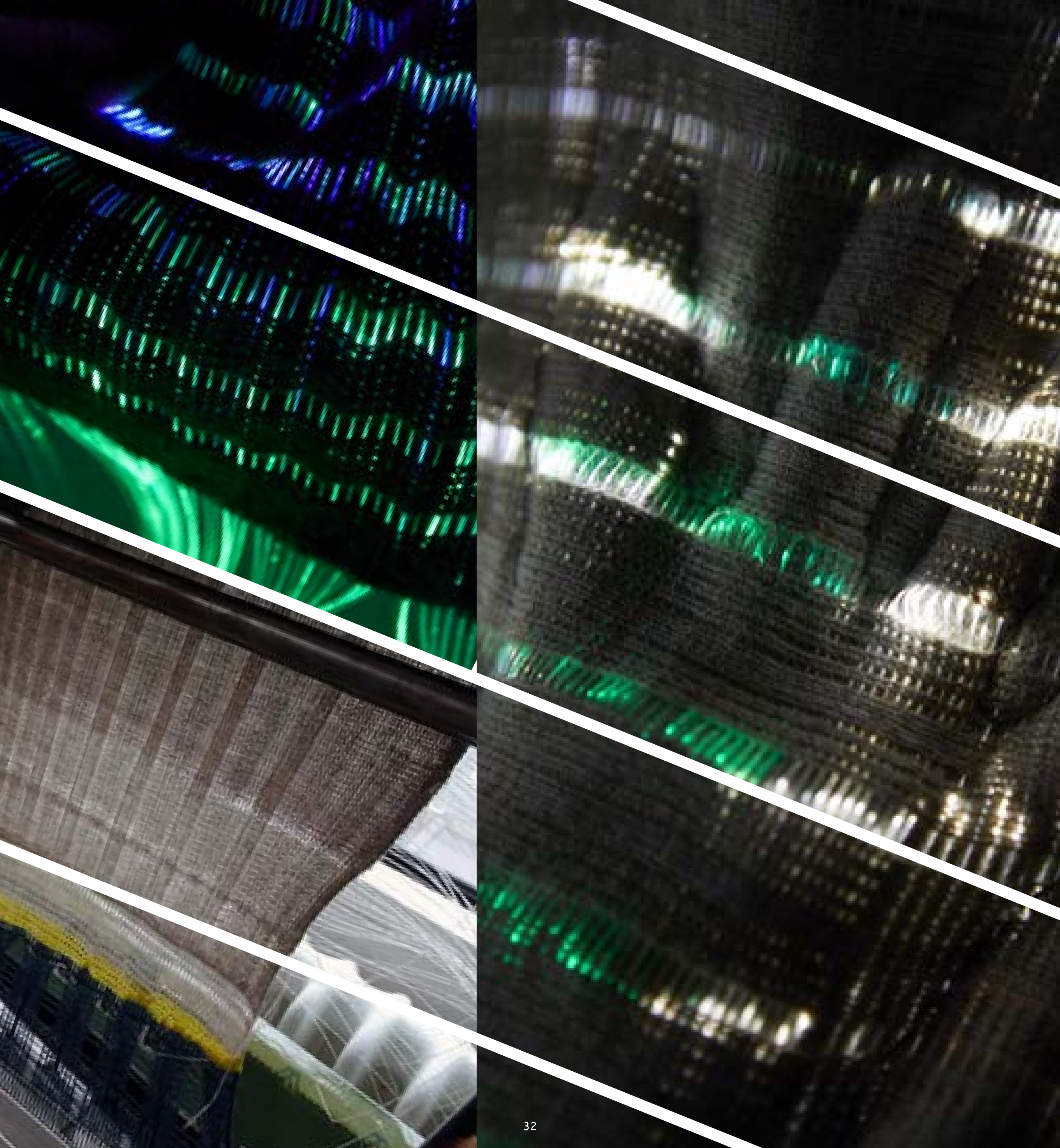
POF is an interesting material to challenge. At first glance, assumptions can be made as to how to handle this material based on previous experience with monofilament yarns, and the students' initial material experiments supported this position. However, on closer inspection and engagement, other technical 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.

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 work of each group is documented elsewhere in this publication, however, extracts from an interview with two of the participants provides an interesting practitioner's viewpoint from two textile students who had no previous experience with POF.







STUDENTSTORIES

Carley Mullally and Winnie Yeung

Carley is a 2nd year weaver, and Winnie a 2nd year knitter, both studying on the MA Textiles Programme at the RCA. Both students have an in depth knowledge of their own specialisms and a shared interest in each other's. Both students adopt the construction techniques of the other's specialism within their own work, for example, Carley will transfer the threads from her woven pieces into knitted constructs that then morph back into woven structures, and Winnie takes a similar approach within her knitted work.

Have both identified each other on the participant list they sought each out to approach the project as a pair, exploring the combinations of knit and weave within the same piece.

Their account of the project provides some insight into the motivations and material considerations behind their decision making.

Mullally was aware of the substantial precedents for weaving POF, particularly the work of Tan at HKPU and Sarah Taylor at Edinburgh Napier. She decided to concentrate on the difficulties of using the fibre and chose to exploit the overlaps offered by a plaid structure, simultaneously employing stability within the weave structure and allowing larger areas of floats for areas of light emission.

With a similar mind-set of focusing on the difficulties associated with using the material, Yeung exploited the damage caused by the knitting process itself to treat the POF to emit light. The effect was more constant and even than the specific targeted areas chosen by Mullally. Yeung needed to pay particular attention to the thickness of the POF material, together with care during the knitting process to achieve her desired result of using the bend in the knit structure to deliver the light emission. She acknowledges that it would have been much simpler to use inlay techniques, however, this was at odds with their combined approach of using the known difficulties of the material as a point for discovering new thresholds of tolerance and possibility.

Both of them actively sought to discover the failure points of the material and process combinations in order to establish their design territory. This is a good example of thinking through making and the value of materials-led experimentation to establish new knowledge, whether this knowledge is new to the individual or new to the world.

Both participants expressed the value of direct engagement with the material. Mullally says, 'Once you start using the fibre, particularly when you start to scratch and etch the surface of the material, you see it happening in front of you'. For her, like other textile practitioners, the experience of this process gives ownership and authority over the exploitation of the tactile and visual properties of the materials.

When asked how she would approach working with another unfamiliar material with exceptional properties, for example, auxetic yarns, she replied that she would adopt a similar methodology of tackling the known problems and difficulties and interrogating the yarn through a series of material experiments based on her own repertoire of skills.

For both students, the failure points were the most important and informative moments of learning to use a new material and both enjoyed the problem solving aspects of moving on from these failure points to the next material experiment. In addition to the specific knowledge gained about POF, the approaches learnt from the workshop and the challenge of a new material have enabled them to develop additional transferable skills they see as being beneficial in the future.

Working in a mixed disciplinary group gave all participants insights into other approaches to design, and in Carley's and Winnie's case the experience led to a deeper understanding and appreciation of their own discipline and what their unique offer is. For both of them, the slowness of the making processes gave them the opportunity to reflect as the work developed in their hands and they could make adjustments to their idea as they worked. Essentially, they took one idea as a start point and expanded this through the making process. They noted how different this was to experiences working with other design disciplines that might rapidly generate a large amount of initial ideas from which something is selected for development.

This collaborative workshop demonstrates the importance of building practical skills within the design community so that adequate understanding and successful exploitation of new materials and the subsequent contribution to future economies is ensured. Within these parameters the importance of learning through failure cannot be overemphasised.

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ACKNOWLEDGEMENTS

CraftTech Touring Exhibitions
Hong Kong
The Hong Kong Museum of Medical Sciences
6-11 March 2018

United Kingdom
ArcInTex Conference, Edinburgh School of Art
April 2018

The production of this exhibition and book result from research collaboration between Institute of Textiles & Clothing, The Hong Kong Polytechnic University and the Textiles Programme, School of Design, Royal College of Art, UK.

Tan and Toomey are grateful to Mr Wong Wang Wah and Mr Kevin Hui for their technological support and kind assistance with the production of photonic textiles. Thanks are due to Shao Li, Feng Guang Wen for component development and Miu Wong for designing this book.

Published by Royal College of Art, UK. March 2018
ISBN: 978-1-910642-31-0

Research Access
CraftTech Portfolio accessible on these repositories and website:
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About the Hong Kong Museum of Medical Sciences

The Museum building started life as the Bacteriological Institute, Hong Kong's first purpose-built public health and clinical laboratory. Situated in the historic Chinese residential district of Tai Ping Shan, it was built in response to the 1894 Plague outbreak and opened in 1906. In addition to its work in the surveillance and control of Plague and other infectious diseases, it also produced vaccines and provided diagnostic tests.

Originally, there was the main building and two subsidiary blocks: one designed to accommodate the attendants (now the Museum Annex), and the other a laboratory animals house containing stables (demolished in the 1980s).

With time, the role of the Institute changed as did its name, becoming the Pathological Institute after World War II. It continued to be used as a laboratory until the 1950s and as a vaccine production centre until the 1970s.

In 1990, the Government declared the site a Monument, and it became known as the Old Pathological Institute. The Hong Kong College of Pathologists, recognising the potential of the building, and that it was important for the public to be aware of the history and development in this region, petitioned the Government for its use as a museum. Despite competing claims, the bid was successful. In 1996, the Monument was revitalized as The Hong Kong Museum of Medical Sciences.

Other than the necessary repairs, the Museum retains the Monument's original external and internal features, and is acknowledged as an excellent example of built-heritage conservation.

MUSEUM OF MEDICAL SCIENCES
香港醫學博物館