NTERSECTIONS
A CONFERENCE EXPLORING COLLABORATION IN TEXTILE DESIGN RESEARCH

13 SEPT 2017
Loughborough University London

S++ : A Hybrid Textile for Healthcare and Well-Being Contexts

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This item was submitted to the proceedings of the Loughborough University Textile Design Research Group INTERSECTIONS Conference 2017 by A. Toomey.

Citation: Cassim, J., Toomey, A. & McNair, J. (2017) *S++ : A Hybrid Textile for Healthcare and Well-Being Contexts*. In Proceedings of Intersections: Collaborations in Textile Design Research Conference, 13 September 2017, Loughborough University London, U.K. Available from www.lboro.ac.uk/textile-research/intersections.

Additional Information:

Publisher: Loughborough University (© The Authors)

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Abstract: This paper presents a collaborative, design-led research project between KYOTO Design Lab (D-Lab), the Department of Advanced Fibro Science, Kyoto Institute of Technology (KIT) and the Royal College of Art's Textiles Programme (RCA). The project involved an initial one-week workshop, followed by a 6-month design research associateship at KIT's D-Lab – an innovation incubator delivered through practical design methodologies and interdisciplinary collaboration. The focus of this project was to investigate the possibility of re-engineering chirimen, a traditional 'intelligent' silk crepe fabric being woven in the Tango Peninsula, in northern Kyoto Prefecture. Varying the weave structure itself and introducing PTT, a thermoplastic polymer, enabled the creation of a hybrid textile of silk which is hydrophilic and Polytrimethylene terephthalate (PTT) which is hydrophobic. This hybrid textiles structure offers new product applications for chirimen silk in healthcare contexts against a background of industry decline and shrinking markets for this highly sophisticated textile.

Keywords: Collaborative research; Inclusive design; Hybrid textile; Chirimen silk; Healthcare

Introduction and Project Aims

KYOTO Design Lab was inaugurated in 2014 as an interdisciplinary design and architectural research centre independently funded by the Japanese Ministry of Education, Culture, Sports, Science, and Technology (MEXT) at the Kyoto Institute of Technology (KIT). KIT is a national university established in 1949 which traces its origins to two schools – the Kyoto Craft High School established in 1902 and the Kyoto Sericulture Training School in 1899. As a result, KIT is one of Japan's three major centres for textile research alongside Shinshu University and the Tokyo University of Agriculture and Technology with particular expertise in the materials, life and information sciences and fibre technology.

Under the theme of *Innovation by Design*, KYOTO D-Lab's mission has been to use design as the driver and means to bring together KIT's expertise in different fields and to work with external partners, particularly in areas where design can have a significant impact. One irony, however, is that while KIT has a well-regarded faculty of design and architecture, textile design is not a curriculum subject, there are no looms on campus and it does not have any capacity to weave prototypes although it boasts comprehensive fabric testing facilities. Thus, D-Lab's textile-related projects to date have involved KIT's textile engineering and materials science expertise with external partners providing the technical input and D-Lab the creative direction and project management.

In August 2016, KYOTO D-Lab held a 5-day interdisciplinary workshop on the theme: Intelligent Textiles Scenarios for Healthcare and Sports Contexts.

The area of intelligent textiles was chosen since it presents a rich area for both crossover scenarios that span healthcare (mainstream, specialist, disability and age-related), sports and extreme environments as well as those relating to specific aspects of each. It also directly draws on the specialist expertise of the project partners in their different fields. Intelligent textiles can be defined as those with inherent material qualities, those with embedded technology or a combination of both. The project was centered on the development of new inclusive product scenarios for these areas harnessing new materials science developments, the inherent material qualities of chirimen silk, the design expertise of KYOTO D-Lab and the Royal College of Art's Textiles Programme and KIT's inclusive IT specialism, prototyping abilities and textile engineering research network.

The Project Professor at KYOTO D-Lab, Professor Julia Cassim, and principal investigator in this project is an international leading expert on inclusive design and has published extensively on the subject.

Contextual Review

Designing for a healthcare context requires input from a number of stakeholders with each one having a different set of priorities, knowledge base, use of specialist language and terminology relevant to their

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individual field. Penetrating these potential barriers to arrive at a shared understanding and interest is an important step for all collaborative initiatives. In this case, the challenge was increased by the participants' differing native language and therefore relied heavily on Cassim's bilingual fluency in English and Japanese. The stakeholders who contributed to this project included a major manufacturer of performance fabrics and embedded technologies, a Kyoto care home, a chirimen silk weaver together with the project partners and a multi-disciplinary group of participants who responded to an open call.

1. Contextual Briefing

Familiarisation with the unique properties and weave structure of *chirimen* silk, together with an understanding its complex production processes, was an essential start point for the project. For the textile practitioner, an understanding of the emotive and sensory values of materials are a necessary precursor to the design of specific product. To this end, and in advance of the workshop, a study visit was organised for Cassim and McNair by the Kyoto Prefectural Center for Northern Industry in the Tango Peninsula. Manufacturers of *chirimen* silk crepe and the central *chirimen* processing cooperative for the region were visited to investigate and understand the context and issues surrounding the decline in *chirimen* production and the potential and drawbacks for its use in the healthcare context. The other contextual briefing took place on the first day of the workshop where speakers from Gunze, a major manufacturer of performance fabrics, a Kyoto care home, Anne Toomey and Professor Sachiko Sukigara briefed all participants on their areas of expertise. The participants were grouped into small teams, each led by RCA Textile graduates. For the following four days, each team visualised and prototyped a set of design ideas, which were presented to an invited audience for input with McNair remaining after the workshop end for his six-month Design Associateship. His design brief for the Design Associateship was defined in two questions:

Can *chirimen*, a traditional 'intelligent' silk fabric be re-engineered to allow it to meet the functional requirements of the healthcare market?

Can the new design scenarios opened up by this new material help revitalize the *chirimen* industry and enable the retention of its skills and knowledge base?

2. Why *Chirimen*?

The moist climate of the Tango Peninsula, which borders the Japan Sea coast is particularly suited to the production of textiles and is known for its *chirimen* or silk crepe, a traditional 'intelligent' silk which was introduced to the area between 1716-36 but has its origins in China (The Cultural Foundation for Promoting the National Costume of Japan). *Chirimen* is the generic name for silk fabric in which right-laid and left-laid hard-twist yarn are alternated in the weaving process(Inoue & Niwa, 2012). '*Chirimen* are classified by difference in yarn, fabric construction and the size of the rugged crimps on the surface' (Nakae, 1993). While there are many variations of *chirimen*, *hitotoshi chirimen* is considered to be typical. The weft uses raw silk which has been twisted approximately 3,600 times per metre while the warp is generally twisted 1,200 times. Depending on the desired weave texture, the right-laid and left-laid twist can also be varied and need not be identical. The silk yarn is then compressed during the complex processing stage of the woven cloth in which the sericin, that coats the separate fibres and effectively glues them together is removed by plunging the woven textile into four alternating baths of boiling alkaline water to which soda carbonate and sodium lauryl sulfate has been added (Figure 1).

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Figure 1. **Removal of the sericin at the Tango *chirimen* processing cooperative**

Source: KYOTO D-Lab

This results in the partial untwisting of the weft and shrinkage of the fabric by up to 30% after which the width is re-calibrated to the required size in the complex processing steps that follow. The result is a raised, shimmering pattern of fine crepe-textured crimps on the surface, which are responsible for the distinctive drape of the fabric and its pre-eminence as a kimono fabric (Figure 2).

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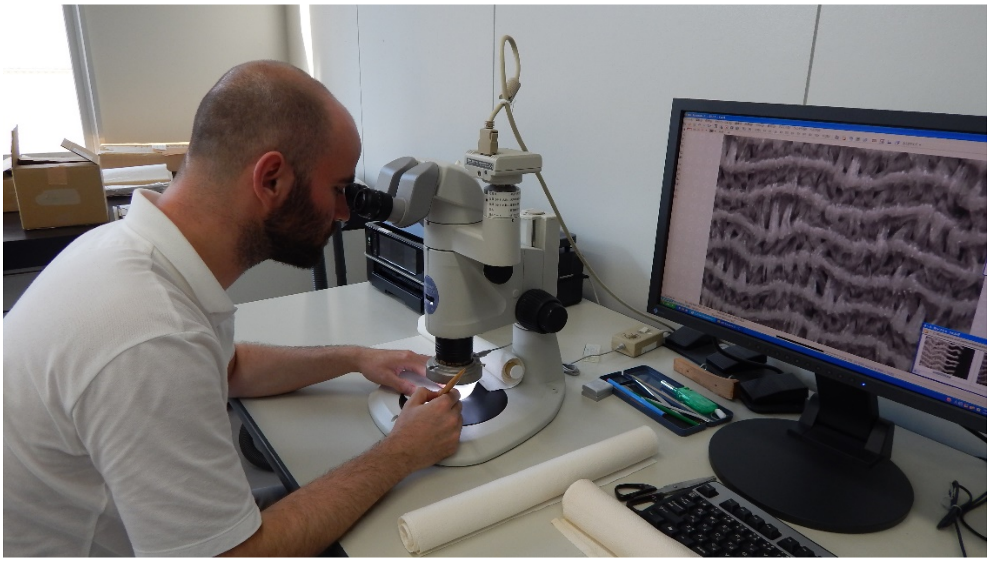

Figure 2. Inspection of *Chirimen* fabric at the Kyoto Prefectural Institute for Northern Industry

Source: KYOTO D-Lab

3. Reasons for the *Chirimen* Industry Decline

The focus of the S++ project was to investigate whether it was possible to re-engineer *chirimen* so that future scenarios of use and new product applications could be found for it against a background of industry decline and shrinking markets for this highly sophisticated textile (Figure 3). A kimono requires one *tan* of cloth measuring 13.5 metres in length and 38 cm wide. In 1973, its peak year of production, 996,000 *tan* of chirimen were being woven but by 2016 this figure had been reduced to 310,000 *tan* according to Kyoto Prefectural Institute for Northern Industry statistics.

The industry is in decline for a range of reasons due primarily to the contemporary preference for western clothes over the *kimono* for everyday wear in Japan. This manifested itself first in the immediate postwar period where silk was superseded by wool worsted for use in everyday *kimono* and silk *kimono* entered the realm of high-quality *kimono* for formal occasions or as luxury goods alone (Hashino, T. 2015). Other factors are the lack of contemporary design input into an industry characterised by a strong relationship between wholesaler and producer whereby the wholesaler commissions the textile based on the style trends of an ageing market and according to a fixed set of colour conventions that are seasonal, related to the age of the wearer, the occasion at which the kimono will be worn and leave little room for innovative or disruptive approaches in terms of colour or pattern. As a result, the designs themselves are often based on stock patterns or variations of traditional motifs adapted by the manufacturer without any formal design input. This and the narrow 38cm width of the fabric in turn limits the potential of *chirimen* to be considered for other product scenarios beyond those of traditional clothing or accessories. The closed nature of the industry with few international connections due to a lack of linguistic skills on the part of producers have further exacerbated the situation as has the disconnect between dyer and weaver whereby the cloth is dyed primarily in Kyoto and delivered via the wholesaler as white cloth. There are, however, encouraging signs of change. With the rise of direct marketing via the internet, some producers are able to bypass

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the wholesalers and sell directly either via their website or by invitation in department stores in pop-up displays where what is now an ‘exotic’ craft is demonstrated. A younger generation of experimental producers are working with international haute couture clients as a result of the exposure and promotion of their work by Kyoto Prefecture at such international trade fairs as Maison & Objet and Premiere Vision.

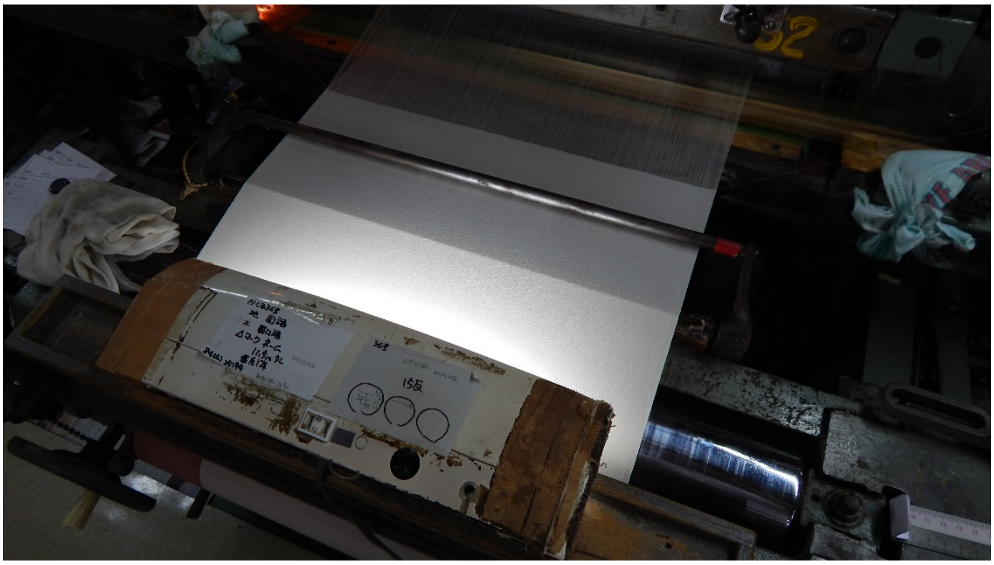

Figure 3. *Chirimen* silk fabric being woven in the Tango Peninsula
Source: KYOTO D-Lab

4. Functional Demands of Healthcare Textiles

It was, therefore, important to find new design contexts for *chirimen*. Given the beneficial qualities of silk as a material, Japan’s super-ageing society and the burgeoning healthcare market, healthcare textiles was an obvious choice but its cost and other factors precluded its use. It was clear that *chirimen* would have to be re-engineered to be sufficiently durable to meet the functional demands of the healthcare context. Thus, it would need to be combined with a more durable low-cost yarn whose qualities could enhance the final fabric and deliver the functional elements that silk alone could not.

Frequent laundering at high temperatures for sterilization and stain removal is also a *sine qua non* for healthcare textiles resulting in many that are synthetic in composition. Their high performance characteristics, however, are often derived from chemical additives that may be environmentally unfriendly and can actively promote the development of adverse skin conditions (Silas, JD et al 2007). Thus, the design challenge was to retain the therapeutic properties of silk whilst ensuring that the hybrid textile created was sufficiently robust to withstand the functional demands of healthcare scenarios.

The new materials’ physical properties required considerations regarding absorbency, tenacity, flexibility, softness, moisture management and air-permeability. The latter three properties in particular

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were crucial for situations in which patients may be bed-bound, incontinent or spend long periods in fixed positions such as in wheelchairs and thus are vulnerable to the risk of pressure sores (Figure 4).

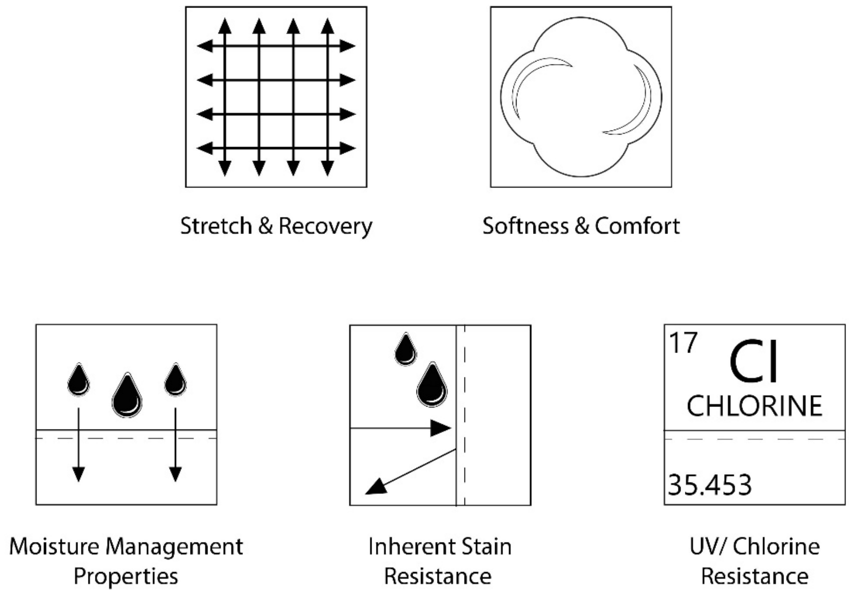

Figure 4. Functional requirements of textiles for the healthcare setting
Source: KYOTO D-Lab

Collaborative Methodologies and Mechanisms of Delivery

Where the collaboration centres on design and involves a range of partners from different fields, three separate mechanisms have been created at D-Lab by Cassim to deliver this interdisciplinary approach – an Open Workshop Programme, a Design Associate Programme and a Designer–in-Residence Programme, of which the first two were used in this project. The first mechanism consists of intensive design workshops of up to five days, which are organised in collaboration with a research group at KIT and a partner university and/or researchers or designers overseas with expertise in the workshop theme. Design workshops of this kind follow the Challenge Workshops model developed by Cassim while at the Helen Hamlyn Centre for Design at the RCA (Cassim, J. & Dong, H. 2013) and can be said to be an accelerated version of the front end ideation stage of a design project. As such they have been used at D-Lab as a seeding ground to brainstorm ideas for the Design Associate Programme, which directly follows the workshop.

The Kyoto D-Lab Design Associates program is a six-month research-based innovation incubator delivered through practical design methodologies and interdisciplinary collaboration. In it a young designer from abroad or from within Japan is invited to work collaboratively with the same research group and external partners to develop a project in response to specific needs or potential areas of

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innovation identified prior to or during the workshop. This programme has a history of successful collaborative research projects. For example, in 2015, two young designers - Frank Kolkman from Design Interactions at the RCA and Michelle Baggerman from the Design Academy Eindhoven joined KIT as KYOTO D-Lab Design Associates. Both were matched with existing research teams at KIT – Kolkman worked with Professor Masamitsu Yamaguchi of the Department of Applied Biology while Baggerman worked with Professor Teruo Kimura of the Department of Advanced Fibro-Science. In both cases, design was used a mediating and transformative tool to propose new applications and scenarios for existing research and to prototype and refine them in the D-Lab workshops. The results of both have been outstanding with Kolkman's project winning a 2016 Dutch Design Award.

Technical and Logistical Collaborative Methodologies for S++

The S++ project followed the same methodology with an initial workshop on the theme of 'Intelligent Textiles Scenarios for Healthcare and Sports Contexts' held at KYOTO D-Lab from August 29 – September 2, 2016 in advance of the project start. Anne Toomey, Head of the Textiles Programme at the Royal College of Art (RCA), a specialist in the subject, was invited to lead the five-day workshop and brought three recent graduates of her programme, including McNair, the new Design Associate chosen for the S++ project. They led the three teams of textile engineers, materials scientists, weavers and designers who participated as a result of an open call. The KIT research group was headed by Professor Sachiko Sukigara from the Department of Advanced Fibro Science and included Professor Noriaki Kuwahara, a specialist in embedded technology and Dr Kazunari Masutani from the Department of Bio-Based Materials. A *chirime*n silk producer, a major manufacturer of performance fabrics and a Kyoto healthcare provider for elder citizens also participated.

In the S++ project, given the inability to prototype any fabric samples on campus and the fact that neither Cassim nor McNair were weave specialists, the support of the Kyoto Prefectural Center for Northern Industry in the Tango Peninsula was enlisted. The role of this public body is to support the textile industry in the region through research, development, technical support and promotion. Their collaboration proved vital to the realization of the S++ project in two key aspects:

- At the start of the project, their Senior Researcher, Ichiro Izawa effected the crucial visits by Cassim and McNair to different *chirimen* (silk crepe*)* producers. This was to enable them to understand the production process and the challenges facing an industry characterized by small family firms with an average of 1.6 employees of which 78.5% are aged over 60, according to the centre's 2016 statistics. Without this introduction in a country where introductions by trusted third parties are vital, it would have been difficult for the research team to establish contact with the key players in what is essentially a closed traditional industry or even to conduct the basic contextual research necessary to advance the project.
- The fabric samples were woven under the guidance of Ichiro Izawa and his team at the centre in two batches following their technical input regarding optimal weave structure for the proposed hybrid fabric and the likely *chirimen* behaviour as a result of processing (Figure 1). The initial batch was also tested on the spot at the centre to measure potential shrinkage once the sericin was removed for each fabric sample.

Thus, the collaboration with the Kyoto Prefectural Center for Northern Industry was primarily technical and logistical in nature and the relationship characterized by a strong *quid pro quo* factor of mutual self-interest. KIT's inability to technically deliver the project was counterbalanced by the Center's lack of any external design network or internal design expertise, which hampered their own mission to find new possibilities for *chirimen* to stem the industry decline

Collaborative Fabrication Methodology for S++

1. Re-engineering the *Chirimen* silk

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In re-engineering the Tango *Chirimen,* we took advantage of the differential in the yarn twist, the fact that silk shrinks and when used for both warp and weft could serve as a firm structure to hold the PTT filament and ensure that it would sit on the surface of the finished fabric thereby meeting the functional requirement of optimum moisture management. Varying the weave structure itself and introducing PTT, a thermoplastic polymer, enabled the creation of a hybrid textile of silk, which is hydrophilic and Polytrimethylene terephthalate (PTT) which is hydrophobic. The result is a structured fabric in which the tightly twisted silk yarn untwists during the processing stage, pushing the PTT toward the skin surface (Figures 5 & 6).

It was important that the new fabric be as sustainable as possible to reduce its environmental impact. The PTT yarn used was Dupont's Sorona® manufactured under license in Japan by Teijin as Solotex.® PTT is made from the naturally occurring starch in the kernels of corn. Du Pont describes it as having a three-part environmental story. Composed of 37% plant-based materials renewable resources instead of petrochemicals, Sorona® requires 40% less energy to produce that an equal amount of petrochemical-based polyester making it a more environmentally-friendly alternative than conventional polyesters. Producing Sorona® reduces CO2 emissions by up to 60% over an equal amount of petroleum-based polyester (Dupont 2017) (Figure 8). Initial advice and support in obtaining raw materials was given by Dr. Kazunari Masutani, a specialist in PLA in the Department of Biobased Materials Science, at KIT (Figure 7).

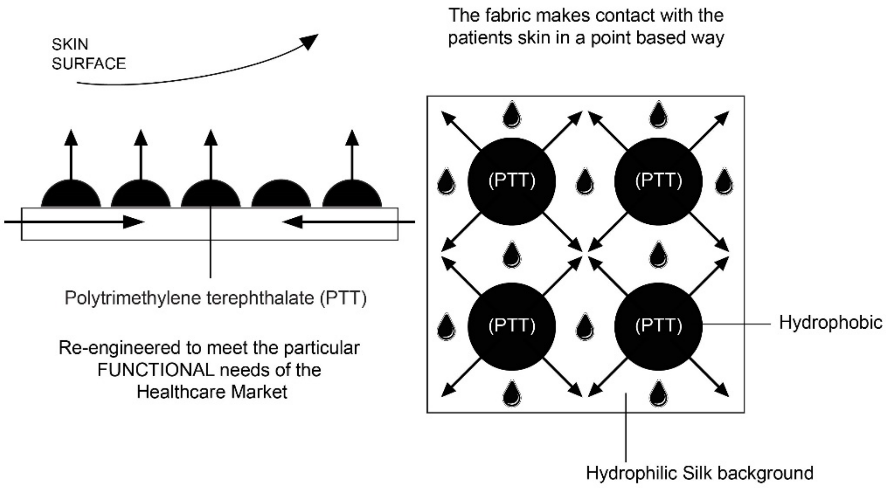

Figure 5. Wicking properties of S++ fabric
Source: KYOTO D-Lab

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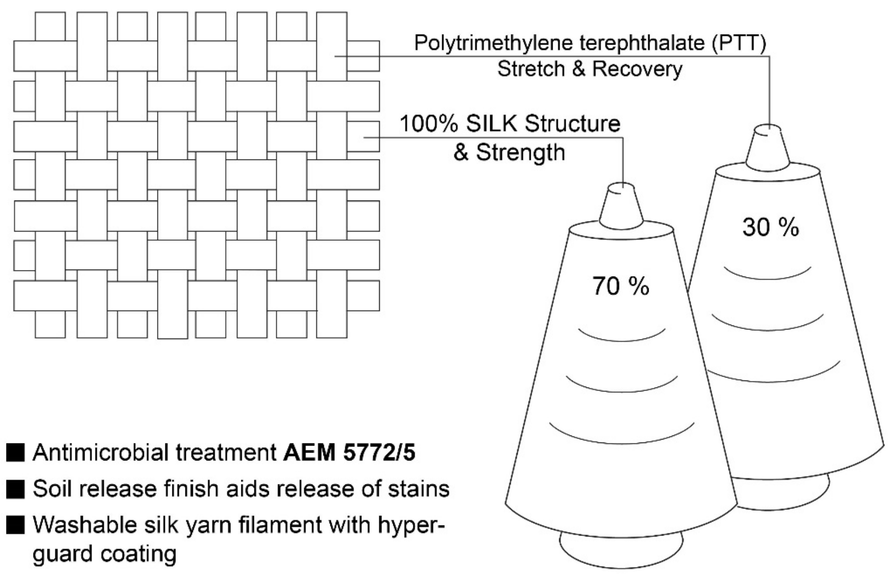

Figure 6. Structure of the S++ fabric
Source: KYOTO D-Lab

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Figure 7. Discussion with Dr. Masutani at KIT's Department of Bio-Based Materials
Source: KYOTO D-Lab

2.The Choice of PTT and Weave Structure

Polytrimethylene terephthalate (PTT) has other qualities that recommended its compatibility for the silk yarn in comparison to PLA which was the initial research focus. PTT could provide essential stretch and recovery, softness and had moisture management properties and inherent stain resistance, including UV and chlorine resistance. Silk, on the other hand, is temperature regulating, has moisture wicking properties and is also bio-compatible.

In re-engineering the *chirimen* to meet the constraints of the healthcare environment, the weave of the fabric, including the structural parameters had to be taken into consideration given the difference between the yarns and the need for the PTT to sit close to the skin surface. The double weave structure was designed to maximise air and moisture permeability, factors which were pre-determined in the designing phase and realised in the weaving phase under the supervision of Ichiro Izawa.

3.The Benefits of the New Hybrid Textile

Using the hydrophobic PTT yarn close to the skin surface in a point-based, embossed way allows free movement of air penetration, moisture and carbon dioxide, providing the skin with oxygen more efficiently, whilst pushing moisture away from the skin surface toward the hydrophilic silk background. Both PTT and silk are continuous filament yarns. Thus, not only do they wick moisture more effectively away from the skin but also allow for a woven textile to be created with a smoother surface, in comparison to the cotton or poly-cotton alternatives commonly used in the healthcare environment (Figures 9 & 10).

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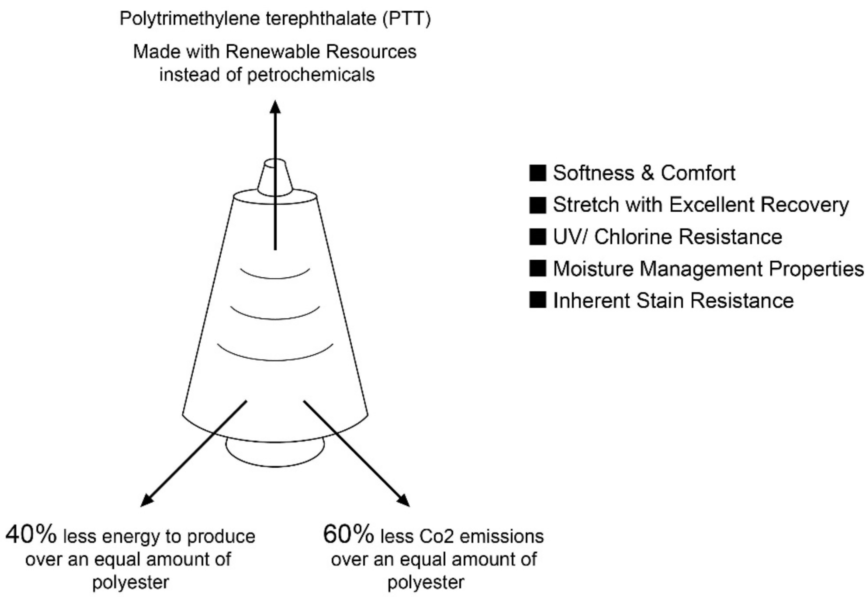

Figure 8. Polytrimethylene terephthalate (PTT)
Source: KYOTO D-Lab

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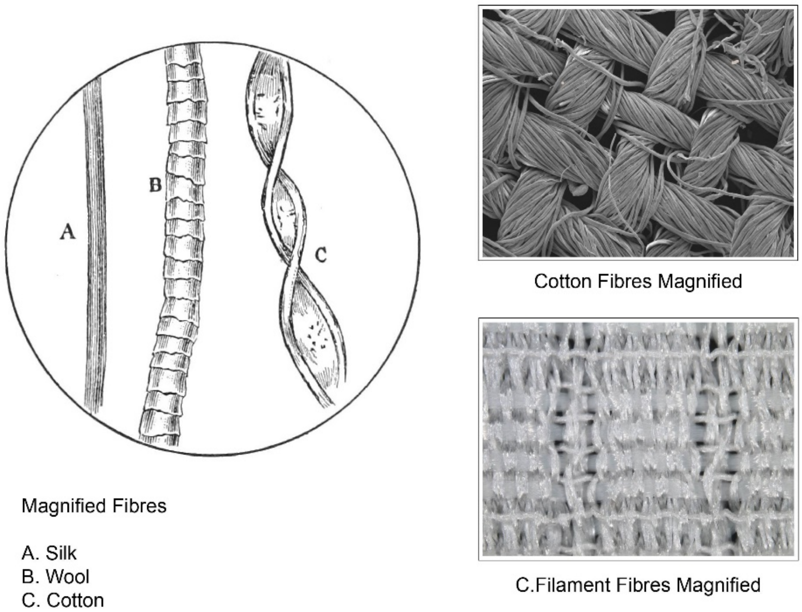

Figure 9. Magnification of cotton fibre and filament woven structures
Source: KYOTO D-Lab

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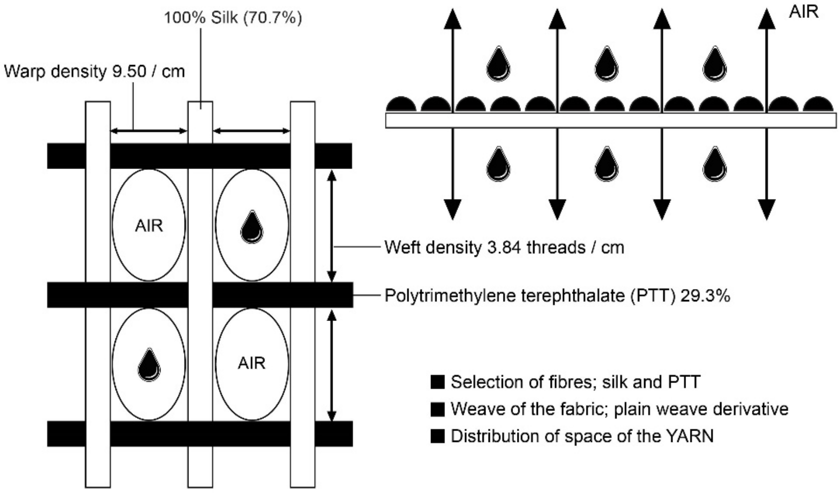

Figure 10. S++ fabric
Source: KYOTO D-Lab

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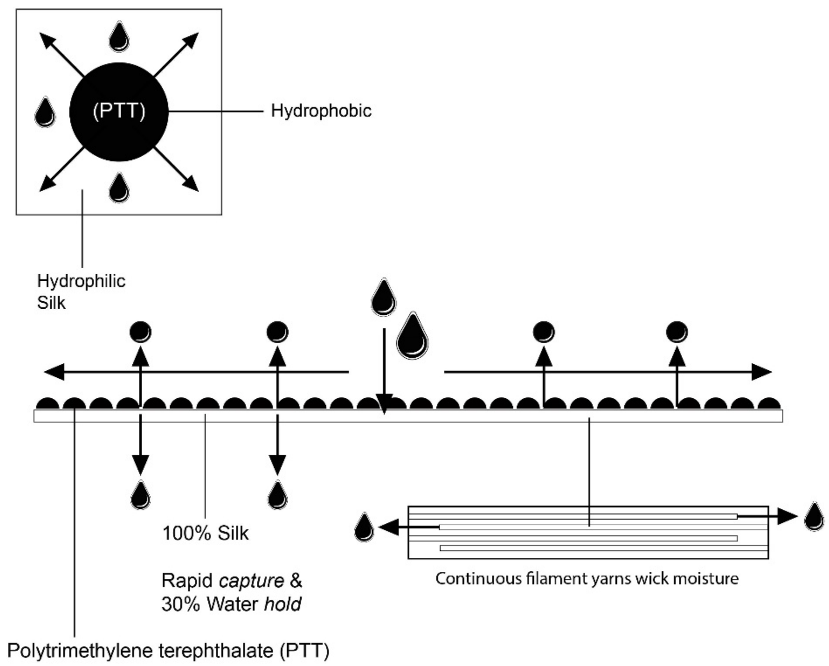

Figure 11. Wicking properties of S++ fabric
Source: KYOTO D-Lab

The silk background helps to keep the skin dry because the hygroscopic fibre can rapidly capture and hold one-third of its own weight in moisture without feeling damp (Figure 11).This absorbed moisture remains at body temperature and is evaporated into the environment or absorbed by outer layers (Figure 12). It was necessary, also, for the silk to be stain resistant and to incorporate antibacterial qualities. Silk is a protein fibre and can promote the growth of bacteria, thus it must be coated with an antimicrobial treatment such as AEM 5772/5 to inhibit the growth of germs and bacteria. To ensure the silk yarn was stain resistant like the PTT yarn a hyper-guard coating was used; this soil release finish protects the delicate silk yarn.

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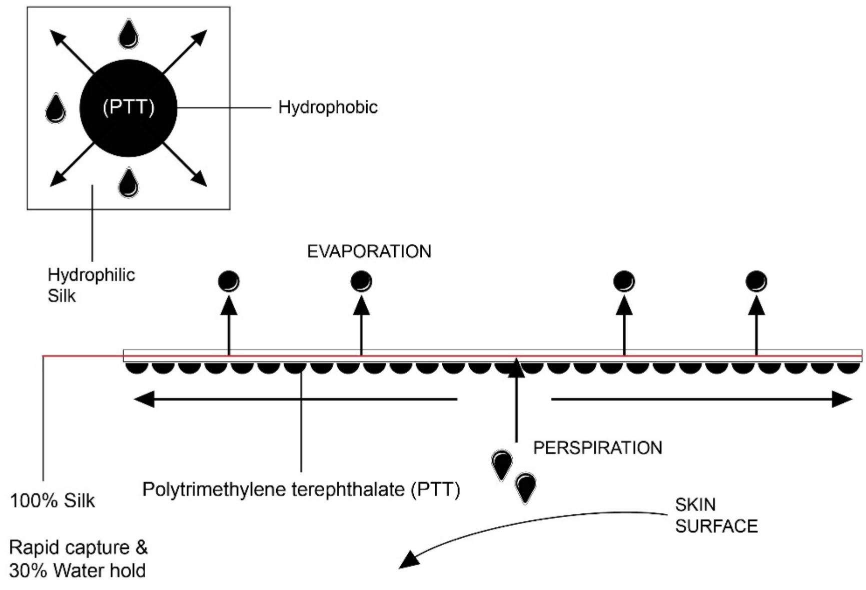

Figure 12. Moisture management properties of S++ fabric
Source: KYOTO D-Lab

Summary of Collaborative methods for S++

During the course of this project a chain of 3 different models of collaboration were used (Figure 13). It is doubtful whether any single model used in isolation would have yielded comparable results.

The initial interdisciplinary workshop on 'Intelligent Textiles scenarios for Healthcare and Sports Contexts' held at KIT's D-Lab in Kyoto followed Cassim's Challenge Workshops model (Cassim, J. & Dong, H. 2013). Stakeholder participation and contributions included a chirimen silk producer, a major manufacturer of performance fabrics and embedded technologies, textile engineers, material scientists and a Kyoto healthcare provider for elder citizens. Using an Inclusive Design approach to develop a shared understanding of the scope of the project, the workshop was mediated by three design-led teams. The team leaders were all textile designers, whereas the team members' profiles were multidisciplinary and included architecture, product design, computing, textile engineering, material science and industrial design. This stage of the project helped to produce the research question and the context for the Design Associateship.

The Design Associateship followed Cassim's D-Lab model of practical design methodologies and interdisciplinary collaboration. However, there were some distinct aspects of this stage of the project that identify with a Design-STEM model, that is an adaptation of the conventional design process that aims to merge the creative, opportunity-seeking aspects of design with the systematic, knowledge-seeking aspects of STEM (Toomey, A. & Kapsali, V. 2014). Design-STEM is characterised by one or more of the following points:

- Designing with advanced materials

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- Designing advanced material systems
- Design prototyping using advanced fabrication
- Designing products with advanced functionalities

The S++ project used DuPont's Sorona® PTT, manufactured under license in Japan by Teijin as Solotex®, a highly sophisticated polymer. Designing the simultaneous, and thus advanced, functionalities of both hydrophilic and hydrophobic behaviours within one fabric created an advanced 'material system' for healthcare.

Critically, a Design-STEM approach locates the designer at the epicentre of the activity, as a someone who
can understand enough STEM to not only exploit a novel or emerging material but is able to absorb it into their 'design toolbox' and has the agility to manage and contextualise innovation emerging from STEM communities.

In the case of the S++ project, Cassim and McNair were able to gain necessary technical knowledge in advance of the start of the project through study visits to the chirimen producers and identified and sought out the relevant additional expertise and knowledge required to convert the idea of re-engineered chirimen silk into a reality. Whilst both the collaborations with the Tango chirimen weavers and the Advanced Fibro-Science Department were essential for the success of the project, they both followed an agenda set and led by D-Lab. Additionally, McNair had to step across into the domain of the textile technologist to learn how to analyse the S++ fabric in the Advanced Fibro-Science labs in order to determine and understand its structure and performance.

The third, and final stage of the project was a collaborative workshop held at the RCA's Textile studios after completion of the Design Associate programme and involved MA Textile design students from weave, mixed media and print specialisms. Taking the S++ material as a start point and working within the framework of healthcare scenarios, the students worked with McNair and Toomey to explore potential applications for the fabric. This also included future modifications and adaptations of the fabric. The results of this workshop were included in D-Lab's Tokyo exhibition (Figure 14) and will help to inform future scenarios of use and new product applications. The model used here bears strong resemblance to Totorice et al's 'Braided' model of framing the creative process and involved both individual and shared research interests and contextual reviews, collective reflection and dialogue in order to arrive at a shared outcome: Future scenarios of use and new product applications for S++ (Totorice, C., Davelaar, E. & Cobb, K. 2016)

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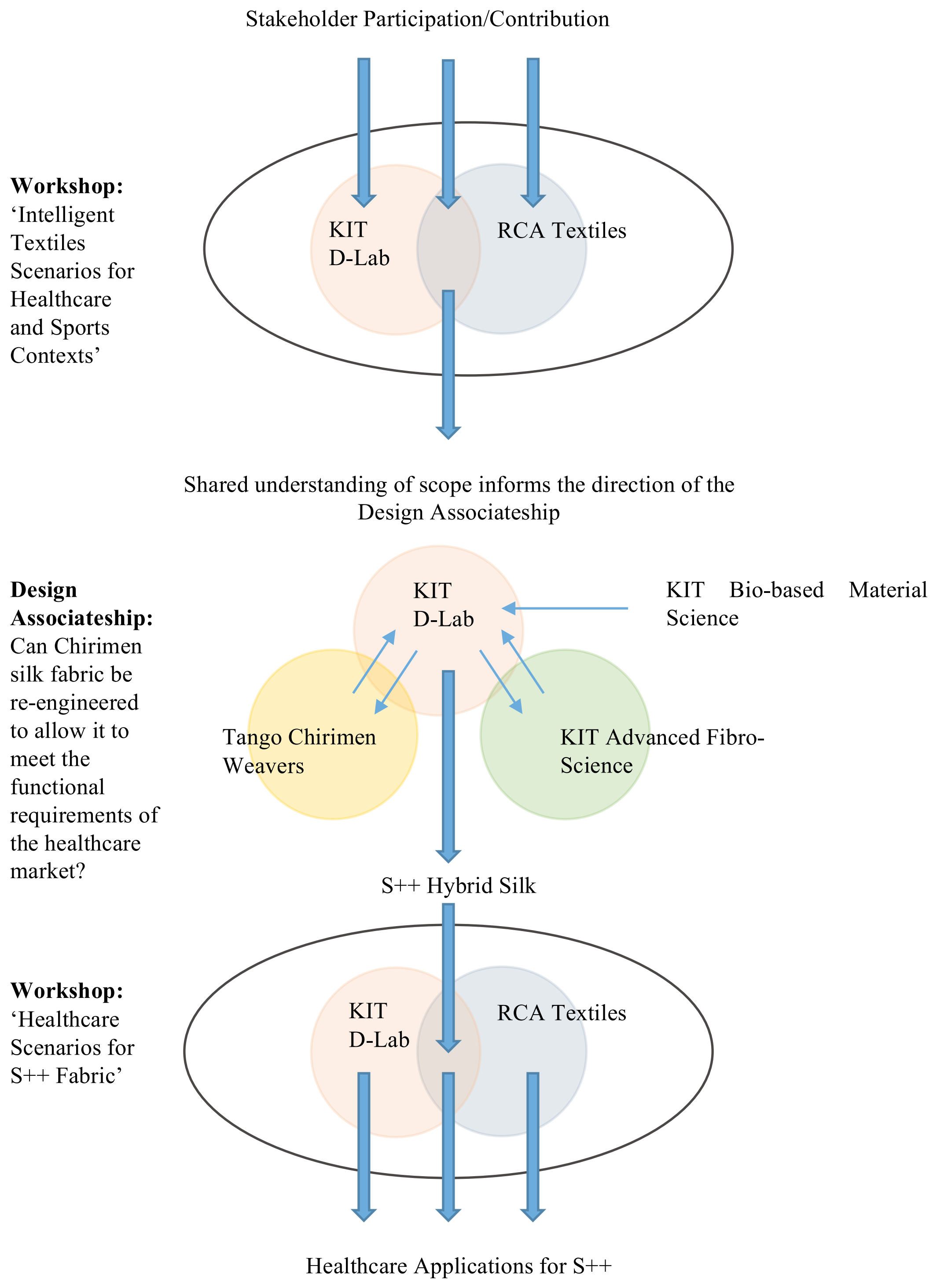

Figure 13. Summary of Collaborative models for S++

Source: RCA Textiles

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Figure 14. KYOTO D-Lab exhibition
Source: KYOTO D-Lab

Future Scenarios of Use and New Product Applications

The design context of this research-led project has been healthcare performance textiles but there are other contexts and product applications where the fabric may be used which would require consideration of other necessary properties. The characteristics of S++ focused on the materials' ability to wick moisture, control moisture and temperature, antimicrobial and anti-odour properties including stain resistance.

During the development and weaving of the fabric samples, it was observed that by changing the ratio of silk yarn to PTT yarn, the end product applications became more varied. For example, using more PTT than silk creates a fabric which has more stretch, support and recovery than the original ratio of 70% silk to 30% PTT making it suitable for a range of support items such as ankle and wrist supports, chemotherapy caps or the traditional *haramaki* (belly bands) used extensively in winter in Japan for lumbar comfort. These are commonly produced in either wool or cotton while the hybrid silk fabric would add significant thermal and other advantages. These and other scenarios were the subject of a workshop held at the RCA's Textile studios after the completion of the Design Associate programme that aimed to expand the new product applications for S++ and highlight future modifications of chirimen silk. Following the project and a two-week textiles summer school organised by KYOTO D-Lab in collaboration with the Centre, the RCA and the Design Academy Eindhoven(DAE) in August 2017, D-Lab's design expertise has been enlisted by KyoTango City and the center to help organise events in advance of the 300th Anniversary of *chirimen* in 2020.

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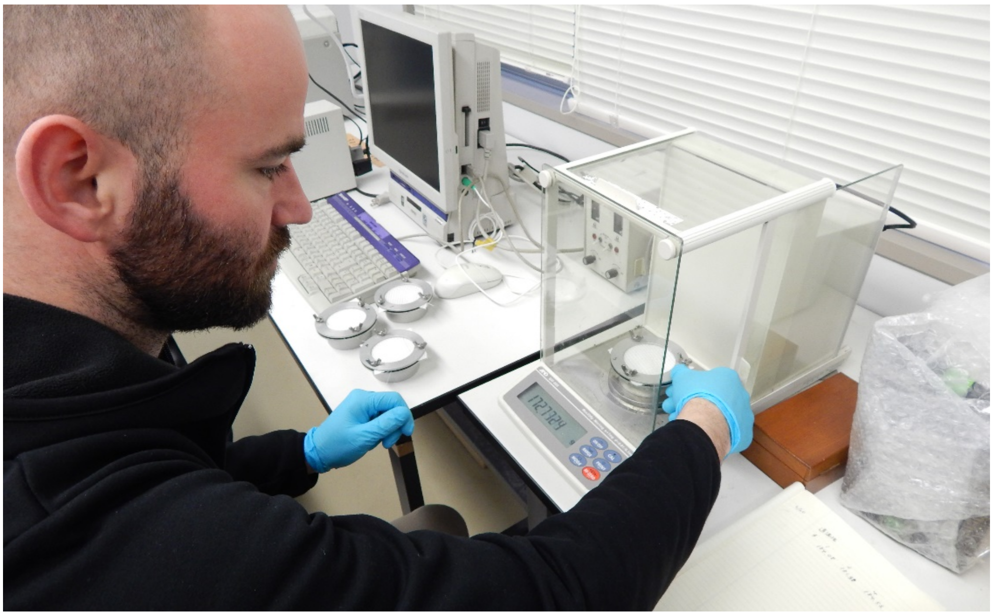

Figure 15. Testing the S++ fabric within the KIT Fibre and Textile Science Department
Source: KYOTO D-Lab

Testing the Results

Once woven, the re-engineered fabric was tested in the Advanced Fibro Science Department at KIT for its surface and mechanical properties and is currently being considered for a patent application (Figure 13). Hence these results are not included in this case study.

Conclusion

Interdisciplinary projects of this type are complex to manage in terms of communication where the project partners do not all share a common language, the necessary technical information cannot be accessed easily and the need to step across into other disciplines in order to acquire base-line knowledge and specialist vocabulary to reach a shared goal both limits and delays the speed of design decisions but which conversely allows a lateral perspective. The initial workshop involved multi-disciplinary, international participants and relied on Cassim, as a fluent Japanese speaker, to act as interpreter for many of the participants. Without this, many of the nuanced details important in the early stages of identifying the research question and the shared goals would have been lost. McNair as a first-time visitor to Japan is not fluent in Japanese, and neither McNair nor Cassim were weave specialists or textile technologists which posed several obstacles in the second stage of the project. However, where there is a shared interest in the success of the project which will vary depending on the perspective and context of the project partner, successful collaboration can take place. McNair came to the project with no pre-conceived cultural notions about *chirimen* and could therefore think freely about how to use design as a tool to innovate. In the same measure, Ichiro Izawa and the Kyoto Prefectural Institute for Northern Industry which boasts no English speakers brought their technical expertise to the subject alongside a vested interest in supporting their local industry. However, it was necessary for KYOTO Design Lab to serve as a trusted mediating institution to allow this exchange to

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happen. The overall role of design in this collaborative project goes beyond that of generating new ideas for product into one of understanding and mediating the group dynamic, synthesizing and organising the collective thoughts into a cohesive plan and, finally, the overarching viewpoint of the entire project in order to direct and assimilate the relevant skills, knowledge and collaborative activities necessary to deliver the outcome.

Acknowledgements
The authors would like to extend thanks to Kyoto Institute of Technology's KYOTO Design-Lab and to Ichiro Izawa and the Kyoto Prefectural Centre for Northern Industry in the Tango Peninsula.

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