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New Textile Transmissions: Reviving traditional textile crafts through replication, unlearning and prototyping

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Abstract

Heritage arts and crafts are vital to a nation as they are an artistic expression of its cultural connotations as well as a reflection of its historical development. They are visual communication tools utilised to present and sustain the cultural characteristics and artistic traditions of a particular region. Many of these skills, however, are on the verge of extinction. According to the research published by the Heritage Craft Association [HCA] in May 2021, the total number of 'endangered' crafts increased to seventy-four, along with an additional twenty new 'critically endangered' crafts added between March 2019 and May 2021. Finding solutions or strategies to slow down the pace of extinction has become increasingly critical for all heritage crafts.

This paper considers some of the contextual and methodological issues of a practice-based doctoral research project that focuses on modern technologies and the endangered textile crafts and the culture associated with minority ethnic groups in China. The main objective of this research is to add a new dimension to traditional crafts by integrating new technologies such as electronic textiles to rejuvenate them. This paper explores the translation of aspects of traditional crafts into contemporary textiles through processes of replicating and prototyping. This strategy, based on the communication of textile knowledge is distinct from other approaches such as the use of handcraft techniques in haute couture or luxury product lines, it seeks to revitalise crafts by employing an unlearning process and acknowledging experiential knowledge through iterative, hands-on textile prototyping processes to create more contemporary modes of textile expression, rather than product applications.

A selection of prototypes, including experiments with traditional weaving and embroidery techniques, as well as the use of these techniques in developing e-textile experiments, will be discussed. This practice-driven research encourages creative risk-taking, happy accidents, and improvisation by experimenting with traditional stitch structures, ancient and new yarns and unfamiliar e-textile components and processes. This paper reflects on diverse prototyping processes and shares insights from a collaborative process with experts from various disciplines. It explores how modern technologies, contemporary materials, and traditional handicraft processes can be cohesively combined to produce interactive e-textile narratives through material understanding and making processes.

Heritage crafts, Experiential knowledge, Prototyping, Unlearning, Interactive e-textile, Narratives

Global production systems and the digital revolution have accelerated the abandonment of many practices including traditional craft and their associated skills, artifacts, and tools. Heritage crafts have served important purposes to societies and individuals in the past. They were the objects in which we stored memories, commemorated significant life events, or

demonstrated identities. However, people continue to seek aesthetic gratification, community and meaning. This paper explores ways culture and memories can be embodied as narrative into new interactive textiles, offering additional meaning, relevance and value to the textiles. To achieve this, a process of learning and replicating was initiated. This included sourcing textile samples, copying, practicing and experimenting with traditional embroidery and weaving techniques from books or online. The project has also involved experimentation with a wide range of conductive materials and consultation with multidisciplinary experts. The processes and methods of prototyping and un-learning (Marr & Hoyes, 2016) have contributed to the development of new perspectives, a broadening of cross-disciplinary and cross-cultural understandings, and an exploration and focusing of a design research topic.

Background

Daniel Carpenter of the Heritage Crafts Association (HCA) notes that the disappearance of heritage crafts is not only a loss of beautifully handmade objects but also the stories behind each craft and the tradition that once helped shape the people and history (Carpenter in Madden, 2020). A sizable percentage of the world's population are living a faster-paced, life of mass consumption while the value and sense of satisfaction in taking time to create has diminished in importance. While awareness of heritage crafts has been better promoted in recent years, and governments are also working on strategies to create economic value by utilising such intangible heritage (Yang, Shafi, Song, & Yang, 2018), the enormous impact that colonisation, industrialisation and globalisation has brought to traditional cultures and their handicrafts has been immeasurable. The rapid development of new production technologies has further accelerated the demise of heritage crafts. Prior to industrialisation, most products were handcrafted by artisans in small workshops or at home. Expertise for each technique was accumulated through generations. Artisans spent years honing their skills before passing them on to descendants. This cycle is being discontinued as descendants loose interest in continuing the tradition, or cannot make a living doing so (HCA, 2017). As existing artisans become older and without successors, we lose more of our past and cultural heritage.

The research documented in this paper engages with traditional textile crafts of minority Ethnic groups in Southern China. Their location in remote areas and localised economies, has meant the clothing culture of Chinese ethnic minorities has been well preserved as they were less affected by mainstream society and external cultures. Most of these ethnic minorities didn't have writing systems or existing characters suitable for their own languages. In order to preserve their own history without written records, messages were embedded into their textiles along with the method of 'jiang gu' (verbally transmitted legends), as a dual assurance to pass on customs or knowledge to descendants. These messages or memories turned their costumes into carriers of traditional culture (Shijie, 2018).

Several examples that demonstrate this aspect were identified in this study, namely heritage textiles from the ethnic minority groups known as the Miao and Yao. The Lanjuan dress from the Miao, an indigenous group living in the south and southwest areas of China, is a skirt decorated with migration pattern in the Guizhou area and white lantern pants from Baiku Yao, demonstrate how storytelling has been used in the context of minority cultures. Legend suggests that Lan Juan was a female leader and heroine of the 'Miao' group. For the purpose of escaping advanced enemies, she led her compatriots to the south. In order to record the

journey of the southward migration, Lan Juan created a method of utilising-coloured threads to mark different landmarks they encountered along the way on her clothes. For example, when they departed from the Yellow River, Lan Juan sewed a line of yellow thread on her left sleeve; when crossing the Yangtze River, she embroidered a blue thread on her right sleeve; when crossing the Dongting Lake, she embroidered a lake-like pattern on her chest. Since then, every time Lan Juan crossed a river or mountain, she would record the experience on her dress. At the end of the journey, her dress was covered with densely embroidered intricate patterns from neckline to the hem. According to the marks Lan Juan remembered, she later created an exquisite wedding dress with a variety of different coloured threads and meaningful symbols for her daughter. This wedding dress is named after her and has become a lasting memorial of the remarkable leader. Nowadays, the wedding dress for a traditional bride is similarly decorated as the ancient Lanjaun dress which is a way of honoring the heritage (Ronghui, 2007). Minority groups in China used craft techniques to record ethnic culture and to journal history.

The diminishing standing of traditional crafts illustrates the need for more research in this field, to discover viable methods to bring new vitality to this heritage. This paper discusses work in progress presented through prototypes, including embroidery and weaving samples. By revisiting traditional textiles and surface embellishment techniques, the replication method focuses on learning and identifying aspects of the tradition that can be carried forward into the present. The prototyping method aims to examine potential ways of incorporating new elements into traditional approaches. An unlearning strategy (Marr & Hoyes, 2016) is employed to assist the researcher to engage more with the prototyping processes rather than a set-end product. It highlights the discovery of new perspectives and happy accidents by embracing uncertainty and encouraging creative risk-taking during the prototyping process.

Methodology

Replication

Replication is a method of reproducing an item, technique, or knowledge by employing tools, materials and conditions that are sufficiently identical (Peels, 2019). It is also a procedure to validate findings by repeating the same process (Plucker & Makel, 2021). By combining customary knowledge and practical experience, it is also a valuable technique used in fields like archaeology to recover or recreate long-lost techniques or textiles (McKendry, 2019).

Replication, in this research, is a strategy used to assist the researcher in understanding techniques and, above all, in establishing a connection with the past. The process of copying and replicating these processes connects the researcher/maker to a time when craft skills were needed for survival and textiles were both a significant investment of human labour and a piece of precious memory. This learning by-doing and making approach is acknowledged and promoted by craft educators (Niranen, 2021).

The Un-learning Strategy

Replication and continuity are critical to the practice and sustainability of traditional craft. They have been vital not only in understanding technique, but in understanding deeper cultural

contexts and values. Processes of replication were the first step in understanding and practicing traditional craft techniques. However, in order to develop new potentials and awareness of these traditional crafts, the project needed to move beyond replication. The concept of unlearning (Salustri & Rogers) was introduced as a way to go beyond the habitual:

> Once we have learned to do something in a certain way, we will tend to do that thing the same way forever, or until a 'better' way presents itself (and sometimes, not even then). In this way, we will tend to not try other ways to do a thing because we have learned one way of doing it (2008, p. 7).

This research employs a risk-taking approach by merging an open-ended, process-led research method with an 'unlearning' strategy of consciously exploring material boundaries and experimenting beyond the unknown. 'Unlearning' is a course of action which offers opportunity to acquire new perspectives and create new hybrid practices through 'un-learning' established parameters and laying existing assumption aside (Marr & Hoyes, 2016). It concentrates on the actual process rather than a preconceived outcome. Due to the uncertain and risky nature of this method, the end results of each research cycle could be valuable setbacks, happy accidents or total failure and shift in direction (Marr & Hoyes, 2016). By embracing uncertainty, the researcher was encouraged to engage more with process rather than preconceived or expected end results. This hands-on experiential learning process enables the researcher to identify intricate knowledge and acquire new perspectives through textile experimentation.

Toiles as Prototypes

A sample is a product which represents a group or batch of products, in order to assess their quality, style or design (Sayed, n.d.). A textile sample is a piece of fabric designed to demonstrate a larger whole. In this project sampling is used as a design strategy in conjunction with replication as methods of prototyping. In fashion design, a garment sample is commonly known as a toile, and the process of making the sample is referred to as toiling (Tokens, 2020). The term prototype is used in various industries, such as product design, and engineering design. The production of samples and toiles in fashion and textile design are also forms of prototyping.

Prototyping is a design process of creating multiple artefacts in order to swiftly test or develop ideas before the final product is manufactured (McElroy, 2017). This method can be used at various stages of the design process. In the early concept stage, it can be used as a tool to experiment or explore ideas (concept prototypes); or to identify problems or refine ideas at later development stages (proof of concept prototypes); it can also be employed to communicate and sell a product to a client at the final stage (working prototypes). Depending on the project requirement, prototypes can be constructed at various scales, in two or three dimensions, and with low or high fidelity (Valentine, 2013).

This research has employed the term sample or sampling method for any two-dimensional textile prototypes created in the early stage of the project to eliminating terminological ambiguity. Samples in the form of smart garments (toile) or e-textile experiments are referred to as prototypes.

Prototyping methods are employed in conjunction with an action research framework throughout this research. The process unfolds in iterative cycles of making, testing, and

reflecting. Making is the process of transforming ideas into tangible form. Testing is a crucial step to determine the future scenario of use. Reflection takes place throughout the process (reflection in action) and is also an important final step to consider and critique the viability of the prototype (reflection on action), (Schon, 2006).

E-textiles

Textiles have surrounded people across different cultures and historical periods. Most traditional textile narratives are expressed through motif, but textile expression also uses sensory or embodied experience to enhance or perform aspects of the narrative. Through vision, touch or gesture, textiles can be used to evoke emotions or memories.

E-textiles is an emerging field that allows electronic components like batteries, lights, sensors, and microcontrollers to be embedded in textiles. E-textiles are included in various-categories such as wearables and smart clothes. They are incorporated into forms such as garments, accessories or furnishings to provide additional functionality such as sensing analysing, and transmitting relevant and appropriate information, services and resources (Seneviratne, 2020). They are often integral to the wearer.

Beyond functional applications, e-textiles are also being explored as an artistic medium or form of communication. Examples include: The Interactive Pillow project (Enervi, Redstrom, Redstrom and Worbin, 2005), which consists of two pillows, each in a different location, that are designed to connect and light up when one of them is hugged. The 3D Printed Conductive Sequins project (Ma and Yamaoka, 2022) is inspired by the traditional craft of sequin embroidery. When a force, such touch or press, is applied to the sequins, the circuit generates a signal that is sent to a computer. They also function as motion sensors, responding to body movement and posture detection. These projects have brought valuable insights to this research because they have used prototyping processes to develop interactive textiles that react or respond to human engagement to enhance textile communication.

An important material associated with e-textiles is conductive thread. It is often made from silver or stainless-steel fibre and utilised for sewing or weaving connections between electronic components. Copper tape and tin sheet, seen in traditional ethnic Chinese textiles, were used in initial replicated samples. However, their conductive properties were identified during later prototype stages, and both were used as alternative conductive materials. Metallic threads and metal beads were also explored in combination with conductive threads and traditional materials. A list of e-textile materials is included here to explain the components used during the prototyping process.

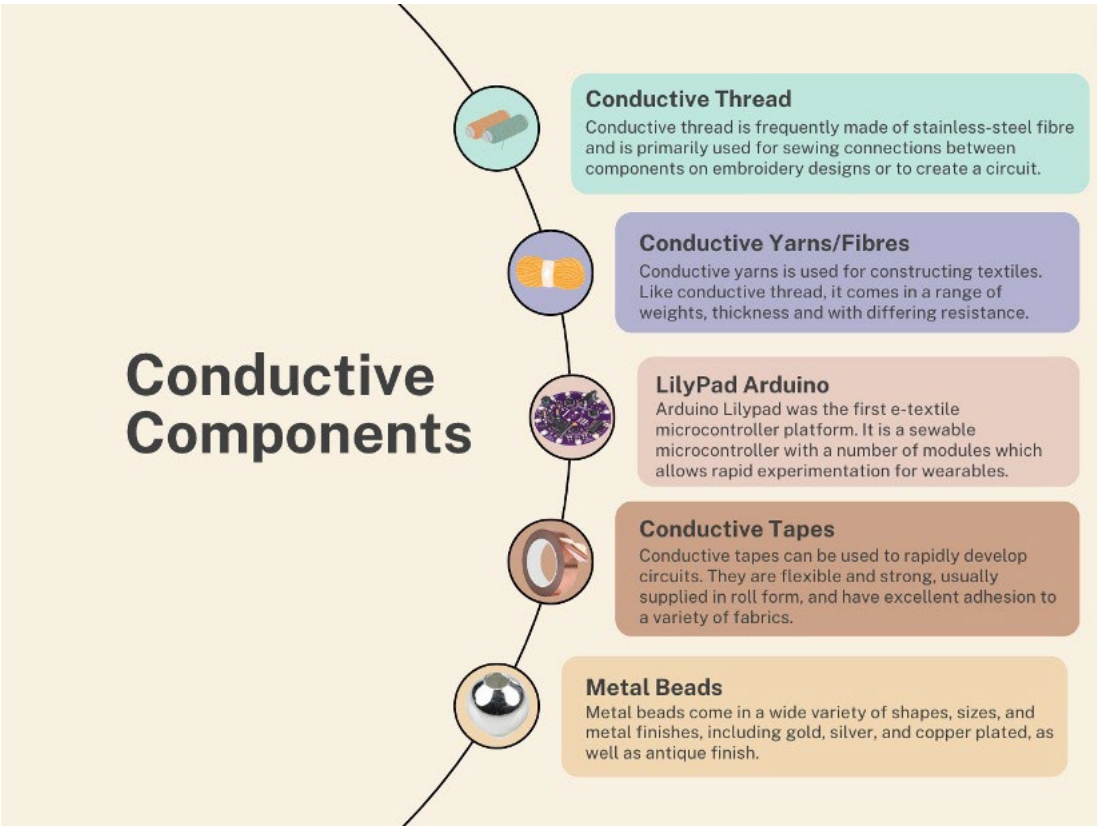


Figure 1: Wang, L. (2022). Conductive components

The structure or pattern of a textile also played a significant part in the prototyping process as it affects the behavior and thus the electronic characteristics of a textile. Before starting the actual making process, consideration and planning must be given to where electronic components can best be placed and ensuring that the positive and negative traces do not cross over at any point. In terms of weaving, different types of conductive yarns and patterns were tested first in order to understand the behaviors and electronic characteristics of the textile.

Textiles are highly expressive materials that can elicit emotions or memories through vision and touch (Davis, 2017). Creating interfaces for people to capture or receive information in ways that engage other senses can be culturally embedded in textiles (Davis, 2019). Initial experiments revealed the possibility of textile expression through technique by utilising traditional techniques and the inherent expressive ability of textiles in combination with new materials and the interactive potential of e-textiles. This project explores new possibilities for traditional craft through making, with an emphasis on interactive and story-telling textiles.

Traditional Techniques

Embroidery and weaving are ancient arts that span many cultures. A key distinction between these textile methods is that weaving produces a textile, allowing for the inclusion of different materials within the fabric construction, while embroidery is like a form of applique that is attached to a textile's surface. The following overview of two traditional techniques - tin embroidery and weaving/embroidery combined stitching – introduces forms that were identified through the making process of this research as having potential for e-textile application. This potential is linked to the materials used and the spatial configuration of the yarn in or on the textile.

Tin Embroidery

Tin embroidery is a technique of the Miao people which uses the metal ‘tin’ as an additional ‘thread’ in their complex embroidery patterns, utilising both regular embroidery threads and tin strips. The normal threads form a stitched foundation on the cloth, and tin is then applied as a unique type of decorative technique on top of a stitched pattern to emphasise the main design and also add a rich gloss to the textile (figure 2).

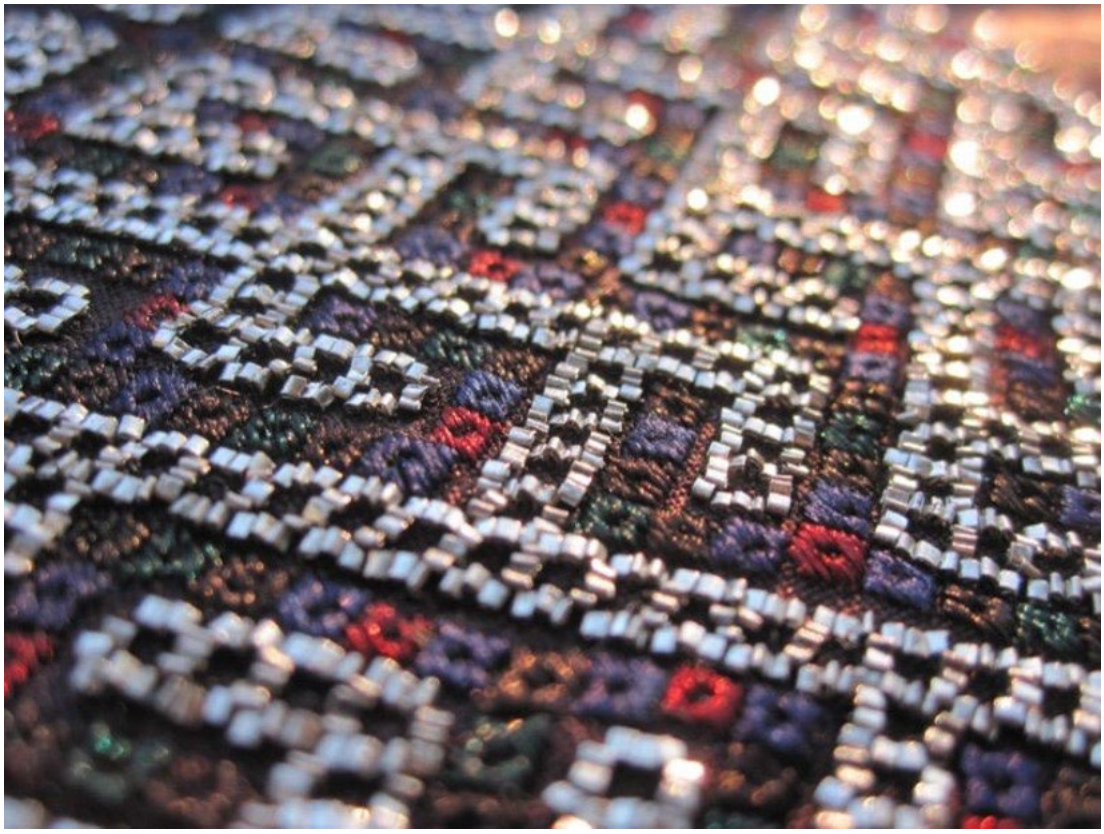


Figure 2: Banfudehuajiushu. (2016). Tin embroidery

The embroidery patterns used by the Miao people originated from and have been passed down using paper cutting techniques. However, artisans from Liufu Miao in Guizhou province of China recorded their pattern in a different way where each family had their own master pattern moulds, also known as ‘mother patterns’ (Ying, 2016). This is an indispensable tool for younger generations to learn the skill which has always been regarded as a family heirloom passed on from generation to generation, normally between mother and daughter or daughter-in-law.

In addition, the Miao people believe silver holds special social and cultural connotations. It is closely associated with the religious martial arts and historical migration of the Miao people (Ying, 2016). For the Miao people in Jianhe, costumes made using tin embroidery were a symbolic, non-verbal way of recording and communicating their own unique social and historical situation and a tool to define their identity, taste and temperament. Liufu Miao utilises these special embroidery patterns as the main carrier to generate and express specific meaning in different circumstances. These symbols can be decoded by locals using their own rules.



Figure 3: Banfudehuajiushu. (2016). Embroidery creation by a Miao artisan

Weaving and Embroidery Combined Stitching

Two forms of weaving and embroidery combined stitching were of particular interest. The first type applies needlework on top of a semi-finished patterned handwoven fabric, comparable to modern cross stitching. When experienced artisans weave the base pattern into the cloth, they attempt to replicate the texture of the embroidery to make the combination look more seamless.

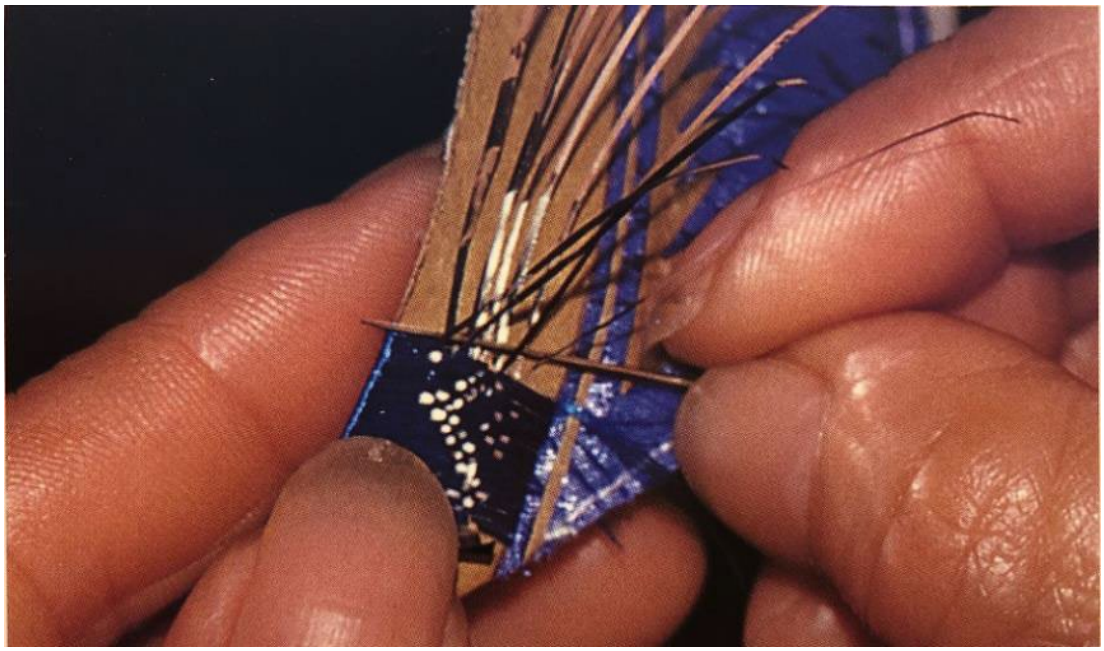


Figure 4: Torimaru, T. (2018). One Needle, One Thread

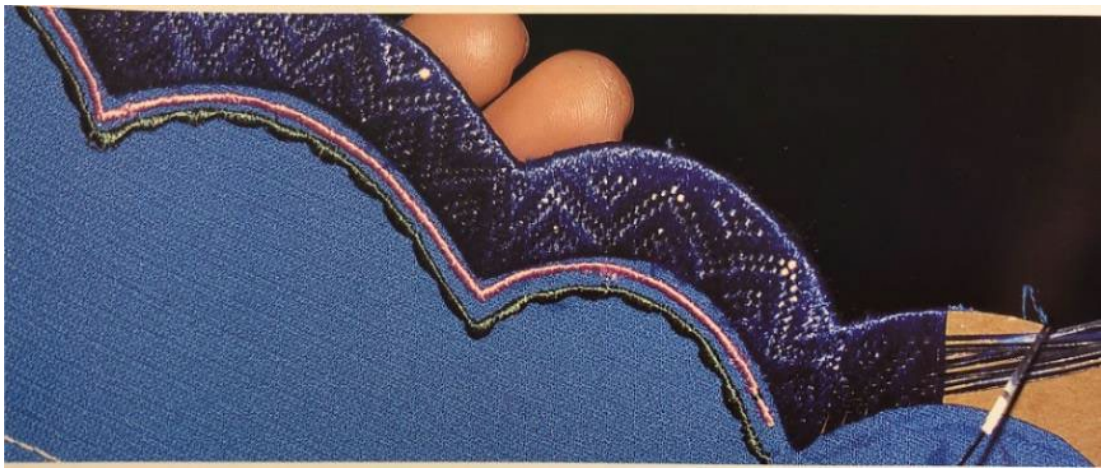


Figure 5: Torimaru, T. (2018). One Needle, One Thread

The second form of weaving and embroidery combined stitching uses strings of embroidery thread or strips of tinfoil as warp, another group of embroidery threads as weft and the needle as the shuttle (Torimaru, 2018). The artisan must first set up and secure the warp threads before using the needle to shuttle through them to create the pattern based on the chosen design. The process of weaving is cleverly combined with embroidery in this technique and the resulting textile is extremely detailed and intricate (figures 4 and 5). This is a hand-held weaving technique that is impossible to produce with a traditional handloom. Miao artisans make significant use of this technique with tinfoil as binding fabric to decorate the raw edges of their costumes.

Both types of weaving and embroidery combined stitching, along with tin embroidery are methods that are further explored in this research. Reviewing these processes enabled a deeper understanding of the fundamentals and theory of the stitching, which aided subsequent stages of research through the making process.

The Prototyping Process

This section discusses four key stages of the prototyping process – replication, textile exploration, e-textile prototyping and reflection (figure 6). It begins with the initial process of learning and practicing selected techniques, then progresses to a series of experiments with different machinery, modern materials and embroidery/weaving structures. This is followed by the development of e-textile prototypes and concludes with the refection stage to determine the next course of actions.

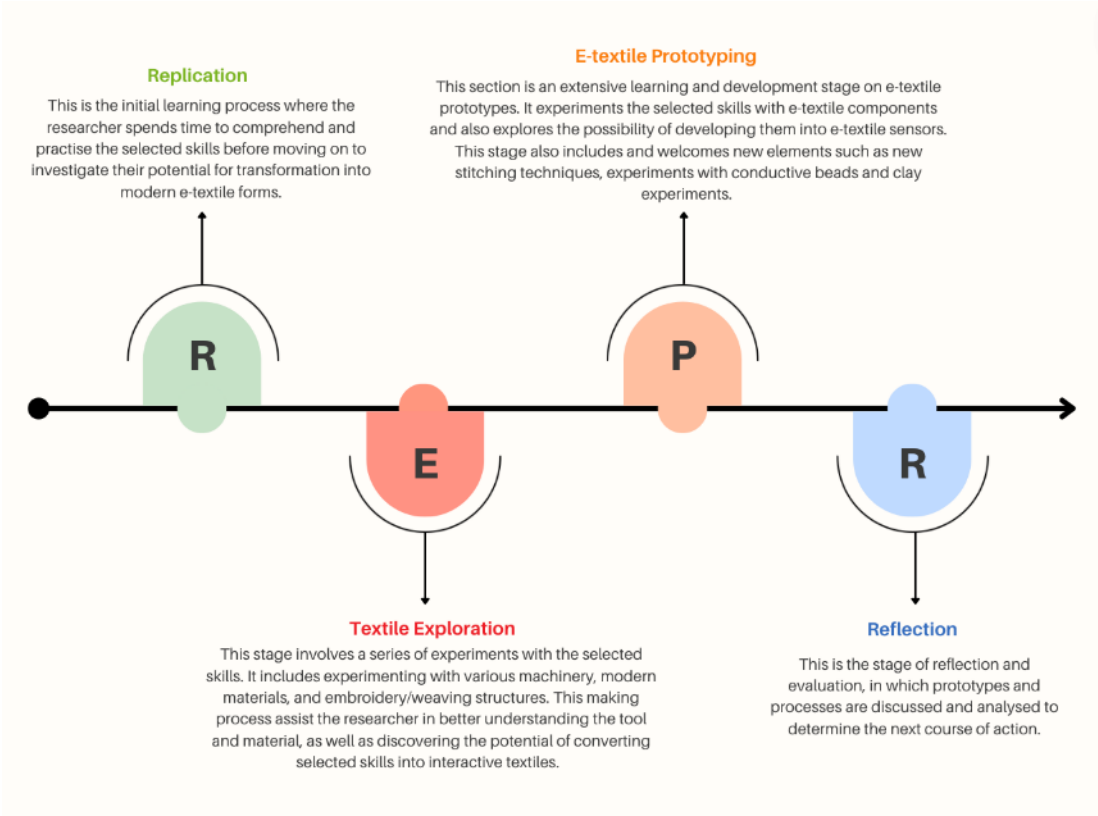


Figure 6: Wang, L. (2022). The prototyping process

Initial Stage – Replication

The replication method has been a crucial part of the research as a learning process to comprehend and practice the selected skills before the project moved to exploring the potential for transformation into modern forms. There are two types of replications used in this project: 1. Re-creating the technique as closely as possible using similar equipment and materials, and 2. Re-creation using modern materials or technologies.

Figures 7 and 8 below show examples of the first type of replication. They are the first set of prototypes created by the researcher using readily available materials to learn technique. It is not a straightforward experience to replicate these traditional skills because there is limited

information online or in books to immediately understand the techniques. All the knowledge to replicate the textile comes from a combination of prior experience as well as sourcing online photos and documentary videos. The process of replicating these techniques was not only informative in understanding how the structure functions, but it also provided an appreciation for the significance of material preparation and the amount of practice required to achieve the desired result.



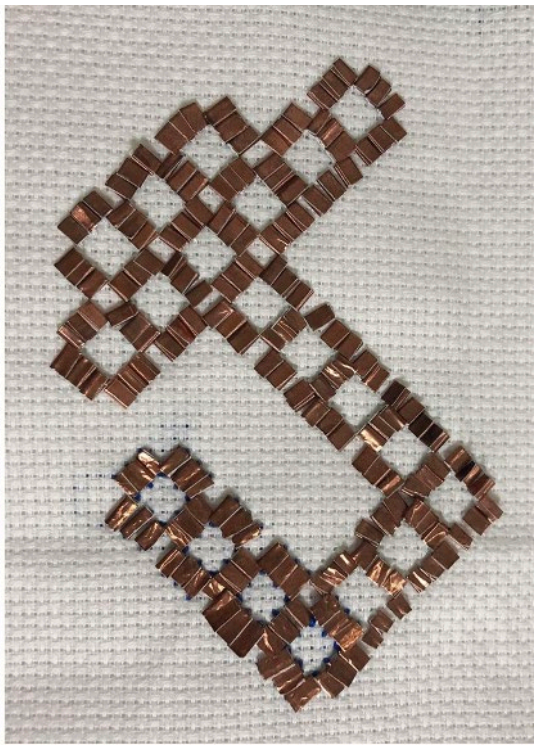
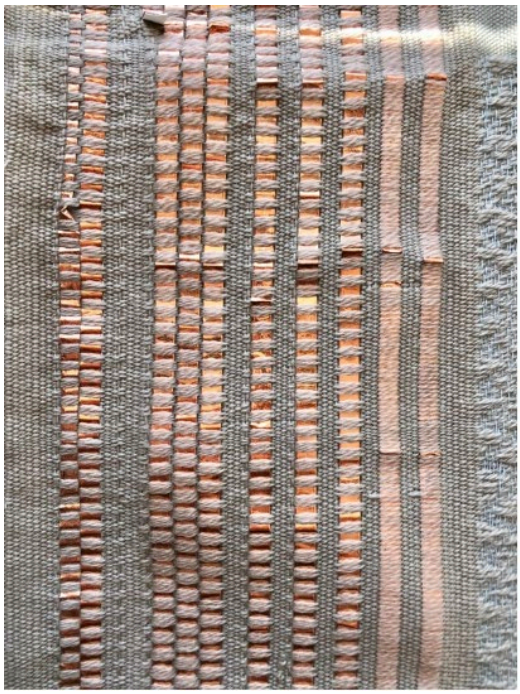


Figure 7: Wang, L. (2021). Traditional Weaving stitching A

Figure 8: Wang, L. (2021). Traditional Tin Embroidery (Based on Miao techniques)

After gaining a basic understanding of the skills, samples were developed employing modern machinery and materials. The sample in figure 9, shows first attempts using a more contemporary approach towards traditional weaving/stitching. Experimentation with the same method using a continuous conductive copper strip on a TC2 digital weaving loom involved several different weaving structures. These included plain weave, basket weave, and twill weave. Figure 10 shows an experiment involving a more complex weaving stitch structure using conductive threads. Since conductivity is a crucial component of smart textiles, new embroidery structures were first prototyped by hand before transferring them to the digital loom to save time and material and build knowledge through processes of making. Having embroidered and woven multiple samples, with many mistakes, a more nuanced understanding of both traditional skills and e-textiles was gained. These experiences and insights contributed greatly to the next phases of the research.



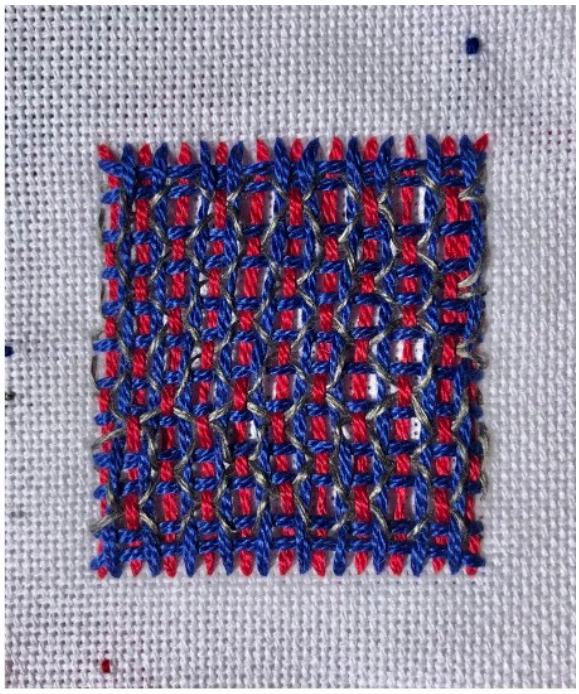


Figure 9: Wang, L. (2021). Weaving TC2 Loom Sample A

Figure 10: Wang, L. (2021). Experiment with weaving stitching K

Textile Exploration – Weaving



Figure 11: Wang, L. (2022). Experiment on a desk loom

After the initial replication and learning processes, a series of woven samples were produced to test out different machinery (figure 11), yarns and weaving structures. Samples were made

using ultraviolet (UV) reactive colour-changing yarn, temperature-sensitive colour-changing yarn, glow in the dark yarn and a variety of conductive yarns (figure 12-15). The procedure was intended to assist the researcher in better understanding the materials and tools and to explore the potential of converting them into interactive textiles through the making process.





Figure 12: Wang, L. (2021). Weaving TC2 Loom Sample B (Left) – conductive yarn with twill weave

Figure 13: Wang, L. (2021). Weaving TC2 Loom Sample C (Right) – conductive yarn with satin, twill and satin weaves

Conductive yarns and fibers are available in a variety of textures, hardness's and conductivity levels. In general, conductive yarns are frequently made with conductivities that range from 5Ω/m to several kΩ/m (Gottlieb, 2015). To achieve the best electrical properties, they are produced entirely or partially of metallic fibres with stainless steel being the most commonly used material (Tong, 2018). The simplest approach to incorporate these yarns into a fabric is to weave them as a warp or a weft, however, they are generally not insulated (Turner, Salleo, & Parlak, 2020). Project Jacquard by Google's Advanced Technologies and Products team (ATAP), which incorporates electronics into garments by weaving with conductive yarns and threads (Guler, Gannon, & Sicchio, 2016) is a relevant example using such techniques.

Different types of conductive yarns were used in combination with various weaving structures to test out potentials. The stiffer outcomes feel more metallic and less like fabric which made them ideal for shaping. Soft choices were considerably easier to work with and the result resembled more traditional fabric.

The possibility of weaving cultural motifs using conductive yarn was also explored. Figure 16 shows some delicate flower patterns from southern minority groups in China. These flower patterns are subtle because the yarn used is very thin and the weaving pattern is not dense enough. A variety of weaving patterns, including diamond weave, twill weave, and plain weave, were tested using UV reactive colour-changing yarn, temperature-sensitive colour-changing

yarn, and glow in the dark yarn. Challenges, such as, the need for optimal density of the patterns for some yarns to react, the activating temperatures for temperature-sensitive colour-changing yarn, and the necessity of charging glow in the dark yarn during the day, were all valuable discoveries to bring to the next round of prototyping.



Figure 14: Wang, L. (2021). Weaving TC2 Loom Sample E (Left) – UV reactive colour-changing yarn, temperature-sensitive colour-changing yarn and glow in the dark yarn

Figure 15: Wang, L. (2021). Weaving TC2 Loom Sample F (Right) – Dimond weave; UV reactive colour-changing yarn, temperature-sensitive colour-changing yarn and glow in the dark yarn



Figure 16: Wang, L. (2021). Weaving TC2 Loom Sample G – Flower motif (from the southward minority groups in China) with conductive yarn

Textile Exploration - Embroidery

Embroidery is another technique that was explored extensively in this project. Major areas of investigation included traditional embroidery techniques, motifs and an analysis of the material and mechanical behavior of specific stitches. Initially, a series of embroidery samples were created. The aim of these experiments was to test various weaving stitching combinations in order to better understand the structure of the embroidery and how it might be used with electronic materials and components. The exploration of different thread options or combinations was another objective of this sampling process. The hands-on creation process allowed for the acquisition of further experience and understanding.

Weaving stitching was the first embroidery technique learnt during this process. Figures 17 and 18 are interpretations of three-dimensional weaving stitching. These were new concepts that emerged from studying the traditional weaving stitch. Experimentation also involved the use of different types of modern embroidery threads while employing traditional stitching structures (figures 19-20). Although working with conductive thread is not difficult, the threads can become twisted and tangled together very easily, therefore it is crucial to maintain a short thread strand. Metallic embroidery threads are extremely challenging to work with. While they have the same feel as working with genuine metal threads, they don't remain in the anticipated position. Glow in the dark, UV reactive colour changing, and temperature sensitive colour-changing threads perform similarly to metallic threads. Making elaborate patterns using these

threads can be very difficult. Through these experiments it was discovered that ambient temperature has a big impact on temperature sensitive threads and it can be a challenge to maintain the colour.



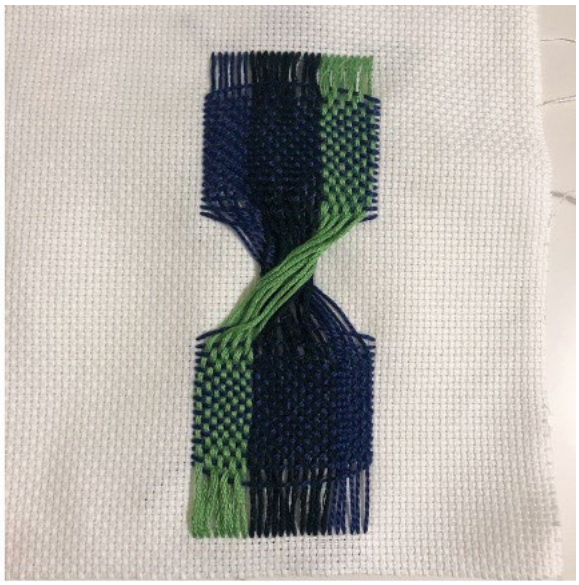


Figure 17: Wang, L. (2021). Experiment on 3D weaving stitching B (Left)

Figure 18: Wang, L. (2021). Experiment on 3D weaving stitching D (Right)



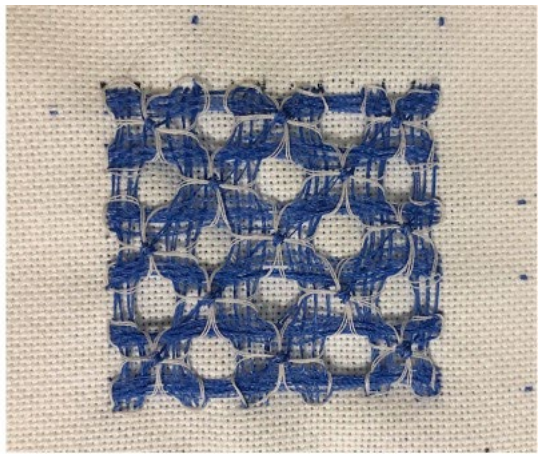


Figure 19: Wang, L. (2021). Experiment on weaving stitching G (Left) – Gold metallic thread

Figure 20: Wang, L. (2021). Experiment on weaving stitching I (Right) - temperature-sensitive colour-changing thread and glow in the dark thread

E-textile Prototyping

Tin embroidery prototype

Prototyping processes were also used to explore the potential of traditional embroidery or weaving techniques to produce e-textile systems. The first prototype drew inspiration from tin embroidery (figure 21). The sample was made up of an LED light, a battery holder, copper strips, conductive thread and regular thread. This prototype relies on decorative copper pieces

to establish the electrical connection for the LED circuit. It was anticipated that the LED light would turn on as soon as the battery was inserted; however, it became evident that the copper pieces were not all sitting flat on the fabric, so some of them were not touching each other. Therefore, the circuit only worked when someone interacted with it, for example, by pressing the copper pieces or moving the entire piece (figure 22). This is where the unlearning strategy resulted in a happy accident whereby the circuit disruption caused by the way the copper moved became an opportunity for gestural interaction with the textile to enable the electronic response or expression.



Figure 21: Wang, L. (2021). Tin embroidery prototype with LED



Figure 22: Wang, L. (2021). Tin embroidery prototype with LED

Net Embroidery Stitching Prototype

The second prototype was inspired by net embroidery stitching (figure 23). Net embroidery is a creative and ever-changing stitch. The embroiderer first creates the outline or nets and then fills in the pattern inside each net. The most common net structures for this technique are triangles, diamond shapes and ball shapes. There are numerous variations and combinations available for both the net structure and the design inside the net. For the e-textile prototype sample (figure 24), a triangle structure and snowflake design were used. The grey conductive threads and the normal, bright orange threads are used to secure and separate certain strings of conductive threads to ensure there are no short circuits or crossing threads. The structure of this technique is fascinating; almost as if it was designed specifically for producing e-textiles. For example, the use of gold metal threads and the use of normal thread in the middle of each pattern to separate the metal threads. The use of mathematics in designing the embroidery layout and the limitless combination of patterns could enable the creation of larger, more complex circuitry.



Figure 23: Nian, B. H. (2017). Traditional Net embroidery stitching

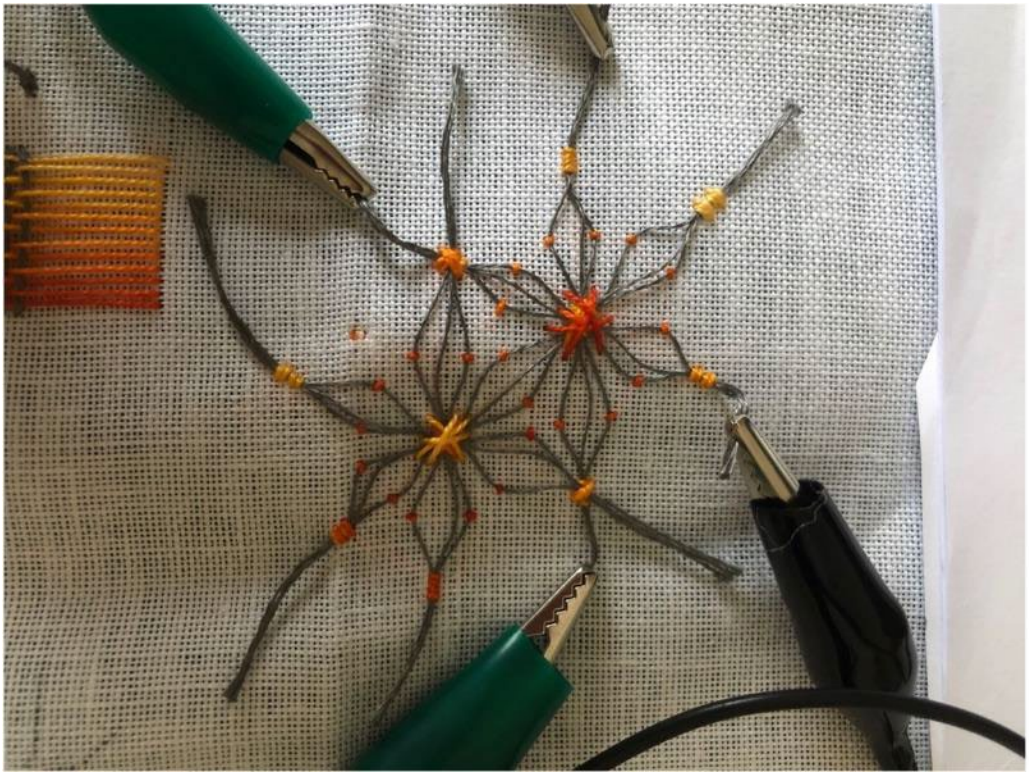


Figure 24: Wang, L. (2022). Net embroidery stitching with conductive threads

Metal Bead Prototypes

The third experiment expended from the tin embroidery prototype, using metal beads, rather than metal strip, to connect the circuits (figure 25). The metal beads are stitched together as closely as possible and secured with seed stitching on the top of the beads. The beads in the centre section were held with regular embroidery thread, while the ones on the sides were made with conductive thread. Because of the shape of the beads, it is challenging to keep them touching or connecting with each other, no matter how closely they are stitched together. This suggested the idea of an interactive embroidery piece that would respond when a force, such as pressing or squeezing, was applied to the beads.

In another prototype using metal beads and conductive yard the conductive thread was used to thread the metal beads and also to make the grey embroidered patches placed next to the beads. The bead loops randomly touch the grey patch on either side as the fabric moves. Figure 27 shows how the top two bead loops touch the left patches while the remaining bead loops touch the right side. This interactive embroidery prototype produces a variety of combinations that could be used to trigger different e-textile reactions. The potential of using the dynamic movement of the textile to generate this e-textile expression as part of a narrative was noted and will be further explored and extended through application on different garment types and positioning in relation to different parts of the body and associated gestures or dynamic movements.



Figure 25: Wang, L. (2022). Metal beads with seed stitching

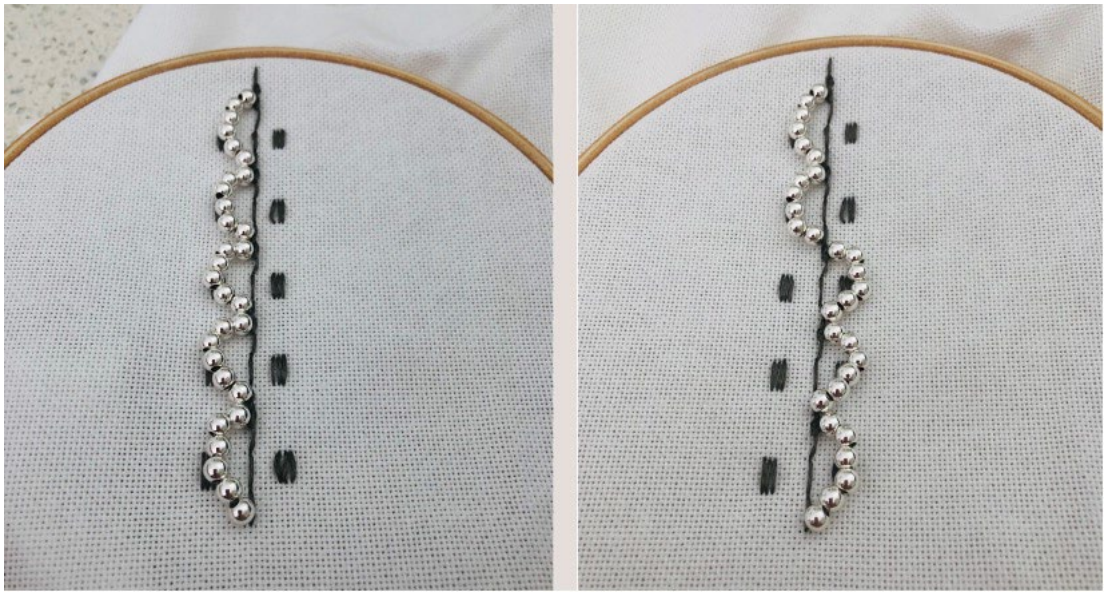


Figure 26: Wang, L. (2022). Metal beads prototype four combination one (left)

Figure 27: Wang, L. (2022). Metal beads prototype four combination two (right)

Sensor prototypes

One e-textile prototype was a bead sliding sensor similar to the Danish Krown Slide-Switch (Plusea, n.d.). For this prototype, beads are strung on conductive thread. When the beads touch, the electrical contact between the threads is bridged, thus closing the ‘switch’. The same theory was applied in the creation of more variations. The prototype in the middle of figure 28 activates when beads touch either side of the conductive thread. If they are touching, the ‘switch’ is closed, otherwise, the ‘switch’ is open. The prototype on the right functions the same, when beads come into contact with the conductive threads at an angle, the electrical contact between the threads and beads is bridged. Figure 29 shows a slightly more complex version of the bead sliding sensor. The beads, however, do not slide smoothly due to the texture and placement of the blue threads. Once again, it only functions when someone engages with it. Tin embroidery was used instead of beads in prototype six in figure 30. This option slides more easily than the bead option.

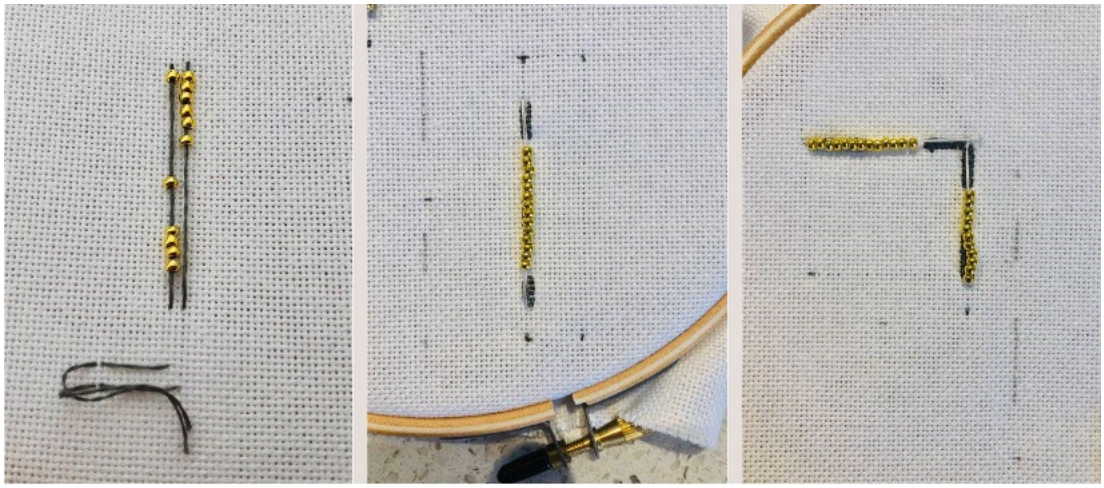


Figure 28: Wang, L. (2022). Metal beads prototype five – slide sensor

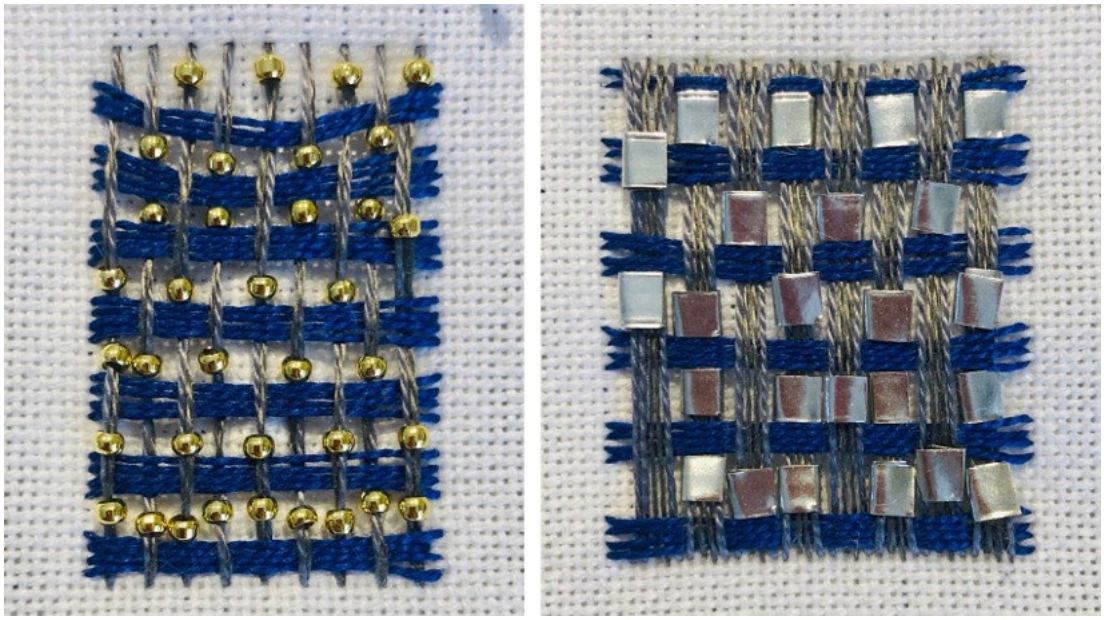


Figure 29: Wang, L. (2022). Metal beads prototype five – slide sensor (Left)

Figure 30: Wang, L. (2022). Tin embroidery prototype six – slide sensor (Right)

The potential of other types of sensors made using traditional techniques was further explored. Figure 31 is a touch sensor made with conductive thread and green embroidery threads. It works like a switch and operates when the grey section is touched. Figure 32 shows a squeeze sensor where weaving stitching has been used to embroider the shell. To achieve a tactile squishiness, the sensor is filled with non-conductive stuffing. It functions similarly to a touch sensor, except the switch can only be activated when squeezed.





Figure 31: Wang, L. (2022). Weaving embroidery – touch sensor

Figure 32: Wang, L. (2022). Weaving embroidery – squeeze sensor

Conclusion

Four primary processes – the replication method, an unlearning strategy, prototyping and narrative through interaction – have informed this project. All four approaches are based on experiential learning through different forms of engagement with materials and processes.

Replication is an approach widely used in the transmission of craft-based knowledge. With limited available information about traditional skills, this method has been used to analyse and reproduce traditional techniques. From an analysis of these samples replicating traditional techniques in combination with the use of new materials, in a prototyping process, new approaches with potential for developing interactive narratives through e-textiles have been identified.

The researcher started this project from a position of interest in e-textiles and the desire to pass on traditional craft knowledge to future generations. A specific form of design output was not established at the beginning of this project. The open-ended nature allowed the researcher to experiment with a range of processes and ideas. An unlearning strategy is critical to this project and was integrated with the prototyping process. By challenging the researcher to think outside the box and experiment with new materials and processes, creative risk-taking was encouraged. Happy accidents and improvisation emerged from this risk taking. This strategy also allowed the researcher to deeply connect to the practice, extending the study in a personal sense. By embracing uncertainty and not having a fixed end product, more possibilities and potential for invention and innovation were opened up (Marr & Hoyes, 2016).

The prototyping process for this project is exploratory. The problem that frames the project is a complex cultural one of the loss of craft and the value of textile narratives. There is no simple solution for this 'wicked' problem (Rittel & Webber, 1973). The experimental prototyping process is about taking risks, putting aside existing assumptions, and exploring the unknown through making.

This paper identifies some techniques and opportunities for producing interactive e-textiles capable of communicating new narratives through a series of prototyping processes using modern technology, contemporary materials and traditional handicraft. The implications of interactive narratives are not fully explored in this paper. The potential of moving beyond visual narrative communicated through symbolism and motif – a strategy used in traditional textile communication – to forms of narrative activation through performative strategies using gesture, movement and tactile engagement – suggest new ways of involving people more intimately and interactively in understanding and appreciating more contemporary textile expressions.

Instead of preserving the crafts in their original form, this research attempts to develop a creative and meaningful blending of the contemporary and the traditional through a making process. This is an ongoing project and the next stage will involve an iterative process of proof-of-concept prototyping - further exploring interactive narrative, drawing inspiration from current prototypes and developing them into smart textile samples or forms. As a practice–based inquiry, the final design outcomes have not yet been determined. It may be presented as garments, or a collection of working prototypes. The final format of the design artefacts will be determined by the behaviour of the textiles, the audience or wearer, and the relationships between textile techniques, materials, and new technologies to enable original forms of textile expression and narrative transmission.

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