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Arctic and Traditional Textile Techniques as Inspiration for Electronic Textiles

In this chapter, we describe the selected artworks from our experience of teaching an electronic textile, or e-textile, course with the Arctic theme at the University of Lapland for the past five years. In each year of the course, the Arctic theme was emphasized in the project descriptions, for example, the use of local materials and/or Arctic nature as a source of inspiration. E-textiles are technological solutions blended with textile materials to design daily products such as interior elements, clothing, and accessories (Berzowska, 2005). They compete for the same spaces on our bodies and in our environment with existing products such as pillows, watches, glasses, bags, and shirts (Juhlin, 2015). A meaningful merger between technology and textile materials requires attention to both practical and aesthetical attributes of the design product. However, the field has developed rapidly on the technological front (Buechley et al., 2013). This situation leads the outcomes more towards practical functionalities (Tomico et al., 2017).

To overcome this, preparing designers in guiding the e-textile development processes is essential (Coleman, et al., 2011). Considering the intersection of design and technology could create more job opportunities for designers, in design faculties, educators have the challenging task of preparing students for this relatively new area. In order to cope with this, we suggest how the textile techniques and Arctic theme can provide inspirations for future designers to explore the aesthetic and social dimensions of e-textile products.

In this chapter and the course, the term ´Arctic´ is interpreted broadly. Arctic nature includes changing seasons and circumstances where nature´s colours, shapes, and patterns vary a lot. Living in the north develops people´s resourcefulness and resilience. People sometimes live on the periphery, which means sparsely populated areas and occasionally low access to public services and other resources (Miettinen, Laivamaa & Alhonsuo, 2020). The artworks from the course have been inspired by this Arctic nature and culture by imitating visuals, sounds and by highlighting cultural factors and sustainability from Arctic lifestyles. While the inspirations from the Arctic theme provided the students with broad directions for aesthetic explorations, traditional textile techniques

such as embroidery, lace, and rug making, together with interactive materials such as conductive threads, inspired students to implement novel use-cases and interactivity bits. The e-textile artworks from the course have been presented in the exhibitions in the university, in the course's Instagram account and even in international design events (Harjuniemi, Johansson & Pyrstöjärvi, 2019; Häkkilä & Johansson, 2018).

This chapter elaborates on how the future professionals of electronic textiles are capable of skilfully combining design and technology for aesthetic explorations starting from the Arctic as inspiration. In addition, we uncover how versatile methods and materials bring traditional techniques to the present day with technology integrations. In the following sections, we first discuss the design approaches to E-textiles, the role of inspiration in design, and introduce different dimensions of Arctic theme and traditional textile techniques that can inspire aesthetic explorations for e-textile products. We then present our course structure and how the inspirations are reflected in the E-textile course by describing selected artworks from the course in detail.

Towards Electronic Textiles

We are living in an age where more and more electronic technology is seamlessly integrated into our daily lives. Thanks to small and affordable electronic modules embedded in most of our everyday products are not just passive artefacts, but they are 'smarter' by detecting and reacting to us and environmental factors. Homes becoming capable of sensing our energy consumption, smartwatches not just showing the time but also enabling us to communicate with other people and cars being aware of the physical environment to drive themselves are just a few examples of those new experiences. In this new infrastructure, the term 'electronic textiles' is used to refer to a specific field where design professions that use textiles as design material (textile, fashion, interior, interaction, and product design) and engineering disciplines coincide with each other. The artefacts created combine textile and electronic materials to design interactive interior elements, garments, and accessories (Berzowska, 2005). The term *smart textile* is sometimes used as a synonym of e-textile. However, smart textiles can be seen as more of an overarching category. It refers to a novel category of textiles including, e-textiles, bio-textiles, shape memory textiles, cosmeto-textiles, high-performance textiles, photoluminescent and thermochromic materials. These textiles and materials have intelligent functions, but not necessarily embedded electronics (Wu & Li, 2019). However, those can react to external stimuli, e.g., mechanical, electrical, thermal, or chemical (Kettley, 2016).

While the e-textiles field recently became more accessible to designers, the idea is not new. The first speculations on making fabrics interactive were apparent in the late 1960s. In 1968, a group of artists exhibited smart garments with electronic heating systems integrated into jackets for body temperature control and with lights for cycling safety (American Crafts Council, 1968). Other early examples within the field were presented on the *Smart Clothes Fashion Show* at the first symposium on Wearable Computers (Rhodes, 1994). By collaborating with engineers from Massachusetts Institute of Technology (MIT), the designers of this show implemented proofs-of-concept for functional fashion pieces, for example, shirts with intercom units and hats that can charge a cell phone with solar power. However, the majority of early e-textile applications were focused on the practical functionalities, often neglecting the aesthetic aspects. This is also visible in the early conceptualization of technology design, where the design process is seen as a rational process that focuses on solving problems to optimize the efficiency of people beyond workplaces (Dunne, 2008).

More recently, as technology has become more accessible to everyone with easy-to-use prototyping tools (Buechley & Hill, 2010), designers have better opportunities to achieve novel applications around aesthetical issues (Ryan, 2009). With these toolkits and also conductive textile materials appearing in the field, designers started exploring social and cultural aspects of e-textiles for example, in augmentation of self-expression via kinetic textiles extending the body movements (Hartman et al., 2015), or in shirts revealing common interests among individuals as icebreakers (Kan et al. , 2015). Besides, the computable and interactive nature of e-textiles opened up new design spaces for sensory expressions such as designing with dynamic textile patterns (Nilsson, et al., 2011) or investigating audio generation via textiles during art performances (Skach et al., 2018).

The e-textile field also provokes much attention in Finnish industries. One of the promising Finnish e-textile start-up companies was *LeeLuu* Labs that developed soft nightlights for children inspired by animals. The interdisciplinary team included textile and industrial design experts and marketing specialists (Espoo Innovation Garden, 2020). *Clothing+* is a company that started as a result of a co-operation research project between the University of Lapland, the University of Tampere, and *Reima Oy*. It was a pioneer in body monitoring technologies, combined electronics and textiles innovatively, and successfully developed heart-rate-sensing shirts and other textiles for the sports and healthcare industry (Keskitalo, 2020). The company's earlier sales and marketing manager is a graduate of the Faculty of Art and Design, University of Lapland. As technology evolves, the textile industry should evolve as well. Internationally, there are a growing number of

examples as the big technology companies such as Google are investing large amounts of product development of wearable technologies and e-textiles (Tahvanainen & Pajarinen, 2014). The local and global industry attention towards e-textiles also points to the need for new design approaches and the importance of educating future design practitioners.

The artworks presented in this chapter exemplify the new design spaces and examinations around social issues. More importantly, they contribute to discussions around sources of inspiration in designing future e-textiles by highlighting the influence of Arctic and traditional textile techniques. In the next section, we elaborate on the role of inspiration in design processes.

Inspiration in Design

Inspiration is a tool in the creative process, leading the way from the world of imagination to the world of objects. It is a creative force which drives and motivates the designer to produce the best feasible result (Aspelund, 2015). Inspiration should be visible in the final product (Strickfaden, Stafiniak & Terzin, 2015), as the word itself is derived from the Latin verb *´inspirare´* meaning *to breathe into*. It can come from a broad range of sources, from comparable products to an object or a phenomenon from nature and daily lives (Aspelund, 2015; Eckert & Stacey, 2000). Inspiration should be actively sought, not awaited and it is not just limited to the beginning of the process. Being re-inspired throughout the creative process is important. But, the activity, in this case, can be just standing still and observing the immediate surroundings or reflective dialogue with the design outcomes. Since seeking inspiration is an active process, sociocultural factors such as traditional crafts, personal ideologies, and skillsets also have strong influences on inspirations (Strickfaden & Heylighen, 2010). Taking these factors into consideration, we use the term inspiration in a broader sense that it is not just visual sources that guide the design processes, but also the inherited knowledge and values coming from the experiences of the designers.

When it comes to creative studies in educational settings, students need guidance for their projects on, for example, where they should start and the needs of the project. They are advised to go to different places and seek inspirational designs or just stop in their everyday environments and survey. In the E-textiles course, students are guided to seek inspiration for their work from the Arctic, their knowledge of textile techniques, and what technology could enable. These combinations of inspirational sources have resulted in many interesting contrasts.

The Arctic as an Inspiration for Design

According to Jokela and Tahkokallio, *"Arctic Design should be understood as actions aimed at increasing well-being and competitiveness in the northern and Arctic areas. The Arctic design combines art, science, and design for solving the particular problems of remote places and sparsely populated areas"* (Jokela & Tahkokallio, 2015, pp. 120–121). In this regard, whilst the Arctic Design usually follows a generic design process (Ulrich & Eppinger, 2016), it might be differentiated from other design approaches in a sense that it is strongly tied to specific challenges and influences that the Arctic geography proposes (Miettinen, et al., 2014).

The Arctic is a region spread around the North Pole, but it has no unambiguous definition of a border as the southern boundary varies (Arctic Centre, 2020). Living in the Arctic means sometimes living in the periphery, extreme climate conditions and surrounded by natural phenomena, for example, the northern lights and midnight sun. The spaciousness of the wilderness forces individuals to focus on what is essential (Seppälä, 2012). Furthermore, the inhabitants of the Arctic region might be considered as being inherently connected to nature and the materials used to survive are mostly found nearby and from sustainable sources (i.e. reindeer leather, wood). In this sense, arctic nature is a substantial part of the cultural heritage. It influences the artefacts used in this region in terms of materials, forms, colours, and changing of the seasons.

Arctic Design takes the unique geographical context and culture of the Arctic into consideration. The diversity of nature and cultural heritage in Finnish Lapland reflects the design language of products (Ikäheimo, 2012). One example, also mentioned by Häkkilä et al., (2018), could be Tapio Wirkkala´s glassware, *Ultima Thule.* This project demonstrates how an inspiration could come from Arctic nature, more specifically melting ice. Northern nature is also a recognizable source of inspiration in the Finnish textile industry with nature-inspired printed and weaved patterns (Marimekko, 2020; Lapuan Kankurit, 2020). On the other hand, design in the Arctic takes inspiration from the Arctic cultural emphasis on using the local resources, materials, and people (Miettinen et al., 2020). In that direction, for instance, Usenyuk-Kravchuk, et. al., (2020) provided a detailed overview of how indigenous cloth-making processes in the Arctic region could provide insights to Arctic Design. Furthermore, Artic Design could be considered different from other design approaches as it also focuses on solving problems in the northern and cold areas with extreme conditions such as dark seasons or persistent ice on the ground (Häkkilä et al., 2018). These circumstances help designers to gain expertise which is built on exciting strengths of the region. The

academic discussion about Arctic Design started almost a decade ago (Tahkokallio, 2012) and the University of Lapland has a vital role in taking it forward as the Arctic and northern culture are at the core of the university´s research profile (University of Lapland, 2020). The Faculty of Art and Design has explored the traditional and contemporary applications in art and design projects and combined future visions under the theme of Arctic Design through context, materials, messages, and other aspects. Häkkilä and Johansson (2018) have showcased with the interactive fair stand examples of how Arctic Design meets technology and how Arctic Design could be a speciality and unique field of expertise.

Arctic design also attracts international interest as it is associated with global megatrends. Typically, at its core, Arctic design is based on simple, calm, and minimalist expressions which are also reflected in Scandinavian form and function principles (Seipell, 2012). This principle is often perceived as useful and globally popular to give a respite for people in a digital and busy environment. However, the way people are experiencing the Arctic is culturally related. As Jokela points out, people are affected by surroundings, and understanding of it is conducted by culture conditions (Jokela, 2012). Therefore, in order to be inspired by Arctic culture for design, it is important to experience it.

Traditional Textile Techniques as an Inspiration for E-Textile Design

Some examples of traditional textile craft techniques are weaving, knitting, needlework, and printing. Those techniques are taught in the Finnish comprehensive schools and learning those constitutes learning about Finnish traditions and cultural narratives (Garber, 2002). For generations, traditional textile craft communities have integrated their cultural narratives within their fabric and made functional textiles that are coded with meaning and purpose. Traditional textile craft processes are slow and long, and craftspeople worked long periods in their workshops. Repetition of patterns and rhythms are created in the making processes while craftsmen acquire knowledge about the materials and possibilities (Tharakan, 2011). On one hand, inspiration for craftspeople can be started by experimenting with traditional textile techniques and adapting the technique to concretize another inspiration point, for example, imitating clouds with embroidery.

On the other hand, textile design is a specific profession that creates patterns, motifs, or surfaces intended for knitted, woven, or printed fabrics. In textile design processes, the suitability of techniques, such as printing, knitting, weaving, embossing, and

embroidery, to the process defines the success of the outcome (Granger, 2015). In this regard, depending on the specific field, textile designers need to deepen their expertise on special technical knowledge, equipment, and materials. For example, a designer who specializes in printing on textile should know that the printed textiles are concentrated to fabric's surface, whereas a designer, working with fabrics, should acknowledge that woven, knitted, or constructed fabrics are created from the scratch and the process begins by selecting fibres and yarns. Also, working with mixed media needs knowledge about utilizing other techniques applied together with either print, weave, or knitting to create fabric. In addition to specific techniques and knowledge, the designs should be suitable for a given purpose such as for the body, product, or space. Current trends, colour awareness, and contemporary design issues are also themes that a designer needs to understand in order to create modern and suitable designs for end purposes. As highlighted above, the textile designers need to consider various parameters in the design process. However, it is common for all specialised fields to start design processes by collecting inspirational materials by gathering, recording, and analysing information. As an example, when designing textile prints, the focus of observation could be on surfaces, images, patterns and colours, or when designing constructed textiles structures, colours and patterns can be inspiring (Steed & Stevenson, 2012).

Designing electronic textiles can be considered as adding technology into the design and crafting processes of textile materials. Inspirations coming from both textile design and crafts are fruitful to explore in e-textiles. The integration of electronics and textiles has an interesting history as conductive materials, for example, metal threads and precious metals, have been used throughout the ages in the clothing and interior elements, like royal costumes, armour and wall textiles. Digital technology and textiles have also an intertwining history as the first computer was inspired by the Jacquard loom (Buechley et al., 2013). These historical connections between E-textiles and textile design practice highlight the importance of having knowledge in textiles when designing and building e-textiles.

In the contemporary view of E-textile design, a typical implementation process includes five stages (Lovell & Buechley, 2010; Hamdan, Voelker & Borchers, 2018): (1) Designing or choosing an artwork, (2) planning the layout of electrical components and traces, (3) creating the artwork and fabric circuit on the base fabric, (4) insulating circuit traces where necessary, and (5) attaching electronic components. Among these steps, especially exploring the attachment of electronic components on fabrics with traditional techniques is often highlighted as a fruitful strategy that yields novel use-cases and ap-

plications (Genç et al., 2018). In this regard, just to name a few innovative approaches, electronic circuits can be printed straight to the fabric (Roinesalo, et al.; Khan et al., 2019). Fibre optic threads, which can transfer light efficiently. can be woven into the traditional tartan weave and illuminate a pattern on fabrics (Bigger & Fraguada, 2016). Similar illuminating fabrics can be created also by knitting optical fibres into the textiles structure (Chen, 2020). Embroidery machines could be used when created patterns and soft circuits (Hamdan et al., 2018). Furthermore, there are new techniques for fabricating textile materials e.g. 3D printed fabrics offered (Takahashi & Kim, 2019). Finally, combining textile and conductive materials gives designers the opportunity to implement fabric sensors and switches (Kobakant, 2020). All in all, these examples demonstrate the novelties that can be achieved by incorporating the textile knowledge into E-textile design processes.

To support young designers in their material explorations, the universities, where e-textiles are taught (the Eindhoven University of Technology, and the Swedish School of Textiles), often include workshop facilities where students experiment with digital printing facilities, weaving machines and the Jacquard loom, knitting, embroidery and sewing machines and 3D printers (Coleman et al., 2011). In our work, in addition to providing workshop facilities, we include workshop sessions, in which the students explore their knowledge on traditional textile techniques with the digital materials, under the guidance of e-textile experts.

The E-textile Course at the University of Lapland

In the following sections, we present an overview of the E-textiles course and describe the selected artworks. The e-textiles course has been taught at the University of Lapland for the past five years. The course was given by two experts: Emmi Harjuniemi, who is a teacher in design technology and has her background in clothing design and Piia Pyrstöjärvi, who is a lecturer of interior and textile design. Also, postdoctoral researcher Pradthana Jarusriboonchai gave guidance for students in programming and building electronics. The interdisciplinary team of teachers and co-teaching have provided different viewpoints and a productive learning environment for the students and peer-learning situation for the teachers (Harjuniemi, Johansson & Pyrstöjärvi, 2019), and it has adapted to the situation in working life, working in multidisciplinary teams.

Participants of the E-textiles course have mainly been master students of interior and textile design, but also a growing amount of industrial design and clothing design stu-

dents have attended to the course after it was included in the *Creative Technologies* minor studies in the Faculty of Art and Design. The aim of the course is to teach the basics of building electronics and programming so that students can build working interactive prototypes from their designs. They are integrating arts, design, and technology and the course is giving them good starting points working and communicating later with programmers and electronic developers. As pointed out earlier, working in interdisciplinary teams is necessary when developing e-textile products. The fields differ in terminology, goals and product development processes. Working in the cross-section of design and technology offers possibilities and challenges to both students and teachers.

The outcomes from the E-textiles course were exhibited in a joint exhibition in the *Arctic Design Week*. The exhibition was arranged together with the course of Product Design for Tangible Interaction. This course was taught Harjuniemi and Milla Johansson, who is an industrial design teacher. The *Arctic Design Week* event takes yearly place in Rovaniemi and gathers people internationally to discuss Arctic issues through exhibitions, seminars, workshops, and participatory events (Jokela & Tahkokallio, 2015). The exhibitions have gained the attention of a vast amount of people who came to experience the interactive textiles. Observations and discussions with visitors gave us feedback about the artworks.

The Course Structure and the Design Process

Each year, the course includes a design task to be accomplished during the semester. The lectures are spread across the semester to support their design process, which includes background research, an ideation phase, technology workshops, generating a conceptual design and implementation of an interactive prototype. The first lecture starts with an introduction to the e-textiles. Previous years´ artworks are reviewed and discussed together. The task of the course is also introduced at the start of the class so students can start the design process. In the technology workshops, students have been introduced to the technology and new materials such as conductive yarns and fabrics. They learn to program, sew soft circuits and use conductive materials in different ways, including making touch sensors and switches with the conductive materials and integrating those to the microcontrollers. A visual example of the design process in technology workshops can be seen in Figure 1.

In the semester of the presented artworks, the programming has been replaced with the possibility to use non-programmable microcontrollers which have e.g. built-in LEDs and touch sensor capabilities (Figure 2). This change was due to our intention of giv-

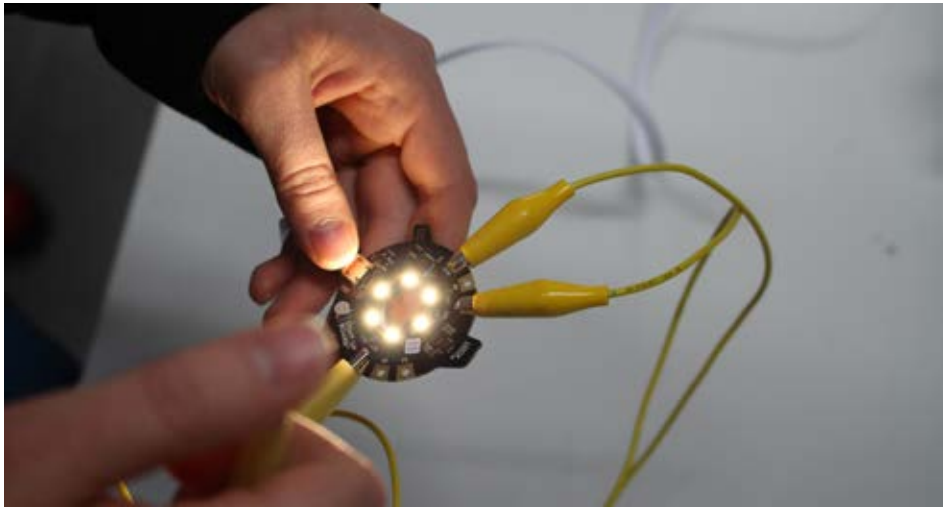

Figure 1. The design evolution of the Secret Message in the technology workshop. (Left) Experimenting the stone form factor with light, (Middle) Embroidering with conductive threads as an input technique, (Right) First prototype. Photos: 1 and 2 Eveliina Muotkavaara, 2018, last 3rd Emmi Harjuniemi, 2018.

Figure 2. Light-up board. Photo: Emmi Harjuniemi, 2018.

ing more time for students to concentrate on their design. Hands-on experiences with the non-programmable boards also enabled students to test their first ideas. Both of the three-and-a-half-hour-long technology workshops included writing short descriptions of the artworks and a prototyping plan. Students had multiple non-programmable boards, electronic tools and materials; plastic sheet, felt, fur, fabrics and conductive materials including fabrics and threads, ink, copper tape and tin foil to build their first inter-

active prototypes. The rest of the semester, they had time to improve the design and were able to use the technology they wanted and any materials they bought by themselves.

The E-textile course has a different theme each year, but it always relates to the Artic in a wide sense. In the 2019 course, the theme was *Creating happiness with e-textiles in the Arctic context*. Upon the introduction of the theme, seeking inspiration from Artic started by getting to know the literature of Artic Design. The students at the Faculty of Art and Design of the University of Lapland are already familiar with Artic Design at some level since the theme has also been addressed in their previous studies.

Despite the students' familiarity with the Arctic, most of them were not knowledgeable about the integration between technology and textiles. However, as they became more familiar with the interactive capabilities of electronic materials through workshops, the students sought inspiration from traditional textile techniques. They experimented with how to incorporate conductive threads and fabrics in techniques like embroidery, lace making and weaving for creating interactive experiences.

In the following section, we present three artworks created under the theme of *Creating happiness with e-textiles in the Arctic context*. These examples are selected as they successfully represent traces of Arctic inspirations and embody traditional textile techniques in e-textiles.

Selected Artworks

Secret Message is an artwork consist of two message-sending-stones. It was inspired by common beliefs that stones have healing energies and soothing one´s longing for a remote partner. The designed shape of the stones and imitation of moss structures were inspired by Arctic nature. It is designed for people, who are far away from their loved ones. The idea is that couples could carry these stones with them and, by using the stones, they can send a message to each other for feeling a little closer. The hand-embroidered details on the stones are partly made of conductive thread, which creates a touch input surface, as well as providing an interactive embellishment on the textile surface (Figure 3). When a remote partner touches one stone, the other stone shows the message 'hello lovely' or 'you are precious' depending which stone the message receiver has. The purpose is to create an emotional connection between people who are apart. The prototype is created with two Bare Conductive´s Light Up Boards, which are microcontrollers with a built-in touch sensor and six LEDs in each (Bare Conductive, 2020a). The artwork creates an interesting contradiction between technology, soft materials and nature, as inspiration was hard, cold stones.

Figure 3. *Secret Message* by Eveliina Muotkavaara, 2019. Photo: Eveliina Muotkavaara, 2019.

Figure 4. *Dead Pine Tree* by Kati Walkeajärvi, 2019. Photo: Emmi Harjuniemi, 2019.

Kelo (Dead Standing Pine) is an interactive wall installation that brings the Arctic nature experience indoors. The idea of this interactive wall installation is based on studies about relaxing sound environments and restorative effects of nature. It was inspired by the traditional lace-making and the Artic soundscapes. The design aimed for public places like hospitals or companies where one can be surrounded by nature sounds to disconnect oneself from the busy day. The multisensory experience is created with the sounds of forest such as the wind blowing in the trees in addition to authentic wood and woollen lace embellishments on it. The lace is made of natural material wool and conductive thread (Figure 4). Conductive thread parts are touch sensitive. These parts are connected to the Bare Conductive´s Touch Board microcontroller that has a build-in touch sensor and an MP3 player (Bare Conductive, 2020b). Different sounds are replayed from the speakers depending on what point is touched.

Figure 5. *Come Well* by Piritta Mettovaara, 2019. Photo: Emmi Harjuniemi, 2019.

Figure 6. *Flying Carpet* by Piritta Mettovaara, 2020. Photo: Emmi Harjuniemi, 2020.

Come Well is an interactive wall textile that welcomes the users back home. It is intended to be placed in a hallway. *Come Well* also has glow-in-the-dark details that remind the enterer of its whereabouts. One can touch the surface created with different textiles, leather and fur materials and hear the greetings from family members. Suddenly the home doesn´t feel so empty anymore. In this regard, this e-textile leaves the possibility for personalization as the sounds could also be recorded and downloaded, for example, family members or relatives. It is intertwining with the culture. The designer also speculated that alternative audio reactions, such as nature sounds or favourite music, could be implemented. The prototype includes Bare Conductive´s Touch Board and speaker. The details enabling touch sensing details are embedded in the rug as conductive fabrics and threads (Figure 5).

The idea of a communicative wall textile is adaptable for different contexts and usage. The process of development continued with another interactive wall textile, called *Flying*

Carpet (Figure 6). The student utilized her knowledge in e-textiles in her master thesis in which she studied traditional weaving techniques of the White Karelian. She made a research trip to the area and recorded voices from her journey. The final woven textile was inspired by traditional weaving techniques and conductive threads were embedded in the woven patterns. These touch sensing details play the recorded soundscapes when touched. The created e-textile is a physical artefact as an embodiment of memories.

Discussion

The Arctic has an influence in design in terms of material use (Miettinen et al., 2020), the reflection of northern nature bits on designed artefact's forms (i.e., Häkkilä, 2018) and the particular problems related to Arctic geography that designs address (Jokela & Tahkokallio, 2015). More specifically, the Finnish textile industry explores the Arctic as an inspiration by, for example, embedding the arctic nature instances to traditionally woven patterns (Lapuan Kankurit, 2020) and printed fabrics (Marimekko, 2020). However, when Arctic inspiration and traditional textile techniques are blended with technology, new opportunities arrive for aesthetic explorations in the field of e-textiles.

The Arctic theme was expressed in the forms of the presented artefacts. It was observable that the students imitated the unique northern nature by using textiles and interactive materials. This merger not only inspired the designers to solely explore the physical forms from northern nature but also elevated the artefacts with Arctic-inspired interactivities. In this regard, while textile techniques and natural textile materials enabled the imitation of, for example, stones from Arctic nature, embroidering with conductive materials made the stones capable of connecting loved ones, who are temporarily separated in sparsely populated geographies (Figure 3). Or, in another example, the inspiration from nature came from the Arctic pine trees (Figure 4). In this example, lacemaking with conductive threads, together with integrated speakers, provided opportunities for representing the embodiments of memories and natural sounds indoors.

The impact of the new opportunities derived from Arctic inspiration is not only limited to geography-specific issues, but the outcomes refer to broader aesthetical and social aspects in e-textiles and/or technology design in general. For example, crafting soft materials of Arctic with technology highlights the potential of making them more comfortable for the user. Or bringing nature indoors with materials and soundscapes provides opportunities to enhance the wellbeing of people in the offices. Also, inter-

active and communicative elements create new values and deeper meanings as being a physical artefact as an embodiment of memories.

Although the Industrial Revolution removed a lot of textile industry from Finland to the East, as in many Western countries, we still have strong expertise in design. We believe that here in Finland there is potential to develop a textile industry towards electronic textiles. To support this, we have a responsibility to educate future e-textile designers to be prepared to explore products in an open-minded manner in the intersection of design and technology. They will contribute by adopting new materials and digital technologies to the next phase in the evolution of textiles and develop novel cultural narratives based on what they have learned from the traditional textile craft communities (Tharakan, 2011). In this direction, the examples presented here suggest using Arctic culture and traditional textile techniques as inspiration sources in user-centric design approaches is a fruitful way to create e-textiles that are meaningful and valuable. Also, the inspiration sources directed the students to use natural materials in combinations with electronic ones. Here, the life cycle of these products is also considered by enabling technological updates – as showcased in the later version of the *Come Well* project updated to embody different sounds for different cases. Another sustainable aspect of the approaches was combining the technology and conductive materials in a way that can be easily separated before recycling. The latter approach is used for recycling electronic materials from the prototypes built in the earlier E-textiles courses.

As highlighted before, the elaboration on the influence of the Arctic in design is an ongoing process. Within this process, our examples showcased the help of Arctic inspiration to the future electronic textile designers while they skilfully combine design and technology. The artworks also discovered how the integration of versatile techniques and technology through the Arctic mindset might bring traditional techniques to the present day. To further this dialogue, the e-textiles have been presented in the exhibitions in the university, in the course´s Instagram account and even in international design events (Harjuniemi et al., 2020, Häkkilä et al., 2018). That has led to national and international networking with the specialists and companies in the field, giving opportunities for discussion, research and co-operations. Local textile teachers from elementary schools visited the exhibition and were influenced by the artworks. They wanted to learn how to do electronic textiles and one of the authors gave them a course about the basics. Pictures and videos shared in social media were found by the Bare Conductive company, whose technology we used in the workshops. They were so impressed with our students´ explorations with their technology that they asked us to send materials. They

published those as a part of their marketing campaign on Instagram (Bare Conductive, 2019.) It contributed positively also to our other aim of the E-textile course which is to give students an empowering and inspiring start in designing and assembling e-textiles. The fact that some of the students, as Mettovaara, have continued to develop their idea after the course and created more advanced projects made us believe that, due to the experiences they had in the course, the future designers become more capable of adapting to evolving technology development and research conducted in Arctic region (i.e., VTT, 2020a, 2020b).

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