Digital Craftsmanship in the Wearable Senses Lab

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ABSTRACT

Wearable and e-textiles as a field has tended to overlook its own documentation, as notions and overarching ideas are developed over time and across individual projects. We would like to begin addressing this by charting the development of Digital Craftsmanship through a number of projects over time. Practically, we propose to show a small selection of garments and samples alongside a simple framework for future documentation of work.

CCS CONCEPTS

H.5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous

KEYWORDS

Digital craftsmanship; documentation, theory development, soft wearables; interaction design; dynamic fabric.

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1 Introduction

The field of wearable soft things or soft wearables has developed from a niche concern to an increasingly broad area of research [5, 9, 11, 19]. As high performing materials have become more widely available and our systems of making and production

more sophisticated, we see wearable electronics projects emerge not only from the arts and fields of technology, but also from fashion, design and engineering. With the so-called 4th industrial revolution promising a much more flexible and automated factory work floor, we may soon see increasing levels of simple traditional electronics incorporated into soft things in our everyday lives [4].

We believe that the future of soft wearables is now broadening up to include programming, not just electronics and interactive behaviour, but programming the whole garment in terms of its material, its form, its manufacture, its level of personalisation, associated services, and its direct relation to both its user and the social cultural and economic structures around it. In order for such complex frameworks to emerge, we need structures and terminologies not just to analyse past work but to frame new projects and developments as they emerge.

2 Digital Craftsmanship

Over the last ten years, the notion of digital craftsmanship has developed through the building of our research projects and teaching in the lab. The term emerged as an attempt to describe the skill of expressing a designerly or artistic aim, manifested through soft physical materials, through a system underpinned by the digital material.

In our understanding, this digital material stretches from technological inspiration, technology envisioned in a project, technology required for execution, to technology for manufacture. Instead of considering the physical execution of an idea as the last and final step of a process, we wanted to allow material exploration, physical craftsmanship and skill to be central to our work with a set of materials that increasingly include digital material and notions.

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This means that our projects increasingly combine programming, mathematics and material explorations, making use of crafting and open-ended making to imagine and craft new digital/physical objects. The digital often constitute the core material to be expressed through embodied objects ranging from the mundane to the complex; cardboard, recycling, fabric, embroidery, metal, printing and laser cutting etc. As a result, we are essentially working on material explorations of immaterial ideas in the context of post-human technology and new materialism [1, 14, 16].

In practice, this means that we consider digital assets design material, to be addressed and worked with in craft-like techniques, through hands-on making and sketching, moving through a number of computational design and manufacturing techniques all aimed at producing explorative designs of material/digital objects. All this manifest through a very hands-on craft approach to working with machinery such as flexible substrate 3D printers, laser cutters (fabric, vinyl, leather etc.), digital embroidery weaving and knitting. In this, our aim is to explicate our understandings of both machines and making towards a point, where we can make use of the technologies available to us as expressive mediums for craftsmanship.

3 Documentation Framework

To this end, we have focused on understanding and analysing our own lab outcomes, what they explored, how they were expressed, and the extent to which they requiring a renewed understanding of the industrial work floor and its possibilities, as we work towards developing a renewed understanding of the roles of machines and aesthetics. These projects have already been documented in a number of publications on individual project level [2, 7, 8, 10, 12, 13, 17], but here we wanted to expand the scale, to be able to begin looking across projects over time.

In order to do this, we developed a simple framework, seen in fig. 1. By looking through these projects we see three levels of complexity in the manner in which they each relate to the data in and around their own production and designs. The three levels are the product level, the system level and the service level.

1. At a product level (digital material production), the development of wearable technology is driven in part by the culture of “maker” DIY digital fabrication. Digital knitting, weaving and printing allow us to combine yarns, fibres or filaments with different material properties in different ways (structures) for each part of a garment. This is widening the design and production space, but also allows us to consider the craft aspects of innovative textile work.
2. At a system level (personalized design process), algorithmic treatment of digital personal data allows the shape, design and finishing to be programmable and therefore modifiable in a way that still keeps the identity of the designer while the fitting to the customer’s identity, moving body, and

context of use. In the following examples, we see increasing levels of digital complexity on the designs.

3. At a service level (end user programming), we can use digital sensing and actuating capabilities to enhance its physical properties by adding control systems integrated in the textile. In this way “Self-programmed” behaviour and functionality allow us to create new applications by programming the mapping between digital functionality and physical interaction. In the following examples, the complexity present in the designs continues to increase as the wearable is used and experienced by its owner.

As a crucial part of sharing and understanding this process we believe that making the physical material available alongside the analysis of their context is a key component is allowing digital design and craftsmanship to develop a research culture for the future [3, 6, 15, 18].

Craft & Tech	Material	Data	Project name	Project description	Author(s)	Year	Photo
Automation generated puppytooth woven patterns	A collection of woven jacquard fabric with a five color pattern. The pattern appears as a contrast of darker and lighter colors, resembling the traditional black and white pied-de-poule pattern.	The generator is a one-dimensional automaton that enables the development of a so-called puppytooth pattern. It is possible to extend the automaton, which offers a rich playground for various types of semi-random, yet pied-de-poule like behavior.	A Cellular Automaton for Pied-de-poule (houndstooth)	With the use of the cellular automata theory, a more abstract pied-de-poule can be generated. The pattern was used to weave fabric from which garments are made.	Lee Feijs, Marita Toeters	2017	Photo by Robin van der Schaaf, styling by Marita Toeters (© Marita Toeters)
Woven image recognizable illustrations	Woven fabric that includes visual markers that enable image recognition by the software.	The Digital 3D characters and technological animations mapped to the textile matrix in Augmented Reality.	TexTales Dream Bear edition	TexTales is a project in the intersection of textile tradition and technological innovation. TexTales explores the storytelling through traditional textile and augmented reality fairytale application. Digital properties extend the textile capabilities and allow the long-lasting textile to change in time to change together with the users. The developed stories demonstrate the possibilities for such storytelling.	Kristi Kuusk, Johan van den Akker, Textelblauw, Lindell, Martijn Zubransky	2015	
digitally animated fabrics and embellishments	Pink-colored woven jacquard textiles and fabrics embellished with silver sequins made of acetate	Shimmering pastel-colored animated videos digitally composited onto fabrics in real time via a chroma key smartphone app	Phem	Phem is a fashion brand concept for garments that use hybrid digital-physical fabrics. It can also be understood as a design exploration for fabrics that can be digitally animated, or fabrics that have the dynamic abilities of a computer screen.	Angella Mackey	2018	
Knitted sensing	Martijn wove knitted fully fashioned long sleeve shirt with integrated conductive yarn	Data about parameters related to movements of the upper body are collected through the stretch and interpreted by mobile application.	Vigour	Vigour is a piece of wearable technology for geriatric patients that would enable the physiotherapist to gain more insight in the patient's exercise and their progress. The garment can be worn all day and thereby gather a lot of data. Next to this the garment can be worn when executing rehabilitation exercise and give feedback to the wearer by making sound or optionally also vibrate to encourage the wearer.	Martijn ten Bhömer, Pauline van Dongen, Oscar Tomko	2016	
	The knitted textile structure allows the unimulated conductive yarn to act as capacitive sensors, the knitted conductive threads as the connection to the power and holds knitted pockets that house programmable microchips.	The programmable electronics allow the LED to act to the data transferred from the act of stroking the fabric against the wearer's skin.	Tender	Tender is a garment that reacts to stroking. It lights up separate pockets on the body according to how they have been in contact with the skin. By stroking the garment it is possible to “move” the lighted part of the wearable. It can be used to gather light around the neck, chest area for reading, and hands area for the spotlight to find something in darkness or for other playful effects.	Kristi Kuusk, Martijn ten Bhömer, Paula Kozmar, Textelblauw, Tilling and Metatrónica	2012	
3D printed personalized material properties	A shoe with a sole made with Filaflex, a TPE (thermoelastic elastomer) filament for 3D printing, and vegetable tan leather upper.	Temporal composite is created from the act of walking whether from a single footstep on a capacitive sensor or over the lifetime of wear and tear of the shoe	Solemaker	Solemaker is an interactive demonstrator for scanning, designing and manufacturing shoes. As an Ultra Personalized Product Service System, this process includes the scanning of feet, the design of the sole, the manufacturing of the sole, the manufacturing of the upper. This is all coordinated via the solemaker in website.	Troy Nachtegaal (and Lee Feijs)	2016	
Thermochromic ink & Thermogram	Screen printed designs applying thermochromic ink on a blend of cotton and elastane fabric.	A thermogram from the body was combined with 3D body scan data to generate patterns based on algorithms to generate Voronoi diagrams and image sampling with the Grasshopper plugin in Rhinoceros.	Epic - Expression, performance, identity & control	EPIC is meant for the amateur athlete who wishes to be able to express and control their performance. The skin temperature will be measured and visualized by the color changing interface to give an organic data visualization when the body has warmed up and is prepared for the exercise. The pattern on the sportswear becomes even more personalized through an algorithm that uses data from a thermogram to create a concentrated pattern at the thermal peak areas.	Kim Soave, Lisa Mallo, Gerd, Liu Baowang	2016	
recursive patterns engraved based on fractalization theory	Made of laser engraved multilayer woven polyester fabric, the garments are realized using laser cutting and a collection of other techniques such as stitching and welding	Design patterns generated through recursive algorithms applying fractalization theory and fractal functions systems to make fractals	Fractal Art Fashion	Fractal Art Fashion is a mini-collection of three attractive high-tech fashionable garments based on the new fractal line: pied-de-poule: a body stocking, a parka (coat) and a jacket. The patterns on the fabric are laser engraved and created through algorithmic design. (The photo shows Laurens multilayer woven polyester fabric).	Lee Feijs, Marita Toeters	2015	

Figure 1: Part of an example page of documentation framework.

4 Examples of Work

In the following figures (figure 2-5) we will show a number of project examples. We propose a selection of them for the exhibition.

Figure 2: Flow (2015). Bruna Goveia da Rocha. Flow is a wearable that includes six inflatable chambers that push against the body to cue fundamental joint movements of the wrist and forearm to foster learning physical activities, such as fencing. The integrated chambers and air ways in Flow operate as a material extension of the actuators responsible for the inflation; removing the air pumps from the area of actuation. [10]

Figure 3: Solemaker (2016). Troy Nachtigall (and Loe Feijs). Solemaker is an interactive demonstrator for scanning, designing and manufacturing shoes. As an Ultra Personalized Product Service System, this process includes the scanning of feet, the design of the sole, the manufacturing of the sole, the manufacturing of the Upper. [14]

Figure 4: A Cellular Automaton for Pied-de-poule (Houndstooth) (2017). Loe Feijs, Marina Toeters. With the use of the cellular automata theory, a more abstract pied-de-poule can be generated. The pattern was used to weave fabric from which garments are made. [8] Photo by Robin van der Schaft, styling by Maaïke Staal (© Marina Toeters)

Figure 5: Phem (2018). Angella Mackey. Phem is a fashion brand concept for garments that use hybrid digital-physical fabrics. It can also be understood as a design exploration for fabrics that can be digitally animated, or, fabrics that have the dynamic abilities of a computer screen. [12]

5 Proposal

For ISWC, we would like to propose an exhibit of garments and samples originating from our lab over a longer period of time. We will pick three examples, one from each of the categories mentioned above. These examples are all exhibition ready, but we will make the final selection when we have a better understanding of the space of the exhibition. Together these samples will illustrate and document past work at the lab, but also provide evidence of the process of developing the notion of digital craftsmanship and how we use this term and practice in the lab today.

6 Requirements for Exhibit

Our garments and samples have no technical requirements, in the sense that they are stand alone. If possible, we would like to present at least one on a mannequin, but we can also have them on hangers or lying flat on a table. In addition to this we would like to distribute our data sheet as seen in fig. 1. as a proposal for the beginning of a future taxonomy of digital craftsmanship work.

6 Vision for the Future Past

We are hoping that through showing not just examples of work at ISWC but also our simple framework for analysis, we can engage the community in conversation about not just what we did, but also what we may do next, how it fits with other work and communities and how we may document and share out experiences and knowledge.

6 Conclusion

We believe that future of wearable soft things may still have technology physical embedded, but they may also be non-technical devices, where the technological innovation lies in the manner of their manufacture, the way they are personalized towards their users and uses, and finally in how they are related to product service systems throughout their use cycle. In order to build such visions of the future we want to refine and evolve the notion of digital craftsmanship. Exhibiting at ISWC is a step towards doing this in conversation and collaboration with our wider wearable community.

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