Crafting Smart Textiles – a Meaningful Way Towards Societal Sustainability in the Fashion Field?

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Abstract
Smart textiles with its vast range of possibilities provide a considerable opportunity for societal sustainability for the waste-oriented fashion industry. May the new textiles react to the environment, wearer, have a mind of its own or simply provoke and inspire people – it is a great tool for the transition from the product-oriented industry to the service-minded economy. Fashion field needs to mature and adapt to the new rules set by the user within today's environment. While developing the new field of smart textiles, this paper stresses the importance of learning from traditional crafts and the value of craftsmanship.
We start by introducing the importance of crafting and connecting it to the industrialized way of producing. Then, we ask whether we could merge valuable insights from both in order to develop the smart textiles area. Later, you will find an example project merging Quick Response (QR) codes with traditional embroidery that inspired a set of TechCrafts explorations in a form of student projects. In case of the embroidered QR codes, the link to technology is an add-on feature to textiles. In the other examples, craftsmanship technologies are used to create the textile substrate itself. These explorations are the input for a discussion about the role of craftsmanship and skills in developing materials with interactive properties that is held with relation to the possibilities for societal sustainability.

Keywords
Craft, Crafting Smart textiles, Digital technology, Societal sustainability, Culture of connectedness

Introduction
Textiles and traditions, and rituals and crafts related to them have existed for millenniums. Natural fibers spun, weaved or knitted together have been close to the human body, environment and conscious for basic survival purposes, social distinctions, expressing different power relations and even interacting with the spiritual realms.

Crafts and everything related to them are much more than some old techniques. Sennett (2008, p. 9, 149) describes craftsmanship as "basic human impulse, the desire to do a job well for its own sake," and craft as a more advanced level of technique, such that the "technique will be intimately linked to expression".

Everything from the cultivation of the plant up to the finalization of a garment used to be done by a specialized hand, therefore each step, stitch and loop had their own personalized share of attention and time. Processes were slow and people involved could put their own personalities into it – "learning about themselves through the things they made" (Sennett, 2008, p. 8). With mechanical production textile and garment processes got standardized, automated and, due to the shift towards consumer culture mindsets, extremely wasteful.
Smart textiles are around for a while now with a great technology-driven emphasis on what is possible to develop. There are many inspirational examples around that express how technology and textiles could exist together creating effects or even feelings. For example, stage targeted products of CuteCircuit (2012), Hussein Chalayan (2012), XS Labs (2010) or Ying Gao (2012). What if now that new techniques emerge, in order to craft a more sustainable future, we would get inspired from ancient techniques and meanings as well? Many rules for life, ways of living and making things got changed during industrialization. Certain decisions and directions towards efficiency and standardizations killed older and long-lived principals of quality, individualized approach and value of handwork. Crafts were considered too time demanding for mainstream in that period, but now re-considering some decisions that led us to mass production, they sound inspiring and worth looking into.
Could we learn values passed on for generations through making and transfer/translate them to the smart textiles applications? What would have a similar meaning to us today and what would get lost in translation?

Technology and material developments allow us to create smart objects, like apparel. Garments are able to sense, track and output movements, temperature, touch, sound, moisture, pressure, bend, orientation, light, etc. Textile objects react to whatever we wish for; data gets transferred between desired parties in no time. For example, the Hug Shirt (CuteCircuit, 2012) that as a very clever hoodie senses characteristics of a hug (strength of the touch, skin warmth, heartbeat rate) from one person and transfers those via Bluetooth and mobile network to the recipient. Now, all these possibilities may act rather as gadgets unless they find a meaning during the design process.

Fashion industry, suffering in exhaustive sustainability issues, doesn't need a further drive by the "next cool" thing that is growing the pile of waste in few months. Next to all the efforts done in wiser material use, reuse and recycling, vintage promotion, new business models, it needs a way to close the loop from materials and energy use to the industry and user, and back to the industry and user. (Fletcher and Grose, 2012) This is not a material driven change: it must be a deeper behavioral turn. A change that makes garments more valuable to the users: through the combined influence of the process, materials, final outcome, care taking and disposal. Steps taken by designer, producer, supplier and with the greatest impact: the user. In such multi-stakeholder approach projects similar

to CRISP Smart Textile Services play a leading role with their goal being to integrate the design and production processes of textile, technology and services (Bhömer, 2012).
However, considering the ungraspable complexity of the whole system, how to make sure the "smart" garments created are actually leading us to a desired direction?

Behavioral turn

In the 18th century, when people used to craft textiles and garments for their personal and family use there was much more supporting it than just the act of knitting, weaving, sewing etc. Rituals of making together used to bring people into workshops to craft high quality items. Those activities tightened bonds between makers and made them share much more than a skill with each other. They shared life experiences.
Everything was made with a heart and soul in it, therefore with exceptional quality and purpose to last as long as possible.
With industrial age "The machine introduced a new element concerning the relation of quantity and quality," (Sennett, 2008, p. 109) reversing the relation between the two got expressed through waste. Not only post-consumer waste, but also pre-consumer waste and production waste started to grow in uncontrollable amounts. Garments go through systems that are invisible to consumers and lack of value and appreciation due to it. Combined together with the mindset of nowadays where "the function of culture is not to satisfy existing needs but to create new ones - while simultaneously maintaining needs already entrenched or permanently unfulfilled" (Bauman, 2011, p. 17) we have achieved a fashion industry proud of low quality cheap disposable clothing. Everyone needs to change constantly. As Bauman (2011, p. 24) puts it "Time is indeed passing, and the trick is to keep pace with it. If you don't want to drown, you must keep on surfing: that is to say, keep changing, as often as you can, your wardrobe, furniture, appearance and habits, in short - yourself."

This opposes to the culture mentioned before, that used to build a person up stitch-by-stitch, day-by-day and year-by-year. Handicraft used to be an important part of it. "Just one hundred years ago a woman's worth in Setu was judged by her skills in handicraft. There couldn't be any small mistake for the girl to be seen as a good future mistress. It was thought to be her mother's fault when a girl could not manage handicraft" (Summatavet, 2005, p. 68). She says that before marriage a girl had to have woven all the material needed for her future husband's clothes. This was seen as a preparation to step into independent life. And the care for each detail in handicraft was seen as one's ability to craft the life in general.
According to Bauman (2011, p. 52) these traditional rules for life had become a hindrance rather than help in the new conditions. "It did not matter that under other conditions, now receding into the past, they had helped people to live in a

spontaneously created, but change resistant, atrophied and corroded society: now these rules were turning into "superstitions" and "old wives tales" becoming a burden and the main impediment on the road to progress and the full realization of human potential". (Bauman, 2011, p. 52) Education and social reform took people further from the old beliefs and fashioned us according to the dictates of reason and rationally designed social conditions.

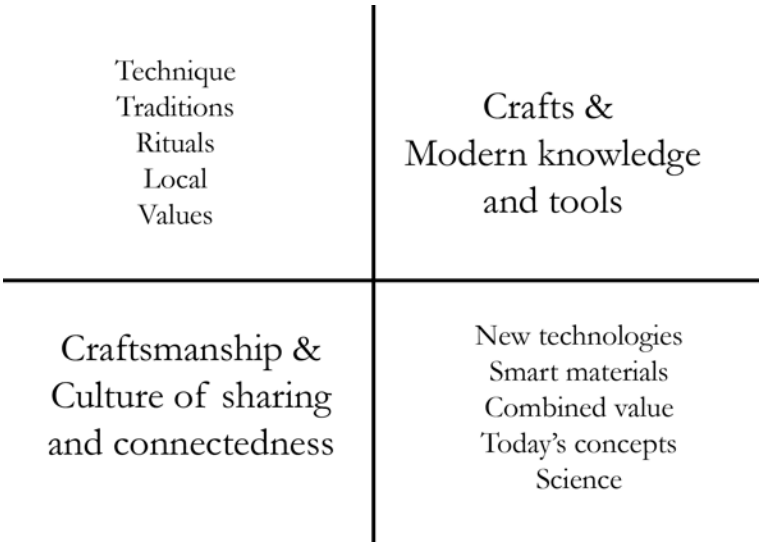

Figure 1: Possible merging combinations for culture and technology

In times of blooming handicrafts sewing, knitting, weaving and crochet were part of the skill-set of each respectful girl/woman. Putting aside reasons for keeping woman's hands busy, like keeping them in houses or away from politics and general discussions, those meditational hand practices were part and also built further valuable traditions and rituals of making together, giving meaning to things done, ornaments on clothing and accessories. Those mindsets supported and developed very personalized local approach to living. Each piece had an author who's life story was also known to the rest of the community and therefore values such as unstoppable drive for quality and tight bonds within a family and community were honored.

Today we are overwhelmed by new emerging technologies and tools, such as laser cutting, 3D printing and smart materials, like conductive textiles, yarns, thermochromic dyes, Arduino etc that get more and more accessible and easy to handle for the end-user. We have different problems and priorities than there used to be in the 18th century. Technology developments have given us new ways of looking at things and tools to play with. We like to be connected and belong, similarly to what used to be, but in a new non-geographical way.

There seems to be a nice synergy between craftsmanship with its drive for detail and quality and values applied through tradition and rituals, and the modern culture of sharing and connectedness. Also combining craft techniques and the hands-on approach with knowledge and tools emerging and still to come, we

have the potential to achieve a very sustainable combined value of old and new. Maybe some of the decisions and directions (not) taken while pursuing the efficiency in production and development lines that has shaped our "the way it's being done" could be questioned or changed. Fashion designers are inventing and proposing new ways for sustainability, but since this means asking questions about speed and "fast fashion" principles, also doubts economics as we know it, those alternative emerging directions take time to get adapted and appreciated.

Some examples as the impact-led fashion models replacing trend-led ones as defined by Fletcher and Grose (2011) would be adaptable garments, that can be adjusted and changed in order to fit or suit a certain situation, including trans- and multifunctional clothing that replace several other garments or are meant to be worn in various scenarios. Also clothes that can be worn through seasons, modular play of assembly or shape change.
Another example could be optimizing garment lifetimes or promoting their low-impact use, that can be achieved by enhancing emotional connection of the wearer with the garment, creating durable clothes that can actually be used more than few wash-cycles or changing the way people take care of the garments. Textiles that require no washing and garments designed to accept stains, spills and wrinkles as well as low ironing heat play its role here.
An alternative way towards sustainable business-models are repair services that allow the industry to get other kind of income besides from selling more material and garments. Designing and working with local materials and artisans for local culture helps to develop smaller communities, which means improving from inside.
Biomimicry - another exciting emerging field - ".. is not simply a tool for copying. Rather it is understanding and applying nature's principles - surprisingly simple at their core - that is more the point." (Fletcher and Grose, 2012, p. 115). That means changes starting from material level up to processes and proposals for seeing completely different, in harmony with nature, business models.
"Slow is not a simple description of speed. Rather it represents a different worldview that names a coherent set of fashion activity to promote the pleasure of variety, the multiplicity and the cultural significance of fashion within biophysical limits. Slow fashion requires a changed infrastructure and a reduced throughput of goods" (Fletcher and Grose, 2012, p. 128). Slow fashion means accepting diversity, producing in small scale, and trusting the partners, valuing making and maintaining and a true price of the product incorporating ecological and social costs.

Within smart textiles and garments development, the main issue today is yet to explore possibilities, push borders of what is possible and propose scenarios of potential use. It is very much material, technology driven - more as a hack to prove that something can work, rather than fulfilling a need and growing upon

that. Crafting smart textiles makes it a slow process, hands-on experience; it allows craftsmen to grow together with their creation and the smart textiles to record a narrative, story — tradition.

Because we envision meaningful results from the tension between crafts/culture and modern technology, our approach is to explore the design options of where these two come together. In figure 1, we can see the existing axes from culture (upper-left) to technology (lower-right). We may expect inspiring design with respect to craftsmanship/connectedness (lower-left) and crafts/technology (upper-right). In the next sessions we explain our explorations.

QR-coded traditions

Looking into such developments Kristi Kuusk wanted to incorporate some of the forgotten old wisdom into the new possibilities of digital and otherwise new technologies. While approaching the integration of textiles and technology she aimed to show and, through that also, see how new ways of communicating can be a mean towards sustainability in the fashion field. After first steps of exploring different combinations of crafts and technology, and seeing what would be more valuable in terms of transferring meaning from one society to the other she ended up pursuing an exploration of embroidered Quick Response (QR) codes carrying cultural information in several layers (Figure 2). This was a first tryout in this series of practicing a craft (in current case embroidering with a machine) and giving it a new modern use while keeping values that inspired the integration in first place within the final concept.

There is a clear parallel between information stored in folkloric garments, accessories expressed by colors, ornaments and placing, and data revealed by QR codes. Both require a key to get accessed. Folkloric embroidery, traditional patterns on mittens and socks, the variations of colors on skirt-stripes – they all meant something specific for the family or village producing and wearing those. The symbols used to be taught and developed traditionally within local communities. It used to be a personal story only understood through the knowledge of the local context and an outsider could only see or hear the meaning if she was given the key to it. (Summatavet, 2005, p. 95) Similarly, in order to understand what is hidden linked to a QR code, it has to be first recognized by software on a mobile device. Whereas now in the "connected world" we have symbols readable by machines universally. The mean of reading might be the same, even message composed with same data, but meaning still varies in different parts of the world for communities used to other kind of inputs.

Furthermore, to ask the question, how could traditional craft support or guide technology as a new craft, Kristi experimented quite a while with merging QR-codes with folkloric embroideries. She prepared some more concrete proposals of

use of this nationalized QR code embroidery. One of them is a concept of bed-sheets that, while scanned, start telling a fairy-tale that originates from the region which patterns and colors are used in its design. For example, sheets with Danish colors would tell a bedtime story about The Little Mermaid or The Ugly Duckling while one imitating Muhu skirt in Estonia shows a cartoon about a princess or allows a parent to read out a story about The Gold Spinners.

Figure 2: QR-coded Fairy-tale pillows by Kristi Kuusk

The beauty of the approach lies not only in the integration of traditional local colors and patterns with new technologies but also in the values, which have been taught through family-line for centuries. Maybe the bed sheets could talk about the kid's own family and therefore enhance the interaction between generations daily basis.
The information referred by the code can change in time, so it is another way a garment to become more valuable while being used. It carries tradition and history in many levels while encouraging new ways of interaction. For example bringing fairytales back into our daily knowledge, not forgetting old wisdom.

Such interactive ornaments on our textiles, on one side feel right - they look and feel familiar. It is just embroidery as it has been used on garments since ancient Egypt. On the other side, it is used in a new way taking into account possibilities of technology today and values important to the current society. It has potential to contribute for a more sustainable fashion and world with the combination of static ornament on a textile being linked to digital dynamic information changing in time.
First examples that were made with the QR embroidery were embodying the garment's history into the code. The story of the item: where and by whom did it get grown as crops or melted from what kind of oil, where did it get woven, knitted, laminated into a textile, what kind of finishes were used, dyes, treatments. Where and by whom did the garments get designed, cut, sewn, finished, sold etc.? Maybe it had another user before - who was it, pictures of her

using it? Maybe the garment got assembled into a second life already? Was the bag in its previous life a dress? It could be a way to make garments foot-print more visible and used or second-hand items more appreciated by their rich visible history. This information could be shown intimately to the wearer or exposed to whoever cares to read it. It could be protected with a key that the owner can share or openly accessible by anyone. The data linked to the embroidery could tell a predefined story or be configured by users. For example, Tiina would get an item with the embroidered code on it. She would enter a website and define in what conditions the specific code would result in what outputs. It could tell a mutual joke on Monday, suggest a cake recipe on Tuesday, play a selected video on Wednesday or even change the output every hour, on special occasions etc. Then, Tiina gives the item to her friend Tom, who gets a new surprise every time he scans it. It is very personally customized gift from Tiina to Tom, therefore embodies potentially great emotional value. Or imagine every morning waking up with an inspirational quote suggested by your group of friends!

Now that the value of the item can grow in time, it does not just get old - it might hide new exiting message next day and the user plays a clear role in the lifecycle of the specific textile object, he must also pay more attention to the care process. If it gets treated in a wrong way the user loses more than merely a cover-cloth. He loses a certain connection to a friend or group, or to a certain database of information.

The QR coded traditions concept can be seen as a physical representation of a virtual value. May it be connected to a local wisdom, inspiring quote, personal message from a friend, fairy-tale, history of the item or something else, the digital data is ever changing and always growing. While the physical embroidery is static and always present. Maybe those could be the tools and artifacts Milli John Tharakan (2011) is asking for, that would help us to find a balance when the changes, caused by rapidly developing technology, are happening too fast.

Towards Crafting Smart Textiles

Application used to be the force demanding material innovation. Now we are strongly driven by the new technologies - anything is possible and that might be the problem! Development in the smart textiles area is mainly driven by material sciences, new opportunities in fiber level. But not everything technologically possible is necessarily valuable. Creating something technologically very challenging and fancy has no value if nobody needs it.
Tharakan (2011, p. 189) suggests creating narratives for smart textiles. Referring to the modern constant lack of satisfaction she argues, "The ability to transcend the physical through myths and the slowness in the making and use of craft artifacts could be some of the missing ingredients that our soul and senses are longing for."

New valuable concepts can be achieved mixing traditional and new in different levels. There are various approaches possible to take to integrate technology and crafts. We have done series of explorations in Eindhoven Technical University (TU/e), Industrial Design, Wearable Senses theme. And based on that we are making first attempts to create a mutual language to talk about crafts mixed with technology.

During a project TechCrafts Bachelor students started up each getting to know one craft rather deeply. They researched about weaving, silversmiths, crocheting, knitting, bobbin lace making etc. and found themselves a master of the specific craft to learn from. From practicing the skill, they took a step further and started to merge the old technique with new materials and electronics keeping in mind what the craft traditionally had served for. The intention was to learn the wisdom of the old craft and to bring it into today, not as a museum would do - preserving it, but hacking, cracking, re-thinking and inventing way.

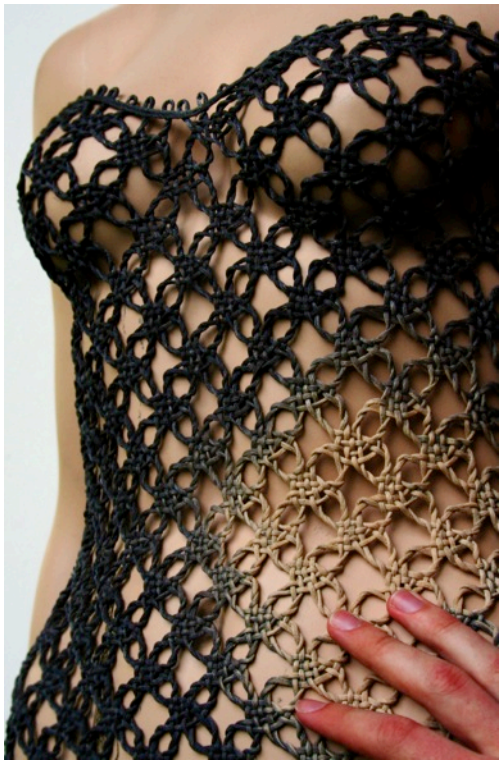

Figure 3: Unlace by Eef Lubbers as part of the TechCrafts project

Unlace (Figure 3) is an interactive lace lingerie garment which allows two-way interaction for the piece to react on touch and heat up thermochromic yarns, while also the interactive change invites and guides the touch into desired places. Combining bobbin lace making together with its values of slowness and details with new smart materials, we have a very delicate piece of technology.

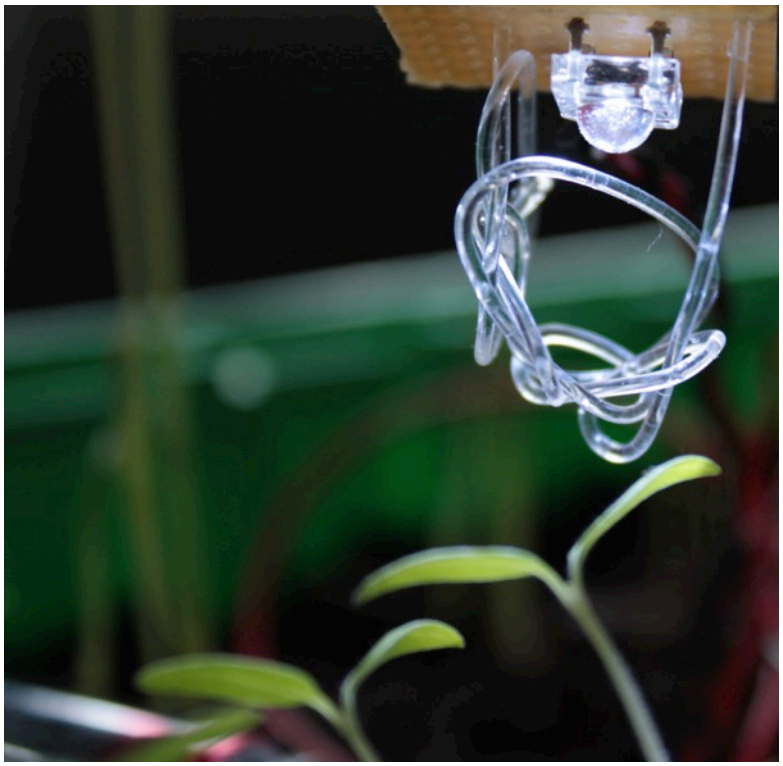

Figure 4: Morrow by Liza Blummel as part of the TechCrafts project.

Morrow (Figure 4) is a fence made for climbing plants. The stimulating lights will turn on when a person interacts with the fence. In this way the plants will grow towards the light. It creates a moment for observation and realization between plant and the one taking care of it.

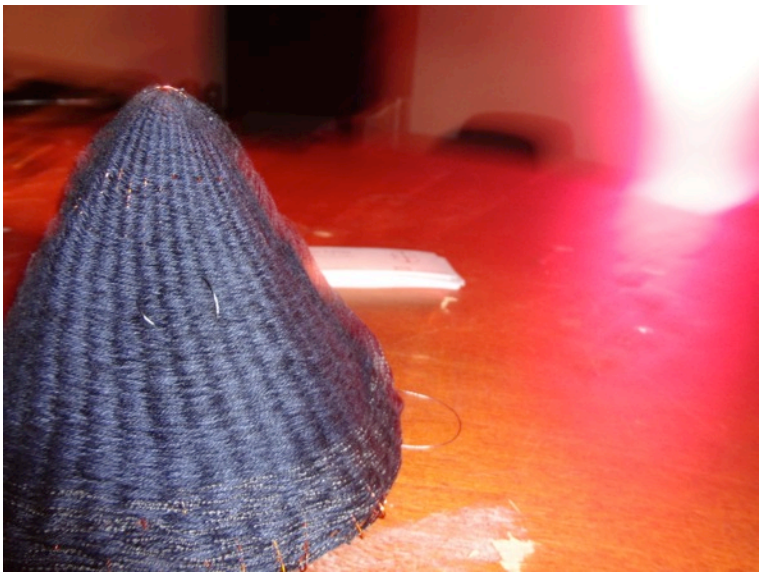

Figure 5: Intimacy tower by Orfeas Lyras as part of the TechCrafts project.

Intimacy tower (Figure 5) is a circular woven tower that uses the textile to represent the complexity of one's inner self and the growth of it with his

experience. It plays with the privacy and the allowance to reach it. The goal of the tower is to create empathy between people that have the same experience at the same time.

Discussion

"Technology can be part of the actual textile (e.g. smart textiles), a tool for their creation (e.g. the software CAD), or used to manipulate the input (e.g. using wearable technologies)." (Seymour, 2008 p. 173)
From the described and other realized projects conducted in TU/e we can see that the concepts developed through making with one's hands and learning straight from a master even after combining with high technologies still carry the core values of the craft started with. And even if the prototypes are not technically perfect, they incorporate a strong value for relationships between people or environment and people. "Skills are also a certain way against superficiality. Skills lead to quality, to refinement, to depth." (Trotto, 2011, p. 42)

Strong Do-it-yourself (DIY) communities and Fablabs around the world are supporting open-source digital fabrication, which unites global design, and local assemble, production. Making things helps us to learn about ourselves (Sennett, 2008, p. 8) and give values to the objects around. With those developments part of the making process becomes visible again. "Work created with the hands gives birth to new ideas." (Trotto, et al., 2009, p. 13)

When talking about crafting smart textile we don't necessarily mean applying the skill of handicrafts, but moreover the attitude to make things ourselves, give personalities to them and to appreciate the value created by combining time and attention – our most valuable resources. The rapid prototyping tools and digital technology can be seen as a key element here.

"In response to the excess of globalization and over the top industrialization, there's a renewed interest in local traditions and crafts. Since the eighties Van Slobbe holds a passionate plea for the value of crafts and says it is the "new luxury" the world is in need of." (Hirvonen, 2009) Joining the new luxury of slowness, time and attention provided by craft together with possibilities provided by the advancements in technology and ways of communication and living there might be an idea towards more sustainable (fashion) world.
Crafts incorporate a lot of layers of value in them; it has to be made explicit. Textile realm that has naturally step by step developed from handicrafts into industrialized factories has a new challenge as smart textiles, to tackle. It missed the slow need-driven beginning, as textiles had, and has to start already from industrialized point of view. The field is too immature and deserves a childhood of playing hands-on trying to figure out how and why everything could

function. We could let smart textiles find its own way of seeing the world, without the dominating industrialized-consumer glasses.
Similarly to the development of digital applications, websites users need to have access to the tools, skills and inspiring materials to craft the smart textiles in order to the revolutionary valuable things to happen and be noticed. For this platforms, such as Kobakant, introducing techniques and do-it-yourself projects, by Mika Satomi and Hannah Perner-Wilson (2012) are essential as much as availability of small amounts of new functional materials.

"Ornaments used to protect, cleanse, heal and also communicate and serve as a ritual sign. People used to leave part of themselves together with the ornament" (Summatavet, 2005). Having similar ambitions for smart textiles we must gather patience to let time craft the path for it.
"Our economy is stressed because our material world operates on the basis of physical resources that we do not have, and waste we have nowhere to hide. Perhaps the first change we should make is to stop producing and consuming things we do not really need that make the waste that no one wants, especially waste that is toxic to ourselves and our fellow beings on this planet." (Pauli, 2010, p. 7) Toxic waste is a gentle topic around smart garments. Let's make really sure to learn from what fashion industry is already able to teach us today, to treasure quality over quantity, trusting relationships over dependency and meaningful applications guiding people to that direction.

Conclusion

Clothes and objects provide a crucial "carrier" service, helping to bond the relationships between others and us and with the society as a whole. The continued relevance of things to people through change or novelty is essential in this context, for all of these relationships are in constant flux as our own perspectives and the values of society co-evolve (Fletcher and Grose, 2012, p. 138).
Textile industry is heading towards smart and interactive garments valuing our need for connectedness and sharing. With lost craftsmanship approach of drive for detail and quality and values applied through tradition and rituals, craft techniques and the hands-on approach this next stage could be ecologically more responsible stepping stone for the next eras approaching.

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