Call for contributions: ‘What is textile design research?’
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Title of contribution:

Physical tools for textile creativity and invention

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Summary:

Two textile research projects (one completed and one ongoing) are described, where physical inspirational tools are developed and tested with the aim of stimulating textile creativity and invention, i.e. the use of textile materials in new kinds of products, thus bringing textiles into new contexts. The first research project (completed) concerns how textile designers use new responsive materials and technologies, whereas the second (ongoing) concerns how architects and design engineers can use textile materials. In both projects, the developed inspirational tool is tested through workshops with the mentioned stakeholders. In these workshops, new ways of disseminating the results from research in textiles and textile design are experimented with.

The submitted contribution therefore mainly addresses the role of interdisciplinarity in textile design research as well as the impact of new materials and technologies on directions and approaches in textile design research. It presents one example of what textile design research is.

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Textiles – an interdisciplinary field
From we are born and until we die, we are surrounded by textiles that are directly in contact with our skin as clothing, part of the interior environment in our homes, at work, in hospitals, in cars and in public transportation, or part of the outdoor environment as geo-textiles. Most of these textiles are designed based on both aesthetic and functional requirements. The field of textiles is thus interdisciplinary in its very nature. (Heimdal, 2009)

Compared to most other (stiff) materials, textiles have unique properties: they are stretchable and flexible; this partially explains the versatility of applications where they are used. Furthermore, depending on the fibres that have been used, how these have been spun, how the textile structure has been constructed, coloured, pre- or post treated, the resulting textile will be suitable for a defined application. In each of these steps choices are made that have an impact on the final textile.

The inherent interdisciplinary nature of textile design is well integrated in the textile design profession. In fact, Wiberg (1996), who has studied the formation of the textile design profession in Finland, defines the following two aspects of the work of a textile designer: on the one hand the artistic-intuitive and on the other hand the scientific-technological. She further states that the intertwining of these two aspects is what characterizes the industrial textile designer’s work.

Even though scientific-technological aspects are part a textile designer’s work, it can according to Berglin (2008) be stated that when textiles are designed mainly for aesthetic performance, it is considered to be textile design, whereas textiles designed mainly for technical performance are seen as belonging to the field of textile engineering. However, recent advances in material and textile technology, as well as the miniaturizing of electronics blur the traditional border between the two professions (Berglin, 2008). Furthermore, the nature of textiles is changing, as they are given new properties and functionalities, which expand their areas of application (Braddock & O’Mahony, 1998, 2005) (Lee, 2005) (McQuaid, 2005). Many responsive materials and textiles have in fact been developed since the 1970s, mainly for applications such as aerospace and the military. This has an influence on both professions, in the sense that textile designers tend to look more into technical and technological issues than earlier, and that textile engineers are given new possibilities when it comes to functionalizing textiles.

The emergence of new application fields for textiles based on non-textile technologies (in addition to the textile technologies) thus also has to be included in the design process. These developments make new kinds of cooperation with experts from other fields necessary, outside the traditional textile professions. Important aspects of any product design process are the physical materials and technologies that are worked with – this statement is particularly valid for textile design, and becomes even more important as the materials that are worked with change radically. Using new materials is in fact a challenge and one of the situations when interdisciplinary cooperation can be particularly fruitful (Heimdal et al. 2009). The next section presents the results from such cooperation.
The first project: an inspirational tool for responsive textiles

In an interdisciplinary practice based research project with the aim of communicating some of the possibilities within responsive textiles to textile designers, an inspirational tool consisting of two responsive textiles was developed and tested. Collaboration partners were apart from the two authors of this text, an art historian (Hanne-Louise Johannesen), an architect (Michel Guglielmi), a textile designer (Priya Mani), a medialogist (Marija Andonovska) and an electrical technician (Asbjørn Holland Christensen).

Responsive textiles

A responsive textile is defined as a structure consisting of a textile material as well as eventual add-ons that as a whole is able to give a certain response to a given stimuli. The fact that the developed textiles are responsive differentiates them from traditional textiles, which do not to the same extent respond to stimuli in their environment. One could nevertheless argue a material such as wool is also a responsive material, because of its self-rinsing abilities, and its suitability for low as well as high temperatures. However, this response is much more subtle than the one provided by the responsive textiles constituting the inspirational tool. In fact, these will give responses that are very easily sensed (primarily visually) by the person interacting with them.

The adjectives “smart” or “intelligent” are today commonly used to describe responsive materials and textiles of different kinds. Some use these two words almost interchangeably, whereas others draw clear distinctions between the two (Addington & Schodek, 2005). However, these adjectives are an exaggeration of the capabilities of the materials. In fact, the textiles are not able to think, in a smart or intelligent manner, they are only able to give a certain response to a given input or stimulus. That is why the adjective “responsive” is preferred. The developed inspirational tool consists of two responsive textiles, described in the following.
Prototype 1: the textile that can move
When the user (e.g. a textile designer) touches certain areas on the textile, it moves, and changes shape. Depending on which area of the textile he/she touches, different shape memory wires are activated; their contraction makes the textile move and change shape. Different shape changes can in theory be made, depending on the fabric and the way the wire is attached to it: the chosen way to do this is to cut lines in a flat fabric that are opened and pulled apart when the shape memory wire contracts, to reveal an underlying material.
Prototype 2: the textile that has eyes and blinks back to you

Using a torch, the user lights on the textile, this responds with different light patterns, depending on which solar cells the torch is pointed (Figure 5 and 7). The solar cells work in two ways: on the one hand they transform the light from the UV torch into power and on the other hand they work as light sensors, connected to a microcontroller (a LilyPad Arduino). For each solar cell, three dynamic light patterns have been programmed.

Figure 6 Solar cells, LEDs and LilyPad connected in a soft circuit by conductive embroidery thread.

Figure 5 A light pattern is activated by pointing a torch on one of the solar cells.

Figure 7 Light pattern with lilac fabric.

Figure 8 A lilac fabric is covering the black bottom fabric. Optical fibres cover some of the LEDs.

Figure 9 Detail: a flexible solar cell and a bundle of optical fibres.
Workshops
In order to test the inspirational qualities of the responsive textiles as well as intermediary materials and to understand how they could be part of a design process, they were tested at three occasions. The term “intermediary materials” refers to functional parts of a given responsive textile. This can e.g. be a textile button, which is a part of the textile that can move, or the conductive embroidery thread, which is a part of the textile that has eyes and blinks back to you. The inspirational tool was tested at the following three occasions.
- A weeklong workshop for architect, design and art students in Strasbourg, France (Figure 10, 11, 12 and 13).
- A workshop for third year textile design students at The Danish Design School in Copenhagen (Figure 14 and 15).
- At the international textile fair TechTextil in Frankfurt, Germany (Figure 16).
Findings
The workshop with the textile design students clearly showed that the two developed responsive
textiles are efficient idea triggers, when staged in a context-directed brainstorming. Together with
the insights gained in Strasbourg, this workshop as well as the participation at TechTextil give a
systematic image of how physical objects can be used as inspirational tools in a textile design
process (see flow chart on the next page, made after Berglin, 2008). The two responsive textiles
together with a range of intermediary materials constitute an inspirational tool, which can act as:
- Trigger for idea generation — i.e. as a starting point for a design process. This is most efficient
  when there is a clearly defined use context for the developed idea. For this, both simple
demonstration materials and fully developed prototypes are efficient. The latter give rise to more
concentrated but realizable ideas, whereas the first gives rise to wide associations, which however
seem more difficult to realize.
- Solution proposal in an ongoing design process — i.e. where the problem to be solved has already
  been defined. For this, materials without a defined context and that have simple functionality
  seem most appropriate. As solution proposals, the physical objects can be given functionalities
  and applications that were not thought of when they were developed: the idea to use the shape
  memory wires to create ventilation is an example of this; it is an unexpected consequence of the
  chosen cut-out pattern, which was chosen for its aesthetic qualities.
In addition to revealing how physical objects can be used as inspirational tools the testing of the responsive textiles also revealed the importance of the meaning designers give physical objects, i.e. the semantic meaning of the physical object. The word ‘semantic’ can be defined as the science of the meaning of words. The term ‘semantic properties’ in fact describes how we can describe the impressions objects give us in words (Lenau & Boelskifte, 2004).

Figure 17 displays all the words chosen by the textile designers to describe the textile that has eyes and blinks back to you - the bigger the font, the more persons chose the word. A discussion during the workshop revealed that it was very important to them that the materials were “textile”, not just add-ons. They meant that it would be much better if the solar cells could be printed right onto the textile; instead of integrated by sewing the way it was now. This seems to indicate that the semantic meanings read from the responsive textiles were of a limiting character. That a given material or technology is new and unknown to a designer could contribute to make it interesting at first glance, but the physical object and its properties also have a meaning in addition to that – this is due to its semantic properties.

Figure 17 All the words used by the textile design students to describe the textile that has eyes and blinks back to you. The bigger the word, the more persons chose to use it. The words were chosen from a list containing 77 words.
In order for the semantic meaning to be read by the designer, the physical existence of object is necessary: the designer needs to see the object, not just hear a description of it. In fact, a physical object possesses a number of semantic properties associated with the meaning we read from its form, colour, texture or other properties. For the technical properties there exists a well-developed and commonly accepted terminology that can be used for product search and materials selection (Ashby, 1996). This is however not the case for the semantic properties (Lenau & Boelskifte, 2004). The importance of textiles' semantic properties learned from this project is planned to be investigated further in the ongoing research project presented hereunder.

The second project: a textile design kit for architects and design engineers

Why is it mainly textiles designers and textile engineers that work with textile materials? If other professions such as architects and design engineers to a larger extent used textiles it is possible that new application areas for these would emerge. The subject of the presented project is the development of a tool that facilitates the communication, exploration and development of textile potentials by architects and design engineers. The goal is to explore how persons not normally working with textile materials can become interested to do so, and how they can integrate the textile materials in their design process.

Project idea
The first part of the project consists of an initial investigation of the design process and material selection process as carried out by architects and design engineers. This investigation will be based on qualitative interviews with practitioners who have an interest in and experience with the use of textile materials. Practitioners who have little or no experience with this will also be interviewed.

The results will be used for the development of a textile design kit, which makes it possible for architects and design engineers to visualize form giving possibilities offered by textile materials. Initial experiments have been made with fibre and textile composites, since such materials could be well suited as a part of the textile design kit. Fibre and textile composites (Figure 18, 19 and 20) are considered as an extension to textile materials since they represent a kind of transition material between stiff materials and soft textiles. They possess advantages from both kinds of materials; it is possible to make a double curvature surface thanks to the flexibility of the textile, but also to create bending stiffness, which normally is not a property of textile materials.

Figure 18 Double curvature fibre composite made of glass fibres and polypropylene.

Figure 19 Mould used to manufacture double curvature fibre composites, at the Material Research Division at Risø DTU.
Textiles are perceived through their relationship with something, or someone else – they do not exist in a vacuum. This relationship is crucial for the way textiles are considered and used in different contexts. An important issue is thus to understand which properties and qualities that define a material as a textile for an architect or a design engineer and how it is justified. In understanding this, the semantic properties of the textiles, i.e. the meanings that are read from them are expected to be of importance. In order to look into this issue, the developed textile design kit will be staged at collaborative workshops with the mentioned stakeholders as participants.

**Physical tools help innovation**

Ezio Manzini states that:

“Every object made by man is the embodiment of what is once thinkable and possible. Something that someone was able to both think of and physically create.” (1986, p.17)

Concerning textile materials, many things are possible – in the sense that it is possible to create something physically, but is it thinkable? It is physically possible to create a textile wall (Figure 21), but is it thinkable for an architect to do that? If it is not thinkable, how can it be made thinkable? Is it thinkable to combine textiles and concrete to create outdoor furniture (Figure 22)? The goal of the textile design kit is to extend the limits of what is thinkable. In Manzini’s citation lies a pre-codified understanding of knowledge as being processed in a specific order: first we think, and then we create. Does it need to be that way? The developed textile design game should function as a kind of prototyping tool, making a physical visualization and creative experimentation with textiles possible. Creation could thus precede thinking.
Figure 21 Textile wall developed in a joint project involving students from DTU, the School of Architecture in Copenhagen and North Carolina State University investigating the possibilities in using textiles for new purposes within buildings.

Figure 22 Range of prototypes developed by students at DTU and the School of Architecture in Copenhagen investigating the possibilities in using textiles and flexible membranes as moulds for casting outdoor furniture.
Vallgårda & Bendixen state that:

“There is a material side of design that we cannot address through the studies of use and social practice – the properties and potentials of materials, forms, and structures must be explored through another kind of studies. How we can operationalize material objects by engaging them in situations that give us access to their properties and enable us to explore their potential.” (2009, p.1)

This kind of situations is at the core of the project, which in fact focuses on tools that facilitate the operationalization of textiles by architects and design engineers in order to explore new ways of using them. The collaborative workshops, as well as the development of the textile design kit, should be situations where textiles are operationalized.

Bendixen & Vallgårda describe a dilemma, and evoke both the problem and its solution. One could ask whether there is a way to perceive and understand textiles which is less good than others. Persons with a textile educational or practical background tend to perceive textiles differently than those who don’t. Furthermore, the cultural coding of what textiles are is very strong, and this can be a limiting factor when new patterns are attempted created.

Nature of textile design research
Different types of textile and textile design research can seem difficult to categorize, because they cover historical, technical, scientific, commercial and aesthetic disciplines, and theory- as well as practice-based research. Kane, Matthews and Moriarty (from the DUCK website) suggest an overall distinction between 1) research into textiles and textile design, 2) research through textile designing and making or 3) research for textiles and textile design. This proves useful when reflecting upon the nature of the described research.

The two described research projects in fact provide one example of what textile design research is. In this view textile design research is research through and for textiles; through textiles because experimental design processes are carried out and studied, and for textiles because the ultimate aim is to contribute to the creation of textile artefacts which embody results from advances in textile materials research. With roots in textile engineering and engineering design, the second research project tries to bring textile materials in the hands of practitioners outside the textile professions, such as architects and design engineers. This is done by developing physical tools to facilitate visualisation and experimentation with the possibilities offered by textiles. Ultimately, this could for example result in textile materials being used to create new kinds of buildings.

Conclusion
The first project shows how an inspirational tool for responsive textiles can be used as a trigger for idea generation early on in a design process. It also reveals the importance of the semantic meanings different stakeholders read in physical objects, and that this has an influence on the inspirational effect of the given physical object. The focus in the first project was mainly on textile designers.

In the second project, the stakeholders do not belong to the textile professions. One research questions is thus which effect this will have on the requirements for the textile design kit. The making and staging of the kit should facilitate the exploration of textile material characteristics on all of the following three levels:
- **Property:** A property is valid no matter the context in which the material is placed; it is an intrinsic, sharp definition. For a woven upholstery fabric, it could be its area weight or its fibrous composition.

- **Function:** A function requires a relationship, a use context. For the same upholstery fabric, it could be its flammability or its shapeability.

- **Meaning:** A meaning is an interpretation of what one finds important, a symbolic expression. For the sofa covered with the mentioned fabric, it could be the associations it generates as a person looks at it.

It is however likely that the function and the meaning will be the prevailing levels as the textile materials will be seen in relation to some product or architecture concepts.

Crucial to the success of the textile design kit is that it fits into the design process of the concerned stakeholders (the architects or the design engineers). Special attention will thus be paid to understanding this design process, mainly through interviews and workshops.

Both projects encompass and explore two complementary dimensions. A process dimension related to the understanding of how an inspirational textile tool can be used in collaborative workshops in order to facilitate textile creativity and invention by different stakeholders. A product (outcome) dimension related to the understanding and exploration of the textiles themselves, their properties, functionalities, meanings. This dimension is explored in the development of the inspirational tools, but also through the concrete outcomes of the collaborative workshops.
References


Heimdal, E. 2009, *Interactive Inspirational Tool for Responsive Textiles*, dissertation for the MSc in Design & Innovation, Technical University of Denmark, Department of Management Engineering, Lyngby, Denmark.


All photographs have been taken by the authors.

Links:
http://polynet.dk/textil/tex_arch.htm to read more about the Textiles in architecture and design project.

http://polynet.dk/textilbeton/index.html to read more about the potential of materials – concrete textiles project.