ABSTRACT
Designing Dynamic Textile Patterns

Progress in chemistry, fibres and polymers technology provides textile designers with new expressive materials, making it possible to design dynamic textile patterns, where several different expressions are inherent in the same textile, textiles that, for example, could alternate between a striped and checkered pattern.

Textiles are traditionally designed and produced to keep a given, static expression during their life cycle; a striped pattern is supposed to keep its stripes. In the same way textile designers are trained to design for static expressions, where patterns and decorations are meant to last in a specific manner. However, things are changing. The textile designer now deals also with a new raw material, a dynamic textile, ready to be further designed, developed and/or programmed, depending on functional context.

This transformation in practice is not an easy one for the designers. Designers need to learn how to design with these new materials and their specific qualities, to be able to develop the full expressional potential inherent in "smart textiles design".

The aim of this thesis is to display, and discuss, a methodology for designing dynamic textile patterns. So far, something that mainly has been seen in different experimental and conceptual prototypes, in artistic expressions and for commercial efforts etc.

In terms of basic experimental research this thesis explores the turn in textile design practice through a series of design experiments with focus on contributing to identifying and characterizing new design variables, new design methods and new design techniques as a foundation for dynamic textile patterns.

Keywords: smart textiles, textile design, designing dynamic textile patterns
CONTENT
BACKGROUND
Introduction .........................................................2
Technology & Materials ...........................................6
Design Variables ...................................................10
Design Methods ....................................................16
Form & Colour .....................................................23

DYNAMIC TEXTILE PATTERNS
Designing Dynamic Textile Patterns ..............................28
Overview / Design Examples .....................................30
Publications ..........................................................34
Exhibitions ............................................................36
How to Read the Design Examples ...............................39
Definitions of Dynamic Principles ...............................40

DESIGN EXAMPLE
Design example no. 1 Textile Disobedience ..................45
Design example no. 2 Fabrication Bag ........................103
Design example no. 3 Textile Display ........................115
Design example no. 4 Costumes ................................139
Design example no. 5 Graffiti Cloth ..........................161
Design example no. 6 Do Pattern ...............................185
Design example no. 7 Functional Styling ......................197
Design example no. 8 Burning Tablecloth ....................239
SUMMARY

Textile Design Expressions in Dynamic Textile Patterns .............. 252
Dynamic Design Variables ........................................... 255
Classification of Textile Patterns ..................................... 259
Expressions & Rationale ............................................... 260
References ............................................................. 262

ACKNOWLEDGEMENTS

.................................................................................... 270
INTRODUCTION

Textile designers may help out to camouflage you or to make you stand out, to tell a story about the upcoming season, to make a statement or a comment, to make a cold and draughty floor feel more comfortable, to shield out the sun in a window or just create more privacy indoors. Textile designers can help out with protecting the bathroom from getting too wet, covering up a bad hair-day, keeping your things in order and making them possible to carry around. When you don't want to be naked, textiles are to be found in an infinite number of different qualities developed to protect your skin from stains, moisture and all sorts of weather and adventures.

Textiles are widely used but often hidden, for example in tyre covers and water hoses. Textiles prevent roads from getting damaged, they create safety in airbags, and in architecture textiles are used as roofs (more seldom they are used for wrapping a whole house, as Christo and Jeanne-Claude did). Even in space textiles are important, to create safety, comfort and leisure for astronauts.

In my present hometown in the south of Sweden, umbrellas are used almost on a daily basis to protect from rain. In the south of India umbrellas are also used daily, to protect from the sun. The situations where this textile product is used are central and although this is nothing new it inspired me to use the environmental context more consciously in my textile designs, i.e. to use the surroundings more consciously when designing a textile expression in different situations and for various reasons of use.

In soft furnishing, textiles are often used to show the interplay of light and shadows created by curtains, sun blinds, marquises and umbrellas. I wanted to investigate textiles in different types of environmental contexts, one of them was the impact of the wind on textile expressions. A collection of rustling curtains was developed, where the material (a viscose-bast) made a gentle and crisp sound when affected by the wind from an open window.

In that example, environmental information – such as the wind – can be seen as an analogue building block for creating a specific expression. The design was made with the movement from the wind in mind, but not using the wind as flags do, which focuses more on using the wind for showing a message or
making a statement. The design also differs from how materials in outdoor sports equipment are used mainly for blocking out the wind.

In parallel to the rustling curtains, I designed a collection of colour changing curtains. These textiles changed colour through sunlight: during night the curtains were white and at sunrise they turned colourful. A new type of functionality appears in the textiles; the expression(s) relates to ambient information in a new way.

Now new kinds of building blocks have been introduced into textile design. Digital information can be used as building blocks for creating dynamic textile patterns, something that makes environmental information programmable.

To design using new types of building blocks, with quite unexplored qualities introducing new design variables, requires a revision of the foundations of textile design expressions.

It is of course possible to design in the same way as you would when using traditional materials, but that makes it hard to grasp inherent possibilities in new materials and techniques. It could be that you come up with a fantastic expression, but then more by chance. If we do not know what we are dealing with, it is hard to predict what the outcome will be.

When I started to design with changing materials in 1999/2000, the possibility of change really fascinated me. These materials added new dimensions to textile design, but I soon realized how hard it would be to really use the inherent qualities to their full potential, in a more sophisticated way.

With the first samples, made out of printed and woven textiles that changed colour reacting on light conditions, I wanted to show a clear change from one expression to another. A white fabric that turned colourful, from one expression to another and back.

A problem is that the objects carrying the colour change so to speak, tend to direct focus away from the exploration itself. It is a curtain, a garment, a bag, a carpet etc. Yes, it did change expression, but so what? To be able to focus on inherent dynamic possibilities, the abstraction level of the designs is crucial.
We are neither familiar with changing textiles, nor with making a phone call by speaking into the collar of the jacket, it may even seem a bit ridiculous. We need to experiment with these materials to explore their expressive potential, to find examples that guide us in handling and developing them more carefully and to better identify their true nature.

Textiles are today undergoing a radical change in expression and functionality, but all textiles will not transform into multifunctional high technology textiles. My personal favourite material is pure wool, one of the most magical and outstanding materials. Most of the new materials available in the textile field should not be compared with wool and other natural fibres, and neither should we compare the stuff we are making out of these new materials with traditional textile products, clothing and soft furnishing. In many ways it is more relevant to think of new, so called, smart textile materials and applications as a matter of combining two materials, textile materials and computational technology, that among other things opens up for new types of textile patterns. (Post et al, 2000) (Redström, Redström & Maze 2005)

This is also what we have seen in the first examples of combining textiles and computational technology. We communicate through pillows, clothing and toys. We go from putting our personal electronic equipment in our pockets, to electronics embedded into soft textile structures. (Redström, Redström & Maze 2005) (Braddock & O´Mahoney, 2005) (Farren & Hutchinson, 2004) (Aarts & Marzano, 2003)

It seems eons ago that the head of IBM estimated that the world would need four or five computers at most. Today computers are omnipresent, affecting every aspect of our lives. Textiles have not escaped their influence which we can see everywhere, from the use of computer-aided design (CAD) for structural or decorative purposes, to the Internet as a tool for sales and communication. Coupled with this is the development of wearable technology that includes the computer, but goes far beyond it. Embedded electronics, “wearables” or “wearable technology” are various terms used to refer to such systems. The intention is to allow the wearer to communicate with people and interact with the environment with greater ease. (Braddock & O´Mahony, 2005)

Traditional textiles have their way of developing over time, for example by being reused; old clothing is torn up and integrated in making new fibres or used in rag-rugs. The initial textile change in this way into a new piece of
textile. Today on the other hand textiles have the possibility to change from one expression into one or several different others and then return back to an initial expression, where they naturally react and adapt to environmental conditions or are being programmed to do so.

Often textiles are made to fit into a perfectly calculated system, to fit industrial ideology regarding design processes, material, production, manufacturing, logistics, economy and recycling. And from now on, changing expression during use. This new paradigm causes us to rethink previous steps in the process. What does design, and production, mean if the textile contains several expressions and thus different types of use – a sweater actually being expressed as ten sweaters or a mobile phone.

When materiality is about to change our ways of expressing through textiles we clearly need to revisit the foundations of design work and reflect on the ways in which we work. So how do we find our ways of doing things?

Annie Albers is reflecting over similar problems from another time;

At the Bauhaus, those beginning to work in textiles at that time, for example, were fortunate not to have had the traditional training in the craft: it is no easy task to throw useless conventions overboard. Coming from Art Academies, they had felt a sterility there from too great a detachment from life. They believed that only working directly with the material could help them get back to a sound basis and relate them with the problems of their own time.

At first they played with the material quite amateurishly, gradually, however, something emerged which looked like the beginning of a new style. Techniques were picked up as it was found to be needed and insofar as it might serve as a basis for future experimentations. (Albers, 2000)

The way to learn about a new materials is through the material itself, to forget conventions and suggest new styles and semantics, starting with basic expressional experiments.
Technology & Materials

Textiles were probably made on handlooms already in the late Stone Age and patterned textiles, made by inlaid weft threads have been found in Egypt (dated 945-745 BC). Coptic textile patterns found in Egyptian tombs some hundred years earlier show textiles with papyrus and lotus blossom designs. By then, decorative patterns were embroidered or painted on single coloured weaves (Volbach, 1969). Weaving is still a technique that is being developed, as well as being one of our most familiar method of making textiles, as a “raw material” for further processes to make a decorative and/or functional textile with processes such as printing, pleating, coating etc. A decorative expression and/or function could also be made during weaving, in more or less advanced techniques.

Traditional materials, like natural fibres, have a much longer history than man-made fibres. Humans have used plants, wool and proteins for thousands and thousands of years. Knowledge about how to get hold of the raw material, make it into a fibre, produce a yarn and later into a decorative textile, is a strong foundation of craft and culture. Machine made textiles got its aesthetics initially from the traditional handmade expressions, later the industrial process has slowly adapted and developed to industrial settings and more or less found its own expression and nature. In Japanese textile industries, contemporary textile design and art, the textile craft tradition is still clearly visible and adding value by developing new expressions within machine made textiles. (McCarty & Mcquad, 1998) (Millar, 2005)

With man-made fibres, the producer is able to determine the fibre characteristics and tailor the dimensions to a larger extent. Physical and chemical modifications can also be made, for example: matte or bright; strong and less extensible, or weaker and more extensible; and reduce flammability. Natural fibres, however, are an agriculture crop and the producer has only limited control over the characteristics of the fibres produce; the ground conditions, the weather and the climate are the most important influences. (Wynne, 1997)

Different metallic materials have been used in textiles for some time, mostly for decorative purposes and for construction in fashion design, but today the metals have found a new context with their conductive qualities. Both used for shielding electromagnetic pollution and for transmitting electricity, reflections etc.
Smart textiles materials

Smart textiles materials introduce extended functionality in textiles, were textiles could pick up signals/information and react on surrounding conditions with changes in its expressions.

Smart materials and structures can be defined as the materials and structures that sense and react to environmental conditions and stimuli, such as those from mechanical, thermal, chemical, electrical, magnetic or other sources. According to the manner of reaction, they can be divided into passive smart, active smart and very smart materials. Passive smart materials can only sense environmental conditions or stimuli; active smart materials will sense and react to the conditions or stimuli; very smart materials can sense, react and adapt themselves accordingly. (Tao, 2001)

New materials make unfamiliar things possible within textiles and high tech textile materials relate to a large number of definitions and communities, such as smart textiles, smart materials, intelligent textiles, intelligent fibres, smart fibres, e-textile (electronic textile), new textiles, interactive textiles, photonic textiles and in some examples more close to computational technology as wearable technology, wearable display, smart garment, data visualization, wearable electronic, wearable communication, wearable keypad, fashionable wearable, fashionable technology, electronic fashion etc. (Cf. Mattila, 2001; Seymour, 2008; Baurley, 2004; Georgia Tech Wearable Motherboard, 2010; Farringdon, 1999).

Smart textiles could be seen as a new type of, soft, hardware, where computer software can influence the textile expression just as strongly as colour and form previously has done. A changeable expression in textiles can be achieved in many different ways, with or without the influences from computational technology; by light manipulation (i.e. holography), by transfer light in optical fibres or in luminescence materials like electroluminescent or fluorescence (afterglow). Thermochromism provides colour change by heat, and photochromism by UV-light. There is a range of other chromic phenomena that provides a colour change depending on electrical current, pressure, friction etc. At present these latter phenomena have been investigated to a lesser degree for textile applications.
Thermochromic pigment

TC (thermochromic) colour change from one colour to another by temperature changes. This pigment is used for textile applications (for example t-shirts in the late 80’s), in plastic for toys and gimmick products, kitchen equipment like water boilers, adhesive thermometers for aquariums, visualizing energy in batteries etc.

The general property of TC colours is that of a reversible change of colour by a change in temperature. There is both a colour as well as temperature range of TC pigment, for textile applications; 8°C, 15°C, 27°C etc. Variotherm AQ Concentrated Colours is a TC pigment that gets its colour changing property from spherical particle capsules of film (water insoluble), but possible to dissolve with general pigment and water based solvents for textile printing. The different colours have individual fastness with respect to light and are washable in 40°C, (Zenit, 1996).

Photochromic pigment

Colour changing by PC (photochromic) is available in the form of pigment and yarns and changes colour by exposure to UV-light (ultraviolet light). This effect is used for example for toys, plastic products and gimmicks. PC print pigment and yarn shows a reversible colour change when exposed to UV-light. At present, the colour change in the pigment is from white to another colour; yellow, pink, blue, turquoise, magenta or green. Yarns are also available with colour changing properties from one colour to another (not from white) available in a limited range of colours. (SolarActive, 2010)

Electroluminescence

EL (electroluminescence) is an optical and an electrical phenomenon developed for military equipment and EL is today used for instrument panels and safety lights in vehicles and aircrafts, billboards, backlight on LCD, lamps etc. EL is found as either film sheets or wire and can be cut into individual lengths or sizes.
Simplified, EL is made by phosphors on a conductive print or on top of a conductive core (depending on whether it is a film or a wire), an electrode and a protective encapsulation. By using EL, light is created by switching on an electrical power source. Compared to other light sources this is a low electricity consumption light source and show no heating effect. EL requires high voltage and AC (alternating current) transformer (that may cause a noise). (Kula & Ternaux, 2009)
Design Variables

The final expression of a textile depends on many different factors. Heritage and available material, techniques, needs, culture etc., all influence the way a designer chooses to express something. That something is created by a combination of various design variables such as colour, form, patterns etc. A textile designer is presented with an almost endless number of choices, design variables, to handle in the design process.

The textile design brief most often relates to a specific area of application, i.e. apparel textiles, interior and furnishing textiles, consumer textiles or technical textiles etc. Depending on the nature of the brief the design process has different starting points. The brief also relates to different working conditions: for example when working in larger textile companies the interpretation of the brief relates to the company profile (ethics, production capacity, design policy etc.), when working with small-scale production, the designer is to a larger extent controlling the interpretation of the brief. A textile designer may work with more or less the whole process from creating a brief to a product ready for manufacture, or can be especially trained as a coordinator, textile technician or designer of printed patterns etc. (Wilson 2001).

Jacquie Wilson describes the textile designer as a designer that understands, and is trained in colour, form and pattern techniques and is either designing directly in the loom or investigating and exploring colours, textures, shapes and patterns by sketching. The final result, the specific textile, depends on a series of choices and combinations with respect to materials, colour, form, construction etc. All these design variables, methods and expressions relate to, and interact with, each other.

Design is always design of something given; we express function, materialize ideas, try to meet user requirements, provide solutions that conform to given specifications, solve problems, turn given abstractions into concrete expressions. It is basically a constructive and rational practice; we define things relating basic design variables to given abstractions. In design practice we then look for work methods that to some reasonable extent can help us ensure that a proposed design provides solution that conforms to given specifications, meet user requirements express given functions, materializes given ideas. (Hallnäs and Redström, 2006, p. 32)
Design variables are the designers “tools”, the extensional information needed to express intentions within a textile. The extensional perspectives cover “visible” aspects of the design process, work methods, design choices, technical construction etc. Designing is all about balancing these different design variables to accomplish a given task, the design brief.

Consider the following example:

*Design a collection of textile patterns with inspiration from ancient Egypt Coptic textiles. The collection should involve a total number of 6 patterns for;*

- 1 tablecloth, size 120 x 120 cm, jacquard technique
- 1 tablecloth, size 150 x 300 cm, report height 40 cm and 75 cm width (mirrored) jacquard technique
- 3 variations of kitchen towels, size 50 x 65 cm, shaft technique
- 1 placemat, size 35 x 25 cm, shaft technique

Number of colours: one colour in warp and maximum two colours in weft.

The designer could also be given material samples together with a specific colour brief.

The designer could need, or be interested in, more detailed and specific information, but this is one example of a quite common design brief.

At a certain stage in the design process, when sketches are getting ready for making an original, technical issues need to be adjusted and translated to meet production conditions. For a woven textile, all details are described in a weaving plan with technical descriptions covering everything from yarn number to length of ready-made meters of fabric. All information needed to make a specific textile is collected. The needed details may of course vary from textile to textile. Later on, a test weave is made to try out constructions etc. and to adjust errors together with the designer, all to make sure that the pattern and the construction function as planned. After the test weaving, adjustments are made and the production can begin.

To meet the brief designers use their interpretation, imagination and intuition to understand the task given to them. Through background research, sketches, pictures, etc. the designer moves into the problem area to find pro-
Some designers start to work directly with the actual material and start weaving in the loom, while others prefer to sketch on paper or on the computer, and later transfer an original to a textile material. Sketches and ideas are often presented to the client after a first period of sketching, to make sure that the solution conforms to the requirements given by the client.

The conditions for what designers are able to predict and plan for are strongly dependant on design methods, something that has evolved in parallel with material developments. Though methodology is of a more invisible and acquaintance perspective it is basic with respect to impact of the final expression.

Historically, textiles are made by hand and the knowledge about weaving has been transferred over generations, with a hands on approach to the overall process of making a textile. What changes did the industrial era bring to the textile expression? Designers, some without practical knowledge from textile making, transferred sketches in one material to another - from paper to textile. What was lost and what was found in the industrialisation with respect to expression?

...the normal method of evolving the shape of machine-made things, and the earlier method of craft evolution, is that trial-and-error is separated from production by using a scale drawing in place of the product as the medium for experiment and change. The separation of thinking from making has several important effects:

1. Specifying dimensions in advance of manufacture makes it possible to split up the production work into separate pieces which can be made by different people...

2. Initially this advantage of drawing-before-making made possible the planning of things that were too big for a single craftsman to make on his own, e.g. large ships and buildings.

3. ...not only to increase size of products but also to increase their rate of production. A product which a single craftsman would take several days to make is split up into smaller standardized components that can be made simultaneously in hours or minutes by repetitive hand labour or by machine. (Jones, 1992, p. 20-22)
These were important factors in the development of industrial design, and opened up for new design possibilities, as well as a design methodology guided by new production techniques providing higher economical values; the expression of things was influenced by a rational and geometrical thinking.

The design approaches that arose in response to industrialization-modernism and the more recent reactions to it – postmodernism, late modernism, and deconstruction – have all proven insufficiently responsive to users. Designers judge their work accordingly to static, geometrical criteria born of their medium, two dimensional scale drawings, while design users are concerned with the dynamic, experiential process of using things. (Mitchell, 1993, p. 131)

Design methods have slowly developed to cover form, function and later how to design a user experience. And, now there is also a need to further develop methodology that covers the designing of dynamic expressions.

In this way, while certainly open for (personal) interpretation and investigation in many ways, the design brief typically contain a set of variables to be addressed by the designer(s). Ranging from aesthetic terms to technical requirements, these variables outline a design space in which the final design ought to be located.

As we try to develop and extend current textile design practice to include the range of new possibilities discussed here, what are the new variables that this shift introduces? Or rather, which of all the new variables that dynamic textile patterns introduce are the most important to include or relate to when describing a design space, as we do in for instance a design brief? Presumably, not all variations have an equal impact on the overall expression of the textile and so locating the variables with the most impact (aesthetic, technical, etc.) becomes central.

Information and expression

The understanding of textiles and computation changed radically in the late 20th century with the introduction of a series of experiments in textile computation.
Experiments with metal yarn for power supply, to transmit data and to create sensors etc, such as the Electronic Tablecloth, Musical Ball, Musical Jacket and the Firefly Dress (Post et al. 2000). Patterns that muddles the border between graphic art and digital information (Redström, Skog & Hallnäs, 2000) and the integration of technology in personal objects (Moriwaki, Doyle & O´Mahony, 2003).

The use of conductive yarn and fibres for power supply, communication, and networking and material for display by the use of electronic ink, nitinol, and thermochromic pigments (Berzowska, 2005). Textiles created using traditional textile manufacturing techniques, spinning conductive yarns, weaving, knitting, embroidery, sewing, and printing with inks to produce electronic textiles and soft computation are explored by Berzowska (Berzowska, 2005).

These new textiles are at present located somewhere on the border between design, art, haute couture and research as can be seen in (Seymour, 2008) (Colchester, 2007) (Lee, 2005) (Evans et al. 2005) (Braddock & O´Mahony 1998). World wide new applications and expressions are nowadays suggested, seen both in experimental designs and as products and works of art on the market (International Fashion Machines, 2010) (Cutecircuit, 2010) (Luminex, 2010).

The textile artist Sarah Taylor (Gale & Kaur, 2002) experiments with new expressions in textiles by integrating unconventional lightning materials in weaving. Another example with light embedded in textiles is the Silent Alarm Clock by Rachel Wingfield (Loop, 2010).

One textile artist working with the design of colour changing textile patterns is Maggie Orth, who made a Dynamic Double Weave in 2004. She explores how repeated colour changing textile patterns can interplay with a repeat of a software.

The weaving is printed with our thermochromic ink formula, which changes color when heated. Drive electronics send current to the individual pixels, heating the resistive yarns and changing the color of the ink. Expressive software controls the patterns and sequences of the color change events. (Orth, 2010)

More investigations into the technique, and expression of colour changing textiles pattern, are made within the area of thermochromic liquid crystals by
Sara Robertson (Robertson et al, 2008). Similar to Orth, she uses heat to activate a colour change, but in this case it is from heat sources attached under the textile. When Orth creates a changing pattern by using heated yarn linear in a woven structure, Robertson et al use their techniques to create organically and rounded shapes. Responsive textile surfaces with colour changing textile patterns are made by Zane Berzina (Berzina, 2004) where different ways of achieving a colour change are presented, for example by laminating a conductive yarn with a thermochromic printed pattern.

To develop a design practice that includes all these new expressive, and impressive, materials, we need to further develop our understanding of them as design materials; we need to learn how to master these materials to able to include them in our toolbox. How could a designer possibly choose a colour when we do not know what actual colours will be shown? Random expressions could be fun in some situations, but to be able to control and use the changes we need to know more about the materials as well as finding new design methods and vocabulary to describe and discuss a colour that could be green at one time and bright yellow the next.
Design Methods

Looking through history seems to be an everlasting method for the development of expressions and styles. During the time when Gothic architecture and pre-Raphaelite movements influenced English culture, the designer William Morris built his mediaeval inspired house. There was then the need to decorate in an appropriate style, something that ended up with a company producing decorative articles like wallpapers and textiles in the 1860’s. (Naylor, 2000). Much of Morris’ designs are inspired by aesthetics from the Middle Ages and Gothic cathedrals and influences from his work are still embellishing our houses.

Josef Frank is another designer and architect that has developed a huge amount of appreciated repeated textile patterns. Several of his prints are inspired by nature and especially made into floral patterns. Others are inspired by maps and paintings etc. For his well-known pattern *Anakreon* he “translated” inspiration from the 3,500 years old fresco *The Blue Bird at Knossos*, Crete, into a textile (Wängberg-Eriksson, 2007).

In most professions, it is tradition and of common practice to build on others work, from past or present times. Results can seldom be presented as the work of only one person, it is always related to or referring to something that has been thought of or made before. It is an ongoing movement, where several small findings re-build knowledge as well as setting a specific style and understanding.

The Open Problem as Design Method

Eadweard Muybridge made photographic sequences of humans walking, running, jumping, boxing, dressing, pouring etc. in the late 19th century (Muybridge, 1984). It all started with an argument between two men. One of them insisted that during a fast trot a horse would at one specific moment have all four legs off the ground. Muybridges developed a method to capture the movement of the horse, in order to find a proof. To illustrate his experiments he developed the zoopraxiscope (cf. Muybridge, 1984) to capture the expression of motion. He ended up with being in the process of inventing the motion picture. During the process he collaborated with Stanford University,
to develop chemicals and mechanical equipment that featured a 120 feet long background and a set of 24 cameras. This is a typical situation when problem solving is the driving force for design and technical development.

Nature Inspiration as Design Method

The methods and the overall design process of designing textiles for the hotel Mandarine Oriental, Tokyo, by the Japanese textile designer Reiko Sudo (Nuno, 2010) is a process she describes as follows;

All stages of this design work are represented: from initial concept drawings, to mock-up studies and test samples – some ideas went no further – to the finished fabrics that now adorn the walls, ceilings and floors of the more public spaces, as well as appointment blinds, partitions, bedcovers, upholstery and lampshades. Imagistic textiles have also been used purely as artworks to round out the “Woods and Water” theme throughout the hotel. (Sudo, 2006)

The Chief executive and the one who gave the brief to Sudo, to design interior textiles for Mandarine Oriental Hotel describes the design expression;

Guided by the main themes of “woods” and “water” the hotel has been conceived as a single large tree, with the guestrooms as branches. These themes are expressed using original materials on everything from wall treatments, carpets, fabrics, screens and furniture. In keeping with traditional Japanese aesthetic, no single object has been created to stand alone, but rather all items come together to create a harmonious whole. Says Edouarde Ettedgui, Mandarine Oriental Hotel. (Sudo, 2006)

In this project the designer has chosen inspiration from nature, by looking at colour and form, and by interpreting the spirit of the nature. When making choices regarding the textile expression, she describes and motivates her source of inspiration in a poetic manner;

Walking through the woods, here and there pools of light wash over the dark forest floor, a picture of calm repose rendered here in handmade paper on velvet.
Rays of gold slanting down through the branches inspired this delicate weave in gold and clear threads.

This powerful image of the roots that support the great trees of the forest is knitted with stainless steel microfibre and flame-treated by hand to discolour the metal to a deep, dark patina. (Sudo, 2006)

Sudos description and connection to nature as the source of inspiration is a widely used method with respect to colour combinations, forms, light, texture etc. This frequent source of inspiration has also influenced Otto Frei and Bodo Rasch’s work. They have investigated light architectural constructions, by looking at self-forming processes from nature, for example crystallization, earth erosion, clouds, viscous masses, drops of liquid, bubble clusters etc. They have also looked at animal and human technologies for building design, like spider web, birds and wasps nest, primeval houses, path systems in medieval towns, antique buildings like Pantheon in Rome, bridges, fishing nets etc.

Natural constructions are not just any objects of infinitely variable diversity for us. We are looking for those constructions that show with particular clarity the natural processes that create objects. We are looking for the essential. We even speak of the “classical” when something that cannot be improved becomes visible. (Otto & Rasch, 2001)

Is the term “classical” in their work similar to a classical expression in textile design, where colour and shape have found its harmony and cannot be improved? They performed basic research, in a multidisciplinary group consisting of architects, engineers, biologists, philosophers, historians and physicists. To have a topic examined by an interdisciplinary team where each profession has a specific task and perspective to the overall topic strongly influences the final result. In this work, natural phenomena of constructions were investigated with building models and some later developed into full-scale architectural buildings and tents.
Behaviour and senses as design method

In 2000 Kenya Hara produced the exhibition “RE-DESIGN: Daily products of the 21st Century” (Hara, 2007). He invited participants from professions such as graphic design, product design, architecture, photography and advertising etc. to “re-design” a given object. As one example he gave the product designer Naoto Fukosawa the task to re-design a tea bag. Hara describes Fukasawa as a designer “capable of not only creating hit products, but also include the user to take certain actions” (Hara, 2007). For the exhibition Hara produced a prototype example of each project. For the tea bag Fukasawa came up with several suggestions; a tea bag with a coloured ring in the same nuance as perfectly brewed tea. It’s not to tell tea drinkers that the tea is “ready”, but to start a discussion about how people personally want their tea, using the coloured ring as a reference colour. Another example is a marionette-shaped tea bag to combine the motion of dipping and the dancing of marionettes.

The Fukasawa method is to examine our subconscious behaviour and design for that. This manner of thinking reminds me of an emerging cognitive theory called “affordance”. Affordance is the comprehensive understanding of both the subject of an action and the environment that “affords”, or allows for, a certain phenomenon. For instance, standing seems to be a behaviour imbued with the will of the subject (the standing person), but in reality, standing wouldn’t occur if there were no gravity and no decently solid surface on which to do it…In the case of standing, both gravity and solid surface are said to “afford” the action. (Hara, 2007, p. 44-45)

Say you need to design an umbrella stand. Some sort of tubular object immediately comes to my mind. But Fukasawa insists that we should eliminate this idea. He says all we should do is cut a groove 8 mm wide and 5 mm deep into the concrete floor at the buildings entrance. Visitors looking for a spot to put their umbrellas would be quick to look for a spot to stick the top end…people using it may have no idea that the groove is an umbrella rack. The orderly row of umbrellas would be the result of unconscious behaviour.

Haras method for merging technology and creativity by new design proposals, also suggests a way of discussing design critically; how to use human wisdom and technology, what should we aim for and what to realize? In 2004 Kenya Hara initiated the exhibition “HAPTIC Awakening the Senses” (Hara,
He wanted to investigate how to design for all senses and wanted to raise a “creative awakening of the human sensors – the design of the senses”.

When we think about design it’s harder than we might expect to start designing without thinking first about colour and shape. Take a coffee cup for instance. Any designer would be itching to ask to do a sketch as the first phase of the process. Not for this exhibition. I asked all the participants to start from the point of thinking on how that coffee cup could stimulate and awaken the senses, before even coming up with an image for its form or anything else. (Hara, 2007, p 70)

In design, the pre-understanding to create and design for an expression during the 20th century has deep roots in form and colour. In Hara’s brief to the designers and artists for the exhibition he changed starting point (the design method) as well as the expected result. He wanted the designers to think about how a coffee cup could stimulate and awaken the senses, and how this would be achieved by the use of colour and form but also by using the context with respect to both spatial and temporal conditions.

Rudolf Stingel has in his artwork “Home Depot” included the temporal and spatial perspectives. In the installation he designed a room to be expressed by the movements and activities of the audience. In the first phase the room looks proper and new. During the exhibition the interior starts to degrade and show traces from the activity in the room. In the end of the exhibition, the room has totally changed expression and looks like its been torn down for centuries, but has actually only been exhibited for weeks. (Schmidt, Tietenberg & Wollheim, 2006)

Just as form and function are closely related in traditional design, computational technology and use are related when it comes to interaction design.

Use means that we – the users – do something with a thing. Use is always also use for something – not just of something. Just being a user – i.e. merely doing whatever with something – does not characterize any deep relationship with things. It merely states the fact that I do certain things. But behind the mere “use” of something there is that someone doing something with specific intentions...Use thus indirectly refers to what we do with things. (Hallnäs and Redström, 2006, p. 53)
What we do with things is closely related to the expression of things. Why, and what makes us place a specific kind of textile on the floor and others in our beds?

What basically characterizes interaction design, both as academic subject and as design practice, is the combination of act design with a view of computational technology as a new expressive design material. Interaction design is not a subfield of computer science, but is a link between basic research in computer science and product applications. (Hallnäs and Redström, 2006, p. 25)

The textile design profession could benefit from using computational technology as an active part in textiles, not only as a tool for production, as in conventional textile production. As Redström and Hallnäs propose, computational technology could be seen and thus used as a new expressive design material.

Computational technology as design material is not simply a matter of computer hardware, but about all the things it takes to make something “computational”: it takes programs to be executed, mechanisms for executing the programs, interfaces for controlling the programs and “displays” and other interactive surfaces for manifesting the results. (Redström, 2001, p.39)

Those who work with the technical developments and implementations of hardware must…understand that computers and programs in use are not neutral technical solutions, but rather expressive things that depend on a collection of – conscious or unconscious – basic design choices, aesthetical in nature. (Hallnäs and Redström, 2006, p. 25)

Textile designers could in a similar manner be more open for computational qualities in other ways than merely for faster production. The contemporary textile designer and artist Kirsten Nissen uses digitally controlled looms, and body data for pattern generating in dynamic systems. She has developed a design system to create woven patterns that relates to human and environmental conditions, and uses that as a design variable to decide colour and form expression. She describes it as follows:

The work represents 8 days of weaving, 8 hours a day. The loom employed is a TC-1, a manual loom with a digital thread controller. In an iterative feedback process, measurements are taken of the weaver’s body, such as temperature,
pulse, blood pressure and blood sugar; other registrations are made of temperature, light and sound in the room; these are used as input data in a pattern generator. The pattern is transferred directly to the digital loom where the weaving proceeds as with a traditional handloom, the weaver’s reactions are recorded as biometric measurements, which then provide the next items of input for the pattern generator. (Nissen, 2008)

This way of working results in textile patterns with structure in their expression and repetitions, but with fascinating irregularities where some of the design variables decide form and colour depending on temporal conditions.

The choice of design methods is crucial for the final result. The introduction of new materials challenges us in developing new ways of thinking and new ways of working.
Form & Colour

A basic course in design and form was developed at Bauhaus in 1919 by Johannes Itten. Since then, design and form studies have been documented and developed by Itten throughout his teaching and later collected in the book *Gestaltungs- und Formenlehre* (Itten, 2001).

Itten defines basic forms to be: the square, the triangle and the circle. When a designer handles forms they deal with design variables like balance, repetition, contrast, unity, motif, style, space, line, shape, value, texture for a certain aimed design expression.

The basis of my theory of composition was the general theory of contrast. The chiaroscuro (brightness-darkness) contrast, the material and texture studies, the theory of forms and colours, the rhythm and the expressive forms were discussed and demonstrated in terms of their contrast effect. Finding and listing the various possibilities of contrast was always one of the most exciting subjects, because the students realized that a completely new world was opening up to them. (Itten, 2001)

Wilson has developed this further from a textile designer’s perspective and defined design as the visual arrangement of design elements to create effects by using space, line, shape, form, colour, value and texture. What textile designers, and artists, do is to handle these design elements with focus on balance, movement, repetition, emphasis, contrast and unity (Wilson, 2001).

Compare with typical basic elements and principles we handle in digital design tools, e.g. plane, line, points, formal compositions, translation, rotation, reflection, dilation, informal compositions, gravity, contrast, rhythm, centre of interest, space, the illusion of depth in space and the illusion of volume in space (cf. Wong, 1997).

Some basic structures on how to create a repeated pattern;

*Straight repeat.* A motif is repeated in horizontal and vertical displacement

*Running bond/tile/brick wall repeat.* A motif is repeated in a halfway horizontal displacement
Half drop. A motif is repeated halfway down in a lengthwise displacement

Motifs can also be mirrored and/or rotated and then repeated by displacements in straight lines, horizontal and/or vertical to show any sort of repetitions.

In traditional definitions of the notion of form, by Itten and others, it is taken for granted that form refers to static spatial form. This is something we have to rethink when we work with colour and structure changing textiles that also introduce temporal form elements.

As sound lends sparkling color to the spoken word, so color lends psychically resolved tone to form. (Itten, 2001)

How we experience colours is subjective, but designers are trained in chromatics to be able to design and choose colours in a more objective way. Also to use different colour and form combinations to achieve an expression to stand “out” or direct attention in different ways, i.e. to hide forms or highlight another etc.

In the commonly used chromatics by Johann Wolfgang von Goethe he aimed to give a more objective approach to colours. In both Goethes (Goethe, 1970) and Ittens (Itten, 2001) chromatics colours were handled that were built up from three primary colours: blue, red and yellow. By mixing these colours you achieve all other colours, the system is also adding white and black into the colour sphere for light and dark.

The NCS system (natural colour system) (NCS, 2010) has its basis in this way of thinking. For designers and manufactures this system offers a precise classification of colour and hue in terms of numerical codes. When describing a colour, a manufacturer may also find it important to ask in what light the colour will be seen, produced and used. Even the conventional chemical pigment colours have a certain variety depending on the surrounding circumstances (Sällström, 1996). Also Josef Albers mentions how relative our perception of colours is and argues that a colour is seldom seen as the colour it “really” is. In his studies he does not aim for giving any specific answers, but suggests ways to study the colour phenomena in relation to design work (Albers, 2006).
We are able to hear a single tone. But we almost never (that is, without special devices) see a single colour unconnected and unrelated to others. Colours present themselves in continuous flux, constantly related to changing neighbours and changing conditions. (Albers, 2006)

As “gentlemen prefer blondes”, so everyone has a preference for certain colors and prejudices against others. This applies to color combinations as well. It seems good that we are of different taste. As people in our daily life, so it is with colour. We change, correct, or reverse our opinion about colours, and this change of opinion may shift forth and back.

Therefore, we try to recognize our preferences and our aversions - what colours dominate in our world; what colors, on the other hand, are rejected, disliked, or of no appeal. Usually a special effort in using disliked colors ends with our falling in love with them. (Albers, 2006 p. 17)

Colours are strongly influenced by surrounding conditions, not only from light etc., but also from colour interaction, as proposed by Albers; the Bezold Effect, subtraction of colour, after images etc (Albers, 2006). But this does not cover the way new colour changing phenomena behave, as seen with new expressive textile pigments, for example TC colours. These new subtractive colours show an unpredictable expression between their first and second state, and describing them they show more similarities to how additive colours may appear than to the traditional subtractive ones. Still TC colours need to be looked at, and described with an exception on how conventional colours traditionally are presented.
DYNAMIC TEXTILE PATTERNS
Designing Dynamic Textile Pattern

Textile patterns are traditionally designed to stay in a fixed expression, a static textile pattern. This means that form, colour structure e.g. is designed to give the same expression in the calculated lifetime of the pattern (Lan-din, Worbin, 2004). Comparing dynamic textile patterns with static textile patterns, the dynamic textile patterns show an inherent quality to change expression during use, from one to another, or several other expressions.

To take full advantage of the inherent expressional qualities in smart/new high tech materials and techniques we need to further investigate them as design materials and design techniques. There is a need to deepen our understanding what it means to design dynamic textile patterns; to develop methods and techniques for the development of textile design practice.

In this thesis, eight examples have been selected from a range of projects (Worbin, 2006), to visualize and describe experimental explorations of dynamic textile patterns. The design examples are presented and described both with respect to intensional and extensional perspectives, to define an overall design process. I characterize basic design decisions by breaking down the work process into issues of methods and variables (the extensional perspective) and expressions and rationale (the intensional perspective).

This thesis is the result of practice based design research; an investigation and exploration of design by designing. Most of the projects have been done in close collaboration within multidisciplinary teams, with different specific tasks for different professionals; electro engineers, textile designers, textile engineers, interaction designers, programmers, artists and philosophers.

All experiments and examples presented in this thesis focus on certain aspects of dynamic textile patterns, experimental research examples posing questions and exploring ways to handle and develop dynamic textile expressions. There is an important difference here, between the experimental research example within the context of practice based design research and the textile pattern within the context of professional textile design practice. The function of the research example is to display questions and results of experimental research which means it is possible, and often necessary, to bracket issues of aesthetic completeness and refinement and also issues of personal expression; function and focus is different.
The main results that the design examples present, concern new types of variables in textile design and development of new textile design techniques.

The experiments are explorations in search for a deeper understanding of dynamic textile patterns as a foundation for the development of textile design practice, rather than experiments to test given well-defined hypotheses. Several of the experiments are made in parallel and overlap each other in different ways, still each design example focuses on specific perspectives of dynamic textile expressions.
Overview / Design Example

Textile Disobedience / Rather Boring

*Revealing a hidden pattern in a surface pattern*

This dynamic textile pattern consists of a surface pattern, built up from small repeated forms. Some of the form elements are printed with conventional pigment and others are printed with heat sensitive thermochromic pigments. Using this technique a designer may hide messages, expressions etc. in a surface. The colour change is reversible and will slowly start to change back to its original expression once the heat source is removed.

Textile Disobedience / Being Square

*From one form to another and back*

This dynamic textile pattern is designed to change from one form to another. Three main variables affect the final expression; how the fabric is woven, the printed form/pattern and the voltage level (temperature). The patterns for the apron and the tablecloth are printed on similar fabrics, but whereas the apron has a striped print in thermochromic pigment, the tablecloth instead has a static print with a conventional pigment. When the electrical power source is switched on the stripes change into a checkered pattern, gradually changing into a pattern similar to the static one printed on the tablecloth. This is a reversible textile pattern and will change back to its original expression when the electrical power source is switched off.

Fabrication Bag

*A pattern consisting of static forms that change colour*

This is a dynamic textile pattern that consists of static forms. The forms change colours, from one to another and back. To design this kind of pattern, printed forms in TC were placed on top of heat elements. The electrical power
supply to the heat elements is switched on and off by a program. This is a reversible textile pattern that slowly changes back to its first expression, grey dots in different shades, when the electrical power is switched off.

Textile Display

*From one to an infinite number of expressions*

Three dynamic textile patterns are designed to change from one repeated pattern, to another, repeated or not. The printed TC pattern reacts with a colour change, where the colours fade away when exposed to heat. Under the printed fabric there is a grid of 25 heat elements. When the electrical power source is switched on, the heat from the heat elements makes the printed pattern fade away. As long as the heat is switched on the given section will be colourless, and when the heat is switched off it will return to its original colour after a few minutes. By making a surface pattern, built up from forms aimed to correspond to the form of the heat elements, there will be a distinct change in the composition when the pattern changes. The printed pattern will develop and transform over time. It is both the design of the form and the way it is repeated that affects the change, as well as in the time sequences given in the program.

Costume and Wall-hanging

*Colour and form changes by body movements*

Three dynamic textile patterns are designed to change individually, from one colour and pattern to another. Heat elements are woven into the wall hanging, and when switched on they remove different sections of printed TC patterns. The heat elements are controlled by three circuit costumes, which in turn are controlled by the movements of the ones wearing them. As long as the electrical power source is switched on the colour change will last, it will slowly return to its original colour when the heat is switched off. The way that the dynamic pattern is expressed depends on how long the electricity is switched on, and how the dancers move in their circuit costumes. Thus the movements influence the expression in different time sequences. This is a reversible textile pattern and will change back to its original expression.
**Graffiti Cloth and Colour Map**

*Colour change investigation and a colour map*

Three heat sensitive thermochromic colours are mixed with conventional pigment to change between two colours, based on shifts in temperature. By using a special printing technique – overprint – another three colours are added in the “heated” stage of the print, when the conventional pigment becomes visible.

The dynamic pattern is expressed through colours that change from one to another, while some colours stay in their initial phase. Another possible expression is that a whole surface changes into a specific colour. As long as the heat is switched on the colour change will last, to slowly return to its initial colour when the heat is switched off.

**Do Pattern**

*Colour and form changes due to external objects*

In this design experiment external objects are used to create a colour and pattern change on a textile printed in thermochromic colours. Specially designed porcelain cups interplay with the tablecloth. The position of the cups creates the surface expression. A repeat of the expression (repeated patterns) appears, or not, depending on how the user places the cups on the surface. This is a reversible textile pattern and will change back to its initial expression as the temperature falls.

**Functional Styling / Spår (Trace)**

*Expressional changes in real time due to pressure*

This design example is made as a carpet that lights up when someone walks on it. The repeated patterns react in real time and change back with some seconds delay. The light is achieved by using an electroluminescent wire, that requires an electrical power source to be switched on / off which is controlled by a program. This is a reversible textile pattern and will change back to its initial expression when there is no applied pressure on the carpet.
**Functional Styling / Dimma (Foggy)**

*Expressional changes due to light conditions*

In this design example the pattern changes from one expression into a specific number of expressions and back, depending on the surrounding light conditions. Three light expressions are programmed to appear, under the influence of surrounding light conditions. The light material is an electroluminescent film that requires an electrical power source to light up. The way the dynamic pattern is expressed is to visualise how the environment affects an object, the carpet.

**Functional Styling / Glöd (Spark)**

*Expressional changes due to and in order to visualize temperature*

A carpet is woven with a linear print in thermochromic colours on top (the pink colour), and under the carpet there are heat elements. The linear form changes into squares when heated. The way the dynamic pattern is expressed is meant to visualise how heat can be used both as a heat element in its own right, and as an initiation of a colour changing pattern to show changes in temperature. The expression of the pattern depends on the electrical power source supporting the heat elements being switched on and off. This is a reversible textile pattern and will change back to its initial expression when the heat elements are switched off.

**Burning Tablecloth**

*A non-reversible dynamic textile pattern*

This design example is single coloured at first, but during use a pattern starts to “grow” on the surface. This design example shows a pattern that changes from a single colour and plain structure into a colour and structural change, by being burned out using an electrical power source. This pattern exemplifies a non-reversible dynamic textile pattern, where the textile expression is gradually built up over time.
Publications

This thesis is based on the work presented in the following publications:


Worbin, L 2007, Dynamic textile patterns, designing with smart textiles. (Short version of Licentiate thesis, Department of Computer Science and Engineering, Chalmers University of Technology and The Swedish School of Textiles, University of Borås) *Proceedings of Textile Review, special issue Technical Textiles*. Jay Narayan Vyas, Ahmenabad, India

Worbin, L 2005, Dynamic textile patterns, designing with smart textiles. Licentiate thesis, Department of Computer Science and Engineering, Chalmers University of Technology and The Swedish School of Textiles, University of Borås

Ernevi, A Eriksson, D Jacobs, M Löfgren, U Mazé, R Redström, J Thoresson, J & Worbin, L 2005, Tic Tac Textiles. *In proceedings of the conference for cultural heritage and the science of design CUMULUS (International Association of Universities and Colleges of Art, Design and Media)* Lisbon, Portugal


Landin, H & Worbin, L 2005, The Fabrication Bag- An Accessory To a Mobile Phone. *In Proceedings of Intelligent Ambience and Well-Being (Ambience 05)*, Tampere, Finland


*My family name before marriage was Melin.
Exhibitions

Parts of the work in this thesis have been exhibited at:

Processes Fashion and Textile Factory, Borås, Sweden, 4-14 December, 2008
Joint exhibition production by Henrik Bengtsson, Amy Bondeson, Barbara Jansen and Linda Worbin
Exhibiting Costumes and Wall-hanging

Textile Possibilities Rydals Museum, Rydal, Sweden, 1 June-12 October 2008
Production by Amy Bondesson, Hanna Landin, Anna Persson, Linda Worbin and Rydals Museum
Exhibiting Textile Display, Costumes and Wall-hanging, Graffiti Cloth, Do Pattern and Burning Tablecloth

“Designing for Happiness” Design competition with exhibition, Kyoto, Japan, March, 2008
Production by Cumulus (Cumulus, 2010)
Exhibiting Burning Tablecloth

Curator Ulla E.son Bodin, The Swedish School of Textiles
Exhibiting Being Square

Brainport-Material Laboratory, Dutch Design Week, Eindhoven, the Netherlands, 21-29 October, 2006
Production by The Swedish School of Textiles, Borås Sweden and Matereo, Paris. France
Exhibiting Fabrication Bag

Smart Textiles and Interaction design The Röhsska Museum of Fashion, Design and decorative Arts, Gothenburg, Sweden, 8 June -8 August, 2006
Presented as a part of Hanna Landins and Linda Worbins licentiate thesis.
Exhibiting Textile Disobedience, Being Square, Rather Boring, Fabrication Bag and LampCurtain

Stockholm Furniture fair Stockholm, Sweden, 8-10 February, 2006
Production by The Swedish School of Textiles
Curator Ulla Eson Bodin
Exhibiting *Textile Disobedience*

*Body and Space* Salone Satelite Milan Design Week, Milan, Italy, 5-10 April, 2006
Curator Ulla Eson Bodin, The Swedish School of Textiles, Borås, Sweden
Exhibiting *Being Square and Rather Boring*

*Body and Space* SAS MATERIO, Paris, France, June-August, 2006
Curator Ulla Eson Bodin, The Swedish School of Textiles, Borås, Sweden
Exhibiting *Being Square and Rather Boring*

*Tough Fabrics- Advanced Fabrics Exhibition* IFAI (The International Fabrics Association International) Henry B. Gonzales Convention Centre, San Antonio, Texas, USA, 27-29 October, 2005
Curator Marie O´ Mahoney, England
Exhibiting *LampCurtain*

*Design 4 Elements* Design centre, Essen, Germany, 2006
Curator Margarita Matiz Bergfeldt, Sweden
Exhibiting *Rather Boring*

*Design 4 Elements* Ambiente messe Frankfurt, Germany, 2006
Curator Margarita Matiz Bergfeldt, Sweden
Exhibiting *Rather Boring*

*Design 4 Elements* Swedish Embassy in Sao Paulo, Brazil, 2005
Curator Margarita Matiz Bergfeldt, Sweden
Exhibiting *Rather Boring*

*Body and Space*, Stockholm Furniture Fair, Stockholm, Sweden, 2005
Production by The Swedish School of Textiles
Exhibiting *Being Square and Rather Boring*

*TextilExit* Galleri Virkki, Helsingfors, Finland, 2004
Production by Gudrun Jakobsson, Hanna Kerman, Linda Worbin and Marga reta Zetterblom
Exhibiting *Textile Disobedience*
textile evolution Textile Museum, Borås, Sweden, 2004
Production by Textile Museum, Borås
Exhibiting Tic-tac-textiles and The Interactive Pillows, in collaboration with The Interactive Institute

textile evolution travelling exhibition in Sweden and Denmark, 2004 – 2008
Production by Textile Museum, Borås, Sweden and The Swedish School of Textiles, Borås, Sweden
Exhibiting The Interactive Pillows

Abstract Information Appliances Borås Museum of Art, Borås, Sweden, 2001
Production by The Interactive Institute and Borås Museum of Art, Borås, Sweden
Exhibiting Abstract Information Appliances
How to Read the Design Examples

By making a series of design experiments, each focusing on a specific issue with respect to intensional and/or extensional perspectives, the experiments cover a broad spectrum of questions all in one way or another related to the basic problem of how to design textiles for visual changes over time with respect to form, pattern and repetition.

The aim is to investigate how to design with new materials that do not behave as traditional textile design materials, to better understand how to design for “textile dynamics”.

Each example is presented in terms of experimental design process descriptions and technical descriptions to provide relevant information about both the actual experiments and the learning outcomes of each experiment.

To illustrate the potential of materials and techniques with respect to in-use situations, some of the design examples have been playing with familiar contexts, such as combining dynamic textile patterns with a table, a bag or a pillow etc.

Other design examples have been placed in a more abstract context, with focus on specific design variables such as colour and form, while we in one bigger project have been dealing with how to transform an experimental/craft process to meet production requirements within the textile industry, a kind of industrial-craft perspective.
Definition of Dynamic Principles

Each of the examples discussed in this thesis are classified with the use of a simple table which characterizes basic properties of dynamic expressions.

Geijer has classified textiles patterns into three main areas (Geijer 2006);

*Plain weaves*
A weave without decoration, but with the possibility of different after treatments like structure, printed colours or embroidery.

*Monotype pattern*
Creating the pattern during weaving, craft, tapestry etc.

*Repeated patterns*
A decoration/pattern that is prepared in advance, for mechanical conditions, to be repeated etc.

Geijer is making her classification with traditional textile patterns in mind. To get a more systematic overview of how to design with new textile materials we build on Geijers work by adding new dimensions in the classification:

*Reversible dynamic pattern* A textile pattern that reacts to environmental stimuli and always comes back to some given initial expression. There is a starting point and x numbers of possible expressions.

*Irreversible dynamic pattern* A textile patterns that changes during use and do not come back to an initial expression, the expression is built up over time.”

This classification of textiles and textile patterns is a basic classification on a rather high level of abstraction that does not take into account variety of technique and material choices.

Reversible and irreversible describes possible changes in the patterns.

A reversible pattern changes from one expression into another or several others, and always changes back to its initial expression. The pattern can also be described as A B A.
An irreversible pattern on the other hand, does not change back to its initial expression, instead it gradually changes into inherent continual expressions. This pattern can also be described as A B C.

*Pattern expression A: a single coloured textile*

changes to

*Pattern expression B: a multi coloured expression*

changes to

*Pattern expression A: a single coloured textile*

Reported and direct describes in what way and when the dynamic textile pattern changes.

A reported pattern is programmed to react in different specific manners and involves digital and/or electronic equipment. For example, to create a change we need pressure at a specific point on a textile, which in turn activates a specific number of changes etc. This kind of pattern may have x programmed expressions and can be turned on or off in relation to spatial and temporal conditions.

A direct pattern is more analogue, but also changes expression depending on the user’s actions. How the change will take place is already designed, similar to a reported pattern, but with room for a direct response. In a direct pattern the changes happen in real-time and thus closer to the person interacting and influencing the expression.

<table>
<thead>
<tr>
<th>Irreversible</th>
<th>Reversible</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reported</td>
<td>X</td>
</tr>
<tr>
<td>Direct</td>
<td></td>
</tr>
</tbody>
</table>

In this set up the table shows a pattern that is reported, programmed to show x different expressions and later to change back to an initial expression.
DESIGN EXAMPLE
DESIGN EXAMPLE

Design example no. 1
Textile Disobedience ........................................... 45

Design example no. 2
Fabrication Bag .................................................... 103

Design example no. 3
Textile Display .................................................... 115

Design example no. 4
Costumes .......................................................... 139

Design example no. 5
Graffiti Cloth ...................................................... 161

Design example no. 6
Do Pattern ........................................................ 185

Design example no. 7
Functional Styling ................................................. 197

Design example no. 8
Burning Tablecloth ............................................... 239
Most often we act and treat a textile pattern as we have learned to, we expect that a tablecloth stays on the table, and that a stain is a stain. With the introduction of new materials, tradition and the expected are turned upside-down. The Textile Disobedience design process was given a similar approach; a collection of experimental tablecloths was made to investigate textile patterns by turning the use of a decoration upside-down. The experiment introduces four disobedient tablecloths – Falling Cloth, Structure Cloth, Traditional Cloth and Do the Pattern Yourself – and two initial dynamic textile patterns – Rather Boring and Being Square.

The Textile Disobedience experiments provides an overall methodological foundation for the experiments in this thesis.
Experimental Textile Design

The experimental collection of disobedient tablecloths was an important methodological exercise in removing mental blocks (cf. Jones, 1992) for the design of dynamic textile patterns. Of course it is possible to design using materials with dynamic properties just like designing for conventional textile materials, but to take advantage of new qualities we somehow need to forget, or put traditions within brackets.

Most textile patterns are designed to show a static pattern; a given expression that is decided prior to production and defined to stay in that state during use of the textile, except for tearing and stains. In production, for example by weaving or knitting, a fabric construction and basic expression is set. A fabric could of course have many after treatments, by dying, printing or pleating etc, before reaching its final expression. But, it is still most often a question of achieving a specific static expression in the end. If you want to change style in a room using textiles, you change curtains or carpets etc. It is the entire static textile object that needs to be changed (Landin and Worbin, 2004).

The Textile Disobedience experiments started with collecting materials and investigations of techniques; a huge range of different textile qualities, screen printing techniques, TC (thermochromic) heat sensitive pigment that reacts with a colour change at 27°C, and conventional pigment etc. An intuitive period consisting of practical experiments took place and resulted in a huge amount of prints with TC pigment, showing prints on different textile materials, organic shapes, simple repetitions of basic forms, my own old designs etc. From this material I soon observed that the pattern didn’t only change colour, but from one shape into new ones, depending on how the TC was printed; pure TC pigment or combined with a conventional pigment, in layers or separate etc. The TC pigment could of course be used to design and print in the way we use conventional pigment, but to use its dynamic quality, new perspectives and methods are required.

After printing the TC textile prints they were placed next to different heat sources such as radiators, computers, body parts, they were ironed and exposed to different heat fans, under tea and coffee cups etc. The overall investigation dealt with learning about how to design with the colour changing materials, with respect to form, colour mixture and heat sources in an intuitive manner, and the aim was to be able to see things from new perspectives.
To understand something is not to be able to define it or describe it. Instead, taking something that we think we already know and making it unknown thrills us afresh with its reality and deepens our understanding of it.

Kenya Hara
Similar to how Rollo May (May, 2005, p. 58-59) describes insights; to work in a focused way with a specific problem or issue with high awareness and then rely on that things will be seen in a new manner after, or in between, focused work and periods of rest.

By printing different TC layers on top of each other and by printing on conventional pigment prints, a pattern could be hidden in a surface, to be revealed temporarily when heated. By creating a TC colour change from dark to light, different forms could be made showing a temporary movement in a composition. This shows new ways of working with composition in a textile, were a motif could change direction and rhythm during use by designing forms that stand out or positioning them in the background, and also by changing the colours from dull to bright. With these materials you may design one expression, with the ability to change from time to time.

From several chaotic expressions and experiments, two patterns were later developed further in a more systematic manner; by focusing on different factors and expressions of change, one at a time, for example if a heat source is placed on top, underneath or integrated into a textile printed with TC, if a colour disappears completely or changes to another colour, if the change is subtle or distinct, if the shape or the colour of the shape changes etc.

Printing methods for the sketching process in the Textile Disobedience experiment:

1. Mixing TC pigment with conventional pigment in a mixture/formula

2. Printing in separate layers; one mixture/formula with TC and another with conventional pigment
A Collection of four Disobedient Tablecloths

Do the Pattern Yourself

“Do the Pattern Yourself” is a heat sensitive pink print, placed on a table together with porcelain cups filled with hot water.

By placing a textile printed with heat sensitive TC in a specific context (a tablecloth and porcelain), a playful and pedagogical approach was taken. At some exhibitions and workshops the table was removed and the tablecloth was placed directly on the floor, to highlight that it was just an experiment with a system of objects (cf. Baudrillard, 1996). In this example I observed how important it is as a designer to actually experience the colour change yourself. A practical and kind of neutral set up like this does give rise to a lot of questions from you, workshop participants and visitors at exhibitions, such as: how long does the colour change appear? How many times can it change? Can it change into other colours, and is it in the fabric or in the print? Can you wash it, is it harmful, where can you buy it and what is it used for?

How long does the colour change appear?

– Depending on ambient temperature and the temperature of the heat elements, the colour change behaves differently. The pink tablecloth on the pictures is in room temperature, around 20°C, and the cups contain boiling water. When placing the cups on the tablecloth, the shape of the colour change will vary depending on whether you keep them on for just a few seconds or a few minutes. The hotter the cups are and the longer you leave them on the surface, the further the shape will spread. If left only for a few seconds a linear shape will appear, which later grows into a filled form. In this set up the shapes will fade back to pink in 30-60 seconds, but a shade of the shapes may remain for several minutes.

How many times can it change, can you wash it, is it harmful?

– Heat sensitive TC pigment gives a reversible colour change that is made to last many times. The chemicals degrade when exposed to high temperatures and ultraviolet light. Therefore it is hard to say exactly how long it will keep
its colour changing qualities. Yes, it is washable. According to the technical information the pigment is not harmful, but should be handled with care; wear gloves during printing and when preparing pigments.

Can it change into other colours?

– This tablecloth is printed to be pink and change into white when heated. There is at present a limited specific colour range available with TC pigment. But, if you for example would like the colour to change into a variety of different colours you could choose another pigment, for example liquid crystals.
Texture Cloth

Texture Cloth is printed and painted with extremely large amounts of swell paint. Its texture makes it almost impossible to put for example a cup of coffee, in horizontal position, on top of it.

This example shows that textile patterns can change the use and inherent qualities with respect to functionality. In this case the pattern restrains us from using the cloth as we are used to using such textiles.

Texture Cloth creates a textile surface where you don’t put for example a glass of water or a cup of coffee.

In what way does texture and structure influence a textile expression? And how much influence is due to context? A well-known material as swell-paint is used in this experiment to illustrate how decoration may be given a new meaning.
Falling Cloth

When *Falling Cloth* is placed on a table, with its size and decoration in a symmetric position in relation to the specific table, the tablecloth will fall off. To keep it in place on the table, it has to be placed asymmetrically on the surface of the table.

When this tablecloth is placed on a table, with size/format and the decorative border in a symmetric position on the table’s surface, it will fall to the floor. This identifies the relation between a tablecloth and a specific table’s surface and size/format. *Falling Cloth* needs to be placed in an asymmetric position on a table to stay on the surface. *Falling Cloth* is an experiment with a decorative printed border made in a collage technique, using swell-paint and glass-mosaic on a slippery synthetic fabric. The border decoration is made by using both swell-paint and mosaic; it is the different weight and placement of the decorations that makes it fall. We are used to place a tablecloth symmetrically on a table with the help of a specific decoration. If I want this specific tablecloth to stay on the table I need to rethink conventions, and rethink what I have been doing without knowing, or paying attention to it.

...expression is said to exist only where there is a mind to be expressed. The face and the gesture of a human being express what is going on inside, and the same may be acknowledged for the bodily behaviour of animals. But rocks, waterfalls, and thunderclouds are supposed to carry expression only in a figurative sense, by mere analogy to human behaviour. (Arnheim, 1954 p. 445)
Traditional Cloth

An experiment exploring a meeting between different expressions; a traditional tablecloth in white linen with hand painted red crosses.

The intention here was to create a distinct notion about a shift in traditions. We express a lot with combinations of different times, styles and figures etc.

If one say “red” (the name of a colour) and there are 50 people listening, it can be expected that there will be 50 reds in their minds. And one can be sure that all these reds will be very different. (Albers, 2006, p.3)
Sketch Processes

*What initiates a change?*

To design for a material that behaves differently when used, turns most of what we think we know upside down. Most often tablecloths have a static pattern, and stains are only supposed to be washed away. But in this example the intention is to show and explore “stains” and marks from a new perspective in expressing a dynamic textile pattern. The intention is also to explore design expressions from a new perspective.

It is not only the design of the TC print that decides the expression. It will also vary with respect to the heat source. How and when a change is initiated, if it is controlled or designed to appear in a given situation etc.

By pouring hot, recently boiled, water on a single coloured water-repelling cloth printed with TC, you create a colour change. It is the temperature of the water that causes the colour to change to white, which is the original colour of the textile before print – note that the figure shows an illusion of something white having been poured on the tablecloth. This way of activating a colour change plays with the notion and expressions of stains. When the water cools down the white shapes turn pink again.
Combining two Shapes

By making a TC print out of nine squares, this tablecloth relates to a game situation. In this set up two objects are interplaying, the tablecloth and the porcelain cups.

In this print several colours (grey, blue, magenta and orange) of TC are mixed into brown with a conventional orange pigment; a brown print that changes to orange when heated.

This reversible colour change, from brown to orange is determined by the time the cup is left on the printed squares, the room temperature and the temperature of the water. The longer the cup remains on the tablecloth, the more the pattern will “grow”. When the cup is removed, the orange form will gradually fade back to original brown.

It can take up to a few minutes before it is fully “recovered”, depending on the temperature of the cup, the room temperature as well as the time that the cup is left on the textile.
Changing Colour or Shape?

Two shapes that meet, the shape of the heat element and the form of the printed pattern; shapes made to interplay.

During textile sketching, different ways of introducing the colour change were examined. At first the heat source was placed on top/in front of the fabric: coffee cups, an iron, a hair dryer etc. Later electric heat pads were used underneath, letting the shapes of the heat elements inside the heat pad create the patterns.

In this example the prints are made by mixing TC pigment with conventional pigment, or used without any mixing. The example seen on the pictures, is printed in three different colours and thus uses three screens. The colours are:

*Red, which changes to orange*: a mixture of orange pigment and magenta TC.

*Violet which changes to light blue*: a mixture of light blue pigment and magenta TC.

*Pink which changes to white*: only magenta TC, it appears white because it is printed on white fabric.

The pattern changes from a homogenous hue of magenta and dark violet to orange, light blue and white. During the change, the pattern transforms from three to six colours (both the colours that are seen from the “start” and the colours that appear), to later show three colours: light blue, white and orange.

All of the TC pigments used in this thesis react with a colour change at the same temperature, 27°C. But some slight differences can be seen in the colour range, appearing as a coloured edge when the temperature drops. Colours change back in different speed, thus not reacting exactly at the same temperature.

When designing with TC reacting at different temperatures, Berzina suggests a colour change by applying several layers of different colours that change at different temperatures, with application of the lightest colour first and the
darkest in a finishing layer. She also proposes that if you design with colour changing pigment that reacts at different temperatures, you should give the highest temperature changes the light colour and lowest activation temperature the darkest colour in order to form a multicolour chromatic design (Berzina, 2004).

This is similar to combining TC with conventional pigment; the nature of the combination is to create a colour change from dark to light. For example, from violet to light blue or from red to orange, as seen in the example. It is not recommended or fruitful to mix a light TC in darker pigment, not if you want see a colour effect. But it may be used if you just want to experiment with a slight change in hue. However, it is still not possible to create a darker colour in this manner.
Pattern in 20 °C.

Same pattern when ironed.
TEXTILE DISOBEDIENCE
Printing on Coloured Textiles

In most of the previous experiments TC prints have been made on a white textile, in this example on a coloured and patterned weave. The conventional pigment (yellow) is transformed into light green when printed on this light blue fabric, the behaviour of subtractive colours. The TC print then shows a colour change from darker to lighter green.
Overprint

Three prints in different colours; grey changing to pink, green changing to yellow, violet changing to light blue, made as over print, thus the green and the orange appears, due to subtractive colour combinations.
3d Structures

Pink 3d structure

Some single coloured textiles printed with TC were wrinkled and placed on top of a heat source. The heat slowly activated a colour change in the textile structure which creates different kinds of expressions. In this way the temperature and the way the heat rises in a material is visualized by the colour change.

A commercially available heat-pad that generates heat from 220V was used. The temperature is adjustable in two steps, low and high temperature. When placing the heat-pad under different kind of textile structures, different kind of expressions appear.

Brown 3d structure

An orange general pigment is mixed with TC, printed on a cotton fabric, and then folded in 1 1/2 cm high pleats. Under the fabric a heat-pad is placed and colour changes gradually appear in the fabric as the temperature rises.

This experiment displays different expressions over time, following the time it takes for the heat to rise within the folded structure. Thus the density and folding of the pleats influences the time it takes to achieve a colour change.
Shaped Heat Elements Under the Fabric

A heat element placed under a textile printed with TC, the heat element is in the shape of a foot. The heat element is made by Calesco Foil and is the kind of heat element used for mobile heating in boots. (Calesco foil, 2010).

The blue sample shows a TC print without binder. It is possible to print in this manner, but the pigment loses its firmness and a crackled surface appears. In this sample though, it is interesting to see that the TC is not as transparent when not combined with a transparent binder. It turns from blue to white on a black fabric. This is also what will cause a slight shade if the TC is used to show a transparent expression when heated. So, the more binder and lighter hue you mix, the more transparent the colour change will seem.

The same heat element is placed under both the blue and the pink print. The blue print is made on a heavier black fabric and the pink on a lighter white fabric. Heat element is connected to a 4,5 V battery.
Integrating Heat Elements in Textile Structures

A carbon fabric was used as a heat element. When connecting the carbon fibre yarn to electricity (maximum 30V) it heats up due to the high resistance of the material. Working with the 100% carbon fibre fabric was difficult, due to the yarn being loose and made out of quite short fibres. Since the natural colour of the carbon fibre is dark grey, it is also quite a challenge to print on it. Of course, a white paste could have been used as a base print to later print the TC on top of, as you traditionally do when printing light colours on dark fabrics. In this sample the TC is used in high concentration without a binder and shows how crucial the amount of binder is to achieve illusion of transparency. This is why a white shape is visible.

A blue TC print was made directly on a carbon fibre fabric and conductors for connecting electrical current were stitched on the back. The last picture in the series of three shows when the electrical current is attached and switched on – the white field is the area that reached a temperature above 27°C.
Heat elements were integrated in the textile structure during weaving, with a combination of conductive (carbon) and non-conductive materials. The carbon yarn that was used for these first woven samples was initially created due to it being a strong composite material, not because of its conductive or heat emitting qualities that were used in this experiment.

In the first test we wanted to create a conductive surface from several single threads by using only conductive material in the weft. Later, single conductive threads were used with an isolating inlay in between, creating a textile where an electrical parallel or serial connection could be made after weaving.

In the handloom, the carbon yarn did not behave very differently during the weaving process, compared to traditional materials, with the exception of the texture being a bit stiff and itchy.

When we decided to integrate the heat element directly into the fabric, various materials to conduct heat were considered, such as Kanthal thread, silver coated yarn, carbon yarn and metal film etc.

Materials with high resistance are used to generate heat, while materials with less resistance “transports” the electricity to the sections that are intended to be heated.
A weave made out of carbon fibre and cotton was given a screen print with TC (grey changing to transparent) and TC mixed with light blue pigment (grey changing to blue). In this sample the weft yarn is grey, just like the carbon fibre. The power supply, 4,5-12V is attached with crocodile clips.

The first picture in the series shows the print without the electricity switched on, in the second power passes through four carbon yarns. The blue forms and white horizontal linear graphic pattern appears when current passes through the conductive carbon yarn. In this sample a 4,5-12V is used. This creates the necessary temperatures (above 27°C) to create a visible colour change. The third picture shows a close up in which two of the connected carbon yarns have power switched on. In this sample you may observe that the heat from the one carbon yarn filling is spread out to about two yarn fillings on each side of the inserted carbon. The level of voltage sets the temperature that spreads in the structure. In this sample a natural fibre is used around the carbon yarn, both in warp and weft. The expression changes in different ways depending on how many of the connected circuits you switch on.
By making a white textile (top picture), the heat element is made visible (the grey lines) to better illustrate and describe what happens and why. The grey lines function as heat elements, similar to the hot porcelain in previous experiments, to heat up and thus to activate a colour change. The crocodile clips are connected to a power source of 4.5-12 V. Grey TC is mixed with pink conventional pigment. When the power is switched on in three carbon yarn fillings, pink stripes appear and split up the grey form.

In the other example with the green print, the TC was mixed with a conventional pigment in a yellow colour.

In these samples the different size of the lines is adjusted by the level of voltage, and also by the connections. This is something that is really hard to do in a precise and controlled manner. Many factors are involved in deciding the way in which the current passes through the textile structure, such as connections, weaving constructions, break of fibres, etc.

The disobedient tablecloths and following experiments with TC prints and heat sources led to further development in two different directions and resulted in the two textile patterns: Rather Boring and Being Square. In these patterns new textile material/dynamic textile patterns is placed in a known context, to better identify new qualities. We also reduced the expressions with respect to irrelevant elements and decorations, to be able to more distinctly learn about new behaviours.
“Rather Boring” is a dynamic textile pattern printed on a tablecloth, with hidden patterns and messages revealed by temperature changes. The pattern is a reversible dynamic textile pattern that changes back to its original expression after colour and form changes.
Methods and Variables

The pattern is built up by small forms (X) in a perfect linear repetition both horizontally and vertically covering the surface. Some forms are printed in TC and some in conventional pigment colour. By mixing similar visual colours in two different pigments (conventional and TC pigment) the surface has a single colour until a hot object reveals a hidden pattern or message. It turned out to be a hard task to mix the two colours, the TC and conventional pigments, to exactly the same colour. If the right colour was not achieved the hidden pattern was visible from the beginning and there would be no hidden message. The two different colours also react differently to light and temperature conditions – the print is made to “fit” in daylight and indoor climate around 20°C. But the same grey hue is still blended from different colours and pigments, thus reacting differently to different light conditions. Several tests were made with different colours, first with green, pink and later on with grey. It was hard to find a suitable colour that could function both with TC and pigment since both the TC colour and the pigment range is limited and consequently hard to adjust to the same hue.

It is also important to make a precise print, and make forms in correct linear and horizontal position to create a balanced surface pattern. If not, the print with the conventional pigment would be visible in advance and the idea of revealing a pattern would be ruined.

The picture on the opposite side shows printed samples where the print fits more or less perfectly, and other where it does not fit at all; see the grey sample below the pink samples. It also shows test prints with the two different frames and some first experimental sketches with the principle of hiding a pattern within another.

The pattern is built up and printed with two different frames, and is in fact two different patterns that are printed to look like one. The idea is that, when seen for the first time, the pattern looks like a single coloured print on top of a white fabric, a pattern that consists of small crosses and covers the whole surface.

When the pattern is exposed to heat, for example hot porcelain cups, parts of the surface pattern will disappear and the conventional pigment print will be visible.
The two plastic sheets in the picture on the next spread illustrate how one pattern is hidden in a surface pattern and built up by small forms, in this case small crosses. The top layer shows the pattern that will be printed in conventional pigments, the bottom layer is the part of the pattern that will be printed with TC.

First, the pattern unit (30x40 cm) was repeated four times, in a row horizontally and vertically. Later on the original was remade, so that four pattern units were printed in one screen. This was done because the pattern was hard to print in a perfect manner, with a perfect repeated fit. Some patterns are not affected much by a small difference in size between the reported repeated forms, but in this case the whole pattern would be ruined by a slight difference in the position of the pattern-unit/report and the idea of hiding a pattern inside another pattern would be lost. The reported pattern was adjusted to fit the ready-made tablecloth, thus only two prints were needed, one with grey conventional pigment and the other with the grey TC.
Dynamic Principles

This dynamic textile pattern consists of a pattern composition built up from small repetitive forms. Some of the form elements are printed in conventional pigment and others are printed in TC. This principle allows you to hide messages etc. within a surface.

<table>
<thead>
<tr>
<th>Irreversible</th>
<th>Reversible</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reported</td>
<td></td>
</tr>
</tbody>
</table>

*Direct* is classified as a direct pattern, a user needs to act in order to achieve a change in the expression. It is also a reversible pattern; it changes expression but will change back to an original expression.

Extended design variables that influence the expression:

- Time that the textile is exposed to heat
- User interaction
- Combination of TC and conventional pigment
- Shape of the form elements
Expressions, Rationale and Learning Outcome

The name Rather Boring refers to expressional intentions and the choice of grey colour and small crosses covering a surface; a rather boring expression, chosen to enhance the changes in the expression.

It also plays with references to old hand-embroidered textile patterns. Using an old technique to express messages combines something well known and traditional with something new. The combination of old and new also gives a strong expression of something unexpected.

The light grey colour was chosen both for expressional and technical reasons. The ability to adjust the colour level in two different pigments (TC and conventional) was limited by the TC colour range available at that time. The rationale behind the choice of grey was also to create a kind of dullness, in contrast to the gimmick like effects of the colour changing TC print. Also to keep a kind of neutral expression for pedagogical reason, to be able to really display what happens and how it is made.

In this design experiment it was important to keep a sense of curiosity and an open mind to be able to grasp what the TC pigment’s inherent qualities could express, compared to conventional pigment. Rather soon in the process it became clear that it is hard to get over the first aha-moment and start asking questions, such as: it changes colour, but what could this be used for? However, the intention is not to find a solution for what this material can be used for. If that was the starting point, one would probably be disappointed, and make another embarrassing t-shirt. The aim is to remove mental blocks in relation to how we see textiles with dynamic qualities to open for careful investigations on what these materials can do.

By breaking down the design process, being alert on what happens, and trying not to direct it into a known process, the intention was to find new possibilities for colour changing pigments.

This design example suggests how to design a dynamic textile pattern in which you are able to hide and reveal a hidden pattern/message in a textile structure. This can be done by designing a pattern from a small form and
hide it amongst similar other forms. It can be almost any kind of small forms, structures etc.

The way the textile pattern is built up depends on the exact similarity of the two different print chemicals, TC and conventional pigment. This is also very sensitive to different light sources and intensity in light. If you for example get a perfect match in daylight, the pattern may not function at all under other light sources. With different light sources the colour will be reflected differently, so when mixing colour it is preferable to use the same light source as will be used further on. Otherwise, the colours should be mixed and matched in several different possible visible lights. It is also important to let the colours, both the conventional pigment and the TC, dry properly before you decide whether the visual colour is correct; the shrinking of the raw fabric when printing can ruin this way of building up a pattern. It could for example be interesting to try a digital printing technique or industrial printing.
Dynamic Pattern Expression for Rather Boring

Pattern expression A:

a repetitive form in linear and horizontal position to create a surface pattern

changes to

Pattern expression B:

some forms in the surface pattern disappear, and others do not change

changes back to

Pattern expression A:

a repetitive form in linear and horizontal position to create surface pattern

A B A

Technical information

Fabric and material: 220-g/m cotton satin, ready-made fabric
Print technique: Handmade screen print
Pigment: Thermochromic (Variotherm), temperature for change is 27°C, and conventional textile pigment
Colour: Thermochromic grey and conventional pigment grey (the pattern that you want revealed is to be printed with a conventional textile pigment and the other forms with TC)
Screen frames: two different frames, one for each print
Binder: Water based
After treatment: Heat-treated in 150°C for 7 minutes
Report size: 40 x 30 cm
Supplement: Apply heat to reveal the hidden patterns/messages
The making:
The textile was glued to the print table when printed. It was also important to print the part of the pattern with least pattern and colour first. When printing in opposite order the raw fabric shrunk too much while the first print dried which in result made it impossible to make a perfect fit.
“Being Square” is a dynamic textile connecting an apron and a tablecloth to each other. The pattern on the apron is dynamic and changes from stripes into cheques. The tablecloth on the other hand is given a traditional “static” textile pattern. When the pattern on the apron changes, it turns into a pattern similar to the one on the tablecloth. The apron’s pattern is a reversible dynamic textile pattern which changes back to its original expression after changes in colour and form.
Methods and Variables

“Being Square” is a striped textile pattern that can turn into squares and back. This is possible by making a weave out of cotton and carbon fibre, with a screen print in TC on top. The carbon yarn is connected in a parallel circuit for power supply. The carbon fibre starts to heat up when the electrical power source is switched on, and by that the colour change is activated. The TC is printed on top of a white fabric and when the colours seem to disappear the form also changes its pattern, from stripes to squares and back.

After the textile was produced an electrical cable was integrated by hand, to create an electrical parallel circuit in the textiles edges. In one sample this circuit was integrated during the test weaving, but this method needs to be further investigated to make a proper connection, i.e. without spark formation. There are still many ways to get a proper connection between two different conductive materials in a textile structure; using snap buttons, conductive Velcro, soldering, conductive glue etc. This suggests a fast way of connecting different materials, but then there is a lack of flexibility and fastness, for example when soldering and using glue.

Barbara Layne has developed a way of adding “soft legs” to electronic components by exchanging hard parts with soft silver coated yarn. This is a precise and time consuming craft, but it means that electronics can be integrated directly within a woven structure in a smooth way. Still, the final power supply needs to be attached with conductive hooks, Velcro, snap buttons etc. (Layne, 2007)

When designing a textile pattern in this manner, to change from one specific expression to another, one may control different sections by switching the power on or off; the designer can foresee the time it takes for the textile pattern to change, and when it will change. In this set up the power is switched on and off manually.

When the power is switched on it takes about 30 seconds for the change to appear in its “final” expression. As long as the power is on, the expression will stay. When the power is switched off, it gradually fades back in 30-60 seconds. The time it takes to change back and forth is strongly influenced by indoor temperature and the time length of the activation.
For the two patterns on the apron and the tablecloth, the forms are masked out directly in the screen frame. To display a similar form (a checkered pattern) when the electrical current is switched on, it is extremely important that the width of the line and the distance correspond to each other. Also the voltage influences whether the checks are thick or thin, thus it is important that the voltage level is correct, to make sure that the camouflage effect is achieved.

In the picture different prints and weave samples are shown, some with conductive material interwoven and/or embroidered.
Dynamic Principles

This dynamic textile pattern is designed to change from one form to another pre-designed form. It is designed in three steps: first a woven fabric, secondly a printed pattern, and thirdly the level of power and how it affects the final expression. The apron and the tablecloth are prints on similar fabrics, but the apron has a striped print in TC and when electrical current is supplied and switched on the lines change into checks. It then changes to a similar pattern as printed on the tablecloth.

<table>
<thead>
<tr>
<th>Irreversible</th>
<th>Reversible</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reported</td>
<td>X</td>
</tr>
<tr>
<td>Direct</td>
<td></td>
</tr>
</tbody>
</table>

*Rather Boring* is classified as a reported pattern in the sense that it is a pre-formed pattern. It is also a pattern that displays a reversible textile pattern, it changes to \( x \) different expressions and always returns to an original expression.

Extended design variables that influence the expression:

- Time that the electrical power source is turned on/off
- The level of voltage
- Shape of the heat source (the carbon yarn)
- Shape of the printed form elements
Expressions, Rationale and Learning Outcome

In this experiment the dynamic textile pattern has two distinct states, striped or checked. By placing a dynamic textile pattern in relation to a static pattern, a camouflage effect is achieved. The static tablecloth pattern does not change expression, but the overall expression changes from two different textile objects with different expressions, to two different objects with similar expression.

While exploring the patterns, the power was switched on when a wearer of the apron moved against the static tablecloth, and switched off as the wearer moved away from the static tablecloth. The relation between the apron and tablecloth, between static and a dynamic pattern, is a pattern and use context that could be explored further.

To design a dynamic textile pattern that changes from one specific expression to another specific expression introduces special problems with the integration of heat elements. The level of power strongly influences the temperature and thus the expression of the dynamic textile pattern, i.e. the size of the squares within the dynamic squares that have to be of the same size as the static pattern (on the tablecloth).

New design variables that this experiment displays include the relation between the woven fabric (in this case the distance between the carbon fibre weft inlaid), the screen print, level of voltage and the time interval of switching on and off the electricity.

For the design of a dynamic textile pattern with this type of extremely precise expression, the heat elements are integrated directly into the weave. In this way no external objects are needed to obtain a colour change, thus the colour change was more controlled, compared to previous example using external objects.

It is hard to make the connections between the carbon-fibre and the power supply cable tight and stable, and if there is a gap between the materials sparks tend to form, which also makes the carbon yarn stiff and more fragile. Thus, the connection between the heat-element and the power supply needs to be further investigated to find a stable and safe solution.
Dynamic Pattern Expression for Being Square

Pattern expression A: stripes on a textile surface

changes to

Pattern expression B: checks on a textile surface

changes back to

Pattern expression A: stripes on a textile surface

A B A

Technical information

Weave technique: Shaft woven principles on electronic jacquard loom
Yarn in warp: Cotton Nm 30/2
Yarn in weft: Cotton Nm 8/4 and carbon fibre
Electro conductive yarn: Carbon fibre with average linear resistance of 80 (R) Ω/m
Weave construction: Panama, (two threads over two) 2/2
Colours: White cotton & dark grey carbon fibre (its natural colour)
Report size of the weave: 36 mm (between the carbon filling)
The woven samples are made at the weaving department at The Swedish School of Textiles.

Print technique: Handmade silk screen print
Pigments: Thermochromic (Variotherm) temperature for change is 27 °C
Binder: Water based
Colour: Grey
After treatment: Heat treated at 150 °C for 7 minutes
Report size of the print: 36 mm (between lines), line 23 mm
For the pattern on the apron and the tablecloth, the forms where masked out directly in the screen frame.
Power supply: 9 V/12 V batteries or 220 V with 9 V/12 V adapter (separate cable for the parallel circuit)
On/off: No sensors are used, power is turned on/off by hand
Electrical connections: Power supply to the carbon fibre is only used for demonstrations
Reaching Audience

Publications

Worbin, L. 2007, Dynamic textile patterns, designing with smart textiles. (Short version of Licentiate thesis, Department of Computer Science and Engineering, Chalmers University of Technology and The Swedish School of Textiles, University of Borås) Proceedings of Textile Review, Special Issue Technical Textiles, Jay Narayan Vyas, Ahmenabad, India

Worbin, L 2006, Dynamic textile patterns, designing with smart textiles. Licentiate thesis, Department of Computer Science and Engineering Chalmers University of Technology, The Swedish School of Textiles, University of Borås


Exhibitions

Curator Ulla E.son Bodin, The Swedish School of Textiles

Stockholm Furniture fair Stockholm, Sweden, 8-10 February, 2006
Production by The Swedish School of Textiles
Curator Ulla Eson Bodin

Body and Space Salone Satelite Milan Design Week, Milan, Italy, 5-10 April, 2006
Curator Ulla Eson Bodin, The Swedish School of Textiles, Borås, Sweden

Curator Ulla Eson Bodin, The Swedish School of Textiles, Borås, Sweden

Design 4 Elements Design centre, Essen, Germany, 2006
Curator Margarita Matiz Bergfeldt, Sweden

*Design 4 Elements* Ambiente messe Frankfurt, Germany, 2006
Curator Margarita Matiz Bergfeldt, Sweden

*Design 4 Elements* Swedish Embassy in Sao Paulo, Brazil, 2005
Curator Margarita Matiz Bergfeldt, Sweden

*TextilExit* Galleri Virrki, Helsingfors, Finland, 2004
Production by Gudrun Jakobsson, Hanna Kerman, Linda Worbin and Margareta Zetterblom
Design example no. 2
2005
Project team: Hanna Landin & Linda Worbin
Fabrication Bag is an accessory to your mobile phone, the pattern on the bag changes by mobile phone activity, calls, text messages etc. Printed static forms (dots) change colour, from one to another and back again. At first the bag is white with grey dots in different nuances, and when somebody contacts your mobile phone the coloured dots slowly change from dull to colourful. Nine heat elements are mounted inside the bag, and when a heat element is turned on, the surface print will change colour.

This is an example of a dynamic textile pattern with static forms that changes colour by digital information. The textile pattern functions as a textile display, where the information builds expressions, and the pattern expresses information.
Methods and Variables

Fabrication Bag investigates how to build up a dynamic textile pattern from mobile phone data, and is linked to previous projects; Fabrication (Landin & Worbin, 2004), The Fabrication Bag - An Accessory To a Mobile Phone (Landin & Worbin, 2005) and Tic Tac Textiles (Ernevie et al 2005). In Fabrication a few initial experiments with different constructions were conducted, introducing programs and dynamic materials. The principle of activating a textile pattern with heat elements hidden underneath a textile layer is also related to the project Tic Tac Textiles. In Tic Tac Textile heat elements were designed to leave a number of specific patterns on two interactive table cloths/surfaces which made it possible to play a distance game of tic tac toe.

In Fabrication Bag, information from mobile phones is used to change the visual expression on a bag. By placing your mobile phone in the bag, and connecting it to a microcontroller, you switch off sound and vibration signals. Incoming calls, text messages etc. are instead expressed by a visual colour change on the outside of the bag.

There is something in the audio and tactile appearance of mobile phones, when putting through phone calls and messages, that interrupts people, making it hard for people to ignore them. It is the design decisions regarding the ring tones and the vibrator settings that can affect whether the form of the mobile phone is being expressed as dependence or not. (Landin, 2009)

What areas could be suitable for private information and what about sharing it with others? We discussed different private and personal placements for displaying information on garment, intended only for a specific person. We also discussed different more or less subtle ways of using form and colour to convey personal messages in public, for example by looking down your own décolletage. Just as we looked at different personal areas on garments, we considered placing the dots at different angles on the bag, depending on whether the change was supposed to be seen by the user of the bag or from a distance by somebody else.

We designed dots, using TC pigment, with different colours and different abilities to change colour or disappear. We explored colour changes ranging from green to yellow, purple to blue, red to pink, red to blue, turquoise to light grey, blue to transparent, dark green to light green etc., in an attempt to investigate the levels of differences that the changes presented.
During this phase of experimenting we also discussed what kind of information that should “create” the different expressions. How should a call be displayed and should a text message or a missed call differ or be expressed similarly? How could this different kind of information be a part of the design of an expression? We decided to use information from x number of actions in the mobile phone, for example: a phone call (from a number in your phone book), a phone call from a number not in your phone book, a text message, a missed call, a specific number to be alert on etc. This information was used to control (by switching on or off) selected combinations of heat elements in real time or with a delay.

To be able to control a colour change we made a matrix of nine heat-elements, where the heat elements were set up to be switched on and off separately or in different combinations. The elements were placed in a first prototype to test the relation between red dots that change into blue, when heat elements are switched on. As long as the heat elements are on, the change in colour is visible. The room temperature also influences the time it takes for a colour change to occur – the colder it is, the longer it takes for the heat element to produce the necessary temperature to trigger a change in colour.

We continued experimenting with different kinds of expressions on top of the heat elements; the size of the dots, if and where the colour change would happen or not, and the relation between the printed pattern and the size of the heat elements.

For the final prototype five different colours were used for the dots on white fabric. The bag’s first expression presents dots in five grey hues which, when activated (heat elements are switched on), change into five different bright colours.
Dynamic Principles

This is a dynamic textile pattern that consists of basic static forms. The forms change colour, from one to another and back. To design this kind of pattern we have a printed form placed on top of a heat element (covering the pattern in size and shape). The heat elements are switched on or off by a computer program.

<table>
<thead>
<tr>
<th>Irreversible</th>
<th>Reversible</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reported</td>
<td>X</td>
</tr>
<tr>
<td>Direct</td>
<td>X</td>
</tr>
</tbody>
</table>

This pattern is classified as a reversible, reported and also direct pattern. It is designed to change expression and to always return to its original expression with respect to colour and form. It is information from a mobile phone activity that initiates colour changes. The dynamic expression is programmed to be reported in different manner; still it is a matter of a direct pattern, because the program (controlling the bag’s expressions) is activated by mobile phone activity. If there is no activity there are no changes in the expression. If there is a lot of activity, the result will be lots of changes in the expression, in this specific example, resulting in a more colourful bag. Since the dynamic textile pattern, and its possible expressions, depends on a “programmed report” one could achieve a temporal dislocation in the expression. The complexity in the program strongly influences the final expression of the textile pattern.

Extended design variables that influence the expression:

- Digital information connected to x specific expressions
- Time that the heat elements are turned on/off
- Shape of the heat elements and textile print
- Textile material and structure (in relation to temperature)
- User context/interaction (phone activity)
FABRICATION BAG
Expressions, Rationale and Learning Outcome

The Fabrication Bag exemplifies how to use specific information to initiate change in a dynamic textile pattern. The reason for choosing to create a bag as a sort of mobile phone accessory was that it is a personal object that can be carried around, just like the mobile phone. A bag can also hide electronic equipment. The idea behind the programming was to connect different kinds of data, calls etc., with different visual design expressions. Depending on the level of code abstraction the bag will be more or less easy to “read”. So there is a learning process involved here; you may eventually learn to decode the different expressions.

Whether the pattern is subtle and vague or clear and distinct is both a matter of reading skills and design prominence.

The bag offers a way to convey a personal message to the owner of the bag, without sound and vibrations. Instead the bag changes from one colour or hue to another according to the principle of “from dull to colourful”. The principle can vary, for example from colourful to colourless, from a cold colour to a warm colour etc.

The relation between data and visual expression introduces new design possibilities, new design variables. Information contributes by changing the visual expression of a dynamic pattern varying from time to time. It can be done in real time, or recorded in advance or with a delay. Not only does this show a new way of building up a textile pattern, it also suggests and exemplifies new behaviours of textile patterns as well as of mobile phones.

The interaction form of the Bag is more ambiguous and indistinct than the interaction form of a typical mobile phone. As a consequence, the Bag introduces freedom or independence as an expression of mobile phone interaction. (Landin, 2009)

The intention was to find different levels of expression in the dynamic textile pattern; from extremely visible changes to more subtle changes. We made dots in different colours, for example one in a green nuance where some dots changed to light green and others didn’t change at all. This change though
was a bit too subtle, too hard to notice and we decided to let the colour change, from grey to a more vivid expression.

We found that it was hard to predict the impact of the room temperature on the pattern expressions. In a cold environment the program needs to switch on the heat element for a longer time, and during a sunny summer day the bag's pattern could change without the heat elements being switched on at all. During one demonstration in winter season, we had to call the bag several times to “heat it up” before the demonstration.

By changing the colour of static forms, creating different patterns and repetitions, similarities, rhythms etc. the expression can change after the textile pattern has been produced. This means that a textile pattern no longer directly displays a complete expression when manufactured, woven, printed etc. Instead the dynamic textile pattern on the bag uses information to form different expressions and reach its full expressional potential, functioning as a display for information technology.
Dynamic Pattern Expression for Fabrication Bag

Pattern expression A:
dots in dull nuances on a white surface

changes to

Pattern expression B:

this pattern expresses a scale of colours in light to dark grey hues, or a completely brightly coloured pattern. The number of dots that are coloured may vary, depending on whether the heat elements are on/off. There are nine different heat elements to be turned on/off individually or combined in groups. X different expressions are possible.

changes back to

Pattern expression A:
dots in dull nuances on a white surface

A B A

Technical information

Fabric and material: 220 g/m cotton, panama 2/2
Print technique: Handmade screen print
Pigment: Variotherm 27 °C (thermochromic heat sensitive pigment) and general textile pigment
Colour: Five general pigment colours are used, with TC grey (adjusted with other TC colours to a specific hue)
grey thermochromic to pink pigment
grey thermochromic to light blue pigment
grey thermochromic to light green pigment
grey thermochromic to yellow pigment
grey thermochromic to orange pigment
Screen frames: Five different frames, one for each print and colour
Binder: Water-based
After treatment: Heat treated in 150 °C for 7 minutes
Report size: 32 X 22 cm
Heat-elements: 9 heat elements mounted horizontally and vertically in a grid
Power supply: 14 V battery
Program: Basic X
Microcontroller: BX24
Supplement: Handle, hard paper to mount the heat elements, the manufactured bag must be large enough to fit the heat elements and the battery.
Reaching Audience

Publications

Landin, H & Worbin, L 2005, The Fabrication Bag - An Accessory To a Mobile Phone. Proceedings of Ambience 05 Intelligent Ambience and Well-Being, University of Tampere, Finland

Landin, H & Worbin, L 2004, Fabrication by creating dynamic patterns. Proceedings of PixelRaiders2, Sheffield Hallam University, UK

Worbin, L 2006, Dynamic textile patterns, designing with smart textiles. Licentiate thesis, Department of Computer Science and Engineering Chalmers University of Technology, The Swedish School of Textiles, University of Borås

Exhibitions

Brainport-Material Laboratory, Dutch Design Week, Eindhoven, the Netherlands, 21-29 October, 2006
Production by The Swedish School of Textiles, Borås, Sweden and Matereo, Paris, France

Smart Textiles and Interaction design The Röhsska Museum of Fashion, Design and decorative Arts, Gothenburg, Sweden, 8 June -8 August, 2006
Presented as a part of Hanna Landins and Linda Worbins licentiate thesis
TEXTILE DISPLAY

Design example no. 3
2005-2008
Project team: Linda Worbin & Christian Mohr (programming and electronics)

Textile Display investigates how repeated basic forms behave as they become dynamic. An experiment was carried out to investigate how basic textile expressions like repetitions can change in a dynamic textile pattern.

Repeated patterns are built up from three different basic shapes; circle, square and line. The designs are made in a neutral colour (light grey) and built up by basic shapes to focus on the issue of form. Three rather similar designs were made for exploration of similarities and useful expressions in relation to a basic traditional form language.
Methods and Variables

Textile Display relates to investigations presented in Textile Displays; Using Textiles to Investigate Computational Technology as a Design Material (Hallnäs, Melin & Redström, 2002). In that project, textiles were used to investigate and express computational technology as a design material. In the Textile Display experiment, things are turned the other way around; computational technology is used to investigate how to build up a dynamic textile pattern.

This design experiment was an attempt to more or less isolate the form variable in an elementary on/off context; the central focus here was on the elementary forms we can build from a simple on/off pattern.

To design for unknown qualities in one material and then translate it to textile is hard. The procedure used has been to sketch directly on textiles, then go back to paper or the computer and define basic principles, and after that return to the textiles, for example to design in layers on transparent films, use a digital layer tool, and also to place cut out paper forms on top of sketches.

The first figure (1-3) shows commercial/standardized heat pads placed on the floor with some space in between, and the second shows TC printed on paper, placed on top of heated pads. The grid-like pattern relates to the distance between the heat elements. In this way one can create a linear grid on a single coloured printed TC surface, by placing the heat elements with some distance from each other – the space in-between is used to create this expression. The last figure shows cut out textile forms printed with TC and yellow conventional pigment, placed on heat pads. The green cross indicates the form and positioning of the heat elements and corresponds to the printed rectangular form. These examples show the relation between the heat source and the printed TC and how it is possible to make them interplay to create new forms, not only displaying the form of the heat element.
Figures 1-3.

TEXTILE DISPLAY
Figures 7-8.
Figures 12-14.
Figures 16-18.

Figures 19-21.
Figures 22.

Figures 23-25.
Pink TC print is used to investigate how to change form, rhythm, size and repetitions by switching the heat elements on/off in different combinations and time intervals. This kind of heat element, a commercially available heat pad, shows how heat creates different shapes in relation to the shape of the heat element. In this set up the heat element heats up a rectangular surface with a single linear heat wire, embedded between foam rubber. On the edges, where the heat element turns, an organic rounded shape appears on the surface. *Figures 4-6.*

Blue TC print with "cut out"/ saved out white shapes. When heated the strong graphical expression changes by shades like a colour change. The intention is to experiment with the relation between a form in the printed “layer” and the form of the heat elements. *Figures 7-8.*

It was important to keep a simple expression, and only use basic form and colour elements to investigate elementary dynamic forms. In the figures on this spread, it is clear that the pattern starts to tell a another story, and not the story of how to design with dynamic textile patterns. This pattern of a wrinkled dress that fades away uses too much symbolism and would lead the investigation in wrong direction. It is more of a first sketch using the inherent dynamic qualities to tell a story. *Figures 9-11.*

A heat pad is cut up in pieces with the heat wire pulled out and placed over and under a heat sensitive fabric printed with TC on a single coloured fabric. *Figures 12-14.*

Searching for different forms by turning the same form around in different positions, this shows how to create different repetitions with the same initial form element. This indicates the kind of movements that can be designed for if placed in a dynamic context: redirection of a repetition, moving forms backward or forward in a composition etc. *Figures 15.*

Sketches of form elements, what forms should be used and what expressions; filled or outlined, rough or smooth, graphical or hand drawn style? The final composition of the printed patterns will later on be made to correspond with the underlying heat element, to create the overall expression. *Figures 16-18.*

Finding a suitable size, colour, structure and position for the print, in relation to the heat element underneath. The heat element is a repetition of
the square, just by placing the form next to the other in length and height. When the heat element is switched on, the printed repeated pattern is broken and changes into new repetitions and forms. Electronic components were implemented and the special made computer program tried out. The program is designed to communicate through a Power Point application that also functions as the interface to control on/off in a visual manner. The displayed square, or combination of squares that you click on the screen, represent the heat elements that will be switched on. Figures 19-21.

After experimenting with the expression of form, repetition and positioning of heat elements and prints, three patterns were designed by using lines, circles and squares. Colour was mixed, printed and after-treated to later be used for textiles to be mounted on the wooden rack with the heat elements. Figure 22.

When putting the prototype together, the heat elements were placed in a wooden frame covered with a reflective foil. The reflective foil was mounted behind the heat elements to reflect the heat to the front of the display. Figures 23-25.

Heat elements were custom made for this project, which gave the opportunity to control the temperature and to obtain a sharp and distinct shape. The temperature from these heat elements creates a precisely defined heated area. The textile was mounted vertically to the heat elements and also fastened on the heat elements with photo-mount spray. The heat elements were only mounted in one of the wooden frames, with all electronic equipment, to fit all three textile patterns. The final display is built up from 25 heat-elements that can be switched on/off individually. The heat elements are square shaped (25 X 25 cm) and are placed in a linear grid, 5 horizontally and 5 vertically. This creates a kind of large-scale pixel based display, with a total amount of 25 pixels. The heat elements are designed in this way to be able to use the wooden rack fully equipped with heat elements and electronics on all three different surface/print designs. Figures 26-28.
Dynamic Principles

Three dynamic textile patterns are designed to change from one repeated pattern, to another, repeated or not. Heat elements are placed under the printed textile, and when switched on they will remove that section of the printed pattern. As long as the heat is switched on, the colour change (change to transparent colour in this case) will last, when the heat is switched off it will tune back into its original colour after some time.

By creating a surface pattern built up from forms corresponding to the form of the heat elements, there will be a distinct change in the composition when the pattern changes. The printed pattern will develop and transform over time, from a repeated structure to a non-repeated, or into new repetitions etc.

The change is influenced both by the design of the form and the way it is repeated, as well as in what sequences and for how long the changes appear.

The time it takes for a textile pattern to change back to its original expression depends on several parameters, i.e. room temperature, temperature shift and exposure time. The time span ranges from 30 seconds to a few minutes.

<table>
<thead>
<tr>
<th>Irreversible</th>
<th>Reversible</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reported</td>
<td>X</td>
</tr>
<tr>
<td>Direct</td>
<td>X</td>
</tr>
</tbody>
</table>

This textile pattern is classified both as a reported and as a direct pattern. Compared to the design example *Do Pattern* (design example no. 6), that is given a similar classification, this example has a stronger relation to a reported pattern than a direct pattern – the expression in *Textile Display* is programmed, still it is possible to reprogram.
Extended design variables that influence the expression:

Temperature of the heat element (and the room)
Shape of heat element (in relation to shape of the printed form)
Shape of printed form (in relation to shape of heat element)
Textile material
Time that heat elements are turned on/off
Combination of heat elements, turned on at the same time (repetitions in time/program)
User context/interaction (programming)

Of course all design variables, both traditional and more well known variables as well as new ones, influence the final result just as strongly. Still in this example the focus is on showing how repeated forms may function when becoming dynamic.
Square.
Circle.
Expressions, Rationale and Learning Outcome

Basic forms were chosen for this investigation to explore how dynamic patterns could function in relation to the design variable “form”. By using basic forms such as lines, circles and squares the aim was to show a principle for how to handle the issue of elementary form for dynamic textile patterns. The expression is simple in order to display results in a clear and distinct manner.

“Circle”
This print is an outlined circular form building up a repeated pattern. The same pattern is printed to overlap in a half drop. The visual pattern changes from a repeated pattern to various other forms of patterns. The different patterns display basic shapes within a given repeated surface pattern, to be broken down into different new repeated patterns or changed into other pattern forms.

The space between the first visible pattern and the following creates another textile expression.

In this example the blank spaces between the forms are closely related to the shape of the heat element.

“Line”
A line is repeated horizontally and vertically to create a checkered pattern. When the heat elements are turned on, it changes the checkered pattern into other arrangements, crosses for example.

In this pattern I aimed for the printed form to show less of the shape of the heat elements, compared to the “Circle”. In relation to the heat elements, this pattern shows more of a new “form”, one or several crosses.

In this example the blank space between the forms are less related to the shape of the heat element, the square, than the “circle”, taking advantage of the space in-between in another way.

“Square”
A printed square is repeated and overlapped in a half-drop. This creates a
surface pattern that consists of squares in different sizes that correspond to the square shape of the heat elements.

Compared to the other two patterns, this example shows a pattern where the heat element’s shape, the square, becomes rather distinct. In this example the blank space between the forms does not play the same role as in the line example, where the shape of the heat elements is less visible.

In all three displays, each pattern expression is strongly dependent on the viewing distance.

When looking from a distance, the expression of a new form is stronger and more visible than if viewed from close by, where the form of the underlying heat elements is stronger in all of the examples.

New pattern possibilities, inherent in all three different patterns, are:
Order turns into chaos
Repetition of small shapes turns into one larger non-repeated shape
One repetition turns into another repetition

The intention was to keep the final design close to a sketch and in a raw format. This is also one of the reasons why the white cotton satin was chosen. During the test print on another material this motivation was balanced with the question of how to “hide” the shade of the TC upon heating. The printed patterns are graphical and show signs of being handmade, to show that it is a handmade experiment. The printed expression also functions as a contrast to the harder shaped heat elements.

The basic forms were constructed in relation to the size of the heat elements. The choice, to make the screen printed patterns by hand and not in a too perfect repetition, created small changes in the repeated patterns that also made them more visually interesting.

In this design example, possible transformations in printed dynamic textile patterns are investigated and exemplified with respect to the form variable and by making different forms and patterns, the degree of notification of a change is more or less subtle.

Also the direction, movement, rhythm, amount and weight of a surface pat-
tern would easily be changed during use in this setup. The composition in this case is twofold: a direction in the static, pre designed forms/patterns and the rhythm in temporal pattern changes. In all these three examples the repetition is placed in a symmetric position to the pattern that it relates to, something that could be interesting to use in both asymmetric patterns and in a more advanced manner in possible future applications.

Depending on what kind of expression a designer wants, for example if the change should be subtle or not, the change can be adjusted in more ways than just by the design of the printed textile pattern. Another possible pattern change (rather than just being switched “on/off”), is the pattern that appears in the actual moment of change, for example changing from grey to white. Different parameters can be set, for example the time it takes to change, if the pattern shifts from one expression to another or if it is designed to be expressed more like a moving image, a series of pictures put together to create a movie-like expression, similar to how motions are put together when producing an analogue film. In this manner one could design a textile pattern with a lot of variations on basis of the design of various time series, i.e. with focus on composition in time.

The total number of combinations is very large in this design example; each one of the 25 heat elements can be switched on/off individually and in different combinations over time. The time interval is x seconds between each change, a parameter that could vary and is a matter of specific design decisions. Using this principle, an infinite amount of expressions/patterns may appear on a textile surface.

It is interesting to compare the two examples Being Square and Textile Displays. Being Square is an on/off pattern, from one expression to another (with stripes that turn into squares and back). Textile Displays has a similar set up, but with one pattern that can change into an infinite number of different patterns. This illustrates the extremes of dynamic textile patterns. It also shows the importance of the range of expressions that a specific textile should be given, and the importance of learning how to design for that.
Dynamic Pattern Expression for Textile Display

Pattern expression A: One specific repeated pattern

changes to

Pattern expression B: X numbers of other repeated patterns, or unrepeated forms or a series of moving patterns

changes back to

Pattern expression A: One specific repeated pattern

A B A

Technical information

Fabric and material: 220 g/m cotton, satin
Print technique: Handmade screen print
Pigment: Variotherm 27 °C (thermochromic heat sensitive pigment)
Colour: Grey heat sensitive thermochromic colour
Binder: Water based
After treatment: Heat treated in 150 °C for 7 minutes

Report size:
“Circle” pattern is a silk-screened pattern.
Size of circle report is 25 x 25 cm
Total size of the printed pattern is 125 x 125 cm

“Line” pattern is a silk-screened pattern
Size of line 12.5 x 12.5 cm
Total size of the printed pattern is 125 x 125 cm

“Square” pattern is a silk-screened pattern
Size of squares is 15 x 15 cm
Total size of the printed pattern is 125 x 125 cm
TEXTILE DISPLAY

Heat-elements
Size: 25 x 25 cm
Material: Special designed metal foil (Calesco Foil)
Temperature: Minimum 37 °C and maximum 47 °C, requires 48 V 30 W
After 3 minutes (turned on) in room temperature (20 °C) the surfaces hold a temperature of around 40 °C, and around 30 °C at the edges. The print needs 27 °C to activate a colour change. We wanted to have some “extra capacity” if we would place the display in a colder room.

Reflector
Size: 150 cm x 150 cm
Material: Reflective film

Wooden frame
Size: 150 cm x 150 cm
Material: Wood (pine and masonite)

Electronics and power supply
Power supply: 220 V, transformed to 48 V

Program
Delphi: Written to communicate with a Power Point program, also functions as interface to control on/off, with a microcontroller for industrial applications
Reaching Audience

Exhibited at

Textile Possibilities Rydals Museum, Rydal, Sweden, 1 June-12, October, 2008
Production by Linda Worbin, Anna Persson, Amy Bondesson, Hanna Landin
and Rydals Museum
COSTUMES

Design example no. 4
2006-2008
Project team: Amy Bondesson, Anna Persson & Linda Worbin
In this design example dynamic textile expressions are investigated in relation to the interaction between body and space.

We designed a collection of costumes as tools, aimed to explore how temporal and spatial conditions may influence and affect visual expressions related to the expressions of body movements.

The costumes themselves have a static expression, depending on how you move in them, certain signals will activate colour changes in a wireless connected tapestry.
Methods and Variables

The Costume project grew from previous experimental research where dynamic textile materials and patterns were investigated in a use context. In the first part of the Costume project we made a collection of six costumes, each reacting with a visual change with respect to UV-light, temperature or power being switched on/off.

The project relates to experiments done in the project Reach (Jacobs & Worbim, 2005), where a pair of hats with dynamic textile patterns interact – as they come close together they share visual expression.

The visual expression of the costumes changes depending on e.g. environmental context and body movements. The woven and knitted textiles were made specifically for the costume project, manufactured out of thermo- and photochromic materials, electroluminescent, conductive and more traditional textile materials like cotton and viscose.

Photochromic costumes

To initiate change in the pair of costumes reacting to UV light, we used a big UV lamp. The costumes were white from the start and changed colour when exposed to UV light. Depending on how long the costumes were exposed, the intensity and the longevity of the colours were influenced. They showed a similar reaction in time as the TC colour prints; as long as exposed to the UV light the colour is visible, and when removed from the UV light it starts to fade back to white.

Thermochromic costumes

This pair of costumes were made with two different textile materials, one heavy knitted cotton material and one light woven silk fabric. These costumes react to body temperature, but with different speed – the light fabric changes much faster compared to the heavy cotton.

Electroluminescent costumes

In the pair of costumes with electroluminescent material, we used both Elam (electroluminescent) film and wire. In the costumes with Elam films, the wearer became aware of body movements through the relation between his/her movements and the level of light, the way it lit or did not lit up as an electrical circuit was closed or not.
In the second costume, Elam wire was used and placed within the construction of the costumes, to make body movements “let” out different amounts of light. These two costumes showed very different characteristics with respect to movement. The one where the circuits were too close/open tended to invite more static movements, as if trying to find out the functionality of a system. The costume with wires embedded in the construction of the costume on the other hand, seemed to open up for a slower, more free and personal way of moving.

Workshop with actors and actresses
We arranged a workshop at Unga Klara Theatre in Stockholm during the winter of 2005 (Unga Klara, 2010) to try out the first set of costumes. We wanted to study the body movements and the reactions from the audience, the actors and actresses as well as the other attendants from the theatre staff. We supplied them with a set of six costumes to be worn in pairs. We gave short instructions about what each pair of costumes reacted to, and we had prepared attributes that were available for them to use: UV-lamps, hair dryers, a teapot with hot water and a cup, and a power supply (Costumes, 2006). We saw how the dynamic textile qualities could be a part of telling a story in a new manner, for example by leaving temporary and reversible colour changes from spitting marks of an actor talking loudly while drinking tea. This is something that was also clear in discussions with the actors.
COSTUMES
Thermocromic costumes.
COSTUMES

Electroluminescent costumes.

Photochromic costumes.
Costume and Wall hanging

During the first part of the Costume project we wanted to investigate the relationship between input and output in the making and expression of a dynamic textile pattern, and focus on how we could activate an expression as well as using the surroundings, and how to in advance direct the expression in a an explicit manner – still, keeping a certain amount of freedom for the performers to be able to influence the final expression. We changed the input from objects in the surroundings, the UV-lamp, teapot and the hair dryers, to activation by body movements. By designing a circuit costume, we could sense through the costumes and use the performer’s movements to create different visual expressions (Persson, Bondesson & Worbin, 2009).

Wall hanging

The output, the pattern expression on the wall hanging, is similar to “Being Square”, with respect to principles of the construction and expression. A heat yarn was woven into the textile and on top we made a screen print in tc TC. In this example, several heat threads were connected in parallel to heat up a specific surface. Heat from the individual threads build up a form, depending on how the heat is spread in the textile. At first a linear pattern is seen, and later the heat spreads and creates a larger form. This is rather similar to how heat and voltage influences the thickness in the “Being Square” (Textile Disobedience, design example no. 1).

During weaving we had some problems with the inlay of the steel yarn, the yarn that would later function as the heat element. The strength of the steel wore down the knives used to cut the edges of the weave, resulting in the carbon inlay not being properly cut. As the machine stopped we had to cut off some carbon yarn waste from the inlay. We also had to leave the machine earlier than planned, thus we could not have all test weaves cut out from the machine before starting to make the fabric for the actual wall hanging. Also, due to the extended amount of time it took to weave one meter of the fabric (seeing as it stopped after every inlay with a carbon yarn) we had to come up with a solution to be able to get the material out for the final piece. We decided that every time the machine stopped due to an error, one of the coloured inlays would be changed. The weave was made with three colour changes, two for the cotton and a third for the steel yarn. The cotton yarn cones were put in a specific order, to be repeated constantly, so when the machine stopped one of the cotton inlays were also cut off and changed by hand. Still, the
Electronics for the costumes.
pattern report for the steel yarn was fixed, but the length of the area for a coloured yarn changed due to how the machinery handled the steel yarn. The result shows a striped textile, with a repetition in the colour order, but not in the size.

When we designed the printed pattern on the wall hanging we wanted to create a visible relationship between a specific dancer/costume and the given area that changed on the wall hanging. This relationship was designed in terms of connecting the pattern that appears on the wall hanging with a corresponding section on the dancer's accessory. We made one accessory each for the dancers, a white accessory with an “isolated” static form painted on top. From a certain angle in the room the two patterns emerge to indicate with a subtle notion which of the dancers that influences a specific form.
COSTUMES
Trying the costume and the wall hanging.
COSTUMES

Pictures from the film “Textile dimensions”.

151
Costumes

Each costume has its own individual movement which closes the circuit and changes the pattern expression on the wall hanging. By using a combination of electrically conductive yarn and cotton, we created a fabric with insulated sections (the cotton) where the conductive yarn sections (silver coated copper) are used as sensors. We used this fabric for the collection of the three circuit costumes. The fabric is the raw material, the sensors could be placed anywhere on the surface. When the sensor area was decided, an electrical cable was attached to that specific row of conductive yarn.

The Performance

The circuit costumes and wall hanging were presented at an exhibition in a performance with three dancers. The choreography was done by the dancers on the basis of the instructions regarding which movements initiated a change in the tapestry pattern, and from music (Textile Sounds, 2008).

Preparations for the performance, looking at the wall hangings position in the room, and trying out the technique in action, can be seen on page 149-150. The areas of the wall hanging that change are rather small in size in relation to the room and the size of the textile, something that of course could be done in a more or less distinct way. The performance was documented on film (Textile Dimensions, 2008).

Apron

With the first costume the actor/dancer has to touch the lower part of his/her leg with the upper arm to create a closed circuit. This costume has its static print on an apron.

Circular screen

With the second costume the actor/dancer has to bring the fabric from the dress to a section on his/her shoulder. This costume has its static print on a circular screen which is held by the wearer.

Collar

With the third costume, a wide skirt, the actor/dancer has to grip two specific spots and bring them together to close the circuit. This costume has its static print on its collar.
Picture from the performance.
Dynamic Principles

Three dynamic textile patterns are designed to change individually, from one colour and pattern to another. Heat elements are interwoven in the wall hanging, when switched on they remove that section of printed pattern on top. As long as the heat is switched on, the colour change will remain, and it slowly tunes back to its original colour when the heat is switched off.

The expression of the dynamic patterns depends on the time that the electricity is switched on in the fabric, which is determined by the dancers moving in their costumes. These factors influence the sequences of length in time and visible colour combinations.

<table>
<thead>
<tr>
<th></th>
<th>Irreversible</th>
<th>Reversible</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reported</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Direct</td>
<td></td>
<td>X</td>
</tr>
</tbody>
</table>

This pattern is classified as a reversible pattern, designed to change expression and to always come back to its original expression with respect to colour and form. The expression is programmed to be reported in a different manner, still it is a direct pattern, since the program actions corresponds to body movements and specific gestures that influence the nature of the expression. If there is no activity in the costumes, there are no visual changes.

Extended design variables that influence the expression:

- User context/interaction (bodily movements in specific gestures)
- Amount of time that the heat elements are turned on/off
- Shape of the heat elements
- Textile material and structure (in relation to temperature)
Expressions, Rationale and Learning Outcome

In this project we explore how body movements take part in shaping a room, the time it takes for a change to appear, and the relation between the movement and the way the change appears. In this set up the pattern is visible as long as the dancer stays in a triggering position/movement. However, this could of course be triggered differently, for example by being digitally controlled to adapt to a time delay, or by different combinations of expressions etc. Other issues include whether the change should be more or less visible for the ones wearing the suits or for an audience.

The costumes highlight some new design variables with respect to dynamic textile patterns:

– The relation between sources of “data”, body movements in this experiment, and the expressions they initiate, creates new design possibilities.

– The time delay between picking signals from body movements and expressing them in the tapestry.

By visualizing relationships between how different given expression elements are affected by functional and/or interactional influence, the connections between expressions related to inherent material properties and those connected to user influence are able to be planned for. (Persson, 2009)

Other issues, more closely related to the borders between textile engineering and textile design, deal with how to directly heat up specific sections to create different shapes. In this experiment we build up the shape from several lines to create a larger area, by having a short distance between the carbon yarns making the heat seem to melt together over that specific surface. Another example of creating a dynamic pattern is by combining the shape of heat and thermochromic prints through layers of heat-sink on a fabric printed with liquid crystal thermochromic (Robertson, 2008) (Christie, Robertson & Taylor, 2007).

There is also the question of how to combine two conductive materials with different resistance. In this experiment we connected a low resistance
material to supply electricity for the carbon yarn used as a heat element in a parallel circuit. It is only the heat element (the carbon yarn) that is integrated in the textile structure during weaving, the power supply was introduced by hand after weaving by twisting the two materials together. This is an issue that can be developed further, and something that can be solved in many different ways: by soldering, with conductive glue, snap buttons, conductive Velcro etc. after the actual textiles have been made.
Dynamic Pattern Expression for Costumes

Pattern expression A:

one specific expression and pattern

changes to

Pattern expression B:

one specific other expression, in this example three different pre-design patterns appear, one at a time or in combinations, due to how the signal from an external object (the costumes) are used.

changes back to

Pattern expression A:

one specific expression and pattern

A B A

Technical Information

*The wall hanging*

Weave technique: Shaft woven fabric
Report size of the weave: 21 cm, (divided in 11 cm plain weave in cotton, and 10 cm with ten steel lines, with two inlaid every cm, with cotton in between)
The cotton is inserted without a repeat in size regarding the colour cotton inlaid, but with colour in systematically order.
Yarn in warp: Wool
Yarn in weft: Cotton and steelcarbon
Electro conductive yarn: Steel with average linear resistance of 419 (R) Ω/m
Construction: Plain weave for the cotton and the steel over 7 threads
Colours: Unbleached natural white warp, weft; dark grey steelcarbon fibre (its natural colour) and 12 colours of cotton yarn.
COSTUMES

Print technique: Handmade silkscreen
Pigments: Thermochromic, Variotherm 27 °C and conventional pigment
After treatment: Heat treated in 150 °C for 7 minutes
Size of the tapestry: Width 400 cm, height 150 cm
Print Colours:
Dark violet to red
Dark brown to red
Turquoise to “transparent”

The Costumes
Knit technique: Circular knitting
Report size: 1 cm, one course of silver yarn/repeat and 7 course of cotton
Yarn: Silver coated copper yarn, cotton
Colours: Silver, and seven shades of green cotton and off-white cotton
Electro conductive yarn: Silver coated copper with average linear resistance of 2 (R) Ω/m

Additional objects
Collar in textile with hand painted pattern
Circle in textile with hand painted pattern
Apron in textile with hand painted pattern
Power supply: Power supply 5-15 V.
Microcontroller and radio transceiver
Additional: Electronic components are connected by hand when placed in the specific room.
Reaching Audience

Publications


Exhibited at

Textile Possibilities Rydals Museum, Rydal, Sweden, 1 June-12 October, 2008
Production by Linda Worbin, Anna Persson, Amy Bondesson, Hanna Landin and Rydals Museum

Project contribution

The first part of the project (costumes used for workshop in Stockholm) was initiated and conceptually developed by Amy Bondesson and myself. The development of the costumes, printing and sketches was made by Amy Bondesson and myself. My contribution also includes production of the UV-sensitive fabric, the involved electronic parts, planning for the workshop and filming in Stockholm. Film and editing by Lotta Lundstedt. I also spent time together with Lotta during the cutting and editing of the film and produced film the introductory scenes for the film “Costumes” myself.

For the second part, costumes and wall hanging presented as a dance performance at Rydal, in this project the concept, the performance and design examples were planned and set up together with Amy Bondesson and Anna Persson. We all took part in basic decisions and concept, I was my self responsible for the creation of the woven fabric with integrated heat yarn, and the textile printing together with Amy Bondesson.
GRAFFITI CLOTH

Design example no. 5
2008
Project team: Anna Persson & Linda Worbin

In this design experiment we wanted to investigate limitations and possibilities in colour changing materials by combining thermochromic pigment and conventional pigment in overprint techniques to achieve an extended range of colours.

Graffiti Cloth was made as an installation for an exhibition, to visualise an extended range of colours in thermochromic pigment. Visitors use fans (hairdryers) to heat up parts and “paint” with a hot air flow. In its first version, the Graffiti Cloth had three different dark colours; through heat from the fan the colour changes from dull to bright.
Methods and Variables

Colour map
When mixing pigment for conventional textile printing, it is easy to tell the colour and hue. Colours will, of course, change a bit from a wet and liquid state to dry and fast, but it is a predictable change. When mixing colours in TC it is a bit like mixing colours blindfolded, because when mixing a colour it will not behave as conventional colours, where blue is blue. Instead it will change colour from one to another depending on environmental conditions etc. A colour in TC will, for example, change from grey to transparent or from blue to yellow etc. What colours you achieve depends on how colours are mixed as well as what printing technique you use.

This experiment started with building up a TC colour map for a one week hands-on workshop “Designing with Smart Textiles” for textile art students at Bergen National Academy of the Arts in 2007 (Bergen National Academy of the Arts, 2010). The idea was to draw a colour map for the TC colours: grey, orange, magenta, blue and green. We made a description for each TC colour individually and for a mixture of 50/50 of two TC colours. After that we combined the TC with conventional pigment colour: red, blue and yellow. This basic description gives a good start when you want to mix your own specific colours and nuances. The colour map was later extended with two other TC colours: yellow and red (The Swedish School of Textile, 2010). The colour samples were made in an open silkscreen frame with TC pigment that changes colour at a temperature of 27°C.

When mixing samples for the map we calculated 1000 g binder and 60 g of TC. This recipe was used equally for all colours. What we can see is that TC colours have different relation between the amount of binder and pigment with respect to the impact of colour changes. Some colour pigments can be adjusted with more colour pigment to achieve the full colour, while others need less. The map is to be used as a first guide, to give information about mixing TC colours, and by mixing TC and conventional pigment.

Colour sample with raster
Later a raster with different grading was used when printing with only two TC and in a mixture of TC and conventional pigment colours, to explore how a difference in colour intensity can be achieved by using a raster in screen print technique. The rasters are graded as follows: 10%, 20%, 30%, 40%, 50%, 60%, 70%, 80%, 90% and 100%.
Print sample: 1
Red (TC) & Yellow (TC)
1. Starting temperature 19.4 °C (measured in the middle of the fabric)
2. The fabric has been exposed to a hot airflow for 30 seconds. The fan is held diagonally towards the fabric.
3. The whole surface is heated with the fan.
4. 30 seconds after removing the fan from the fabric.
5. 1 minute after removing the fan from the fabric.
6. 2 minutes after removing the fan from the fabric.

The textile print is placed flat on the floor on white paper during photography using a flash.
Full capacity from heat fan 1200/1400 W and fan with 2200 W to heat up the samples.
Temperature measured with an infrared-thermometer (Scan Temp).
Print sample: 2
Red (TC) & Blue (TC)
1. Starting temperature 19.4 °C (measured in the middle of the fabric)
2. The fabric has been exposed to a hot airflow for 30 seconds. The fan is held diagonally towards the fabric.
3. The whole surface is heated with the fan.
4. 30 seconds after removing the fan from the fabric.
5. 1 minute after removing the fan from the fabric.
6. 2 minutes after removing the fan from the fabric.

The textile print is placed flat on the floor on white paper during photography using a flash.
Full capacity from heat fan 1200/1400 W and fan with 2200 W to heat up the samples.
Temperature measured with an infrared-thermometer (Scan Temp).
Print sample: 3
Red (TC) & Green (TC)
1. Starting temperature 19.4 °C (measured in the middle of the fabric)
2. The fabric has been exposed to a hot airflow for 30 seconds. The fan is held diagonally towards the fabric.
3. The whole surface is heated with the fan.
4. 30 seconds after removing the fan from the fabric.
5. 1 minute after removing the fan from the fabric
6. 2 minutes after removing the fan from the fabric

The textile print is placed flat on the floor on white paper during photography using a flash.
Full capacity from heat fan 1200/1400 W and fan with 2200 W to heat up the samples.
Temperature measured with an infrared-thermometer (Scan Temp).
Print sample: 4
Blue (TC), Red (TC) & Green (TC)
1. Starting temperature 19,4 °C (measured in the middle of the fabric)
2. The fabric has been exposed to a hot airflow for 30 seconds. The fan is held diagonally towards the fabric.
3. The whole surface is heated with the fan.
4. 30 seconds after removing the fan from the fabric.
5. 1 minute after removing the fan from the fabric
6. 2 minutes after removing the fan from the fabric

The textile print is placed flat on the floor on white paper during photography using a flash.
Full capacity from heat fan 1200/1400 W and fan with 2200 W to heat up the samples.
Temperature measured with an infrared-thermometer (Scan Temp).
GRAFFITI CLOTH

Print sample: 5
Green (TC), Red (TC) & Yellow (TC)
1. Starting temperature 19.4 °C (measured in the middle of the fabric)
2. The fabric has been exposed to a hot airflow for 30 seconds. The fan is held diagonally towards the fabric.
3. The whole surface is heated with the fan.
4. 30 seconds after removing the fan from the fabric.
5. 1 minute after removing the fan from the fabric.
6. 2 minutes after removing the fan from the fabric.

The textile print is placed flat on the floor on white paper during photography using a flash.
Full capacity from heat fan 1200/1400 W and fan with 2200 W to heat up the samples.
Temperature measured with an infrared-thermometer (Scan Temp).
Print sample: 6
Green (TC) & Orange (a mixture of red TC and yellow conventional pigment)
1. Starting temperature 19,4 °C (measured in the middle of the fabric)
2. The fabric has been exposed to a hot airflow for 30 seconds. The fan is held diagonally towards the fabric.
3. The whole surface is heated with the fan.
4. 30 seconds after removing the fan from the fabric.
5. 1 minute after removing the fan from the fabric
6. 2 minutes after removing the fan from the fabric

The textile print is placed flat on the floor on white paper during photography using a flash. Full capacity from heat fan 1200/1400 W and fan with 2200 W to heat up the samples. Temperature measured with an infrared-thermometer (Scan Temp).
GRAFFITI CLOTH

Print sample: 7
Orange (a mixture of red TC and yellow conventional pigment)

1. Starting temperature 19.4 °C (measured in the middle of the fabric)
2. The fabric has been exposed to a hot airflow for 30 seconds. The fan is held diagonally towards the fabric.
3. The whole surface is heated with the fan.
4. 30 seconds after removing the fan from the fabric.
5. 1 minute after removing the fan from the fabric
6. 2 minutes after removing the fan from the fabric

The textile print is placed flat on the floor on white paper during photography using a flash.
Full capacity from heat fan 1200/1400 W and fan with 2200 W to heat up the samples.
Temperature measured with an infrared-thermometer (Scan Temp).
Print sample: 8
Red TC & Blue (conventional pigment)
1. Starting temperature 19.4 °C (measured in the middle of the fabric)
2. The fabric has been exposed to a hot airflow for 30 seconds. The fan is held diagonally towards the fabric.
3. The whole surface is heated with the fan.
4. 30 seconds after removing the fan from the fabric.
5. 1 minute after removing the fan from the fabric
6. 2 minutes after removing the fan from the fabric

The textile print is placed flat on the floor on white paper during photography using a flash.
Full capacity from heat fan 1200/1400 W and fan with 2200 W to heat up the samples.
Temperature measured with an infrared-thermometer (Scan Temp).
Print sample: 9
Blue (TC) & Green (conventional pigment)
1. Starting temperature 19,4 °C (measured in the middle of the fabric)
2. The fabric has been exposed to a hot airflow for 30 seconds. The fan is held diagonally towards the fabric.
3. The whole surface is heated with the fan.
4. 30 seconds after removing the fan from the fabric.
5. 1 minute after removing the fan from the fabric
6. 2 minutes after removing the fan from the fabric

The textile print is placed flat on the floor on white paper during photography using a flash.
Full capacity from heat fan 1200/1400 W and fan with 2200 W to heat up the samples.
Temperature measured with an infrared-thermometer (Scan Temp).
Print sample: 10
Red (TC) & Green (conventional pigment)

1. Starting temperature 19.4 °C (measured in the middle of the fabric)
2. The fabric has been exposed to a hot airflow for 30 seconds. The fan is held diagonally towards the fabric.
3. The whole surface is heated with the fan.
4. 30 seconds after removing the fan from the fabric.
5. 1 minute after removing the fan from the fabric
6. 2 minutes after removing the fan from the fabric

The textile print is placed flat on the floor on white paper during photography using a flash.
Full capacity from heat fan 1200/1400 W and fan with 2200 W to heat up the samples.
Temperature measured with an infrared-thermometer (Scan Temp).
Print sample: 11
Blue (TC) & Yellow (conventional pigment)
1. Starting temperature 19.4 °C (measured in the middle of the fabric)
2. The fabric has been exposed to a hot airflow for 30 seconds. The fan is held diagonally towards the fabric.
3. The whole surface is heated with the fan.
4. 30 seconds after removing the fan from the fabric.
5. 1 minute after removing the fan from the fabric
6. 2 minutes after removing the fan from the fabric

The textile print is placed flat on the floor on white paper during photography using a flash.
Full capacity from heat fan 1200/1400 W and fan with 2200 W to heat up the samples.
Temperature measured with an infrared-thermometer (Scan Temp).
Print sample: 12
Red (TC) & Yellow (conventional pigment)
1. Starting temperature 19,4 °C (measured in the middle of the fabric)
2. The fabric has been exposed to a hot airflow for 30 seconds. The fan is held diagonally towards the fabric.
3. The whole surface is heated with the fan.
4. 30 seconds after removing the fan from the fabric.
5. 1 minute after removing the fan from the fabric.
6. 2 minutes after removing the fan from the fabric.

The textile print is placed flat on the floor on white paper during photography using a flash.
Full capacity from heat fan 1200/1400 W and fan with 2200 W to heat up the samples.
Temperature measured with an infrared-thermometer (Scan Temp).
GRAFFITI CLOTH
Graffiti Cloth

For Graffiti Cloth we experimented with possibilities and limitations of colours in TC pigment. By combining TC pigment and conventional pigment in overprint techniques we achieved an extended range of colours. In this context Graffiti Cloth explores colours that have two inherent colours in one.

When making the Graffiti Cloth we intended to make an obvious and clear colour change. We were thinking about grey and dull walls that turn into colourful walls by Graffiti artists by distinct and obvious colour changes. The way hot air flows are used to reveal the bright colours is a bit like reversed painting; you remove the darker colours with a “fan-painter”.

We mixed three different TC colours with conventional pigment, to make them change from one colour to another. We also decided to make the print in an overprint technique, so we would have several more colours in the ready printed pattern. The print, seen in the first phase, just shows a shift in nuances, but when heated, the conventional pigment colour appears and these are the colours that gain the most because primary colours were used (yellow, red and blue) to create the three secondary colours:

- yellow + red = orange
- yellow + blue = green
- red + blue = violet

We obtained secondary colours by printing and mixing techniques.

The three secondary colours have to be mixed very carefully. They must not lean towards either primary component. You will note that it is no easy task to obtain the secondaries by mixture. Orange must be neither too red, nor too yellow; violet neither too red, nor too blue. (Itten, 2001)

It was a challenge to get the colours to function well in the different steps, a nice TC colour that would function with the colour that it would change into, as well as combining it with an overprint. To make an overprint the colour needs to be transparent enough to make the secondary colours appear. This is just like making a traditional overprint with conventional pigment, but with an extra dimension. Through this way of printing we actually mixed and designed for three colours at the same time. If the overprint with yellow over
red was too strong there would be no overprint at all, and if it was too light it would not affect the red enough to create an orange.

To mix the TC pigment with a conventional pigment is like mixing colours for a traditional overprint, but more advanced. We could say that we have been mixing for three colours; the TC, the pigment and the overprint (to match with the other colours).
Dynamic Principles

Three heat sensitive TC colours are mixed, to change between two colours, one when heated and one when not. By using an overprint technique we obtain another three colours and several more different hues – as a consequence of the way in which the overprint was made and placed, the expression still changes from one colour to another.

The way the dynamic pattern is expressed visualizes how heat sensitive TC may function with a traditional pigment; how to design a colour, with two different inherent colours and expressions. Pure grey for example, changes to grey, and a blue combination to pure blue. As long as the heat (over 27°C) is turned on, the colour change will last, when removed, the colour slowly returns to the original colour.

<table>
<thead>
<tr>
<th>Irreversible</th>
<th>Reversible</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reported</td>
<td>X</td>
</tr>
</tbody>
</table>

The classification for this design example is a reversible direct expression.

Extended design variables that influence the expression:

- Print technique
- Colour mixing
- Textile material
Expressions, Rationale and Learning Outcome

Colour map
During the workshop “Designing with Smart Textiles” in Bergen it was obvious that the students that really engaged in systematic colour mixing made the most of the material qualities in their designs later on. They could, for instance, involve the disappearance of a colour in the story of a textile pattern; one student made a pattern with several planes on collision course. She had made the planes on collision course in TC to be transparent when heated, so that only some of the planes disappeared. Another student made a face with the ability to change expression, from sad to happy. Most of the students came up with similar ways of using the TC colour’s qualities in their textile patterns and designs.

To mix dynamic “colours” is more time consuming, in general, compared to mixing conventional colours. Mixing a TC colour that changes from one colour to transparent is easier than mixing a colour that combines TC and conventional pigment. To be able to control the latter, to obtain a specific and exact nuance, is a challenge. It is a time consuming work of mixing TC to an exact colour and hue. The print needs to dry, and first after that you can heat it up to see the result, then adjust it and let it dry, heat it up again and so on until you have the intended mixed colours.

Colour sample with raster
Printing with a raster technique is another way of handling and printing with TC colours. A scale of the colour is obtained, in this case from 100% to 10% on a scale with 10 steps. By using raster you could also mix colours during printing, to make a colour weaker or to change into another colour.

Graffiti Cloth
The TC colour range is quite limited, and thus we wanted to combine pigment with TC to make the colour spectrum broader.

We are pleased with the amount of colours that we managed to combine and also that we managed to make a clear and distinct expression in the nuances and colours.
By making our own TC primary colours we could achieve secondary colours by overprint on the pigment colours. This technique can be used if you for example want to combine one shape in pigment and another in TC to create a third in the intersection of two patterns, or if making a larger screen on top of another to colour a fabric.

Depending on what kind of patterns and colours you would like to design, there are different possible techniques with different inherent qualities. If you for example want to make a pattern and/or form that changes colour, you could benefit from mixing the colours for one print. But it is of course also possible to make two similar prints on top of each other. The raster technique could be useful if you want to hide a pattern inside another one, similar to “Rather Boring” (Design example no. 1) but on a different scale.
Visitors trying the Graffiti Cloth at an exhibition.
Dynamic Pattern Expression for Graffiti Cloth

Pattern expression A: one specific colour expression, dark and dull

changes to

Pattern expression B: another colour expression, bright colour

changes back to

Pattern expression A: one specific colour expression, dark and dull

A B A

Technical Information

For the colour map, Variotherm AQ concentrated colours, reacting with a colour change at 27°C, have been used.
Fabric and material: 220-g/m cotton satin, ready-made fabric
Print technique: Handmade screen printed, a direct print made by saved out parts
Pigment: Variotherm 27°C (thermochromic heat sensitive pigment) and conventional pigment, Acra-K.
Binder: Water based
After treatment: Heat treated in 150°C for 7 minutes
Colour mixing:
We have been mixing and printing with three different colours:
- Grey TC that changes to blue (pigment)
- Brown TC that changes to yellow (pigment)
- Dark violet TC that changes to red (pigment)
The colours were mixed to be used in an overprint technique to obtain another three colours in heated/activated state; orange, green and light violet.
Orange: overprint by TC mixture with general pigment red and yellow
Green: overprint by TC mixture with general pigment blue and yellow
Violet: by TC mixture with general pigment blue and red
Reaching Audience

Exhibited at

Textile Possibilities Rydals Museum, Rydal, Sweden, 1 June-12 October, 2008
Production by Linda Worbin, Anna Persson, Amy Bondesson, Hanna Landin
and Rydals Museum

Project Contribution

The first part of the project, the colour map, was initiated and created by me (together with students from the workshop in Bergen), and later by me continuously during my thesis work. The TC colour maps with raster, colour mixture and printings was made by me, the raster screens were created by Helena Engarås, the Swedish School of Textiles, University of Borås.

The second part, the Graffiti Cloth was created by Anna Persson and me. We have been mixing colours and printing the textile together, as well as preparing the installation for the exhibition at Rydals museum.
This design example focuses mainly on how external objects influence the creation of a dynamic textile pattern. The final expression is not set in the actual textile; it is rather built in the interaction between the textile and specific external objects, where porcelain cups and a textile pattern are designed to interplay. The form of the cups intended to function both as a form to build up a repeated pattern on a single coloured textile, and to connect to another form, printed on the textile. The position of the cups creates a pattern that either forms a repeated pattern or is spread out irregularly, depending on how the user plays with, and interprets, the relation between the textile and the cups which make the user’s role crucial for the final expression.

The textile is printed with a heat sensitive TC print and when the cup (filled with hot liquid) is placed on the surface new patterns appear. This design experiment is done to make it easy to express a dynamic principle, where two different objects and forms interact to build up new expressions.
Methods and Variables

This experiment builds on previous investigations, especially Textile Disobedi-ence and the example Do the Pattern Yourself (Design example no.1). In the latter example, the heat from porcelain cups is used as a kind of stamp to leave traces on a tablecloth. When developing Do Pattern, ordinary porcelain cups and the traces they left were tried out on fabrics together with a series of patterns in an overall investigation of dynamic textile patterns.

Do Pattern is inspired by experiments with textile prints and samples done in Tic Tac Textile (Ernevi et al. 2005). In this project two interactive textile surfaces are used as a playground for a tic tac toe game from a distance. The textile patterns are built up from a specially designed heat element, placed under a single coloured fabric, programmed to heat up in a real time game situation. The fabric is also heated up by cups placed directly on top, something that is further investigated in Do Pattern with the involvement of specially designed cups with crosses and circles to open up for the possibility to play games.

Finding form, colour and material

In this experiment it was important to find a clear and visible form and colour change. It was also important to decide if the heat source (in this example, the porcelain) should make a mark on a single coloured textile or to fit a printed form. The form of the cups is designed to function in two ways, both to create a repeated pattern on a single coloured surface and/or to function with given printed forms, in this case the brown circles.

The cups have two different shapes; a cross and a diamond shape. When the cups are placed on the tablecloth, heat gradually creates a pattern on the textile print. The shape of the pattern will appear differently depending on the amount of time that the porcelain is left on the table as well as on the temperature of the liquid in the porcelain cups. If the hot porcelain is left on the tablecloth longer, the heat will gradually create another form, different from the initial form which resembles the form on the porcelain.

The cup with a cross could be used to build a repeated pattern on a single coloured tablecloth, forming a grid if placed in a straight repeated pattern. In a half drop, a surface with crosses is shown. It could also be used to build up different irregular or figurative forms etc. The diamond shaped cup could create a rounded shape if placed in a straight
First sketches for the porcelain cups.
repeated pattern. Or, just like the cups with the cross, it could be used to build different irregular or figurative forms etc.

It is hard to predict how the heat affects the textile in an exact manner, and therefore the expression is somewhat unpredictable. For example, if there is a wrinkle on the fabric then the expression will not be exactly the same from time to time. Further on, a shielding top coating was applied to some of the printed samples, in order to make sure that the tablecloth could stand exposure to moisture and stains without being ruined.

By designing the expression as a rather ordinary and simple tablecloth one makes the effect of change even more distinct. Basic forms are used to better understand how dynamic expressions can function and be constructed with respect to elementary principles of dynamic patterns.

Porcelain
The cups are a bit oversized compared to traditional porcelain cups, to fit the installation and the room that the installation was intended for, but also to show that the cups are not made for drinking. It is an objectification of a cup to display principles for how cups and tablecloths could interplay.

After the first prototype of the cups was made, we tried it on the printed circular shapes. We also tried the different shapes next to each other to see how the size of the form changed when burning the stoneware. Following some tests, a form/mould in plaster was created so that we could create several similar cups. Before white glazing the raw cup, they got their finish by grinding/polishing/scratching the surface.
Repeated patterns with form A on a textile printed with grey TC.

Form A

Straight repeat

Half drop

Tilt, straight repeat

Tilt, half drop
Repeated patterns with form B on a textile printed with grey TC.
Dynamic Principles

During use one may create a pattern that is repeated or not, depending on how external objects are used in relation to the given textile print. The position of the porcelain cups creates the dynamic textile expression on the surface.

This pattern is a reversible pattern, it is designed to change expression and to always come back to its original expression in colour and form.

<table>
<thead>
<tr>
<th>Irreversible</th>
<th>Reversible</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reported</td>
<td>X</td>
</tr>
</tbody>
</table>

This pattern is classified as a direct pattern, since the form of the porcelain is designed to create both a variation of patterns on the surface.

Extended design variables that influence the expression:

- Temperature of the liquid and room
- Shape and material of the porcelain (in relation to temperature)
- Textile material and structure (in relation to temperature)
- Time that the cup touches/stands on the tablecloth
- User context/interaction
Expressions, Rationale and Learning Outcome

In this experiment specially designed porcelain cups were designed to leave two different kind of forms. The printed pattern on the tablecloth reacts with a colour change when exposed to heat over 27 °C. By pouring hot liquid, for example coffee or tea, in the porcelain cup and placing them on the tablecloth a reversible dynamic textile pattern will become visible. After removing the porcelain the colour gradually changes back to its original expression.

The printed form on the tablecloth and the one on the porcelain together buildup a shape visible only in actual use.

Brown circles were printed in TC mixed with conventional pigment, size and shape were made to correspond with the design of the porcelain cups. Different kinds of forms of the cups as well as on the print have been tried, both with sketches on paper and screen-print on fabric. The idea was to keep a simple expression to explore new possibilities following this principle of interplay between a textile and external objects. Basic forms were chosen on the porcelain and the print to function both as elementary forms to build up a repeated pattern and to correspond with a given printed form.

The “directness” of interaction in this example is relatively high, compared to previous design examples such as Textile Display (Design example no. 3). In a way the changes in this example are also pre designed to appear with respect to given shapes on the cups. But in using the cups you decide how to place them on the tablecloth and thereby you also decide the direction of the patterns and the form of changes.

Experimental use context

The notion of two known objects interacting in an unexpected way – a cup that leaves marks on a tablecloth – seemed to function well and at the exhibition, many of the visitors tried it. Lots of them also asked what this could be used for. The cup and the tablecloth seemed to be too distinct and too abstract at the same time. Some people did not care so much to understand, they were just happy to have been surprised about something, others were more interested in the colour change from a technical, chemical and/or economical perspective and some from a product developing aspect, as well as from
a textile design perspective. As a visitor/user you could experience ways of changing the pattern on the printed tablecloth, you could easily see the different expressions in the same design with respect to basic design parameters such as time and temperature.
Dynamic Pattern Expression for Do Pattern

Pattern expression A:
one specific form expression

changes to

Pattern expression B:
new expressions appear, depending on how a user places an external object
(in this case the porcelain) different expressions appear

changes back to

Pattern expression A:
one specific form expression

A B A

Technical Information

Print technique: Handmade silk screen
Pigment: Variotherm (thermochromic heat sensitive pigment) and Acra K
(conventional pigment)
Colour: Brown to yellow
After treatment: Coating Performax 19170 D (acrylic for tablecloth), heat
treated in 150 °C for 7 minutes
Fabric and material: Printed on 220g/m cotton, satin
Textile pattern:
Handmade silk screen
Size of circle report is 29.5 x 39.5 cm
Porcelain cups / heat-elements:
Size and form of the bottom pattern is about 2 mm thicker than the rest of the
material.
Diameter: 8.5 cm
Height: 11.5 cm
Reaching Audience

Exhibited at

*Textile Possibilities* Rydals Museum, Rydal, Sweden, 1 June-12 October, 2008
Production by Linda Worbin, Anna Persson, Amy Bondesson, Hanna Landin and Rydals Museum

Project contribution

I created this project myself; sketches for the porcelain cups and tablecloth, the mixing of colours, printing etc., except creating the final porcelain cups which were made by Birgitta Jönsson.
Design example no. 7
2008 (project start 2006)
Project team: Christian Mohr, Anna Persson, Linda Worbin, University of Borås and Gunilla Lagerheim Ullberg, Peter Magnusson, Peter Otell, Anna Schou, Kasthall Carpets AB

Functional styling is a series of experiments based on a collaboration with Kasthall AB (Kasthall, 2010) within the Vinnväxt/Vinnova Smart Textiles Initiative (Smart Textiles, 2010), (Vinnova, 2010). The idea was to do experimental design research on dynamic textile patterns together with product developers in the textile industry.

Kasthall is a company with a long tradition in producing high-class quality woven and tufted carpets.

The overall aim was to investigate new smart materials and textile techniques in relation to carpets, and to explore decoration with inherent functionality; a functional styling.
The idea was to developing a series of full-scale design examples of carpets with a functional styling. The project resulted in three experimental prototypes for carpets; Spår (Traces), Dimma (Foggy) and Glöd (Spark).

Spår senses when someone is walking on the carpet, which then lights up in different patterns, to show you the way or to leave a trace.

Dimma is a combination of a carpet and a lamp. The light elements light up with different intensity depending on the surrounding light conditions.

Glöd is a combination of a mobile heat-element and a carpet, with a pattern that indicates if and how much heat that is turned on.
Methods and Variables

Workshop at the company
The project started with a workshop at Kasthall, with the aim to discuss how carpets may function in the future. Technical staff, designers as well as management participated in the workshop.

The workshop started with an introduction of related and previous design examples, investigations and experiments in ongoing research within the area of dynamic textile patterns. One example is LampCurtain, a textile with light integrated in the weaving construction (exhibited by Worbin, 2004). Another project with light integrated into a woven structure is the Interactive Pillow project (Redström, Redström & Maze, 2005). This project deals with a dynamic textile pattern activated by touch, in this case in two separate textile objects that communicate wirelessly. Other previous investigations with respect to sensing information in a room and using it for activating a dynamic textile pattern, are presented in (Melin & Jernström, 2003). Another project is the Tic-Tac Textiles (Ernevi et al 2005) in which textile patterns are created by and from heat elements placed under a textile layer.

We handed out pictures with more or less connection to carpets, pictures from everyday situations both in public spaces and in private rooms to facilitate and open up for a discussion. We asked all participants to individually answer the following questions for each of the pictures:

1. What new function could a carpet have in this specific situation?
2. What qualities has the carpet got?
3. What material is the carpet made of?
4. How will this carpet be used?
5. Other comments or ideas?

We collected all the written material, sorted it and printed it on different coloured paper.

Blue: 1. What new function could a carpet have in this specific situation?
Pink: 2. What qualities has the carpet got?
White: 3. What material is the carpet made out of?
Yellow: 4. How will this carpet be used?
Orange: 5. Other comments or ideas?
When we had written it all down we started to make new scenarios by mixing the notes in the same categories and sorting new ones. The aim was to generate stories and ideas for new carpet concepts.

A few examples:
A carpet that could replace the electrical switch for lamps
A wrestling carpet for people living in cities
A carpet that controls your digital equipment
An alarm carpet
A carpet that shows where you are heading, for example in hospitals
A carpet that cleans itself
Etc.

On basis of this material we continued the discussion and came up with the three different areas that we wanted to explore further in the project:

A carpet that can show directions, and traces of people that have passed by – later resulting in the carpet *Spår*.

A carpet that can light up, and function both as a lamp and a carpet – later resulting in the carpet *Dimma*.

A carpet that can function as a heat element and a display – later resulting in the carpet *Glöd*.

In *Functional Styling* we were dealing with how to transform an experimental/craft process to fit production requirements in the textile industry. By using older kind of weaving machines with shuttles, we could insert a weft inlaid in various sizes. Still during weaving we had to stop the machine and make some inlaid by hand; a kind of industrial crafts process. An example of combining traditional craft combined with modern technologies is the work done at the Japanese textile company NUNO (Millar, 2005). They have in a very successful manner managed to combine traditional expressions with industrial production. A similar, but at the same time quite different, approach is needed in future developments of the Smart Textiles field, where there is a need to form a modern type of textile craft where textile and computational materials and techniques can merge.
SPÅR (Traces)

At first the carpet “Spår” looks like an ordinary woven carpet, but when you start walking on the carpet a pattern will light up in sequences under your feet.

The “carpet” senses steps and is programmed to light up in a specific manner. It can also be re-programmed to change the behaviour of the carpet. In this example the dynamic textile pattern is both functional, showing the way or leaving a trace, and decorative; a functional styling.
Methods and Variables

We started to collect materials that could be programmed to change visual appearance, such as optical fibres and electroluminescent wire. In parallel we looked into how to sense pressure from footsteps in a textile material. We wanted to be able to sense when and where somebody walked on the carpet, and with different light patterns, show directions and display traces.

Weaving

For practical reasons we decided to use Kasthall’s existing warps, constructions and yarn qualities. We made different woven samples in shaft weaving machines to try out different colours (black and white), textile materials (wool and reflective lurex) and different materials for lighting (electroluminescent wire and optical fibres).

After trying both electroluminescent wire and optical fibre, we decided to continue with the electroluminescent wire since it was the most suitable material of the two to use inserted in the weft. This material also gave a more distinct light in the textile structure, compared to optical fibres in this quality.

We also liked the fact that the wire does not require an external light source, as optical fibre does, something that would make the carpet a bit more flexible as well. The optical fibre does on the other hand easily shift colour in use, since the colour of the light can be adjusted through an external light source. An optical fibre would probably function better with another weaving technique, such as warp knitting, or by insertion in the warp instead of the weft. Here the optical fibre broke in the edges and made a mess with the other weft material. The wire on the other handmade nice loops in the edges. This is not only a decorative matter, but also a matter of designing the power connections as the wire needs to be separately connected to power each time that it is cut. The weaving machine that we used is an old fashioned type of machine, that does not cut the edges. It was not without trouble that the wire was integrated due to it being hard to achieve an even tension on the whole surface between the electroluminescent wire and the wool yarn. But the skilled weaving staff at Kasthall managed to solve it and they also placed a backing, a kind of fixative on the carpet, to stretch and fix the size and structure.

We decided to weave a standard size carpet; width 90 cm, length 200 cm. This is a reasonable size for a first prototype to try out the setup on. The electroluminescent wire was inserted by hand and all the wires were connected individually, which is the main reason why we chose a rather small scale experiment. When we had a carpet with the light wire integrated into the
weave we started to experiment with different ways to light up the pattern by programming the carpet.

The idea to use the carpet to show a direction would fit better on a longer and a larger carpet. So, the size and the way the carpet is programmed is of course closely connected to use and expression. For this prototype we decided to program the carpet to light up the way someone walks. Here time becomes an important factor, how long will the trace be lit after you walk on the carpet, etc?

We used white wool in the warp, combined with two different electroluminescent wires; one that changes from pink to white light and the other from white to blue-green light. We designed for a carpet with a hidden pattern, and by making the design very calm and traditional the change is more distinct. The purpose was to visualise the principles of picking up signals and using them in building a carpet pattern. We decided to play with old traditional woven carpets like rag-rugs to get a clear and obvious change with very simple and basic expressional elements. We also tried two different kinds of sensors: a pressure sensor (triggered by footsteps), and capacitive sensors. The principle of a capacitive sensor is that a sensor area (in this case a knitted metal area) is setup to work as a capacitor which changes its capacitance (ability to store electric charge) depending on whether a person is present or not.

We made a few first tests with a carpet from Kasthall’s existing product range to learn about the material and the weight in relation to picking up signals from footsteps. The capacitive principle for sensing turned out to be the most reliable solution given the limitations of the project.

The amount of sensor areas is five, and the size between them is designed and calculated with respect to the size of a step, a rather small one, of $\frac{1}{2}$ meter between the sensor areas. Also the different pattern sequences follow from the size of footsteps and the sensor areas. The electroluminecent wire builds a form that consists of three individually controlled light wires that create an elementary pattern which is repeated five times over the surface of the carpet.

**Experimental use context**

When the carpet is walked upon, sections and patterns will directly light up. When leaving the carpet the light will slowly fade away and back to the initial expression.
FUNCTIONAL STYLING
Dynamic Principles

Pressure indicates changes in a textile pattern, it is an expression (pattern section) that reacts in real time and changes back with a delay of x seconds.

The dynamic pattern expresses how body movements (pressure) initiates change in a textile expression. The textile object is both picking up the information (the input) and expressing a colour change (the output).

<table>
<thead>
<tr>
<th>Irreversible</th>
<th>Reversible</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reported</td>
<td>X</td>
</tr>
<tr>
<td>Direct</td>
<td>X</td>
</tr>
</tbody>
</table>

This pattern is classified both as a reported and a direct pattern. This is because the pattern is designed to change depending on how you use the carpet, but at the same time the preformed expression is reported.

Extended design variables that influence the expression:

Pressure (walking, jumping, lying etc)
Time that carpet is under pressure
User context/interaction
Program (when the change should appear, combinations/rhythm of change etc)
Expressions, Rationale and Learning Outcome

The aim of this experiment was to better understand both techniques and design qualities when integrating light in woven structures. We have shown that such a type of light integrated carpets can be produced industrially, but with the involvement of major handicraft components. The electroluminescent wire needs to be inserted by hand, as well as the electronic connections that have to be mounted by hand.

We worked on and involved the programming late in the design processes, something that could be turned around in future projects. It is clear that the programming opens up for a huge range of new design variables. Further on, it could be interesting to start with the programming possibilities and then design and weave a material for a specific program.

The aesthetic pattern on the carpet can easily be changed from a carpet that shows a trace (in real time or with delay etc.) into a carpet that indicates a specific direction, simply by programming the carpet. These changes can be done even after the textile is produced, and a basic textile pattern is designed.

We use the footsteps to build up a dynamic textile pattern, something that encourages the designer to make new decisions, and offers new ways to design, for example by asking questions like;

How long after sensing a step should the output, the light in the carpet, be turned on, and how long should it stay on? Where on the carpet should the light be displayed? How many different sensor areas and how many output possibilities are available?
Dynamic Pattern Expression for Spår

Pattern expression A: one specific expression, calm and traditional

changes to

Pattern expression B: a number of light patterns change the expressions, depending on how you interact/step on the carpet, to a lighted pattern

changes back to

Pattern expression A: one specific expression, calm and traditional

A B A

Technical Information

Weave technique: Shaft machine (Kasthalls own weaving plan), electroluminescent wire is inserted by hand.

Yarn in warp: Flax (Kasthalls quality, confidential)

Yarn in weft: Wool (Kasthalls quality, confidential) and electroluminescent wire

Weave construction: Kasthalls quality, confidential

Colour Wool: White

Electroluminescent wire; Pink wire turns to white light, white wire turns to blue-green light

Size of carpet: Width 90 cm, length 200 cm

Supplement

Sensor: Capacitive sensor, electrical cable enlarged with knitted steel fabric, placed underneath onto the carpet

Power supply: 9 Volt battery or 9 Volt from plug in, electroluminescent wire requires alternating current

Program: Basic X, reported pattern is turned on in sections

Microcontroller: BX24
DIMMA (Foggy)

In this design example we combined light with a tufted structure. The carpet “Dimma” is connected to a sensor that controls the intensity of light in the carpet.

Carpet patterns and the intensity of light depend on environmental light conditions. The light in this carpet can be seen as a light source and influences the ambience with a variety of expressions.
Methods and Variables

To explore how light elements could be combined with a tufted carpet, we started to work with existing qualities from Kasthall’s tufted range. We started doing experiments with one white and one black coloured quality. We cut holes in the carpets and placed electroluminescent film underneath the tufted structure. Later on we received tufted samples with special holes, circular shapes without any tufted woollen material on top. We cut out the tufted bottom weave and placed the light film under the carpet. We made lots of different experiments with materials and intensity of light, turning the light on and off, placing other structures on top of the light film etc.

After some experiment we moved on to the hand tufting machines to create some new qualities, specially designed for our light requirements. We started to tuft holes in different sizes and tried to make the surface more transparent, both by using different amount of material and by trying out different materials. We also tried to tuft with optical fibre, but the material was hard to use in the tuft machines, and did not work out at all. We stitched some optical fibres in by hand and made a few samples in after-glow material etc.

We did try with different positions, colour and sizes of the light films in different tufted qualities and experimented with a heavy quality, where the light only appeared in cut out or saved out holes. It looked like a deep hole in the room/on the carpet. We continued to work with these “holes” and in some holes we placed different decorative structures and forms to create a pattern that would appear when lit up.

In parallel we worked with a thinner quality, where the light films would be visible through the tufted surface. We tufted in rows and sawed some to create a lighter and more transparent quality. We wanted to try out more than one colour in the light and decided to use two colours and to continue to work in a systematic way with the position of the films, next to each other in horizontal and vertical rows.

When the carpet with a more transparent quality was ready we placed it over the “under” carpet. Since all the light films can be switched on/off individually there is a huge range of different possible patterns we can design/program for.
FUNCTIONAL STYLING
When exploring the small and single electroluminescent light films under the tufted samples, we simply switched on and off the power by hand. Later on we had a program that controlled all films individually.
FUNCTIONAL STYLING
Experimental Use Context

For Dimma we use a program which gives three different possible expressions. These expressions are pre-designed to function in a specific manner depending on the light level in the room. This gives us three levels of light that trigger the patterns, which in turn are built up by different levels of light.

<table>
<thead>
<tr>
<th>Time</th>
<th>Expression</th>
</tr>
</thead>
<tbody>
<tr>
<td>Afternoon</td>
<td>Stage 1: amount of light films changes between 13 and 12</td>
</tr>
<tr>
<td>dusk</td>
<td>Stage 2: amount of light films is 3</td>
</tr>
<tr>
<td>night</td>
<td>Stage 3: amount of light films is 1</td>
</tr>
<tr>
<td>dawn</td>
<td>Stage 2: amount of light films is 3</td>
</tr>
<tr>
<td>morning</td>
<td>Stage 1: amount of light films changes between 13 and 12</td>
</tr>
</tbody>
</table>

Expression in stage 1
This stage changes between two different expressions. Every second, one light film is switched on at one time and the next the other films are switched on, resulting in an expression that in one moment shows up a white-light checked patterned carpet and changes to blue-green-light checked pattern.

Expression in stage 2
The squares light up one neighbour square, and three squares light up at a time. The pattern is designed to change constantly, with one light switched on and off at the same time. Like 1,2,3 – 2,3,4 – 3,4,5 etc., but it can also change and reverse at any time, like; 1,2,3- 2,3,2 etc.

Expression in stage 3
One light film is switched on at a time, when it is switched off a neighbouring film is activated and lights up.

It is first in this stage, were we actually tried out a specific series of programs for Dimma, that we could see the range of different possible expressions. It feels like this combination of a textile layer and a programmable layer opens up for a huge number of new possibilities.
Dimma in the moment of change between the two stages in "Afternoon mood".
“Dawn” in motion.
“Dusk” in motion.
FUNCTIONAL STYLING

"Afternoon" stage 1.

"Afternoon" stage 2.
Dynamic Principles

Three expressions are programmed to work in different light conditions, with the light of the given environment controlling the level of light in the textile.

The dynamic pattern expresses how different factors may influence each other, the environment interacts with the output, the expression of the carpet.

<table>
<thead>
<tr>
<th>Irreversible</th>
<th>Reversible</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reported</td>
<td>X</td>
</tr>
</tbody>
</table>

Direct

This pattern is classified as a reported and reversible pattern. It is programmed to act with respect to environmental light conditions.
Expressions, Rationale and Learning Outcome

It is interesting to explore the combination of expressions of light in the room and expressions of light in the carpet, and we have discussed what would be most suitable: to have a high level of light in the afternoon (stage 1), dusk (stage 2) or in the evening (stage 3). We worked in a rather systematic way, with respect to woven expression, the position of light elements and with respect to programming. The Dimma prototype can be used to inspire further developments and to experiment with specific use situations. It could be interesting to go back to the first design example, Textile Disobedience (Design example no 1) and use similar experimental design methods, placing the carpet in an anti-use situation, where you don’t want but still need light. In a cinema, in your bed room, in a rather light room at a day care centre, in the street by night, in a park under a dark tree, under a bridge, in a walking tunnel etc. And maybe it is not the room that needs to be fully lit up if you for example want to read during night, it is the book etc. We have also been discussing if this kind of lamp-carpet could fit on the wall and in the ceiling, or to cover both.
Dynamic Pattern Expression for Being Square

Pattern expression A: one specific expression

changes to

Pattern expression B: changing to x numbers of light expressions

changes back to

Pattern expression A: one specific expression

A B A

This pattern needs to be switched on, to show a light pattern, and when switched on it constantly changes and adapts to surrounding light conditions. Running the program, the carpet shows a big contrast when on or off, something that can be changed by trying out other programs where the temporal and spatial parameters are expressed in different manners.

Technical information

Tufted technique: Kasthalls own technical plan, confidential
Size of carpet: Width 140 cm, length 200 cm
Colour and material: White wool

Supplement
Light-film: Electroluminescent film sheets A3 size
Light-film colour: Pink film turns into white light, yellow-green film turns into blue-green light
Power supply: Electroluminescent film, requires alternating current
Program: Delpi, a communicative code was written to be used with a power point program, with which you can control on and off.
Microcontroller: Industrial applications for controlling input and output (I/O)
FUNCTIONAL STYLING

GLÖD (Spark)

This carpet is a mobile heat source, a carpet to heat up cold floorings. The carpet also has a pattern that changes depending on the amount of heat switched on.

The pattern indicates if the carpet is hot or cold. The temperature, or the level of heat is regulated manually. Each of the 18 heat elements are switched on individually.
Methods and Variables

Initially we looked at the TC pigment colour map (Design example no. 5) and extended it with some new colours that would fit with our project. The idea was to develop a carpet within Kasthall’s range; Polka (Kasthall, 2010), a white and red striped carpet. We looked at different colour combinations, if it would be possible to mix the exact red colour of the Polka carpets in TC etc. It turned out that we could not achieve the same intensity of red with the TC colours that we worked with. So we started to sketch with other colour combinations, we tried out a cold colour, a turquoise that would disappear when heated to make the warm red Polka appear in only red and white when heated to a maximum. The turquoise did leave a rather grey shade on the light parts on the Polka, when printing it as long lines in the warp direction. As a consequence of this we decided to change colour or/and pattern.

We made lots of sketches on the Polka carpets, in full-scale by placing different cut out paper shapes on top. As we had no experience from sketching on carpets from before, it was a good idea to do sketches in full scale, to be able to explore colours and forms directly. In parallel we also worked with different colours for the TC print.

Before we printed the carpet we did three different print experiments on the back of the carpet, to try out the pigment, the printing technique and the colours and temperature that we could achieve in the fabric quality of the carpet.

We also looked at the more general issue of how to integrate heat into carpets, both with respect to methods for integrating heat directly into a textile structure, and for methods of using separate heat elements placed under the carpet. We did a few first experiments by creating a textile structure, in this case a knitted structure, where we used a heat-yarn (Beakert HT steel yarn) (Beakert, 2010) in a similar way as presented in the pattern Being Square (Design example no.1). The steel yarn was connected to a power source and the TC print on top of the fabric gradually started to heat up and change colour, from grey to transparent. Gradually as the fabric heated up, the yarn created a fine line on the printed TC. The hotter it became, the more the heat spread in the fabric, and the fine lines changed to another shape.

This shows the knitted pieces with the “heat-element”, the Beakert steel yarn
integrated into a cotton fabric with a TC screen print on top. The steel yarn is connected in a parallel circuit and connected to a power supply, the resistance in the Beakert yarn creates heat within the fabric and colour changes appear. See pictures on page 229.

This test shows that when we gradually increase the level of electricity, the white line also changes in size and shape, from detailed lines to thicker, and eventually the entire surface changes into a white rectangular shape. The print only changes in one part of the print, where the power is attached on the back.

Following the basic direction of the Functional Styling program – to make experimental prototypes to show new possibilities rather than solving technical details – we decided to use external heat elements for this prototype. We used a specially designed metal foil, which corresponds in size and shape and fits with, the Polka patterns. We also conducted tests with foil as reflectors under the carpet, to direct and reflect the heat to the top, instead of spreading and leaking out against the back, in this case the floor.

The golden rectangles seen in the pictures are (on page 228) the heat elements (Calesco Foil, 2010), simply to be attached on an under-carpet to be placed under the printed carpet. The white rectangles on the pink printed lines show the first tests with switching the heat element on under the carpet.
Experimental use context

At first sight Glöd is striped, in two different red nuances and a pink one. The carpet also has a small glimpse of white between the woven red line and the printed pink line. The carpet is equipped with a controlling unit, where you can switch on/off 18 heat-elements individually. The colour change in the carpet also displays the level of heat that has been set. Each white rectangle indicates that one heat element is on.

When heated, the heat elements create a sharp graphical form in the pink TC print, when the heat gradually warms up or cools down, the expression resembles more closely to the softness of water colours.

It functions well to visualise, and at the same time build up, different kind of patterns on the carpet. The carpet could, depending on how the heat elements are switched on/off, build both symmetrical and asymmetrical patterns, as well as changing the overall expression from a striped carpet to a checked one if all the heat elements are switched on at the same time.
3 heat elements have been switched on.
Another combination and number of heat-elements that have been switched on.
All heat elements switched on, the maximum of heat, and a striped carpet has turned into a checked and striped one.
Dynamic Principles

It is in a use situation, by switching heat elements on/off, in a hands-on manner, that the carpet expresses differences by temperature and by visual changes.

Heat elements are mounted under the carpet, and a linear form is printed on top. This form changes into squares when heated. Two forms are corresponding: the shape of printed stripes in TC that changes due to the rectangular shape of the heat elements.

The way the dynamic pattern is expressed is to visualise how dynamic textile patterns could be used to express a temperature change, and the other way around how heat could be used for the creation of a changing pattern.

<table>
<thead>
<tr>
<th>Irreversible</th>
<th>Reversible</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reported</td>
<td>X</td>
</tr>
<tr>
<td>Direct</td>
<td>X</td>
</tr>
</tbody>
</table>

This pattern is classified both as a reported and as a direct pattern. This is because the pattern is designed to change depending on the way you use it, but at the same time the preformed expression is reported.
Expressions, Rationale and Learning Outcome

_In what different ways do the patterns use the idea of change?_

The level of heat is expressed through the intensity of appearance of white rectangles on the carpet. The equipment to control the different heat elements is one way of showing how a dynamic textile pattern could be built up by turning heat elements on/off.

Expressions and the range of different patterns are limited by the different possible combinations of the 18 heat elements.
Dynamic pattern expression for Glöd

Pattern expression A:

one specific colour expression, pink and red in a linear pattern

changes to

Pattern expression B:

another colour expression, pink lines are broken up into white and pink squares

changes back to

Pattern expression A:

one specific colour expression, pink and red in a linear pattern

A B A

Technical information

Weave technique: Shaft (Kasthalls own weaving plan, confidential)
We used “Polka”, an existing red and white carpet from Kasthalls range with flax in warp and wool in weft.
On this we printed pink TC rectangles on the white areas on the “Polka” carpet.

Supplement
Heat element: Made by Calesco Foil (Calesco Foil, 2010)
Power supply: 48 V and 30 W
Program: Basic X
Microcontroller: BX24
Reaching Audience

The *Functional Styling* program has been presented at Sensuous Knowledge 4, Bergen National Academy of the Arts, Bergen Norway, 7-9 November, 2007

Project contribution

Project initiative, project application and budget (Vinnväxt project within Smart Textiles) was done by me. I also planned the start up workshop with Kasthall. Workshop participants at Kasthall: Magnus Ryd, Kjell Brobacke, Göran Wikmark, Bengt Hallberg, Peter Eriksson, Gunilla Largerheim Ullberg, Siv Andersson, Fredrik Gabrielson, Karl- Magnus, Daniel Jonsson, Anna Schou, Peter Otell, Peter Magnusson.

Gunilla Lagerheim Ullberg (chief designer), Peter Magnusson (product developer), Peter Otell (product developer) and Anna Schou (product developer) from Kasthall and Anna Persson and myself, have worked together in discussions and with the design of the final prototypes, which covers material choices, colour, interaction, programming and electronics specifications. We have had an open and close discussion. The printings on *Glöd* are made by me, Anna Persson was responsible for knitting and the design of the sensors. Electronics and programming was done by Christian Mohr. Woven samples and woven carpets were made by Immi Bäcklund and Lars-Göran Kjällquist. The tufted carpet and sample were made by Stefan Andersson and Mathias Andersson.

The collaboration with Kasthall AB has developed the work concerning the investigation of how to design dynamic textile patterns, into a specific product range and context, i.e. working together with the textile industry and professional working designers and product developers. Still, the result presented here is a matter of experimental product development. There is still a
gap to bridge between results in experimental design research and commercial product development. If any of the carpets would be subject to a product developing process all steps in the design process as well as the result would have to be related to the context and limitations of commercial product development and production.
BURNING TABLECLOTH

Design example no. 8
2006-2007

Project team: Anna Persson, Hanna Landin & Linda Worbin

This design example is about designing a dynamic textile pattern that changes during use. Compared to the other design examples that have been presented in this thesis, it differs by not being reversible. A textile expression is gradually being built up, and may change from time to time, but does not change back to an initial expression.

This design example also investigates and exemplifies how information could build temporal textile expressions.
Methods and Variables

Burning tablecloth was inspired by the idea of using textiles to investigate computational technology (cf. Hallnäs, Melin, & Redström, 2002). But in this experiment computational technology was used to investigate how to create a dynamic expression in textiles.

We started out by making knitted and woven textile samples with circuits in Kanthal wire (Kanthal, 2008) interwoven into traditional textile structures and materials; wool, cotton and polyester etc. When switching on the electrical power we produced a burnout textile pattern. Experimenting with various textile structures we explored different patterns by connecting the textiles to a power source. The Kanthal thread is a metal wire that starts to glow when connected to a relatively low level of electrical power – the material is used as heat element in toasters etc. As the Kanthal wire starts to glow other materials in the textile starts to react, man-made materials like polyester by melting and cotton by a light brown colour change to begin with and later by burnt out holes (Persson & Worbin, 2008). To be able to control the degree of melting and burnouts we made a series of experiments which systematically tested materials at different levels of electrical power.

We also tried out combinations of an underlying layer and a top layer of textiles, to avoid having to embroider the component by hand, and integrated conductive wires in a woven fabric placed underneath the knitted top-layer. This is something that could be further developed, if one would like to make a larger piece. But it limited the possible expressions/patterns in a more static way, although in this state we had been working with under-fabric in a shaft woven technique. This technique was not so reliable; the connections were not tight enough and could of course also cause sparks. To work with sparks in burnout textiles is interesting from an expressional standpoint, but would not be possible to control in the way we wanted. How the material in this set up reacts when heated, depends on a range of factors, such as the textile construction, voltage, time and the level of oxygen in the given environment etc. Several of these parameters are hard to predict in a precise way, but it also gives an interesting expression to the textile pattern. It is something that in a way can be compared to a handcrafted piece of fabric/and embroidery, where you could track/feel the individuality from a handmade piece. This kind of textile pattern is not handmade in that sense, it could be industrially produced, but the expression could, by the lack of exactness in the expressi-
BURNING TABLECLOTH
on, give the expression a trace of craft. For example, when recording the Burning Tablecloth on video we used a draughty floor in a basement, something which influenced the overall expression. The pattern spread in the fabric in a specific way, differing from the tests that were made on tables under a fire protected area at SP (SP, 2010). When hanging vertically the tablecloth started to burn with flames, compared to what happened when lying on a table when it was glowing in a more powerful way and also developed more smoke.

After conducting several tests with respect to materials, techniques and voltage, we made the Burning Tablecloth as a single layered textile/tablecloth with hand embroidery in copper wire. The copper wire creates a parallel circuit in the Kanthal wires (that was integrated during the knitting process). When the power supply is switched on the copper wire leads out the power in a parallel circuit to the Kanthal wire.

The high resistance of the Kanthal wire makes the material glow, and eventually it starts to burn. The highly conductive copper wire will not be heated, it just transport the electrical power.
BURNING TABLECLOTH
The material under the tablecloth also influenced the burnout pattern. We tried to put a glass fibre safety blanket underneath. We also made some burn out tests with a heavy weight paper underneath, something that could be further developed, for example by using this burnout technique to create a kind of surface pattern.

For the Burning Tablecloth, we decided to use a 100% cotton yarn in combination with a Kanthal wire. A large-scale knitted piece was created, and in that piece we made an embroidery with a conductive copper wire (by hand) at the back of the textile. This conductive wire was intended to create a parallel circuit integrated with Kanthal wire. We made connections in the wire ends to plus and minus poles. We conducted a few tests by connecting several sections with the same minus poles, but it was hard to grasp the influences due to the length of wires etc. We then took a step back and made individual connections to each of the sections (that would be burnt out later on) in the textiles.

Experimental use context
This tablecloth is designed to display a textile pattern that is gradually built up over time, in this case depending on mobile phone activity. By using different kinds of information to switch on/off the power to the tablecloth we can build up a trace/decoration over time. The focus here is to show how a textile pattern could be pre-designed to display different expressions at different times, the actual change could also be connected to other kinds of information.

Our intention was to arrange a dinner with wire less connections to all guest mobile phones, a similar set up and technique that was implemented in the Fabrication Bag (Design example no. 2). When enjoying your meal, activity in yours and the others mobile phones will create a burnout pattern in the tablecloth.

We exhibited the design experiment in a static form, where we in advance, at a safe place, burned the patterns and changes in the tablecloth. The actual burnout process was documented on video to show the changes over time.

The film was projected on a tablecloth during an exhibition to visualize the burning patterns, and even show the smoking patterns, without risking a fire, but without the smell when burning, and the “real” experience with dinner guests. Still, it gave us a good idea about the complexity and possibilities in further development.
Dynamic Principles

This textile is initially single coloured. During use, a pattern starts to “grow” on the surface, it is both a change in colour and a change in textile structure and texture.

This is an irreversible textile expression, and a textile expression that is gradually built up over time.

<table>
<thead>
<tr>
<th>Irreversible</th>
<th>Reversible</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reported</td>
<td>X</td>
</tr>
<tr>
<td>Direct pattern</td>
<td>X</td>
</tr>
</tbody>
</table>

This pattern is classified as a reported pattern, the areas where the burnout will take place are preformed, but it is impossible to predict or control how it will be expressed with respect to size and colour. Thus it is also a direct pattern, the way the burn-out is expressed is due to a given context, the amount of oxygen in the environment, how the threads are connected in the loops (the textile construction), how long the power is switched on/off in specific given area of the textile.

Extended design variables that influence the expression:

Voltage
Time that electrical power source is turned on
Textile material and construction
Areas where electronic components are connected (to the conductive material in the textile)
User context/interaction
Amount of oxygen and airflow in the surroundings
Filming of the burn-out tablecloth and close-up front and back of the burned-out pattern.

At exhibition, un-burned tablecloth, set dinner table and a projection of the burning tablecloth.
Expressions, Rationale and Learning Outcome

When designing an irreversible pattern using this non-chemical burnout technique, the designer needs to handle new design parameters. At what voltage does the material react? What does the reaction start with; smell, smoke, colour changes or burnouts? How long should/could a specific voltage be used (before the material totally disappears)? What will the textile pattern change from and into?

The experiment displays principles for how to design a kind of “growing” textile pattern. We have created a repetitive expression, the areas in which the burn out will take place, but in what order and in what way the burnout will take place is depending on what happens during use.

The result is a new design technique where we, in a non-chemical way, can design both traditional and dynamic textile patterns built up from a real time digital source. A pattern making technique, where you do not need to use chemicals on a textile. You more or less “toast” your fabric with a pattern.
Dynamic Pattern Expression for Burning Tablecloth

Pattern expression A:
a single coloured white surface

changes to

Pattern expression B:
dark and light brown patterns appears on the white surface, and in the structure by burning holes

changes to

Pattern expression C:
the dark and light brown patterns and structure changes are gradually increase in numbers

A B C

Technical Information

Knitting technique: Flat knitting
Yarn: Kanthal wire and cotton
Colour and material: White cotton and Kanthal (natural metal colour)
Size: Width 100 cm and length 140 cm, in the centre an active area in size of 50 X 90 cm
Repeated knitted pattern (active area): 10 cm, with total amount of 7 courses of kanthal wire. Kanthal wire is repeated every cm (with a distance of 1 cm = 6 courses of cotton yarn) for 6 cm then it is a plan knit in cotton for the rest 4 cm of the report
Repeated burnout pattern: the burning area are prepared to be 7 X 6 cm, embroidered to the Kanthal threads

Supplement
Copper wire integrated by embroidery
Power supply: 1,5-30 V from a transformer, 220 V
Reaching Audience

Publications


Exhibited at

*Textile Possibilities* Rydals Museum, Rydal, Sweden, 1 June-12 October, 2008
Production by Linda Worbin, Anna Persson, Amy Bondesson, Hanna Landin and Rydals Museum

*Design competition with exhibition* Cumulus, Kyoto, Japan, March 2008
Production by Cumulus

Project contribution

The experiment was done jointly with Hanna Landin and Anna Persson. We were all involved in the overall discussion and conceptual development with different areas of responsibility. My main focus was how to design for an irreversible dynamic textile pattern. I was also running/burning a whole tablecloth (manually, by turning on and off power manually, to test the expression and burn-out capacity) and documenting the process and changing expression on video.
SUMMARY
Textile Design Expressions in Dynamic Textile Patterns

To be able to design with new types of building blocks - new types of design variables - with quite unexplored qualities, we need to break them down into elementary and very basic components. Each design example has its focus on such elementary building blocks and with respect to specific design variables.

In Textile Disobedience (Design example no.1) an overall foundation for the thesis is presented, together with an overall aim to turn traditional textile design conventions a bit up side down. This example explores colour changes in a heat sensitive pigment by experimenting with heat and textile patterns in TC.

To begin with a simple colour changing print was made, with porcelain cups containing hot water placed on top. After that, different heat sources to be placed underneath the textile were introduced, and later on the heat sources were integrated into the textile structure by weaving with special heat emitting textile structures.

This design example exemplifies some basic principles for the design of dynamic textile patterns; let go of the conventional thinking with respect to designing textile patterns, and be aware of the kind of object/material that will initiate the change, and whether it is an external object or integrated in the given textile.

In Fabrication Bag (Design example no. 2) digital information is connected to a textile pattern. The expressions of the bag depend on, and correspond to, activity in a specific mobile phone, and it changes expression from dull to colourful.

In Textile Displays (Design example no. 3) we the dynamic form elements are explored by making three repeated patterns out of basic forms; squares (filled form), circles (outline) and lines. This example explores how traditional basic textile design forms change when using dynamic materials. It is not only the squares, circles and lines that constitute the elementary forms, but also a collection of basic transformations between them.
The Costumes experiment (Design example no. 4) is a bit similar to the Being Square experiment (Design example no. 1) with respect to the construction techniques; heat-emitting material is weaved into the textile with a TC print on top. Activation of the pattern is central in this experiment; human movements in time and space. Using three circuit costumes/dresses you “paint” a wall hanging with certain movements. The change in textile expression is in real time; a new pattern appears on the wall hanging as you perform certain acts.

Graffiti Cloth (Design example no. 5) explores the possibilities within dynamic colour ranges and printing techniques, such as overprints and raster as well as printing with open silk screen frames. A colour map was made which presents TC colours individually and in a mixture, as well as in combination with pigment colours, giving an overview of the possibilities and limitations in using dynamic colours within a textile design context.

Do Pattern (Design example no. 6) further develops the expression with respect to interaction with external objects. A printed form in TC is designed to correspond to the form of an external object, a porcelain cup. The cups create a mark/stamp/pattern and human actions shape the final pattern expression to a large extent.

Functional Styling (Design example no. 7) shows large-scale prototypes made in close collaboration with the textile industry. The design examples are closely related to several other design examples and previous experimental design work; the carpet Spår (Traces) is closely related to the Interactive Pillows (Redström, Redström & Maze 2005), but in this example the same object is used both as a sensor, picking up the signal (the foot step), and an actuator, activating a light pattern within the textile.

The carpet Dimma (Foggy) uses programming and electrical equipment similar to Textile Displays, (Design example no. 3), but is made to react to ambient light conditions, which means the expression is set to depend on environmental conditions.

Glöd (Spark) is related to Textile Display (Design example no. 3) and Being Square (Design example no. 1) and in this example there are 25 heat elements that we can change manually over time. The more heat that is turned on, the more the linear printed pattern changes into a rectangular pattern.
Similar to the Fabrication Bag (Design example no. 2), the Burning Tablecloth (Design example no. 8) builds on information about mobile phone activity. But unlike all other design examples this textile pattern does not change back to an original expression. It shows, by burning, a continuously “growing” expression.
Dynamic Design Variables

Dynamic design variables from the design examples are collected and classified as:

Material and techniques

- Printing technique
- Colour mixing
- Textile material
- Textile techniques
- Combination of TC and conventional pigment
- Areas where electronic components are connected (to the conductive material in the textile)
- Textile material and construction
- Textile material and structure (in relation to temperature)

Time

- Time that the textile is exposed to heat
- Time that pressure is applied on a textile
- Repetitions in time (for example to control the time that an electrical power source is turned on/off)

Interaction

- Bodily movement, specific gestures, pressure (walking, jumping, lying, pushing etc)
- External objects (porcelain cups) touch/stand on/are exposed to the textile
Surroundings/ambience

Surrounding conditions, for example amount of oxygen and airflow
Temperature of heat element in relation to ambient temperature

Dynamic form expression

Shape of heat element (in relation to shape of the printed form)
Shape of printed/woven etc. form elements (in relation to shape of heat element)
The level of voltage
Digital information connected to x specific expressions
Program (when and how a change should appear, combinations/rhythm of change etc)

Some new design variables are here divided into different sections, to get a better overview. Still, it is hard to make a fair division amongst the building blocks because they all strongly influence and interplay with each other.

In Do Pattern (design example no.6), for example, the textile pattern was designed in terms of the quality of the textile and in terms of interaction with external objects, a specially designed cup. In some sense this is similar to how the wind is crucial for the expression of a flag. When you design a pattern like Do Pattern, the textile designer needs to/could design more than the textile to grasp its full expressional potential; to use the wind or to design the interaction with external objects etc. more consciously.

Depending on what the textiles are “loaded” with and how they are designed and produced, the frame is set for how the expression will adapt and react on external stimuli. Dynamic textile patterns introduce the context as a design variable in a new sense. It is an extended design space where “textiles” somehow function as a new “raw” material, a display for dynamic patterns.

Basic guidelines for new building blocks when designing dynamic textile patterns can be summarized as follows: interaction between objects, inherent potential of the materials, digital information, human activity, temporality, spatiality, dynamic colours and dynamic form. These building blocks need to function in a balanced way as they actively influence and overlap each other.
SUMMARY

To highlight new qualities and possibilities when designing for a dynamic expression we can revisit basic traditional form variables to try to understand the change in design practice that dynamic textile patterns initiates. It is both a matter of understanding things like “dynamic line” etc. but also a matter of understanding the change in the variable “line” etc. that dynamic textile patterns introduce:

*Conventional Textile Form*
Forms can be described in terms of basic geometric structures such as points, lines, rectangles, squares, circles and various organic forms.

*Dynamic Textile Form*
A dynamic form could implicitly contain all sorts of conventional forms as it varies from time to time, at one moment it displays one specific geometric structure, later it changes into another, and so on.

*Conventional Line*
A line indicates a direction and could be curved or straight, long, short, thick, thin, ragged, sharp, light, dark etc. It creates complex structures, gives depth, etc.

*Dynamic Line*
A dynamic line could implicitly express all sorts of lines; it could be long at one moment and short the next, change direction, shape, thickness etc.

*Conventional Space*
Conventional space is the space between forms, lines and/or the area around the background which can be a negative or positive space, solid or opaque, linear, outlined or revealing shapes in layers etc. It can also vary in size, colour, texture etc.

*Dynamic Space*
A dynamic space changes, a form that stands out at one time and then reverts reversst to the background. It can contain all sorts of deformations and combinations of conventional space etc.

*Conventional Colour*
For a textile designer a colour system is a basic tool for defining a colour,
i.e. the Natural Color System (NCS, 2010). As textile designers we use such systems to track and describe a specific hue etc.

**Dynamic Colour**

A dynamic colour could be a colour that disappears temporarily, to reveal the underlying colour in a fabric, or another printed colour could become visible. From grey to pink, blue to yellow etc. It is still an open issue how to handle these factors in a systematic way in the textile design practice.

It is an inherent change, a movement, that the dynamic form variables are adding in textile design. Dynamic textile patterns somehow change textile design in the direction of the “time-arts” were movements, gestures and temporal issues are the foundation; film, dance, music and gardening with their changes in nature etc.

The form variables and their expressions refer to an interaction between temporal and spatial components. The temporal dimension is crucial for the expression of a dynamic pattern and influences the overall expression in a basic manner. Compare, for example, the time variable in the design examples *Spår* (the carpet with a linear pattern that appears when you step on the carpet) and *Do Pattern* (the cups that leave traces on a tablecloth). Both examples react with an instant change, by internal change or by placing an external object on top of the fabric. While *Spår* is programmed to be turned on and to fade away in a precise manner, one could say that *Do Pattern* is designed to also react more in connection to spatial conditions, temperature, human intuition and playfulness, it is a pattern that will appear, but with room for personal interpretation and expressions.

Dynamic form variables should be balanced with respect to:

- What initiates a change
- When a change appears
- Where a change appears
- Why a change appears
- The amount of expressions that should appear
- Whether the change should be subtle or distinct
- Whether the change should be made manually or digitally

They should also be balanced with respect to design methodology, design techniques and design material qualities etc.
Classification of Textile Patterns

The classification of textiles in (Geijer 1972) describes in what way a textile pattern is created, and their different basic expressional possibilities, and is divided into the three areas:

Plain weaves: A weave without decoration, that could have different after treatments in structure, printed colours or embroidery.

Monotype pattern (direct pattern): A way of making a decoration/pattern during weaving, craft, tapestry etc.

Repeated pattern: A decoration/pattern that is prepared in advanced, for mechanical production, reports etc.

Geijer makes her classification with traditional static textile patterns in mind. To get a more systematic overview of how to design with new textile materials, we build on Geijers work by adding new dimensions in the classification:

Reversible Dynamic pattern: A textile pattern that reacts to environmental stimuli and always returns to a given initial expression. There is a starting point and x numbers of possible expressions.

Irreversible Dynamic pattern: A textile patterns that changes during use and does not return to an initial expression, the expression is built up over time.
Expressions and Rationale

To design a dynamic pattern means to involve new design variables, to design with and for repeated patterns with an ability to change from one to several other expressions, reversible or irreversible. The design examples aim at displaying suggestions of some basic principles for the design of dynamic textile patterns, by changing form, colour or by turning on or off light elements, integrating heat, connecting data etc.

The design examples aim at presenting basic knowledge for how new expressive materials influence and widen the textile design expression, as well as the profession, and give suggestions for how traditional textile design variables can be “updated”.

Similar to schemata for musical form, we can for instance describe the basic temporal form of a dynamic textile pattern by listing pattern components in series such as A B A, which indicates two elements that both can be seen as traditional static textile pattern and a transformation from one state into another.

When the characteristics of textiles change, the roles of designers and users change with respect to textile products. The notion of a textile as the “final” product will be different from what we today get out from traditional industrial textile processes.

In the future we may view textile as a raw material more and more in a new way. After the actual production there is something to use for lighting, sharing information, comfort etc. with the ability to be given several expressions, and thus functional differences during use, in new ways; it could be that you can sign up for a subscription of design expressions or feel your mail through the carpet.

The transfer into a digital era has a strong influence on the making of artefacts. Digital technique is also changing the textile expressions and textile design:

*Textile expressions change during use; we may design a textile that is white in one state and colourful in another, or change from a repeated pattern to a single form etc. This means that the production of the textile is not where the textiles get*
its “final” expression. During production a dynamic textile gets its raw expression with a potential to change and develop during use.

Dynamic textile patterns can be used to express information of something, by using traditional aesthetical design variables such as colour and form in new ways.

The expression and language of textiles has been enriched to include more or less readable information, or the other way around; aesthetic has been filled with a new aesthetic functionality.
References


Baurley, S 2004, Interactive and experimental design in smart textile products and applications. Personal and Ubiquitous Computing, 8(3/4), pp. 274-281


Braddock, S & O´Mahony, M 1998, Techno textiles: revolutionary fabrics for fashion and design. New York: Thames and Hudson

Braddock, S & O´Mahony, M 2005, Techno textiles 2: revolutionary fabrics for fashion and design. London: Thames and Hudson

SUMMARY


Costumes 2006, film, Lundstedt, L. University of Borås, Sweden


Ernevi, A Eriksson, D Jacobs, M Löfgren, U Mazé, R Redström, J Thoresson, J & Worbin, L 2005, Tic Tac Textiles. In proceedings of the conference for cultural heritage and the science of design CUMULUS (International Association of Universities and Colleges of Art, Design and Media)


Geijer, A 2006, Ur textilkonstens historia. Hedemora: Gidlunds förlag


Hallnäs, L & Redström, J 2006, *Interaction design: foundations, experiments*. The Swedish School of Textiles, University of Borås: The Textile Research Centre and Interactive institute

Hara, K 2007, *Designing Design*. Baden, Switzerland: Lars Müller Publisher


Landin, H & Worbin, L 2005, The Fabrication Bag- An Accessory To a Mobile Phone. *Proceedings of Intelligent Ambience and Well-Being (Ambience 05), Tampere, Finland*
SUMMARY


Millar, I (ed.) 2005, 2121 the textile vision of Reiko Sudo and Nuno. Canterbury: University College for the Creative Arts


Robertson, S Taylor, S Christie, R Fletcher, J & Rossini, L 2008, Designing
with a responsive colour palette: The development of colour and pattern changing products. Advances in Science and technology Vol.60, pp. 26-31


Seymour, S 2008, Fashionable Technology: the intersection of design, fashion, science and technology. Wien: Springer


Tao, X (ed.) 2001, Smart fibres, fabrics and clothing: fundamentals and applications. Cambridge: Woodhead

Textile Dimensions 2008, film, Lundstedt, L. University of Borås, Sweden

Textile sounds, 2008 sound sampling and mixing Hallnäs, L & Persson, A. University of Borås, Sweden


Worbin, I 2006, *Dynamic textile patterns, designing with smart textiles*. Licentiate thesis, Department of Computer Science and Engineering, Chalmers University of Technology and The Swedish School of Textiles, University of Borås


ACKNOWLEDGEMENTS
Thank you Lars Hallnäs for guidance, confidence, freedom, reading, thinking and asking me the right questions through the years. You have almost made me crazy with your ideas on things, but I am so grateful for that. You have helped me to glance and perceive the world from a much wider perspective.

Thank you Johan Redström, for your engagement, supervision and discussions through the years. Thanks to all co-writers: Amy Bondesson, Daniel Eriksson, Anders Ernevi, Lars Hallnäs, Lars-Erik Holmquist, Margot Jacobs, Henrik Jernström, Hanna Landin, Peter Ljungstrand, Ulrica Löfgren, Ramia Mazé, Caroline Müller, Anna Persson, Johan Redström and Johan Thoresson.

Thank you everyone at Kasthall Carpets AB for the collaboration in the Functional Styling project. A special thank you to Gunilla Lagerheim Ullberg, Peter Magnusson, Peter Otell and Anna Schou – it’s been lovely to work together with you.

Thank you for collaborating with me during the making and building of the exhibition “Textile Possibilities” at Rydals Museum: Amy Bondesson, Delia Dumitrescu, Hanna Landin, Christian Mohr, Anna Persson and all the fantastic people and staff members at Rydals museum, especially Ulrika, Staffan and Lars-Göran. It was great fun and what a fantastic atmosphere you have there.

Thanks to Lotta Lundstedt for filming and editing several hours of film.

Thanks to teachers and students at the Swedish School of Textiles for collaboration and an overall enthusiasm and discussion about smart textiles, especially Erik Bresky, Kristina Ahlström Gustavsson, Helena Engarås, Barbara Jansen, Marie Ledendal, Linnea Nilsson, Tommy Martinsson, Fredrik Wennersten and Margareta Zetterblom. Also to my former teachers Barbro Petterson and the late Ulla E.son Bodin for arranging exhibitions and supporting our research within the field of smart textiles at The Swedish School of Textiles.

Thank you, Marjan and Jeaninne for sharing my interest in the design of dynamic textile patterns. It has been an instructive pleasure to guide and follow you in your work.

Thank you Max Sjöholm for proof-reading and Karin Süld for advice regar-
I am also grateful for suggestions and advices from Jan Berg regarding pictures and to Malin Alfredsson for some of the picture adjustments.

Thank you, Mathias and Vera for dinners and home-made bread, and for hanging around with me on fun (and for you, sometimes boring) excursions. I am enormously grateful to you Mathias for sharing my thoughts and for great input, reading and discussions that have improved my research. And thanks for sharing a lovely everyday life with me.

Funding acknowledgment

- Vinnova "Smart Textiles", 2007 ongoing
- Vinnovas Vinnväxt initiative “Smart textiles”, 2005-2006
- Textil and Fashion Factory at Espira for housing me in a studio during 2005-2007
- Torsten Dahlin stipendiet, from SVID Stiftelsen Svensk Industridesign, 2008
- IASPIS (International Artist’s Studio Program in Sweden 2005
- Wilhelm and Martina Lundgrens Vetenskapsfond 1, 2005
- Tekoutbildningarnas Stipendiefonder 2005
- Wilhelm and Martina Lundgrens Understödsfond, 2005
- “Pagrotskyrrumets Designstipendium 2005” from Svensk Form
- "Forskningsstipendium 2005 till kvinnliga forskare vid Högskolan i Borås"