Introduction

It is the possibilities to create dynamic textile patterns in “Smart” Textiles that is in focus in this report. The result will be presented in form of different material and pattern samples. The samples show both different technical solutions and interactions needed to develop a dynamic textile pattern.

My intention with this work is to enlarge the use of a decoration, as something more than a static extra value. We do have a need for beautiful things in our surrounding and I want to explore how dynamic patterns could give decoration an extended use. Where new kinds of values can be included, interaction and the information. The result can be applied in further research concerning both wearables, fashion, soft furnishing as well as for public environment for communications.
Inspiration

A mixture of nature, technology and aesthetics has been the inspiration of this work. In nature endless changes goes on during night and day and through the seasons. Walking outside after a snowfall is a bit like creating with “Smart” textiles. Colours and shapes change and some are hidden until the temperature changes.

Parallel to the work with this report, I have worked in a research group at the Interactive Institute, with the project “It and Textile”\(^1\). Having the possibility to work in an ongoing research project gives opportunities to meet and work together with inspiring people and to share knowledge. Participating in workshops, writing articles and visiting conferences and being a participant in the project “It and Textile” has been a great source of inspiration during this work.

Problem area

Usually my design process concerns reflecting over shapes and colours and then redoing them. By enlarging or minimizing them, reporting them and changing colour. Much of that work is initially done by sketching on paper and further on

\(^1\) More information to be found on www.play.tii.se
this is transferred to textile material. It mainly concerns creating a decoration and by doing that an extended value is given to a textile. This work is often driven by personal taste, tradition and trends.

All this goes this project as well, but when working with for example colour-changing materials my experiences some times become useless. Since “Smart” textiles function in new ways and I don’t have full knowledge about the properties of these new materials, it is easy to start working with them as if it was similar to “ordinary” textile materials. But it is not. Sometimes it feels like working with invisible ink. That’s why much of the work concerns experimenting directly with the materials because it is hard to think in advance on how these combinations of patterns and materials will work together in reality.

**Delimitation**

This work will focus on how dynamic textile patterns can be created both technically and aesthetically, but no work will be done concerning power supply and sophisticated programming.

When working with the textile industry you often aim to solve problems like durability, colour fastness, price and more.

It is not that kind of problems that this project aim to investigate but some reflections and thoughts on the matter will be presented in the chapter “Discussion”.

Instead of limiting the work with all the realities of production, the design process will be brought forward – how to create dynamic textile patterns. The samples are not made altogether manually, like handicraft, rather industrial solutions and techniques are used but in a handicraft way.
Purpose

The purpose with this project is to investigate and develop dynamic textile patterns made out of “Smart” textiles. This will be done by making prototypes that illustrates several possibilities to create dynamic textile patterns.

Questions:

- How can dynamic textile patterns be created using “Smart” textiles?
- What extended properties will dynamic textile patterns give compared to traditional textile patterns?
Background

In this chapter an overview of “Smart” textiles, related research projects and my thoughts about textile patterns will be presented.

Overview of “Smart” textiles

Today there are some different terms used for textiles made out of fibres with possibilities to interact with its surrounding environment. It can be fibres that can react directly with a change of colour to parameters in the environment like temperature, light or pressure. They are called “Smart” textiles, “intelligent fibres” or chameleon fibres. I will use the term “Smart” textiles, but I am not sure this is the perfect term. Here are some examples of “Smart” materials:

Photo chromic: interacts with ultra violet light (sun light) and UV-lamps
Thermo chromic: interacts with temperature changes
Electro chromic: interacts with electric currency
Piezo chromic: interacts with pressure

It can also be a fibre that carries information, for example conductive fibres. There is a wide range of “smart” materials available; optical fibres that carries out (light) signals, electroluminescent materials that are light emitting. Other dynamic materials like Shape Memory Alloys (SMAs) or Memory Metals, has the ability to change form depending on temperature or/and currency. And there is a lot more.

In this work thermo chromatic silk screen print, conductive fibres and electro luminescent wire are further investigated together with more common textile fibres like cotton.

Thermo chromatic print
During the 1980s thermo chromic colour-changing materials where used in skiers clothes to change colour depending on temperature in the slopes and for t-shirts that could show a mark of for example your hand. So mostly they have been used to be heated up with external heat elements, like the sun or body heat. Thermo chromatic silk screen paint for textile can be made by adding microcapsules of liquid crystal to a colour paste. The light will be reflected differently depending of the molecules position, and the position is controlled by temperature.
Conductive fibres
Carbon fibres are a kind of conductive fibres with large resistance that creates heat when connecting power. In car seats a carbon weave is used to heat up the seat during winter. There are other kinds of conductive materials like metal wires and conductive polymers.

Electroluminescent materials
This electroluminescent material emits light when power is switched on, so no light source is needed. This material can be found both as film, wire and silk screen paste. The material is made out of phosphor and conductive materials. In the wire there is a phosphor core with a thin metal wire wrapped around it. When the power is turned on it will glow as long as the power is on. Around the core and the metal wire there is a plastic shelter that can be either transparent or in a wide range of colours.

Some information about “smart” textiles comes from Torbjörn Dartman at Ifp SICOMP\(^2\). During the work I have had the possibility to meet with him and we have been talking about how to integrate electricity into a weave, what materials to use and what techniques that is possible to use today. Together we have tried out the conductive properties in carbon fibres and made a small scale sample. Ifp SICOMP has also supplied the project with carbon fibre yarn.

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\(^2\) Ifp SICOMP is a Nordic institute for composites, fibre and textiles, and rubber.  
[www.sicomp.se](http://www.sicomp.se)  
T. Dartman (person to person communication, winter 2003)
Related research projects

IT and Textile

“IT and Textile” project is a project run by the Play Research studio at the Interactive Institute. I have been participating in this project both before and during my master theses. In the project different textile materials and its properties in combination with information technologies have been investigated. The aim has been to explore how to use computational technologies as a design material where textile can be the visual material. There is a wide range of results; exhibitions, scientific papers and presentations both at conferences and textile companies. One of the more experimental sub projects is the ongoing “Draft” project. Here we investigate how time can be a central parameter when creating a textile pattern.

“Draft”

“Draft”; depending on how long time the guests stay at a table, the larger and more colourful the pattern will become for next coming guests. The table cloth is made in a photo chromic fabric and ultra violet- light is used to “create” the patterns.

One project that gives an example of the combination “IT and Textile” in a more obvious way is “the interactive pillows”. The pair of pillows works like this; one of the pillows is placed in your sofa at home and the other one in a friends or a relative’s home. If you lean back to your sofa a pattern will appear on the other pillow and vice versa. The pillows are made of electro luminescent wire and wool.

3 www.tii.se and www.play.tii.se Play Research in Gothenburg
4 http://play.tii.se/projects/itextile/draft.html
The interactive pillows when they are inactivated and activated.

Other examples

Early projects with electronics integrated into textile were done at MIT (Massachusetts Institute of Technology). One project is E-Broidery\(^6\) and one example from is Musicball. Here an embroidery out of conductive treads served both as a decoration onto a ball of fabric and as the medium to make a connection. When squeezing the ball you could hear music. Another interesting project is the Electronic Tablecloth\(^7\), where a table cloth is used to communicate with a computer. This work is a part of a larger concept called interactive furniture. The "Electric Plaid"\(^8\) by IFM, is a weave that can change from one pattern to another. They describe it as a plaid made in a double weave where you can turn on and off different textile patterns in the weave.

“Loop”\(^9\) is another project where parts of the textile can be turned on and off. The project concerns visual communication indoors and the material used is electro luminescent, both screen print and wire. The areas and the patterns are interactive and react on different things in the surrounding. One example is a blanket that starts to glow, so instead of using an alarm clock you will wake up to your bed linen giving off light.

The examples above are not in industrial production, they are more or less parts of research projects or art installations and can be described as a kind of modern digital craft. Many of the examples need power supply to create a dynamic pattern, something that need to be solved in a proper way before we will see these kinds of products on the market. But there are some companies producing dynamic textiles, one is Luminex\(^10\) that creates a sparkling and glowing fabric out of fibre optics and where power is

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\(^8\) www.ifmachines.com/
\(^9\) http://loop.ph/new/research.html
\(^10\) www.luminex.it
supplied by batteries. The fabric cost about 360 US dollar per meter. The use is most for Wearables and exclusive home decoration.

At Royal College of Art in London there is an ongoing research project called Equator11. This project is a six-year interdisciplinary research collaboration between RCA, University of Lancaster, University College London, University of Nottingham, University of Glasgow and Kungliga Tekniska Högskolan in Stockholm. The main goal is to investigate the interweaving of the physical and the digital worlds by developing innovative systems. The Interaction Design Research Studio at RCA is looking at the home as the area where the new technology could be used. After half time in the project they had come up with prototypes for “Electronic future for the curious home”.

*Drift table* is a table that show the English landscape from above, what you see depends of the weight of things placed on the table. On a small display you can even read where you are.

*Key table* get a sense of people’s emotions from the way they put things on the table. To inform other people of a person’s mood a framed picture is hanging over the table, and emotional entrances cause the frame to swing. This can be seen as a warning to the household’s inhabitants.

*History tablecloth* is a table cloth that tells you a story about the objects that have been placed on the table. By the weight of the objects a pattern is activated. During the winter of 2003 I meet Bill Gaver at RCA and got information about their ongoing work with Equator and during spring 2004 I visited Lancaster and had the possibility to see the “History table cloth” in action. The work has given me lots of inspiration and many similar thoughts can be found in the book Hertzian Tales12. This book presents products, aestethical experiment and critical design.

**Wearables**

Within the area “Wearables” many new possibilities like communication, safety and entertainment are integrated into clothing and accessories. By using interactive technology, and in some cases “Smart” textiles, the items are given extended properties. It can be seen as built in devices giving information or using specific “Smart Textiles” to receive or send out information. During the exhibition “WEAR ME: An Exhibition of intelligent garments, wearable technology and smart materials13IEE Eurowearables’03” many inspiring projects that used “Smart” textiles for Wearables were presented.

Much of the development comes from the space industry but there is also much happening in the field of technical textiles14 and in the field of sports clothing15. It is in these fields that the producers feel a need and potential for product development. This is an area for ongoing research at universities, institutes and the research departments at companies all around the world. When it comes to

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11 Equator is an ongoing research project between Royal College of Art, University of Lancaster, University College London, University of Nottinghill, University of Glasgow and KTH in Stockholm. B. Gaver (personal communication, 14 November, 2003)
12 Dunne, A. 1999
13 www.conferences.iee.org/eurowearable/wearme.htm
14 O’Mahoney, M. Braddock, S. E, 1999
15 O’Mahoney, M. Braddock, S. E, 2002
sports clothing “Smart Textiles” already exist in some of our closets. For example there are clothes with vitamins included, micro-controlled sports bra/top that changes with the movement of the one who wears it.

Elise Co at the MIT Media Lab has created the "Puddle jumper", a luminescent raincoat that glows in the rain. Hand- silk-screened electroluminescent lamps are printed on the front of the jacket. When the rain falls and hits sensors on the back and on the left sleeve the lamps light up and create a flickering pattern of illumination that mirrors the rhythm of falling rain.

Further on, another project is "The Epidermis Interface” New Technology in Wearables Technology and Fashion. A project made by Sabine Seymour and Katherine Moriwaki at Parsons School of Design\textsuperscript{16} during 2002. One project is the "Dynamic-T" (by Naiying Kuo) where the pattern can change unpredictably.

\textsuperscript{16} http://a.parsons.edu/~fashiontech
Planning for creating dynamic textile patterns

The work process started earlier than January, but this is the official plan. Writing the report has been an ongoing task during the period.

January

Sketches and material experience. Working with hand made silk screens and sketches on film, paper and directly onto fabric.

February

Started to make woven samples for silk screening. Important to get woven samples early so there is time to go back and do changes. Working with silk screens onto woven fabric with conductive yarn integrated. Making samples with the electroluminescent wire.

March

Woven samples are ready to print on.

April

Pattern and silk screen frames are made. Printing.
Translation of report from Swedish to English.
Prototypes will be connected and supplied with power.

May

Preparing for my examination.

How did the planning go? I did follow my planning, except for the work with the silk screen printing that needed some more work to be done during May.
Designing dynamic textile patterns - the process

By using a combination of "Smart" textiles, interactivity and information technology new possibilities are created in the textile area. Both for design, production and use.

In this chapter new ways of designing patterns will be in focus for investigation. Initially the sketches for the inspirational work "Textile Disobedience" will be described. After that the investigation of how to create dynamic textile patterns is presented.

The work has two parallel tracks:
- Searching for “smart” materials and learning more about their properties by making samples.
- Investigating how a dynamic textile pattern could be created using "Smart” Textiles.

Textile disobedience

Textile disobedience was an inspirational work with the aim to question what a textile pattern is today and how we use textile patterns without even thinking about it. Some simple samples were made where the textile pattern was intended not to act as expected.

Falling cloth
This table cloth have a border made out of small mosaic squares and if the table cloth is put on a table in a symmetrical way it will fall off it. So if you want the cloth to stay on the table you need to place it in an asymmetrical way. Falling cloth is made out of mixed materials, like glue, mosaic stones and thin synthetic fabric.

Structure cloth
In the Structure cloth the idea was to explore when a pattern/structure becomes too much, even becoming hard to use. Structure cloth is made out of swell paint and pigmented screen print onto a cotton fabric.
Top: Falling cloth, middle: Structure cloth and below; Traditional cloth

Traditional cloth
The Traditional cloth has hand painted red crosses on top of an old traditional table cloth. I wanted to explore the relation between new and old in one table cloth. I like the feeling of this old table cloth with its un-ironed surface. The weight and the fastness in the old table cloth together with the impulsive red made an unexpected combination. The Traditional cloth is made out of an old table cloth and pigmented screen print paste.

Do the pattern yourself
Next step was to start working with thermo chromic materials, and then the table cloth Do the pattern yourself were made. At first sight, it looks like an ordinary single-coloured table cloth but when you place warm objects on it, like a hot cup or a hand, a pattern appears. It is the shape of the objects placed on the cloth that creates the pattern, so depending on the objects different patterns will appear. One idea was to design a system of special made cups and plates designed to make different pattern. But instead I continued to think about different systems and came up with a concept including a sofa and a dress.

The sofa and the dress
The sofa and the dress creates a system where time is used to make patterns. The more time spent in the sofa wearing the dress, the more the pattern of the sofa contaminates the dress. The pattern will grow in number of spots, so the dress will change from single-coloured white to white with red dots. This kind of pattern will visualize the use of the sofa. A sofa that will “camouflage” people sitting in the sofa felt rather funny but a bit too conceptual for my aim with this work. So instead of being locked in making this specific solution
“Do the pattern yourself”

and to spend time solving technical problems in too early stage, the work went on developing patterns in a much wider and more experimental way – dynamic patterns.
These kinds of patterns are not disobedient, but still questioning the norms for how we use textile patterns today.
From the narrowness of Disobedience to the wider sense of Dynamics.

*The sofa and the dress*
**Textile patterns**

A textile pattern is a kind of decoration that tells a story, expressing the period of time the textile is made in and showing traces of how we live our lives. And the choice of shapes and colour is often decided by access to different materials, trends and so on. Today we are surrounded by mobile phones and displays that give us information about all kinds of things (the senders use a common language for information, just like the language of decorations).

When looking at things made in "smart” materials it feels like a common created language is already with, displays are applied onto existing fabric more or less glittering. I have experienced that myself in earlier work within the project “Party textiles” and when looking into the projects of others. As a contrast to this I felt like looking back to old traditions looking for both techniques and aesthetics. I started to look in an old Swedish weaving book about a woman called Johanna Brunsson. Here I found inspiration to both printing and weaving. So by looking both into the near future and back in history I started to work with the possibilities of today.

To make a dynamic textile pattern I had to know what a “static” pattern were. This is something that the work “Fabrication” looks into more in detail. A static pattern is a pattern that does not have the ability to change accordingly to specific parameters in the surrounding as the “Smart” textile can do. But a static pattern will of course change depending on time, stains, washing and so on. But it’s made to stay in one shape, more or less.

**Creating dynamic patterns**

**Thermo chromic materials**

The design process started very direct, without having proper screen printing equipment. Sketches were made directly on fabric to gather knowledge about colours, shapes and the unfamiliar thermo chromic material. In an early stage the thermo chromic material was chosen because of its colour-changing properties during a temperature difference. In normal room temperature the colour won’t change, but if you put your hand on it the colour will change. So the change occurs around 37 degrees Celsius. The material is made in five different colours. These colours can be mixed with each other and with pigment screen print paste. Some initial experiments were made with pigment mixed with thermo chromic paste.

The first samples changed colour by using body heat, hair dryer, hot cups, breath and a heating pad.

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17 Melin, L. Jernström, H. 2003
18 Werner, A. 1982
19 Landin, H. Worbin, L. 2004
20 Supplier is the company Zenit
21 Orange, blue, magenta, green och grey
A brown thermo chromatic silk screen print pigmented with pink that have been heated up with an iron.

The heating pad changed the colour on a whole surface and had an interesting pattern; the shape from the heat element. At this time I started to think about making my own heat element integrated into a weave and print directly on top.

During my work with different patterns I kept coming back to simple single-coloured patterns and started to look at different structures. First I started to print on top of a small-patterned fabric and then to weave a single-coloured weave in two different materials. I hoped to get a small shade in how the screen print paste would work with different materials. The samples were made in cotton/wool and cotton/synthetic silk.

Then I started to make patterns on top of existing patterns to explore how to build patterns in different layers. This was also done in order to try out thermo chromic prints on ordinary pigment. Depending on if the thermo chromic silk screen paste where mixed with pigmented colour or not, a new way of building layers of patterns seemed possible.

Same test piece, first picture shows the colours when not heated up, second picture shows same piece with colours when heated up.
In the shape of the iron the pigment colour appears.

Exploring with the iron.

Looking at how an object can create or change an existing pattern.

First picture shows the pattern heated up by iron, second picture show the same sample cooled down, third picture when the pattern is heated up again.
The first picture shows a dark green print that turns into light green when heated. Next, silver spray on the printed fabric. The tea pot makes then a deeper, 3D-like look.

Using the traditional “Rölakan” patterns as inspiration for the first silk screen prints.

Pigmented thermo chromic print, on top of a pigmented orange screen print.

Print that is cut in two pieces and bound together again.

10/2
Thinking about what my supervisor Kajsa Eriksson and I was discussing, how boring it is when you are supposed to be surprised but can see in advance what it is.
Thermo chromic print onto different fabrics and patterns.

Pleats in a thermo chromic printed fabric on top of a heat pad.

A pattern that turns into new colours when the heat pad under is turned on or when someone is sitting on top of it.

Searching for different expression.
I don’t like the “dead” surface from the thermo chromic print. Could be further developed by working with a small-patterned print that covers the entire surface or by changing the structure of the fabric. Tried to sew small pleats, it is simple and that’s why it is so interesting. The top of the pleats doesn’t change colour like the fabric closes to the heat pad.
Sketches of different “surface patterns” on different fabrics.

Sketches onto different kinds of materials, looking for a surface.

Single-coloured surfaces and simple patterns seemed to give a bigger “surprise”. Another interesting aspect in the search of a surface was to make pleats on a thermo chromic printed fabric.

Why not combine patterns in a different layer, one pattern in the fabric and another printed one on top? I wanted to actually use the pattern in the fabric (made for printing) and print on it. Often a single-coloured fabric is used for silk screening but what happens if a pattern is built with one layer in the woven fabric and another layer in the printed pattern? With these things in mind I started to make some woven samples with heat elements integrated in the weave.
Integrated heat elements

To begin with I started to make a weave for printing. A carbon fibre were chosen to be the heat element and the rest of the fabric would be made of cotton. Most of the earlier samples were made of cotton and I knew how it reacted with the other materials, that is the reason for choosing cotton. The weave needed to be made in a way so it would be possible to screen print upon. Two different colours were chosen, one where the heat element was visible and could be seen as a part of the pattern. In that case a white weft were used. In the second version grey yarn was used so the heat element would be “hidden” in the fabric.

When working with the thermo chromic materials (with the heating element either integrated or externally applied) you can use different patterns for the heating element and the thermo chromic pattern. It becomes like different layers that has to function both separately and combined with each other. It becomes possible to change pattern, from striped to square.
A thermo chromic print mixed with pink pigment. First picture shows the pattern when it is turned off and when turned on the pink stripes will appear.

Some of the first thermo chromic print on the striped weave with carbon fibre.

Thermo chromic print on a weave with carbon fibres integrated. The first picture show the pattern when the power is off and the second and third when power is turned on.

Electroluminescent wire

During the work with thermo chromic patterns another material was explored - the electroluminescent wire. It is a material that “glows” when power is turned on and you almost automatically think about lamps when working with this material. After the first experiments with this “glowing” wire, it turned out to be more about a multi functional or dynamic object instead of a dynamic pattern, although the pattern is changing. One idea was to make a heavy fabric that could be used both as a lamp and as a curtain or a table cloth and a lamp.
Different constructions and material is tried out

Finally a construction and material was found that suited the electroluminescent wire.

Pictures from the weaving department, the sample with electro luminescent wire is taken out of the loom and is hanging from the ceiling. The second picture shows the broken wire.

The material used was cotton, different kinds of synthetic “effect”-yarn, Lurex and electroluminescent wire. The sample was made on an industrial jacquard loom used as a shaft machine. Some more handicraft techniques have been used during weaving though the electroluminescent wire could not be used in the existing system - it had to be integrated by hand. The construction is a “plain weave”, made as a double weave (report of 5 centimetres in length and 7.5 centimetres in height). The wire appears to be sensitive to breakage and during weaving the wire was damaged. It is recommended not to fold the wire more than 90 degrees.

How to make it more “dynamic”? By using a dimmer an even more dynamic pattern could be created, but still it will feel much like a “lamp”.

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Moving on

After this investigation about how thermo chromatic colours, carbon fibres and electroluminescent wire can be used for creating dynamic patterns the work focused on developing two more different patterns. In this stage the electroluminescent material were left behind because it gave too much of an on and off feeling. This compared to the patterns made using the thermo chromic materials, which gave a more dynamic experience. It was time to create prototypes of dynamic patterns. I had learned that working with layers—“double” patterns that works both separately and together - was central for creating a dynamic expression.
Prototypes of dynamic textile patterns

Here some ideas how to build up dynamic patterns will be worked through more in detail. The ideas are; making patterns in different layers that can work both together and separately. When making the final prototypes I have decided to “keep the change as a surprise”. That’s why a rather simple and clean aesthetic is chosen. This is also a choice made to clearly visualise the dynamics of the patterns.

The chosen material for the prototypes is the thermo chromic material and the weave with conductive fibres. These materials were chosen because they gave an experience of something actually changing, compared with the electroluminescent materials that felt like something that were turned on or off.

The prototypes are called “Rather boring” and “Being square”

*Rather boring:* A textile pattern with one pattern hidden in another pattern.

*Being square:* A striped pattern that turns into a squared pattern.
The pattern: “Rather boring”

This prototype is based on the idea of making patterns using external heat elements. The simple single-coloured table cloth from the “Textile disobedience” project lead to this “Rather boring” prototype.

By making a small-patterned print that covered the whole surface of the fabric, a rather ordinary and bit boring pattern were made. I wanted it to be that way because it will be even a bigger surprise when the user will find another pattern on the table cloth. That’s why the pattern has got a low profile in its original state and the colours grey on white are chosen.

Different layers with different patterns were made and when placed together the pattern seams to disappear. The idea was to print one layer with thermo chromic screen print and the other with traditional pigmented silk screen paste, and to mix the two different types of colours into exactly similar colour shade.

This interactive pattern is given different possibilities of changing pattern during its use. It is still a kind of predestined pattern, but with some parameters designed to give the user some room for being a part of changing/creating the pattern. In this pattern the user can create pattern depending on what kind of hot objects is placed on top, like cups, hands, mobile phones, computers and more. After the colour changing, the origin colour will return after some time, hoe long depending on how hot the object placed on the fabric was.

The pattern

The written message is originally made for one of my earlier projects22 and says in Swedish; “Stop the Search, Search, Stop,” so the message can be read both as an indication to search and then stop the search and so on.

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22 -Hoppla! En kollektion föränderliga gardiner. (Translation from Swedish; -Ops! A Collection of changing curtains.)
The pattern to the left is to be printed in thermo chromic grey and the middle pattern will be printed in pigmented grey. On the last picture the two patterns are put together.

**Technical data**

- Hand- silk screen printing with two colours; Grey thermo chromic and grey pigment, textile colours for silk screen printing
- Size of the report: 40 x 30 centimetres (can be changed to fit industrial frames)
- Printed on cotton satin
**The pattern: “Being square”**

This is a prototype showing how a pattern can change from stripes to squares. Also showing how patterns can influence another. The prototype is presented as an apron and a tablecloth. In the “sofa and dress” example from “Textile Disobedience” two patterns were depending on each other and this is based on a similar idea.

In this dynamic pattern an integrated heat element is used to build up one part of the pattern. First a weave with conductive fibres integrated was made and then a silk screen print was made on top of the woven pattern. The print was made with thermo chromatic silk screen paste. When not putting traditional pigment into the thermo chromatic the paint will “disappear” when heat is turned on. In fact the paint isn’t transparent; it is turning into a white shade. If this print would have been printed on a coloured fabric the stripes would not look like they disappear as they do on this white colour.

![Striped pattern prototype](image)

*On the left picture the striped pattern is shown on top, in the right picture the heat is turned on and the pattern slowly change into squares.*

![Sketch and pictures](image)

*A sketch showing the striped apron that turns into squares when approaching the tablecloth. The picture in the middle is showing squares that recently were stripes and last picture is showing the squares for the table cloth.*
Carbon fibre yarn

Sample A                     Sample B

Technical data print

- Hand silk screen printing, sample A grey thermo chromic and sample B grey pigment, textile colours for silk screen printing is used
- Size of the report used for the prototype is made specifically for each item, the repeated pattern is 3 centimetres.
- Printed on a cotton/carbon fabric panama

Technical data weave

- The woven samples are made at the weaving department at The University College of Textile in Borås
- The machine used is an electronic jacquard, but used as a shaft machine
- Warp yarn is cotton Nm 30/2
- Weft yarn is a cotton Nm 8/4 and a carbon yarn
- Weft yarn is 20 treads per centimetres
- Report size: 4 centimetres
- Construction, Panama, two treads over two.

Technical data electronic

- Power supply is taken from either 9V/12V batteries or 220 V with 9V/12V adapter
- The connections between the power supply and the carbon fibre is made for demonstration use only
- No sensors is used in this stage, only simple on and off by hand
Discussion

In this last chapter the goal and its research questions will be discussed followed by a discussion about ethics, environment and economic factors. Finally a conclusion and ideas for future work are presented.

The goal with this project was to investigate and develop dynamic textile patterns made out of “Smart” textiles. This by making working prototypes that illustrates several possibilities to create dynamic textile patterns.

Questions;

• How can dynamic textile patterns be created using “Smart Textiles”?

• What extended properties will dynamic textile patterns give compared with traditionally made textile patterns?

How to create dynamic textile patterns using “Smart” textiles

Creating a pattern using a “smart” textile can be more or less the same thing as creating a pattern using traditional textile materials. Creating a pattern that can change color from one to another can be done easily. This will give some extended properties to the design. But to use the extended possibilities that “Smart” textiles give in a more developed way is a bit harder. New kinds of problems and possibilities have appeared. Some part of the pattern may be invisible until the power is switched on and that creates the feeling of working blindfolded.

Concerning thermo chromic materials, the following ways of creating patterns with heat elements have been investigated:

• Using external heat elements like cups, iron, hot pads, hands etc. both underneath and on top the fabric.

• Integrating heat elements directly into a fabric to be printed on and supplied with power.

Furthermore, the pattern can be created in different ways depending if the design of the heat element will “work together” with the printed pattern or not. The
pattern “being squared” is an example of how two patterns work together. The design on the woven bottom layer is made according to the printed design. So the heat element can both reveal a pattern or build a pattern depending of how it is used.

Here are some design parameters for creating dynamic textile patterns. They can also be explained as different layers of possibilities for creating dynamic patterns.

1. The construction, like woven, knitted or non woven
2. The treatment, like printing etc.
3. The programming, how the power supply will be "turned on and off"
4. The interaction, how people will act upon and use both the textile and it’s patterns

In the example “rather boring” a printed pattern is hidden in another printed pattern. In this case it is of great importance to mix the same color in two different materials, the thermo chromic and the pigment. During hand silk screen printing it was very hard to make such an exact print that is needed for this kind of dynamic pattern. The “hidden” pattern needs to be well hidden, otherwise the pattern and the “surprise” will be ruined. This kind of pattern is hard to make by hand, but will be more easy to make in an industrial way.

When working with "Smart Textiles” it is very exciting to see when a new pattern or colour appears. The dynamic change in itself takes lots of attention and it has some times been hard to focus on the actual design. It is hard to see how it could be used in the best way and to think beyond the obvious properties of the materials. Also, it is important with a distance, a time for reflection where the new material and thoughts can relapse. This is not made in a hurry.

**Extended properties in dynamic textile patterns**

What does a dynamic textile pattern give compared to traditional static textile pattern?

- More than one pattern in one textile
- More than meets the eye at first sight
- A second chance to first impression
- Change of color and/or change of pattern

The patterns do have a range of different patterns to shift between but I see this as a future possibility to use this for something more than only integrating "two in one". It is also a difference in making a pattern that change from one colour to another and making a striped pattern that will become more striped than to make a pattern that turns from striped to single coloured. The same with the example “being squared” when a striped pattern turns into a squared pattern. Something more is happening, the expression is a new. It communicate different expressions within one fabric perhaps we even can find other areas of use?
This can be explored further on if connected with information technology and applied to specific needs within our society.

**Ethics and environmental issues**

When it comes to the thermo chromic materials it is hard to say if they are more dangerous than more well-known materials, but it is recommended to use gloves when working with the paste. It is hard to get information from the manufacturer and the supplier and this is a problem that even commercial companies find hard to get hold of.

Another aspect is the time of use; the ability to change is depending on temperature and how often the material can rest. So, the higher temperature the more it tears of the life span of the material. The same thing goes for the electroluminescent materials, but instead of heat, tearing depends on how high voltage that is used.

It is not satisfactory to mass-produce new objects that uses electricity created out of non-renewable energy sources. This can become a problem but at the same time as we strive for developing future textiles, other research on energy consumption is going on. If this kind of dynamic pattern will be further developed and the power supply solved one can look at this kind of patterns as a textile with multiple properties for several different items. Instead of buying several different textiles for different occasions only a single one can be bought and changed.

In the book *The eco-design handbook: A complete sourcebook for the home and office*23 lots of different products is presented with just as many smart solutions for a better production from an ecological perspective. There are many interesting materials and solutions but nothing about all these objects that we are surrounded by now. I think this is something needed to be brought up to a wider discussion in a time when much textile is seen as throwaway articles.

**Conclusion**

Since this work does not focus on making specific items, it is too early to tell what kind of products these dynamic textile patterns would be best suited for in the future.

My intention with this work was to learn more about ”Smart” textiles and to use those materials when exploring how to create dynamic textile patterns. Further on I hope it will give both inspiration and work as a foundation for a discussion about how we want to use “Smart Textiles” and its ability to create dynamic patterns. This can be formulated into a range of different questions, like; Do we want to hide or show technology? Do we want to integrate information with the aesthetic of an object or separate them? So, when dynamic textile patterns can be created with the ability to build, reveal and hide decoration, can we also use it for communication purposes? If you then look at different areas of use for this kind of dynamic textile pattern it can be

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23 Fuad-luke, A. 2002
developed further on into many different areas, like in the health care sector, public and private environment, both in terms of soft furnishing and for fashion.

**In the future**

What I have found most relevant to continue developing is the idea with the different “layers” of possibilities for creating dynamic patterns. The construction, after treatment (in this case printing), use and level of interaction is creating the condition. All parts of creating a fabric are just as important for how to create dynamic textile patterns.

Concerning research within this area it is of great importance to anchor the results in the textile industry. Creating access between research and industry is a must to develop these materials and dynamic patterns further. The material and samples made during this work will be a platform to use in the next step, getting closer to the use of dynamic textile patterns.

Do you want a subscription of new textile patterns for your kitchen curtains?
Thanks!

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