ABSTRACT
In this practice-based experimental design research project a tablecloth reacting on external signals is designed. The tablecloth is connected to mobile phones and reacts to incoming calls and messages with burned out patterns. Due to the mobile phone activity, changes in colour and structure appear in the table-cloth.

The tablecloth is a way to explore visual and tactile changes in a textile surface. It is also a way to investigate how our relation to mobile phones and mobile phone technology is affected by the way the phones are being expressed.

KEYWORDS
Dynamic textile patterns, burn-out patterns, knitted circuits, textiles and mobile phones.

INTRODUCTION
Imagine that the table is set and dinner is ready. It’s time to sit down and share the moment. That is what we do also in terms of sharing a one time pattern change in the tablecloth, and in terms of sharing each others’ mobile phone activity. Incoming phone calls and messages are not notified by the phones themselves, but through a burned out pattern in the tablecloth, in between our plates.

The overall aim is to explore different materials, material combinations and techniques for developing textile circuits and designing dynamic textile patterns. The tablecloth described in this paper acts as a medium for raising questions about construction and material issues, how different parameters like ways of knitting the heating wires, the time and power used for the burn-outs etc. affect the expression of visual and tactile changes in a textile surface. It is a design example of research into three fields, knitted circuits, textile patterns and peoples’ relation to computational technology, all discussed in this paper.

Today, in many countries and cultures, to meet other people also in some sense implies to meet their mobile phones; the acceptance of audible phone signals is often high. Even though people relate to their phones in different ways, we notice that different kinds of mobile phone cultures have developed in different countries as well as in different companies and circles of friends. Compare for example the number of phone signals and phone conversations you hear on a train between Stockholm and Gothenburg with a train between Kyoto and Tokyo; in the latter example you will probably not experience many audio phone signals at all. In Europe, we nowadays are rather used to conversations being interrupted, anywhere at any time, by someone that is not present who wants to talk to one of us.

Textile-based computing and textile-based circuitry allows the integration of interactive elements into furniture, wearable computing etc. [15]. Some yarns and after-treatments are today manufactured to sense and react to environmental stimuli, be conductive or to emit
light etc. Compared to more traditional textile material qualities, this poses new challenges for the textile design profession. The tablecloth described is a further development of the non-chemical burn-out (Ausbrenner) design technique for irreversible textile patterns [14].

A collection of single coloured tablecloths has been designed. The tablecloths end up with a different number of burned out checks. The checks are designed to appear one at the time, and it is not clear when, or if, all the checks will be visualized. The pattern that appears is dynamic and irreversible; it does not change back to its original appearance. The checks vary in shade, size and eventually also structure.

The burn-out pattern is inspired by earlier experimental textile design works, both our own and others. One example is the textile pattern “Striped and Checked” [20]. “Striped and Checked” (Figure 1) is a weave consisting of both traditional and conductive yarns, screen-printed with thermo-chromatic colours. Cotton and carbon yarn were used in the weft, and the warp consists of cotton yarn. Electricity is lead out to the carbon yarn by a peeled electrical cable. The carbon yarn is constructed as a parallel connection that was made by hand after weaving the textile. The construction of the parallel connection was made so that sometimes unintended spark formation appeared. When turning on the power, the sparks made the textile start to glow and/or burn so that burn marks could be seen. Those burn marks raised our interest.

Other inspiration is work made at Nuno Corporation lead by the textile designer Reiko Sudo where several technical and artistic skilled textiles are designed. One is “Karadaki” made of 100 % stainless steel. The textile and the design process are described as follows:

“We used stainless steel yarns developed by a Japanese tyre manufacturer for reinforcing their radial tyres, and wove an otherwise ordinary cloth. Then, inspired by how cookpans discolor over open flamed, we took a gas burner to our fabric, and watched as it took on brilliant metallic lustres” [11].

Nuno has also made textiles out of maize and other grains, to develop a biodegradable plastic. This textile is highly susceptible to heat, and after “toasting” the fabric it gives a smell of maize [11].

**EXPERIMENTS**

In the era of smart textiles design, the amount of new applications and textile products where metals are a part is growing. Due to the development in the area of new yarns and fibres with electro-conductive properties the area of conductive textiles have, during the last years, been under investigation. Many textile applications in this area are developed for generating heat and for the use as electrical conductors [16]. The need for experiments and research in this area is still big, and this project shows an example of a textile that is knitted with a heating wire and a cotton yarn. Knitting with metals is possible by modern knitting machines like the flat-bed knitting machine used in this project [17]. This machine is able to handle the knitting of stiff materials, like monofilament metals.

**Material Experiments**

In the first experiments heating wires were knitted together with a range of different traditional textile materials (such as cotton, viscose, polyester etc.) in different structures. When electricity is applied, the heating wires leave burned out patterns in the traditional textile material (Figure 2). In the first experiments we looked for textile materials that showed different expressions and reactions when being burned. We looked for diversity in reactions, both visual reactions (material melting, changing colours, burning/glowing etc) and reactions regarding time (how fast and in what way a material changes expression). In what way a material reacts when heated depends on a range of factors such as the textile construction, amount of voltage and burning time etc. [14].

All conductive materials get warm when sufficient power is applied, but the Kanthal heating wires used in the tablecloth are designed to glow and not to break when heated to a sufficient temperature. Kanthal heating wires is normally used as heating elements in household products such as toasters and hair-dryers [7].
Knitting Experiments

Several knitting structures where made as experiments when designing the knitted structure of the tablecloth. Every stitch of the heating wire is visualized and can be seen as a dark pattern or a hole in the cotton when the tablecloth is activated by being connected to power. Different ways of knitting give different burned out patterns in the textile when it is heated. When the heating wire is knitted every fourth stitch, a burn-out pattern appears as dots in the cotton (Figure 3). When knitted every second stitch, the burn-out pattern is almost perceived like a dark line or a cut in the textile material (Figure 4). For the tablecloth the heating wire is knitted so that distinct lines are seen when it is connected to power.

Figure 3.

Figure 4.

The visual and tactile expressions of the electrical burn-outs are depending on a range of things. The textile material, what electrical effect and time used for burning are just some facts that influence the pattern and structure of the burn-outs. For example, if the power is on for a short while, a dark coloured pattern can be seen in the textile. If the power is on for a longer while, cuts with dark edges appear. The visual and tactile expression of the electrical burn-outs is also highly depending on in what way the heating wire and cotton was knitted. The way the textile was knitted becomes obvious when it is heated, as the heating wire leaves traces in the textile material, the cotton.

CONSTRUCTION

The table is set and we are ready for dinner. There will most likely be phone activity during the dinner, but we will not hear it. We will instead notice the mobile phone activity as burned out patterns in the tablecloth. Each call, text message or other activity will trigger a square pattern in the textile. We do not know which phone is calling, and we do not know exactly what will happen with the tablecloth; will it change colour, structure or maybe start burning? What we do know, is that the expression of the textile pattern depends on the phones activity, and the more activity the more burned out squares will appear.

The tablecloth is knitted as a plain knit where cotton yarn is knitted together with a heating wire and a semi-transparent monofilament. Afterwards copper was embroidered to parallel connect the heating wire into square sections. The heating wire and the monofilament yarn are knitted as a reported pattern in sections. The heating wire is used for the burn-outs and the copper yarn for creating parallel connections and to lead out electricity to specific sections in the tablecloth (Figure 5). The function of the monofilament yarn is to create a similar expression in the areas where the heating wire not is knitted. The heating wire could not be knitted in all sections, since areas for the embroidery of the copper wire were needed, not to create shortcuts between the copper and the heating wire.
Until the pattern from the electrical burn-outs shows, it is hard to distinguish the heating wire from the monofilament in the textile. When the tablecloth is activated, the patterns from the electrical burn-outs reveal the sections of where the heating wire is knitted.

The tablecloth is connected to a micro-controller that mutes connected mobiles and checks whether there are any incoming calls and messages. If the answer is positive, the micro-controller turns the power on in different circuits (the heating wires) in the tablecloth. For how long time the power will be on, and what number of circuits will be affected, depend on whether it is a phone call or a text message coming in. It also depends on whether the caller or sender is known. If for example the caller’s or sender’s phone number is linked to a name in the phonebook, the burning effect is stronger than if it is not. Several messages or phone calls from the same person also have a stronger burning effect, whereas several messages or calls from different persons affect a bigger area in the tablecloth.

The chip is programmed so that you do not know where the phone activity might be displayed in the tablecloth. The tablecloth is knitted in such way that you will not be able to identify possible areas of activity (burn-outs). We have also included some semi-randomness in the program. Therefore it is impossible, even for us as designers, to foresee when and where the pattern change will take place. The chance that there will be two table cloths that end up looking the same is very small.

TEXTILES AND MOBILE PHONES

The burning tablecloth changes the way mobile phones are being expressed. Instead of sound, vibration or light signals, incoming phone calls and text messages are expressed by burned out pattern changes. Instead of expressing one signal per mobile phone, the tablecloth will put all phone events together so that there is no difference from your phone ringing or mine. This is meant to accentuate the social setting around the table, to see what happens if we value and express all incommings calls and messages in the same way to all people present. Accordingly, people who call or send messages to the people around the table are not neglected, even though all mobile phones are muted and vibrators are switched off. Their contact attempts are instead expressed in another way.

To sit down and “use” the burning tablecloth is to appreciate the moment in situ in an explicit way. This is due to two things; firstly the participants prioritize people present higher than people not present who might call or send messages, since the pattern changes are more indistinct than what a phone signal usually can be. And secondly the pattern is irreversible; it will be set during one occasion only, and thereafter it will wear traces from it. We wanted to transform phone signals, like tunes and vibrations, to something that could be more of a benefit in a social context. In other words one could say that we use peoples’ communication attempts as textile patterns to embellish the moment.

This tablecloth is a sequel to the fabrication bag (Figure 6) where incoming phone signals were translated into colour changes on the outside of a bag [9]. The tablecloth and the fabrication bag are both experimental explorations on dynamic and changing patterns, and also on how expressions are related to peoples’ interaction with and relation to computational artefacts. The main differences between the two objects from our point of view are that:

– the pattern of the fabrication bag is dynamic and reversible, it can vary back and forth using thermochromic dye and heating elements. The pattern of the tablecloth is irreversible; it changes in only one direction, being more and more burnt since it can not change back.

– the pattern changes of the tablecloth are tactile in another sense than the changes of the fabrication bag. Both the fabrication bag and the tablecloth change temperature, but the tablecloth is also able to change structure.

– with the fabrication bag the focus was only on using one mobile phone, while with the tablecloth we have a social setting with several phones, and the experience is made to be shared.

Figure 5.
Mobile phones are made to notify us about communication attempts and they do it most often with a tune or vibrations, or with the sound of the vibrator. If we do not want to be notified in that way we are able to mute the phone and switch off the vibrator (if not switch the phone off completely.) With the tablecloth and the fabrication bag we wanted to investigate if there could be anything in between, in between an unmistakable audible tune and silence and in between unmistakable tangible vibrations and stillness. That is to through design see if we can make it easier for people to choose from one moment to the next whether they want to be notified or not, i.e. if it is possible to let people decide whether they are interested in being notified, so that it is not just for the technology to “decide”. Therefore we made the notifications more ambiguous and of another kind so that people have to choose how to interpret them. In the fabrication bag this is made both by making the signals of incoming phone calls and messages much more discreet, and by not only displaying an incoming phone call while it is going on, but also to display events that have happened. In the tablecloth the ambiguousness is not that much about discretion, instead it has to do with merging several phone signals into a compounded pattern. 

The bag is made so that you can learn how to interpret it to some extent. Sometimes when it has been demonstrated without explaining in detail in what way the pattern change, people could not see it. To us the change of pattern was obvious. If you would use it for a week, you would probably learn how to interpret the pattern changes. You might for example learn that unread messages are displayed in another way than unanswered phone calls etc. 

The use of the fabrication bag and the tablecloth is very different. The fabrication bag was made to be a complement to a mobile phone – when you do not want to turn the phone off but do not see it as a catastrophe if you miss a phone call either. The tablecloth on the other hand is made to be used actively only during a couple of hours on a specific occasion, after that it can be treated as a wall-hanging. Hence, the tablecloth is not made in such way there is a point learning how to interpret it, as with the fabrication bag. Incoming phone calls and messages are more directly displayed, at the same time they take place. If there is an incoming phone call that event will be displayed as it is going on, and a message will make the cloth burn at some place instantly, not echo also afterwards as in the case of the fabrication bag. The bag was made so that you can take a glance at it and if you think you see some colour changes you can start to wonder if that means that someone are calling you right now or if someone had called you earlier on etc. Depending on how interested you are and how important an eventual phone call or message is for you in this exact moment you can decide whether to pick the phone up and get the answer. The tablecloth is not made in that way. The cloth is not made to be as ambiguous as the bag is when it comes to the displaying of mobile phone events. However, as said, the tablecloth will not give any hints about whose mobile is ringing or if there are several calls at the same time etc, which means that it is more ambiguous in that sense. The focus is accordingly not so much on peoples’ choice of interpretation, but on how they relate to the social context.

To make a tablecloth with the burning textile pattern is an experimental way of looking into how the way things are expressed to us might affect how we relate to them and interact with them. This is in line with conceptual and critical design that asks question rather than providing the final answer to a problem [cf. 3,4,5,6,8,]. The fabrication bag questions our dependency on our mobile phones, whereas the tablecloth questions how we value different kind of social contacts.
TEXTILE PATTERNS

The checked pattern that appears in the tablecloth is visual and tactile. The pattern is meant to be decorative and to carry some kind of information.

Tactility in textile patterns

Together with the senses of smell and taste, touch is traditionally seen as a secondary or “lower” sense in the history of aesthetics [2]. But in interaction design, where interfaces often consist of for example hand or body movement controlled input for electronically based products, touch is a highly relevant sense. There are also several examples of haptic interfaces for output (actuators) [10]. Nima Motamedi argues that touch is a neglected sense and discuss how tactility can be incorporated in the aesthetics of interaction [13]. As examples for discussion, she presents two design projects on that theme. “Keep in touch” is a networked fabric touch screen designed to create tactile experiences for couples in long distance relationships [12]. The other project, “Stay in touch”, is an interactive installation consisting of a fabric wall, where two strangers are able to touch and feel each other through the fabric [13].

In textile design tactility is of course of great interest as well. Apart from the visual impressions of a textile, the sense of touch gives another dimension to the experience of the material and structure.

Handmade versus Information-made

The difference between the expression of a handmade textile and the expression of an industrially produced textile is huge. The expectations of industrially produced textiles are perfect similarity in colour and shades. When a handmade textile is created, the trace of the hand may cause small errors in the shape of variations in shade and structure. The small errors bear witness of the hand making the textile, and compared to an industrial produced textile the handmade piece tells another story. The tablecloth made in this project is industrially knitted, and during use a pattern is added, a pattern that also tells a story. Not a story about the experience of the material and structure.

The tablecloth changes expression during use. The textile material appears as different things at different times. At first it is a raw material, a fabric that is industrially produced. When using the tablecloth on a specific occasion, a pattern is added. The tablecloth’s pattern ends up with qualities similar to a handmade textile.

Just like picking a specific plant to use for dyeing a textile with a certain colour, we pick and use information for turning power on and off in the tablecloth. The result gives a specific expression, the electrical burn-out pattern.

The aesthetic expression of a traditional static textile pattern depends on its aim and use. It depends on whether it should be seen from a distance or close. The same is for the tablecloth’s pattern, but some new design parameters are added. The pattern is changing and will be viewed before, during or after the changes.

Textile patterns have always been reflecting society, technology and trends. Traditional wall-hangings and tapestries exemplify textile decorations as story-tellers or as statements concerning culture, the political situation etc. [1]. The pattern on the tablecloth could be seen as an updated version of a traditional wall-hanging, in the sense of the textile expression relating to a specific occasion, or story. Compared to traditional wall-hangings, the tablecloth tells a story a bit up side down. Instead of materializing statements or thoughts in a static way, the tablecloth incorporates the actual user situation to express that moment.

In Sweden, embroidered wall-hangings telling romantic or political statements were common during the 20th century, and they are still decorating many kitchen walls (Figure 8). Some examples of these statements are:

- "Mitt hem är värsol i vintertid, mitt hem är vila i arbetstid” (“My home is the sun in cold winter times, my home is rest in hard working times”).
- "Tvätta dig om hand och nos, så blir du vacker som en ros.” (“Wash your hands and wash your nose, and you’ll be pretty as a rose”).
- "Fågeln söker fäste, människan bygger bo, eget lilla näste, är den bästa ro” (“The birds search for foothold, the man builds a home, Your own little nest gives the best of rest”).

In these wall-hangings, the pattern is static. Someone has embodied a thought or a statement, and the image is readable and precise. In the tablecloth, everyday conversations and specific information are turned into something abstract, the pattern has an unfamiliar aesthetic expression. It may at a first glance not tell much about the users or designers, and it is supposed to be clear that it is not a traditional static textile pattern.

The implication of the tablecloth is to use invisible and temporal conversations to build a pattern. Just like the implication of traditional static wall hangings, the tablecloth is a “modern” way of showing to myself and others what relations to information and communication in today’s society may be about.

The textile designed got the shape of a tablecloth because we wanted a surface that was close to an everyday activity. The meal and the conversation, the disturbance from mobile phones are used and turned into decorative elements.
CONCLUSION

The result is a design example of a new design technique where we, in a non-chemical way, can design dynamic textile patterns. We want to give traditional textile materials and patterns updated status and use. We also give an example of communicating in a more aesthetic way.

By designing in this fashion we learn more about material combinations and constructions. We also explore how to use for example voltage and time as design variables and in what way information and aesthetics could collaborate.

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REFERENCES

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