Textile Displays: Using Textiles to Investigate Computational Technology as Design Material

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ABSTRACT

As we face an increasingly heterogeneous collection of computational devices, there is a need to develop a general approach to *what* it is that we design as we create computational things. One such basic approach is to consider computational technology to be a *design material*. In the present paper, we describe how a traditional material – textiles – can be used to investigate aspects of the expressiveness and aesthetics of computational technology as design material. As an example of this approach, we use an experimental design project made for an art museum. We describe a series of conceptual sketches of how textile artefacts can be used to re-interpret elementary acts of information technology use and the experiences from working with the final installation of one of them. Finally, we discuss properties of textiles and computational technology, such as expressions related to vagueness, unpredictability and slowness.

Keywords

Aesthetics, textiles, computational things, design methods.

INTRODUCTION

Over time, our conception of what a 'computer' is, has changed significantly. Initially taking its name from a profession, computers were once delicate machines the size of buildings operated by specialists in closed environments. As computational technology is woven into the fabric of our everyday lives, our conception of 'computers' is transformed yet again.

Perhaps a result of the dominance of the 'personal computer', designers working with human-computer interaction have largely come to think of designing the interface or interaction as a matter of designing a graphical interface. However, as we face an increasingly heterogeneous collection of computational devices, there is a need to develop a more general and basic approach to what it is that we design as we create computational things.

When we think about computational things in terms of, e.g., 'mainframes' or 'personal computers', certain images come to our minds. Correspondingly, the notion of an 'information appliance' evokes certain ideas about what it is that we are trying to design (cf. [4]). Looking for a more basic understanding of what a computational thing is, we set out to explore the idea that computational technology is a *design material* (cf. [5,7]).

When we think about computational technology as a design material, it is natural to ask similar questions about this material as we ask about other materials, thereby joining a tradition of investigating new design materials. Such questions do not only concern practical functionality and how to realise it, but also basic aspects of the appearance of a material as it is used in design, such as its expressiveness and aesthetics [2, 6, 7].

In the following, we will describe how a traditional material, in this case textiles, can be used to investigate aspects of the expressiveness and aesthetics of computational technology as design material.

THE FORM AND MATERIAL OF COMPUTATIONAL THINGS

Instead of starting with the distinction between *form* and *function*, this approach rests on the distinction between *form* and *material*. Form is the way material builds things; to build a thing, we form materials. According to this distinction, computational technology *is* a material in the sense that it is an essential ingredient in that out of which we form 'computational things'. This computational material is clearly not only a matter of certain computer hardware, but about all the things that make something 'computational' in appearance.

The central quality, or property, of computational technology as design material is, of course, that which makes it 'computational', namely, the execution of programs. This

makes *temporal gestalt* the central form element of this material: as we execute programs, temporal structures are created. However, just as music has to be performed to be audible, the results of the computational processes must somehow be made available in space for us to perceive them. Thus, we have to combine our computational material with some other material(s) that can be used to display these temporal structures. Typically, this is done using for instance Cathode-Ray Tube or Liquid Crystal Display screens. We are, however, not limited to such techniques.

The basic property we are looking for in this other material is that it has to have *spatial gestalt* as its main form element. Since many, if not most, design materials have spatial gestalt as a main form element, the resulting design space for combinations of computational technology and other materials, is enormous. Clearly, the 'surface' we choose for manifesting temporal structures in space will make a considerable contribution to the overall appearance of the thing, and thus it is important that we investigate different combinations of materials to form an understanding of the different inherent expression qualities.

Textiles and Computational Technology

Even without computational amplification, textiles are highly dynamic – just think about how clothes can be crafted to move in certain ways as we walk or dance. Further, many textile artefacts have established roles and places in our everyday lives in the shape of clothes, furniture, curtains, etc. Often, such textile artefacts have qualities quite far from what we have come to expect of computational things, e.g., a warm, soothing and restful appearance, making this particular combination of materials even more interesting from an interaction design perspective.

When combining computational technology with a material such as textile, it is important to find a way between, on the one hand, just using the textiles to "re-invent" existing interaction devices in a new material, and, on the other, simply enliven certain textile artefacts using more technology. What we should be looking for, in order to learn something about the design materials involved, are their intrinsic expressions and what new aspects can be seen as we combine them.

If we aim to investigate the expressions and aesthetics of computational technology, it follows from the analysis above that certain combinations of temporal and spatial gestalts will be in focus. The combination of textiles and computational technology we are looking for is therefore not primarily a matter of integrating computers into fabric (e.g., [9, 10]), of creating "smart" materials (e.g., [3]), or of creating new kinds of displays (e.g., [12]), but a matter of *using the unique spatial properties of textiles to manifest temporal structures generated by computational processes*.

We are looking for ways of using the dynamics of various textiles to express temporal structures. Such dynamic properties include movement, changes in shape, colour and texture, etc. We can use traditional materials in combination with devices for mechanically affecting the fabric, such as computer-controlled fans to induce movement [5, 11]. We can also use new materials (cf. [1]), such as textiles with ability to change colour (cf. [8]) or with the ability to emit light.

DESIGN EXPERIMENTS

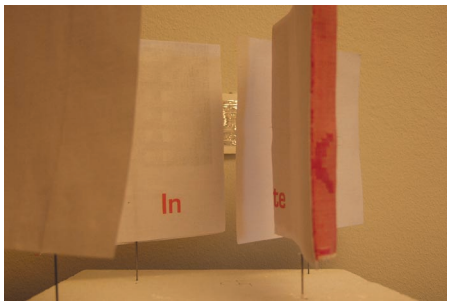
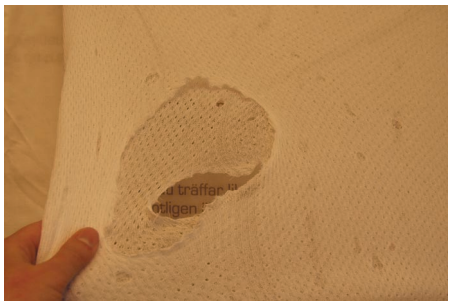
How textiles and computational technology combine can be investigated in a number of different ways. In this project, the focus has been on the aesthetics of computational technology, i.e., on the question of how a computational thing builds its appearance. To study how the specific properties of computational technology result in certain kinds of expression-structures, we have used experimental design to create a collection of examples illustrating different aspects of the expressiveness of textiles and computational technology. In other words, we use systematic design experiments to find out the 'logic' behind the given kind of expressions.

To investigate basic properties of such complex objects as computational things, we, at least initially, have to work with simple examples. Basic temporal gestalts of computational things in use can, for instance, be seen in elementary information-handling acts, e.g., in opening, uncovering, compiling and delivering information. In these experiments, such elementary acts have been subject to re-interpretation using textile artefacts, i.e., we have sketched various ways in which a textile artefact can manifest a given information-handling act. Doing this, we have also tried to amplify the expressions of these basic acts of use, enlarging them to a point where expression comes to dominate practical functionality, rather than the other way around. The result is a kind of "abstract information appliance", i.e., a thing designed on basis of some elemen-tary form of use, but where the expressions of use, rather than functionality in a more practical and concrete sense, are in focus [7].

The following examples have been taken from a project made for Borås Art Museum. First, a series of conceptual sketches, each based on an information-handling act of an information appliance and a re-interpretation of it, is presented. Then, the installation made for the exhibition – the Information Deliverer – is described and discussed.

Conceptual Sketches

In these examples, the information itself is of minor interest, as is the question about what starts the various processes. The expressions in focus depend both on space and time gestalt. These "abstract information appliances" are all examples of *slow technology*, i.e., it takes time to fully comprehend the intended expressions (cf. [5]).


Figures 1-3: Mock-up models were used to test early ideas. Figure 1 (left) illustrates a miniature prototype of an Information Opener. Figure 2 illustrates a model of an Information Marker. Figure 3 is taken from experiments with an Information Uncoverer.

An Information Opener

The information appliance. Any appliance we use to unfold or unpack given information, e.g., an application with a graphical user interface that takes a double-click on a certain type of icon as input and as a response opens up a certain document or picture.

Expression of use: Acts of displaying hidden things. We click on an icon at our desktop, or write a commando, to open a document or extract a compressed file. We press buttons on our PDA or mobile phone to read a message or answer a telephone call etc.

Textile artefact: Large rotating textile screens that, when in certain positions, open up for us to see some distant information written on a piece of fabric hanging there on a wall behind the screens (fig. 1).

Reinterpretation: A complex pattern of large rotating textile screens visualizes the mysteries of opening information. The information we open is always something that is behind the opening mechanism.

The abstract information appliance: Imagine four 2x2 m textile screens mounted on wooden and metal frames hanging in wires. The screens will together display various patterns depending on their relative positions, patterns that indicate the state of opening. Each screen consists of a complex textile structure that displays distinctly different patterns as we see it from different angles. Computer controlled stepper motors turn the textile screens around their axes. On a wall behind the rotating screens we put some information, projection of a TV news program for example.

An Information Compiler

The information appliance. Any computational device we use to compile information, e.g., an information visualisation application where different databases are combined in a search for some information.

Expression of use. Acts of combining information, relating them to each other, in order to form something new.

Textile expression: Layers of broken fabric hanging from the ceiling occlude each other in different ways.

Reinterpretation: Like silhouettes on a wall, patterns of holes in the pieces of fabric create images as we look through them and onto the wall behind. As the layers of fabric move sideways, different images seem to appear. To compile information and create a certain image, we try to move the layers to the correct positions.

The abstract information appliance: Sheets of fabric hanging from tracks in the ceiling. Each sheet has a certain pattern of holes in it, representing some set of information. Computer-controlled electrical motors move the sheets sideways in the tracks. Sometimes, the configuration of positions makes it possible to see an abstract image through the layers and as the layers move, we can try to understand how the different information sources contribute to the compiled images.

An Information Marker

The information appliance. Any appliance that helps us to mark out pieces of information, e.g., a word-processor that enables us to highlight sections of a text.

Expression of use: Acts of drawing and displaying boundary lines.

Textile expression. Pulling various threads in elastic fabric making specific sections of the fabric transparent (fig. 2).

Reinterpretation. Marking information is interpreted through an act of stretching textile material to form transparent “holes” in the material.

The abstract information appliance. Elastic textile material mounted on a large frame in front of information projected on freely hanging textile. Using computer controlled stepper motors we control a process of marking information by pulling threads in the elastic textile material.

An Information Uncoverer

The information appliance. Any appliance that helps to reveal information by means of tracing how something is built. A software debugger is a typical example.

Expression of use. Acts of following a path, keeping track of its history.

Textile expression. Unravelling a piece of knitwear (fig. 3).

Reinterpretation: The structure-revealing process involved in unravelling a complex knitting-structure visualizes the mysteries of uncovering information. The information appears as the knitwear – the cover – disappears.

The abstract information appliance. A complex knitted structure is mounted on a frame. A computer controlled stepper motor pulls given threads to unravel the knitted object.

An Information Deliverer

The information appliance. Any appliance that somehow delivers information, e.g., an e-mail application, a telephone system.

Expression of use. Acts of handing out things. The mail program delivers information as I see mails arrive, the phone delivers information as I talk to my friends.

Textile expression. Floating, flying pieces of fabric on which information is printed using UV-luminescent colours.

Reinterpretation. A complex pattern of floating, flying fabric of various textures visualizes and conceptualises the mysteries of delivering information. The information is simply blowing in the wind.

The abstract information appliance. Large trays are hanging from the ceiling at different heights. Pieces of fabric are lying on the trays. Electrical fans are mounted on each tray, and as they go on and off, different patterns of pieces of fabric falling down to the floor can be seen. As they land on the floor, we can read the information using UV light.

The Information Deliverer – Installation

It was decided that the Information Deliverer would be built as an installation for an exhibition. After experiments with different kinds of fabrics moving in airflows, the trays were replaced with another solution based on large plastic tubes. Information was still to be delivered as pieces of fabric falling to the floor, moving as a result of airflows generated by computer-controlled fans, but they would blow out of a tube standing on the floor instead of off a tray hanging from the ceiling.

Installation overview

A 3,5x6 m podium, 40 cm above the floor. Ten plastic tubes, 2 m high 20 cm in diameter, rise from holes on the podium (see fig. 4-6). Underneath each tube, there are two electronic fans controlled by a micro-controller. The airflow generated by each pair of fans can be adjusted using a dimmer.

Each day, each tube will "deliver" about 50 pieces of fabric that will be blown out of the tube. To each tube, we associated a major news event during the 20th century, such as the first man on the moon, the assassination of president Kennedy, the Chernobyl nuclear accident, the wedding of Prince Charles and Lady Diana, etc. About 50 fragments of texts and images were collected from news articles covering each of these events.

A unique collection of pieces of fabric was designed for each tube and each day. The text fragments were printed using UV-luminescent colour on different kinds and qualities of fabric, reflecting some property of the news event in question. Each collection of fabrics was made in a specific material and each piece had its own shape, folding, etc., and thus floats and flies through the tubes in specific patterns.

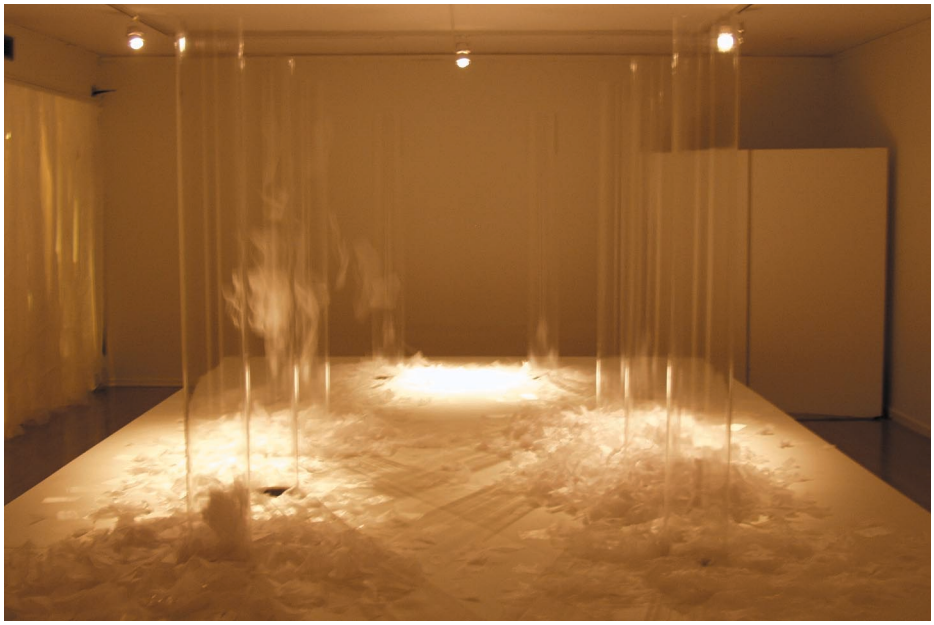
A computer program records and plays back a radio news channel in ten independent "threads". Each one of the threads controls the fans of a tube, making the news "right now" control the delivery of the historical news that blow out of the tubes and down on the podium.

Everything in the room, including the podium and all pieces of fabric, is white and thus the text is visible only when illuminated with UV-light (fig. 7 & 8). Therefore, a special "instrument" consisting of a UV-lamp mounted on a stick, has to be used to read the information (fig. 9).

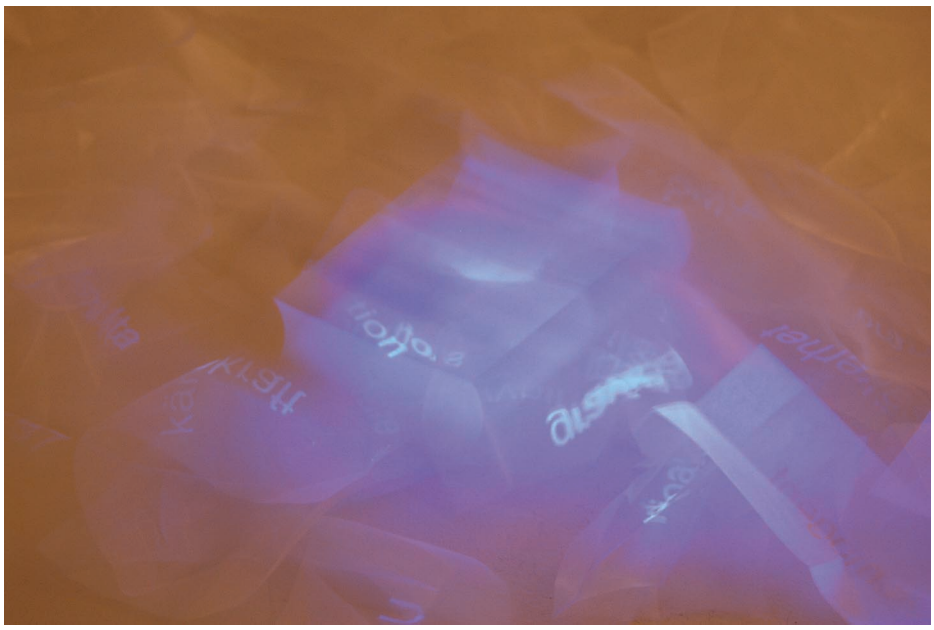
The installation at the Borås Art Muesum was built to run for 23 days, which means that at the end of the exhibition, there were approximately 11 500 unique pieces of fabric lying on the podium. During these 23 days, "news" piled up on the podium in the form of small pieces of textile fabric changing the empty surface into a complex landscape of yesterdays news still lying there to be read and to be reflected upon.

DISCUSSION

We can use examples such as the Information Deliverer to learn more about computational technology as design material in different ways. For instance, we can use it as a kind of critical counterexample to existing designs in order support reflection upon both established solutions to the given interaction design problems as well as what new opportunities arise as we change the preconditions slightly. However, we can also use it as a kind of canonical example, trying to imagine the design space of information delivering devices as centred on the idea of tiny pieces of fabric flying around. The point here is not whether having an information deliverer such as the one described here would be "better" or "worse" than, say, a certain e-mail client, but simply the fact that it would be *different*, and therefore would force us



Figures 4-6: The Information Deliverer. Figure **4** (top) presents an overview of the installation as seen from the entrence to the room. Figure **5** illustrates how the news piled up after the installation had been running for nearly three weeks. The bottom picture (fig. **6**) was taken after two weeks.



Figures 7-9: Reading the text fragments using UV-light. Everything in the room, including the podium and all the pieces of fabric, were white. The information on the fabric was printed using UV-sensitive paint, and could not be seen without the aid of an “instrument”. Basically a UV-lamp mounted on a stick, the “instrument” enabled people to search and read the text fragments in order to try to understand what they were about.

to think about such elementary information-handling acts in a different way. Besides reinterpreting the act of delivering information we also give expression interpretations of basic properties we usually ascribe to information of various sorts, like 'fragmentary', 'incomprehensible', 'hard', 'light', 'straightforward', 'hidden', 'destroyed', 'secret', 'coherent', etc.

The Information Deliverer as a Critical Counterexample

The interaction design for a complex enough information appliance will involve a more or less explicit design of a large number of elementary acts of interaction – interaction design is then understood in the general sense of designing computational things and computer systems as the *things* and *systems* we will work and live with [6]. To achieve a coherent design of all these elementary acts we may use strong metaphors or models together with a basic set of simple actions, e.g., the desktop-drag-and-drop-metaphor used in the design of graphical user interfaces. It is then often intuitively clear what the expressions of the given acts should be like.

If we think of interaction design as the design of computational things and computer systems as the things and systems we will work and live with, and want to move beyond given metaphors and models, we have to question the given expressions and consequently also the basic metaphors and models. The experiment described here can be seen as an attempt to build counterexamples to certain established models and metaphors. These counterexamples concern possible expressions of elementary acts in isolation from other functionally related elementary acts. In this sense, it is pure design of the given elementary acts.

We will probably not learn more about efficient ways of using computational technology to deliver information through studies of the Information Deliverer. Rather, it is a way to ask: "have you thought about what it means to deliver information and how that might express itself in terms of modern computational technology? Do you know that this is something you do now and then every day?" Once the question is asked, we can refer to, e.g., the Information Deliverer as a counterexample: things don't have to be the way they are, they can be very different. For instance, the expressions of information in the process of being delivered might be a "Zen-garden" of floating and flying pieces of fabric, inviting you to moments of reflection and rest.

The Information Deliverer as a Canonical Example

The abstract information appliances described here can also be considered as canonical examples. We may think of the elementary acts as aesthetically interesting in themselves. The expression of such an act can be one of those canonical examples from which the grand model actually is abstracted. To imagine that this is the case seems to be a useful methodological exercise: we turn the counter-example around and pretend that the given expressions are the 'natural' ones in a general context of information appliances.

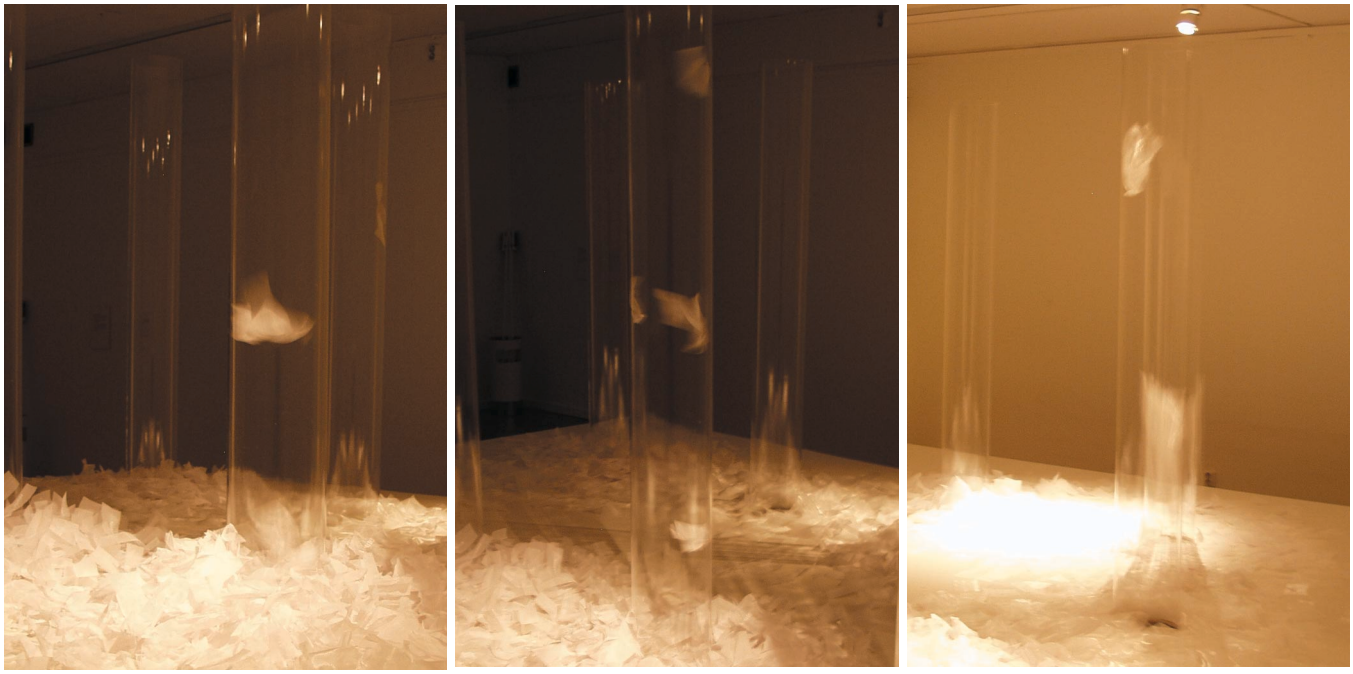
In the Information Deliverer, delivering information is about somehow distributing pieces of fabric. The information delivered is highly fragmentary, and we have a hard time trying to put the pieces together to form an idea of the overall content. It is almost like a guessing-game where certain hints are given to us through a noise of information, not entirely unlike zapping between a large number of TV-channels desperately trying to find something worthwhile to watch while at the same time trying to get an idea of what's going on. In the information deliverer, however, our focus turns to the 'art' of delivering information and as this happens, we almost forget about the information itself.

The art of delivering information using the Information Deliverer, involves intricate design of collections of textile fabrics. Information is not only delivered in the sense that certain texts might be printed on the textile fabrics, but also in terms of how these pieces behave. Almost as if we were engaged in fashion design, we have to think about the materials we use, the shape and texture of the pieces, how they hook into each other or do not, their weight and the colours used for the print, etc., as we try to make the pieces behave in certain ways as they fly around.

In case this was the canonical form of "information delivering", it would perhaps be an area for fashion and textile design, rather than a matter of HCI. Still, the "computational" elements are strong, as the design of the Information Deliverer also is a matter of what initiates and controls the air currents putting the textiles in motion and how this done over time. Dynamic properties of textile material will display the execution of programs through sending, delivering and receiving information. What we see, then, is a way of opening up the area of interaction design for another area of design in a way that does not simply mean that we try to use a new material, in this case textiles, to re-invent or reproduce an existing solution to an interaction design problem. What fashion and textile design could offer here, is clearly much more than simply another way of implementing already established ways of delivering information. The same would hold for the other design examples sketched above.

Expression Qualities

Looking at the design experiments discussed here, it is obvious that we mainly search for something that is different from most present-day information technology in that it is not suited for presenting text and images. At first, it might be hard to see the usefulness of such devices, but, again, areas such as fashion and textile design are examples of design traditions working with such expressions. Now, if we are not looking for ways of presenting text, what might we be looking for instead? Below, we discuss some of the



Figures 10-12: Flying and floating pieces of fabric. Over time, different patterns of moving fabric would occur in a seemingly random fashion as pieces of fabric hook into, and unhook from, each other. To some extent, this behaviour can be controlled by designing the individual pieces of fabric in terms of size, shape, etc., but the complex patterns of movements remain a result of the material properties of fabric and air-flows. Figures **10** (left) and **11** are from one tube, figure **12** from another.

expression qualities of textiles and computational technology that we have found interesting from the perspective of interaction design. It is important to really try to avoid the "functionality-trap" here, i.e., the strong urge to always look for a motivation in terms of functionality, to always look for *the* user. The issue here is to dwell on the material itself, to study its expressiveness through experimental textile and fashion design, not to search for new applications using given technology.

Movement, Change, Slowness

The expressions of fabric put in motion display "where to", rather than "what". While it is difficult to present an image at some given point in time, textiles offer enormous fine-graded opportunities for creating various kinds of movements. In the Information Deliverer, different collections of textiles where used to create a distinct spatial and temporal gestalt for each tube. The properties of textiles of different kinds, shapes, sizes, etc., offer a range of possibilities for manifesting temporal structures in space.

Temporal gestalts can be as 'informative' as spatial gestalts, but we can not capture this information in a snapshot – we have to wait and see what happens over time. Since we are looking at certain combinations of spatial and temporal gestalts, a certain slowness will always be present, as it takes time to see how a certain structure develops over time. However, we can also induce different kinds of slowness by using different materials; some will be easily affected by, e.g., fans controlling their movement or light controlling their colour, but others might need more time to respond.

Complexity, Unpredictability, Vagueness

Depending on what expressions we want to create, we can adopt different strategies to achieve complexity. The kind of complexity we can manifest using textiles is quite different from the kind of complex representations we can manifest on an ordinary computer display. The complexity of textile manifestation may, for instance, come from a certain degree of unpredictability, i.e., that the end result is, in certain ways, far more complex than processes generating it.

Consider the complex patterns of moving pieces of fabric and the resulting landscape of pieces lying on the podium of the information deliverer. This landscape certainly tell us many things about what has been going on, but it is not possible to trace every event back in time. This landscape is abstract in a sense quite different from, say, a complex information visualisation on an ordinary computer screen. We can say that the material properties of textiles can help us achieve a certain kind of abstract information display.

One quality partly arising from the unpredictability of textiles used in certain ways, is vagueness. Quite distinct

from the digital on/off of computers, this vagueness enables information presentation in a different manner. This is not simply a matter of introducing intermediary states between on and off, but a way of manifesting expressions such as "sort of..." (as in "it is sort of moving but it doesn't happen much") or "perhaps, later..." (as in "it seem to be flying out of the tube any minute now, but one can not know for sure"). What it is interesting here is not the fact that it possible to manifest such states, but the fact that these expressions come from the combination of materials chosen. This combination of materials will introduce a certain roughness in expressions, which in general is difficult to model in a precise manner.

Continuity, Presence

As we think about structures unfolding over time, we may also come to think about aspects of continuity. For instance, what traces are left from previous events? The typical computer has a very distinct on/off nature, where the off state erases every trace of what was going on the moment before (except what is saved on a storage medium, that is). From a phenomenological point of view, it has a very discontinuous appearance. The same holds for most electronic devices, e.g., a television set in a living-room: one moment a sparkling electronic 'fire-place', the other a silent black box.

The use of textiles open up possibilities for designing forms of presence that are more continuous. In the Information Deliverer, what has been delivered remain present. Of course, this is not, for many reasons, a universal solution, but it may serve as an illustration of how a more subtle transition between on and off, between being active and in rest, might be like.

Textiles also open up for a more continuous presence in relation to other everyday objects. We have a tradition of using textiles as material in interior design, and it can act as a kind of link between different objects: the clothes we wear, the curtains and furniture of a room, etc., are in a certain sense connected through the use of textile materials. This is something we can choose to, or not to, actively build upon also in the design of computational things.

CONCLUDING REMARKS

What is really the difference between, on the one hand, to think of computational technology as technology that implements certain functionality and, on the other, to think of it as material that builds a certain expression? Isn't it the same difference as between, say, the fact that "1" expresses, denotes the number one and the numerical expression "1" itself? This is the difference between *what* something is in terms of its intended use and the pure appearance of that something in itself – which of course includes its appearance in use – with respect to *that* which builds the given thing. Use is built on expressions, and intended use is what guides the design of things, i.e.. expressions of things.

Computational technology is material that is "visible" in the things it builds, and thus it cannot be reduced to "invisible" technology that implements pure functionality. Consider the appearance of the Information Deliverer: shaped in certain ways, the textile material builds the expressions of each individual piece of fabric. What builds the patterns of floating and flying pieces of fabric? Not only the fabric itself, the tubes, the air currents, the fans, but also the execution of programs, the programs themselves, the micro controllers and computers, etc. – the patterns of floating and flying pieces of fabric display the execution of programs. The idea that a computational thing can be thought of as a 'display', i.e., as something manifesting the execution of programs, is a kind of metaphor that gives a basis for studying computational technology as design material through other types of materials that builds the spatial appearance of the 'display' itself.

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