Storyforming
Experiments in creating discursive engagements between people, things, and environments

Loove Broms

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Storyforming
Till min son/dotter
This thesis introduces and critically reflects on a design programme, *Storyforming*, that explores ways to design objects and places to enrich daily life narratives. Using an experimental design approach, the goal is to exemplify and explore this idea with discursive artefacts that, through their physical and temporal form, act as catalysts in the construction of meaningful experiences.

In the current sustainability discourse, behavioural change has been pointed out as a key factor in achieving a sustainable society. Historically, design has been very effective in increasing production and consumption behaviours by creating new types of needs and, in a way, manufacturing desire (Forty, 1986). Drawing on this, the overarching aim of this thesis is the investigation of the ways design, through a suggested programme, can afford alternative types of meaningful experiences in contrast to the prevailing consumer culture.

The empirical work reported in the thesis stems from several research projects looking into the matter of energy use in relation to design. In addition, two of the projects have been carried out in the author's own design practice. Some concepts are explored more in-depth — involving events such as field studies, situated interviews, workshops, prototype building, design interventions in the form of domestication probes, and contextual studies ranging from a few weeks up to a year — while other concepts exist only as sketches or photo montages. The diversity of these concepts, the design experiments, helps span a design space becoming a new provisional design programme. The idea for this
programme has evolved from observations and reflections made throughout the experiments presented in the thesis.

The general results are the suggested approach of *Story-forming*, which focuses on the design of artefacts supporting daily narratives that can be used to create engagement, meaning, and alternative values applicable to the discourse of sustainable behaviour.

Specific contributions are the selection of design experiments. In the thesis, the experiments have first been examined from the perspective of stories and forming as a basis for the new programme formulation. Through this articulation of the programme, the experiments are revisited through three leitmotifs, part of the provisional programme focusing on different properties related to the aspect of forming. From the perspective of the user, these themes — seeing and accessing designs, exploring and expressing complexity, and sharing experiences and negotiating use — are finally elaborated on in relation to other theoretical concepts as well as their implications for future research.

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1. Introduction

You keep standing for a good while looking at the colours of the tower changing. And finally all the windows turn red again. There is someone out there that thinks like you, after all.

(Dahl, 2007, p.204)
Throughout modern history, design has been successful in increasing the production and consumption of goods by creating new types of needs and, in a way, manufacturing desire (Forty, 1986). Today, modern life itself — and the artefacts in it — is cast in a worldview largely based on consumption and in which meaningful events are sought through fleeting product experiences (Chapman, 2005). When the often short-lived object-user enchantment comes to an end, fully functioning objects are often discarded, making for an ever growing mountain of waste. When producing new things, it is therefore simply not enough to consider only technical aspects of manufacturing and use, such as energy efficiency, choice of materials, recycling, and transportation, without also considering what kind of practices an artefacts will reinforce and what roles it will play in everyday life.

Behavioural change has been pointed out by many scholars within the humanities as a key aspect of ecological sustainability, and here the design of artefacts constitutes a key element — not only by affording certain actions at a given moment but through addressing our deeper aspirations and re-configuring our life narratives. I will use the terms ‘narrative’ and ‘story’ to a great extent in this thesis and, when using them, I do not confine myself to an interpretation connected to written or spoken words, but employ a wider definition of the narrative as a rhetorical mode of discourse including artefacts (Buchanan, 1985).

We construct our reality in the form of material structures that surrounds us. These artefacts are a reflection of ourselves; we have created them and we understand ourselves through them. The artificial world can be seen as the stage on which we enact our daily life. We connect brief events to compose meaning and create a larger whole — an everyday story. There are many fragments that we might leave out of this story; even though they constitute large parts of our time awake, they seem to fade away quickly. Other occurrences become more central. We remember them longer, they constitute key events in how we build identity, construct meaning, and set out goals. By reinforcing certain practices and inhibiting others, artefacts are connected to this process, constantly part of an on-going negotiation of meaning (Masummu, 1987). As designers, we have the possibility of influencing experiences by the shaping of objects and services — reflecting in the process on what should be made visible and what should be hidden. How are our deeper aspirations and dreams manifested in our material culture?

The theme of this dissertation has evolved from projects starting not long before I began the journey of doing PhD work. At the same time as I was involved in my first research project, Aware, looking at energy use from a design perspective, I was working on the realisation of a large scale, interactive light installation called Colour by Numbers. This project was installed in a 72-metre high, unused tower previously used for telecom development in the south of Stockholm. With the installation, you can use a phone to call the tower and change the colours of the top ten floors, allowing for millions of combinations visible over a larger area in all four cardinal directions. In addition to this, you can also see the installation over the Internet through a real-time camera. The light installation became a success, receiving thousands of phone calls over the first days. It figured extensively both in traditional mass media and on blogs around the world. In time, it became a central actor in one bestselling crime

* I will elaborate some more on this in the following chapter.
novel (quoted above) and in one prize-winning youth novel. As of this writing, seven years after its inauguration, *Colour by Numbers* still averages 24 calls per day. Did we know that the installation would be so successful beforehand? Of course, we had our hopes, but the reception has exceeded those. The way *Colour by Numbers* gained popularity intrigued me — people used it in creative ways that neither my collaborators nor I had anticipated. It became like a platform allowing all kinds of communications and expressions to arise. It took part in people’s lives and manifested itself as a symbol for the area. If the technology somehow malfunctioned, we were quickly informed by people in the surrounding neighbourhood who expressed concern that the installation was not working properly.

At roughly the same time, I started working in the research project *Aware*. This project was a follow-up project at the Interactive Institute focusing on energy issues in relation to design. Its predecessor, *Static!*, had produced a series of design experiments that had received a lot of attention both within research and in the general media (Mazé, 2010). The *Static!* project explored the aesthetics of energy as material in design and by reflection in use and the *Aware* project continued in this direction.

Within the discourse of sustainable human-computer interaction (HCI), knowledge and information as primary driving forces for saving electricity started to gain increased interest. Different kinds of information devices like electricity displays, apps, and websites, started to slowly emerge through research contexts and on the market. In the *Aware* project, we were also interested in this. The idea of providing information as a form of democratic process seemed at the time both interesting and challenging. We designed an electricity display called the *Energy Aware Clock* in an attempt to challenge the way this type of information could be communicated to electricity customers — all within the framework of the design programme. Informed by a field study, literature, and previous design experiences, we turned our attention to the gender coding of places in the household and the aesthetics associated with these, as well as in what ways the use of electricity reflected daily activities. In the design of the *Energy Aware Clock*, these themes of explorations were implemented in different ways. For example, materials and the clock metaphor were used to encourage a more central placement. In a subsequent contextual study, nine *Energy Aware Clocks* were installed into the homes of nine demographically similar households for a three-month study. The receptions were very different: while one household found the clock too visible, moving it to the laundry room, another embraced, explored, and discussed it, connecting certain electrical patterns to certain activities. For them, the display helped form a new kind of daily narrative where electricity use was more visible.

These experiences, in combination with the growing engagement around *Colour by Numbers*, made me gradually more and more interested in how one could design artefacts that afford the occurrence of certain events into a meaningful and engaging story. I had a feeling, though at the time not so articulated, that this could be an interesting design strategy within the field of design and sustainability.

The objective of this thesis is to introduce, investigate, and critically reflect on a new design programme that I call *Storyforming* — exploring ways to design meaningful narratives through artefacts. The ambition is not to answer a single research question or to criticise already existing
approaches but instead to consider an alternative way to approach design.

The design experiments that are included in this thesis were not set up with the intention of exploring Storyforming since this programme has evolved out of previous programme-experiment dialectics (Brandt et al., 2011). Instead, the experiments have revolved around several different topics within sustainability and design, where Storyforming has evolved as a gradually more visible design space. The examples are selected from a larger set to examine different aspects that can potentially be related to Storyforming.

In addition to describing the design experiments, this work also reports on design interventions in the home, in the workplace, and in public, in which some of the artefacts introduced into the everyday life of participants affected their social interactions. Also, a larger participatory workshop with stakeholders has been conducted around some concepts that functioned as conversation pieces.

The thesis is laid out in five main chapters. In the following chapter, called Context, I will give a short background to what role design has played in society historically and contrast this to today’s culture of mass consumption. I will look at how artefacts create meaning and why they become meaningful in relation to some theoretical concepts. I will also look more closely at what role objects play in everyday life. The next chapter, called Process, will go through design research in a general way, and elaborate on the design and design research practice. This chapter also includes a description of the programmatic research approach and a personal account of how I came in contact with it. A short summary of the publications that are included is then followed by Experiments.
2. Context

Today we live in a world of objects designed for rapid consumption, objects requiring a minimum of effort and attention to use them, but also objects that leave no lasting impression on our memories — a throw-away world that requires no effort but, at the same time, produces no real quality.

(Manzini, 1992, p. 239)
Already in 1964, in the book *One-Dimensional Man*, the philosopher Herbert Marcuse sharply criticised consumerism, claiming that it is a form of social control (Marcuse, 1964). By constructing concepts of freedom where happiness is symbolised by the consumption of objects, Marcuse suggests that people act irrationally by working more than they need to fulfil very basic needs. New products are constantly produced, calling for the disposal of the older ones, thus fuelling the economy and encouraging people to work more in order to afford more. This leads to a physiologically destructive behaviour that also leaves us ignorant of the environmental damage that consumerism causes. Another danger with this is that when society provides everyone, or at least a majority, with everything needed and desired, all types of critique are absorbed by the existing structure. New radical movements become more like trends that quickly get commercialised and rendered harmless. After some time, we start seeing everything in the same way and it becomes hard to imagine a different society; we become one-dimensional in our thinking.

Society today, still largely influenced by modernistic ideals first proposed during the industrial revolution, operates under a linear perception of time instead of the cyclical conception that came earlier; speed, function, and efficiency are highly idealised and signs of high status. These types of norms have just recently started to become more questioned but are deeply embedded everywhere in society. Bruno Latour makes parallels to Walter Benjamin’s metaphor of the ‘angel of history’ to comment on modernism:

I don’t wish to embrace Walter Benjamin’s tired ‘Angel of History’ trope, but there is something right in the position he attributed to the angel:

The success of technological innovation during the industrial revolution led to the belief that it would bring the forces of nature and culture under control, liberating us from misery and toil and by dominating nature, producing liberation and enrichment (Borgmann, 1987). Although this is true to some extent that technological inventions and ingenuities have liberated us in many ways, this development has also created many problems — the ecological crisis stands out as a clear example of this. Still, with this catastrophe approaching quickly, the modernist (and post-modernist) machine, embodied in endless artefacts, steams onwards mediating certain actions
and inhibiting others. It is not simply a question of everyday moral decisions:

The landscape as well as the city are both highly structured, and our existence furnished with many different kinds of devices and technological systems. These are what instruct people in contemporary societies ‘how to live’ (de Vries, 1999, pp. 15-16).

New technological innovations, life cycle analyses, shifting from products to services, and an increase in recycling are all necessary and important actions needed to curb the effects imposed on the environment caused by consumerism. But they are just symptoms of the larger problem — the high level of consumption itself. Products are not just result of their primary function; they are constantly replaced for their values as signs. Mainstream industrial design has rightfully been accused of dealing almost exclusively with packaging of technology into archaic product typologies with mostly short-lived relationships with the user. Material possessions have become increasingly important as signifiers of status in a rapidly changing culture that is based on a constant evolution of new products. Today, communal values that used to fulfil many basic needs have been exchanged for an individual search for new relations with countless designed experiences. This epoch-making societal transition has cast us within an abstract version of reality in which empathy and meaning are sought from toasters, mobile phones, and other fabricated experiences. Today, empathy is consumed not so much from each other, but through fleeting embraces with designed objects (Chapman, 2005, p.18).

Adrian Forty points out in his book *Objects of Desire* that, historically, design has been very effective in increasing production and consumption by creating new types of needs and, in a way, manufacturing desire (Forty, 1986). As an example of this, one can look at the development of electrical appliances. Although becoming increasingly popular, electricity was in the beginning of the 20th century mainly used for lighting and little else in the household. This led to very uneven power consumption with peaks in the mornings and evenings and almost zero consumption during the daytime. In order to meet demand, the electricity companies had to sustain the same high capacity at all hours, which was not very cost effective. A lot of effort went in to looking for ways to increase consumption during the daytime, and one successful attempt to achieve this was the introduction of electrical appliances. Peter Behrens, a German artist and architect, and considered by many to be the prototypical industrial designer, was hired by AEG — a company that primarily produced electricity but was beginning to enter the consumer market — to design and market their electrical appliances. This turned out to be highly successful. By combining branding and design, the demand for electric kitchen appliances increased tremendously. Common household objects like dishwashers, electric stoves, toasters, kettles, and irons were developed, designed in different styles, and marketed as signs of a modern lifestyle where household chores would be easy and fun to do. Household appliances were said to free up time, making the housewife more of a supervisor of labour than the one actually doing the work. In hindsight, studies have shown that the increased standards of washing and cleaning actually have resulted in women doing more cleaning today than ever before (Ilstedt Hjelm, 2004).
After the modernist era came pop design that rejected the modernist obsession with functionality and durability. Putting the consumer in focus, it became more important for things to be nice than functional. In the seventies, pop design paved the way for postmodern design, completely rejecting the modernist ideals of form following function. Objects no longer merely fulfilled functions but became icons of lifestyle and social status.

As we can see, new technology and the design of artefacts and cultural norms have created a logic of life that to a large extent is organised around economic growth and high consumption, something that we know is not sustainable. Despite the fact that this is not news, there is a clear discrepancy between knowing and doing (DiSalvo et al., 2013). No matter how hard one tries to act on this knowledge, it is challenging because daily life itself, and the artefacts in it, push in the opposite direction. To change this, there is no easy solution, no silver bullet, but rather, many complex challenges that need to be addressed and questioned. This needs to be done in order to build new knowledge on how to make artefacts that reflect and support sustainable ways of living. This is the context in which this thesis operates. In the following pages, we will go through some key concepts used to acknowledge and reflect on this process.

1. Notions of Meaning and Meaningfulness in Design

Our life is greatly affected by technology. Inventions like the telephone, the washing machine, the freezer and fridge, the car, and much more have affected our existence and the way we define ourselves. And not only ourselves, but how we look at others as well: time and distance, our concept of cleanliness, gender, and much more change over time in relation to technological innovations. What came first and what affects the other? Do we shape these technological inventions as we see fit or do they shape us in ways that we do not entirely control? Electricity, the Internet, and even language are man-made constructions that shape how we interpret our surroundings. Previous inventions become parts of mental frameworks that are used when trying to understand something new. Inventions are often anchored in materiality; they are cast into forms and have their identities over time manifested in product topologies. The telephone and the car with their own iconic silhouettes are good examples of this. These artefacts mean something to us, but they can also be meaningful in a more existential way (Hallnäs & Redström, 2002). How do we differentiate between the meaning — as material mass-communication — and the more existential meaningfulness and how have these two concepts been approached in design?

Meaning
How objects are assigned meaning has been approached within several different research fields. I will go through some of the more established traditions here and how they relate to design research.
Semiotics

The way meanings are embodied in artefacts has found popular use in design practice through semiotics — the phenomena of signs. Traditionally concerned only with the classification of sign systems, contemporary product semiotics also incorporate how meanings are communicated through signs. Semiotics builds on the idea that an object can be read just like a text that conveys a number of semantic messages. Semioticians do not mean that the object carries meaning like water in a bucket; instead meaning is constructed in the present when the object is ‘read’. The interpretation of the object is always dependent on the context and the background (Ilsted Hjelm, 2002). For example, different cultures might interpret certain signs completely differently and thus certain products might not be received the same in these cultures.

When designers work with products, they often use terms like signs, functions, meanings, or styles — all part of product semantics. It is said that the designer inscribes messages into the object, which are then read upon interaction with it. Of course, as just stated, the interpretation of the message can vary and the user can choose to use, or abuse, the object in different ways. Product semiotics has been used within industrial design as a way to practise ‘good design’. Rune Monö’s book Design for Product Understanding, which attempts to develop a language of form for product designers, has been used extensively in design education in Sweden (Monö, 1997). When creating a new artefact, one may deliberately cut and paste, merge, and make references to the common material knowledge existing in the internal cognitive models of people. This is not only a conscious strategy for designers, but constitutes a common pattern of how new inventions develop their own shapes out of the already known to gradually evolve into an identity of their own. As an example, the last horse-carriage and the first car looked similar — the car was just a carriage with the horses removed (Ilsted Hjelm, 2004).

Another powerful tool for designers connected to meaning is the concept of the product ‘myth’, coined by the literary theorist, philosopher, linguist, and semiotician Roland Barthes. Barthes described myths as the dominating ideologies of our time (Barthes, 1973). The myths have become so dominant, so normalised, that they seem to be completely natural and normal. They are viewed as ‘truths’. Like metaphors, myths help us to make sense of our experience within a culture. Forty states: ‘Unlike the more or less ephemeral media, design has the capacity to cast myths into enduring, solid, and tangible form, so that they seem to be reality itself’ (Forty, 1986).

Some Notions of Meaning from Cognitive Psychology

Barthes and other semioticians are not the only ones to have approached the subject of meaning through our way of classifying and categorising objects in social and cultural learning. Cognitive scientist Donald Norman calls this type of classifications ‘cultural constraints’, which form behavioural boundaries that help us navigate the unknown (Norman, 1999). According to Norman, there are three forms of constraints: physical, logical, and cultural. Logical and cultural constraints are weaker than physical ones in the sense that they can be refused or simply ignored. They take a longer time to adopt, but once adopted also take a long time to go away. For example, pink for girls and blue for boys would be a cultural constraint according to Norman, while knowing how to insert a credit card into the narrow slot on an ATM is a logical constraint. Things like gates and fences are physical constraints.
Also, in the ‘good design’ tradition, the term affordance is commonly used in HCI discourse and denotes the quality of an object that allows an individual to perform an action. Made popular by Norman, the term has its origin in perceptual psychology where it was coined by James Gibson (Gibson, 1977). Gibson’s original definitions cover how an animal makes sense of its environment by means of its actionable properties, that is, the possible actions that exist between an actor and the world. Norman, on the other hand, originally used the term to denote how objects direct actions, for example, how a door handle can be designed to show users where to put their hands (Norman, 1990). According to this, the affordance is more a property of the object. It can be seen as the offered ‘action space’ that is directly perceived by the user. Norman later suggested using the term ‘perceived’ affordance instead to denote what he meant, which does not need to be the same as ‘real’ affordance (Norman, 1999). A perceived affordance is what the user interprets to be doable rather than what is actually possible.

**Actor-Networks and Scripts**

Another perspective on users inspired by semiotics is Actor-Network Theory (ANT) developed by Madeleine Akrich and Bruno Latour (Akrich, 1992). ANT is an attempt to explain how material-semiotic networks tie together to act as a larger whole. The clusters of different actors that constitute this whole can be both material and semiotic, both human and non-human. These networks are rarely static but exist in a constant state of making and re-making. The relations within these networks are constantly performed and negotiated since they would otherwise dissolve. In this way, meanings get inscribed into — and are played out in interaction with — artefacts. Akrich likens this way of inscription to film scripts where the vision of the designer is written into the object as programmes of use creating frameworks of action where users are obliged to act in relation to other actors within different networks (ibid.). Technical objects ‘define a framework of action together with the actors and the space in which they are supposed to act’ as Akrich puts it (ibid., p. 208). Scripting is most evident when objects are designed to configure users in a very specific way. One example of this is a particular design of public toilets where the flush button was hidden behind the raised toilet seat. To carry out the culturally embedded practice of flushing the toilet, users were required to first put the seat back down — a practice that is less universal (Ingram et al., 2007). Another example of scripting is Langdon Winner’s famous example of a set of bridges over a road that leads to a beach in New York. The bridges were built so low that only cars and not buses could pass under them. Winner argues that artefacts have politics in this way, since the bridges only let people that could afford a car, primarily white people, have easy access to the beach (Winner, 1988). Of course, the user can always reject the action-narrative inscribed into an object, be it toilet-flushing or bridges, and this is part of the negotiations that manifest the networks of actors and make them evolve.

**Meaningfulness**

I have up till now talked about the meaning of artefacts through semiotic as well as cognitive terms to describe how meaning is mediated through artefacts, inscribed by the designer, and read and interpreted by the user. Semiotics and cognitive psychology do well in describing how meaning is expressed through form, but in this frame of reference, the possibility of items also having an agency of their own falls
out of focus. Artefacts do not exist in a vacuum. They are more than just ‘signs’ or the ‘intentions of designers’ — they have their own materiality or intentionality (Ihde, 1990) that create practices beyond what is ‘spoken’ through the language of semiotics. Next, we will look at a few theoretical concepts that better enable us to approach the topic of meaningful experiences through design.

**Intentionality**

We have relationships to objects as things and not merely as signs, and they shape everyday practices through their material properties — objects do more than we tell them to do (Verbeek & Kockelkoren, 1998). For example, the shape of a table also shapes the way we interact; a round table versus a square alters the distance to other guests, influencing hierarchies and conversations during dinner. Writing a text with a mobile phone produces a different text that writing with a pen or a computer, and traversing a city by foot, bike, bus, subway, or car dramatically alters the experience and our view of the city itself. Judy Attfield (2000) writes of this matter:

> The rediscovery of ‘things’ by design theoreticians confirms the turn away from the immateriality encouraged by theories of representation that reduce all meaning to language. (p. 7)

Another example of object intentionality is Martin Heidegger’s notion of readiness-to-hand, which also goes beyond the linguistic aspects between people and things. According to Heidegger, an object can be either present-at-hand or ready-to-hand (Heidegger, 1978). When using a hammer, our attention is not directed towards the hammer but at the nail. The hammer withdraws from our consciousness and so becomes ready-to-hand, shaping our relationship with the world. If the hammer breaks, it no longer enables the hammering of the nail and our attention is directed towards the hammer itself — it becomes present-at-hand. This kind of engagement, the practice of hammering that the hammer provides and numerous other more complex tasks that technology enables, has also been described as the mediating property of objects. They in a way create layers of realities that only reveal themselves when something malfunctions — going from ready-to-hand to present-at-hand. The energy system serves as a good example of this, invisible and ready-to-hand when functioning, only rising to a cognitive level of consciousness when not functioning properly like in a power outage — ironically, in a way only present when absent.

**Focal things**

This type of hidden technology, or the lack of engaging capacity, has been labelled the ‘device paradigm’ by the philosopher Albert Borgmann (Borgmann, 1987). Technological products can be seen as consisting of two main elements according Borgmann: the ‘machinery’ and the ‘commodity’ that it delivers when functioning. The energy system, or the heating system as Borgmann uses as an example, is a device like this. The machinery is hidden away inside walls, behind covers and painted in white — the warmth that it generates is the commodity. We are surrounded by artefacts functioning like this: from basic infrastructure like telephony, the Internet, water, and electric systems to cars, elevators, computers, washing-machines, and much more. These objects have hidden machinery that delivers a commodity with the press of a button. One could say that we have...
become ‘button-pressers’ of sorts, ‘controllers’ of appliances and processes instead of being an embodied part of the underlying processes (Dreyfus, 1991). In pre-technological times, things were different. For example, looking at heating, there was no heating system but a wood-burning fireplace, a focal point of the household. By using wood for making fire, the process of cutting down trees, chopping the wood into pieces, and carrying it into the house for cooking and heating gave a much more direct relationship to energy use and what certain activities required energy-wise, like cooking and heating. But the stove was more than just engaging in its maintenance — it was a focal centre in the household, something to gather around for warmth and cooking, for light, and for social interaction. Borgmann pleads for more contemporary artefacts containing this focal ability, where engagement is encouraged instead of consumption, as in the case of devices. Critics of Borgmann have pointed out that these ideas are similar to older traditions within the philosophy of technology, claiming that technology alienates humans from what they ‘really are’ or what reality ‘really is’ (Verbeek, 2002). It is highly questionable if such a reality ever existed and with many communication technologies, people experience them as also giving quality to their lives in a deeper way than by just delivering a commodity, for example, by bringing them closer to friends and relatives (ibid.). Martin Avila provides an example of this kind of difference in perspectives with a painting by the street artist Banksy (Avila, 2012). Placed in a serene country landscape is a CCTV mast, a sign of human presence. Are we being watched? Who is watching? We see this technology as an intrusion clearly contrasting the ‘natural’ scenery. But as Avila points out, there are also other traces of human presence:

There are also tracks, traces which have been naturalized throughout the years. Perhaps, even more importantly, we assume that the tracks were made by a vehicle such as a cart lead by horses [...] If this is the case, how has our human relationship with horses developed, to the point that we perceive the tracks in the image as natural rather than artificial? To what extent does the cart become naturalized in this human-nonhuman relationship? We could ask ourselves, why do we accept the imprints left on the ground and not the CCTV mast? (p. 18)

Clearly, looking at the design of artefacts through the bifurcation of devices delivering commodities or focal things encouraging engagement risks over-simplifying the implications of technology and how it shapes human practice. Still, from a design perspective, the image of the device and the focal thing can still be valuable when reflecting on how to design contemporary artefacts (Fallman, 2009). Here, this distinction is interesting to reflect on when approaching feelings of meaningfulness. We are unlikely to have any deeper relation to artefacts that we cannot see or access and these artefacts are unlikely to appear in any daily narratives except for when they break down. Drawing inspiration from the concept of focal things is interesting in that it has potential to enrich life and create well-being by creating everyday experiences that are engaging.

According to the medical sociologist Aaron Antonovsky, famous for his work on factors that support human health and well-being or ‘salutogenesis’ — the study of the origin of health — a sense of coherence is the most central

1. Notions of Meaning and Meaningfulness in Design
2. Context
factor in how people handle stress in everyday life (Antonovsky, 1987). Coherence depends on three components: comprehensibility, manageability, and meaningfulness, where the latter element is the most important. The design of meaningful and engaging experiences therefore has direct implications for human health and the extent to which one feels that life makes sense emotionally. When emotionally engaged, we feel as though that part of life is worth investing energy in and that it is worthy of commitment and engagement.

Narratives as Artefacts

The use of stories as a way to organise life experiences has been studied within the field of psychology. Narrative psychology is a viewpoint within psychology that is concerned with how people deal with experiences by constructing stories and listening to the stories of others. According to this field, human activity and our experiences are filled with meaning and stories rather than logical arguments. Whereas cognitive and perceptive psychology focus on the mind as an ‘information processor’, narrative psychology is concerned with how people deal with experiences by constructing stories and listening to the stories of others as part of a social experience — seeing the mind as the creator of meanings. Drawing on this from a design perspective, even though design is a language with its different ‘symbols’ and ‘grammar’, one should consider not only what makes up this language but also what kind of narratives this language is used to create. In his book *Acts of Meaning*, the psychologist Jerome Bruner elaborates on narratives as the primary mode of how we organise experiences (Bruner, 1990). Questioning the overly mechanistic view of human perception following the cognitive revolution in the 1950’s, Bruner’s work focuses on the ‘making of meaning’ as a more active way of understanding one’s surroundings. The world is not just passively ‘taken in’ and interpreted but actively constructed as a way of understanding it (ibid). As was touched upon in the introduction, it has been shown that experiences that do not get structured narratively suffer loss in memory (Mandler, 1984). In our memories, experiences are systematically altered to fit our canonical representations of the social world (Bruner, 1990). When something happens that is out of the ordinary — that is, different from the existing practices of how things are expected to be done — a person who experiences this will most likely explain it through telling a story that contain reasons and in which the exception is given meaning (ibid.). Drawing on this, it is clear that stories, as human constructions, are a powerful artefact that turns consecutive events into something with meaning. The elements that allow meaningful stories to arise are knowable and reproducible, which also makes them designable.

The idea of creating objects that can ‘stage or dramatise’ is not novel. In the project *Design Noir*, Anthony Dunne and Fiona Raby do exactly this, letting the user become both a protagonist and co-producer of a narrative experience (Dunne & Raby, 2001). They compare product design to the ‘Hollywood blockbuster’ and turn their attention to its opposite, the ‘Film Noir’ genre of cinema marked by a mood of pessimism and menace, calling it ‘Design Noir’. By making products that create dilemmas rather than solving them, the user is invited to a psychological adventure (ibid.) Here Dunne and Raby challenge the status quo of mainstream product design, presenting an alternative to engage the user’s imagination through design. This is an interesting example of how one may introduce alternative experiences
that can constitute meaningful building blocks in someone’s lifeworld (Hallnäs & Redström, 2002).

In the book *Emotionally Durable Design*, Jonathan Chapman devotes a chapter to ‘sustaining narratives’ stressing the importance of narratives as a way to increase the durability of relationships established between users and products (Chapman, 2005). The main question asked is why users discard products while they are still working. The same questions of how to create attachment and prolong product lifespan are addressed by Verbeek, who seeks more ‘engaging objects’ (Verbeek & Kockelkoren, 1998, p. 40) and by Manzini (quoted in the beginning of the chapter) (Manzini, 1992, p. 239). Based on this, it is clear that there is a great potential for designers and design researchers to explore sustainable and intellectually rewarding narratives in opposition to the dominant ‘Hollywood blockbuster’ of consumerism. The artefact as a central and present actor in forming meaningful stories together with users thus deserves further inquiry to study how this can be approached through the design process and in what ways these types of stories can emerge through the use of artefacts.

2. Design and Everyday Life

To understand what people are and what they might become, one must understand what goes on between people and things. (Csikszentmihalyi, 1981, p. 1)

As soon as one acknowledges the way design influences the way we think in everyday situations, looking upon the regime of industrial design as a mass medium, the utilisation of the persuasive powers of artefacts becomes a tempting instrument to wield. In the field of persuasive technology, broadly defined as the study of how technology can be used to influence people’s attitudes or behaviours (IJsselsteijn et al., 2006), researchers have directed their efforts primarily at looking at how interactive computer technology can affect user behaviour through use. According to B.J. Fogg, founder of the field, behavioural change requires a trigger, motivation, and the ability to change (Fogg, 2002). A computational device can then be used to apply, for example, a factor of reduction (making some easier to do), conditioning (learning through rewards or punishment), tailoring (providing relevant information at the right moment), and tunnelling (guiding the user through a process), to name some suggested ways to change behaviour. Through the production of new consumer goods, or in this instance more specifically through computer and mobile devices, websites, and applications, users can potentially be persuaded to change their behaviours in different ways. From a wider design perspective, previously mentioned concepts within sociology, cognitive psychology, and design — scripts, affordances, constraints, and semiotics — can also be seen as instruments with similar powers.
Unfortunately for these kinds of approaches, human-artefact behaviour does not only exist within a single instance that then can be repeated to constitute the larger whole. Connected to ideas around ‘motivation’ and the ‘ability for change’ are other kinds of factors that to a large extent also influence the outcome of a behaviour.

Considering that products and places are important not only for their own sake but for the practices they enable, the importance of artefacts required to accomplish what people perceive to be ordinary ways of life becomes more clear — artefacts and practices are closely connected (Ingram et al., 2007). Importantly, practices are not fixed states of affairs. Even though they might contain habits that are repeated in certain manners, like showering daily or eating dinner at a certain time, they are part of a dynamic process where habit and practitioners evolve (Shove, 2012). From the perspective of practice theory, objects and people can be said to be ‘carriers’ of practice. Artefacts act as ‘knots of socially sanctioned knowledge’ that define a social order and direct how activities are carried out (Preda, 1999, p. 347). These activities can become practices revolving around objects, provisional relations that form complex compositions between humans and artefacts. Constantly negotiated and undergoing change, they form assemblages, a concept introduced by Gilles Deleuze and Félix Guattari (Deleuze & Guattari, 1987). According to them, an assemblage is a spatio-temporal composition of humans and/or nonhumans, in which there are ‘vitalities at play’ that make it unpredictable. As a result of this, material things can be said to be part of an on-going struggle to create order and meaning out of a constant stream of experiences. We live in an artificial world, arranged in such a way that it can resonate meaning and purpose back to us, at least in our daily doings. Practices therefore make things important, but not all things, as touched upon earlier. Devices that deliver commodities rarely bestow strong attachments and the same holds true for objects trapped in the postmodern platonic enchantment, where there is little or no attachment to the actual thing but instead to the product as an icon, a symbol, and a sign (Verbeek & Kockelkoren, 1998).

Theory related to design can provide us with an understanding of design as a cultural phenomenon and contribute to our understanding of how people make sense of designed objects, although many artificial objects often constitute ‘a silent and unnoticed part of our physical surroundings’ (Attfield, 2000, p. 14) that we do not even reflect on. When designing new products that are bought, these designs are also included in an already existing ecology of artefacts, integrated with existing objects and practices within a culture of everyday life (ibid.). When brought into homes, there might be conflicts over use, ownership, and placement of objects, as well as anxieties to be dealt with regarding the disruptions new products might bring to established routines and rituals. In the case of the household, this has been accounted for through domestication theory (Silverstone & Hirsch, 1992), describing how members of a household try to make sense of and use a new artefact. According to this theory, objects and their functions are never finally decided, but are constantly re-negotiated in order to maintain control and balance within the household as the object goes through different phases of domestication.

In the book The Meaning of Things: Domestic Symbols and the Self, Mihaly Csikszentmihaly and Eugene Rochberg-Halton study the significance of material belongings in contemporary urban life and how ‘people carve meaning out of
People find signification in objects that are ‘plausible, concrete symbols of the foremost goals, the most salient actions and events in that person’s life’ (Csikszentmihalyi, 1991, p. 30). As an empirical basis for their observations, Csikszentmihalyi and Rochberg-Halton arranged a number of interviews in households:

In one interview a woman showed us with pride a plastic statuette of the Venus de Milo. It was a tacky specimen, with thick seams and blurred features. With some hesitancy the interviewer asked the woman why the statue was so special to her? She answered with great enthusiasm that the statue had been given to her by a Tupperware regional sales manager as a prize for the quantity of merchandise she had sold. Whenever she looked at the Venus replica, she didn’t see the cheap goddess, but an image of herself as a capable, successful businessperson. (Csikszentmihalyi, 1991, p. 28)

Seeing a cherished object connects the past, the now, and the future in a sensible way and produces a feeling of order in the mind. As illustrated with the above example, not all artefacts perceived as meaningful need to be of high aesthetic value, nor do they always have to be of a nostalgic value, evoking memories of past experiences and relationships. The study indicated that younger generations instead prefer objects with a high activity potential.

What a person experiences with an object, and what the actual interaction means to that person create the perceived value of the object. The meaning of our private lives can therefore be said to be built in conjunction with these artefacts. While Csikszentmihaly and Rochberg-Halton focus on households, I believe this holds true for the attribution of meaningfulness in a larger context, something I explore further in this work.
3. Process

What interests me is the way in which, by drawing lines, arranging words, or distributing surfaces, one also designs divisions of communal space. It is the way in which, by assembling words or forms, people define not merely various forms of art, but certain configurations of what can be seen and what can be thought, certain forms of inhabiting the material world.

(Ranciere, 2007, p. 91)
Building on experimental design research, this thesis sets out, within a general discourse of sustainability and design, to critically examine the implications of affording meaningful narratives in everyday life through design. Through a series of design experiments, I investigate this design space, along with the multitude of possible outcomes, in order to better understand what this area of exploration can lead to.

In order to clarify how this research is conducted, I will in this chapter elaborate on this type of research in general and the design and design research practice in particular, positioning this in relation to the field of interaction design from which within I operate. From there, I will move on to a description of the programmatic research approach and how it is conducted both on a general level and through examples from my own experiences participating in these kind of programmes at the Interactive Institute. Being part of this research context, critically exploring the area of energy and design from different angles, the process of the emergence of a new research programme is laid out to prepare the reader for the following chapter, which contains descriptions of the experiments. Before describing the experiments, there will also be a short summary of the publications included in the thesis and in what they have contributed to the formulation of the new programme.

**Design-led Research**

Design-oriented research is a science of the artificial, focusing on what should be and how to achieve it (Simon, 1996). This is in contrast to the positivist natural sciences that study how things are and what already exists (ibid.). In a science for design, the concern is how designers can change existing regularities and overcome contingencies that cause recurring problems to make a difference in present and future societies (Krippendorff, 2004). Design thinkers hail from a variety backgrounds but strive towards the same goal — to add to, or change, the real world (Nelson & Stolterman, 2003). In design-oriented research, the knowledge that stems from studying a design artefact in use or from the process of bringing it into being is the main contribution while the artefact in itself is more of a means than an end (Frayling, 1993). Still, the research artefacts are important results since they express things that might not have been clearly articulated or focused on but are up for other researcher to reflect and react on.

The resulting design experiments should therefore be seen as a form of materialised discussion and ways to map out and understand a design space. As stated by Alex Seago and Anthony Dunne, this type of design is to be seen as ‘a form of socio-aesthetic research towards the integration of aesthetic experience and everyday life through the development of conceptual products rather than working prototypes or models which attempt to simulate a final product designed for mass production’ (Seago & Dunne, 1999, p. 14). The artefacts are used to uncover unknown aspects of a topic and to disclose tensions between the designer’s various intentions, as well as to provoke a reaction in the recipient of the object. The suggestions result in scenarios that can be tested and discussed by stakeholders such as users, policy- and decision-makers, producers, and designers. This type of inductive approach has the potential to create new knowledge and understanding of what further questions to ask. It is often referred to as research through design, or simply rtd (Frayling, 1993). According to art historian and writer Christopher Frayling, one can, by using design to support critical reflection, gain valuable knowledge about how to design future systems of products,
The physical results create a basis for more nuanced discussions about what we desire and demonstrate alternative possibilities to what already exists. Design artefacts act as mediators or agents of key ideas explored, rather than as mere instruments of utility. After all, design is about creating something new and not just recreating what already is. When creating something new, you always make implicit or explicit decisions that are rooted in ethics and not just in logic. For example, socio-technological concepts such as the sustainable society are related to how we wish our society to look in the future. The function of the artefact in this research context is to be a tool for thought to raise awareness and understanding of different issues and concerns.

1. Practice

It is now easier to imagine the end of the world than to imagine the end of capitalism. (Jameson, 1994, p. xii)

By practice I mean an activity, the on-going pursuit of a craft or profession with a customary set of routines, contrasted to theory but not isolated from it. In the following sections, I will start out with some notes on general design practice and then contrast this to the practice of critical design, the practice of interaction design and how this work positions itself within these three practices.

Contemporary and mainstream design, as an activity, profession, and outcome seems to be ill-equipped to deal with societal issues of pressing importance (Fuad-Luke, 2005). The general public confirms this, perceiving designers as mere stylists for a rampant consumer economy (ibid.). Design is thought to deal with only the surface of products and sometimes the word is even used to describe a certain type of aesthetics as an extra product value — expressions like ‘buy this designed kitchen aid’ is not uncommon. Perhaps this is a good example of how closely design is linked to the mass production of goods and the manufacturing of desire (Forty, 1986). Design culture is being stuck in a cage of aesthetic convention as Stuart Walker eloquently puts it (Walker, 2002).

Throughout the history of contemporary design there have been efforts in challenging this regime. Already in the 1960's, the anti-design movement contested design as being ‘blindly “in service” to values set by historical convention or hegemonic ideologies, espousing instead a political and
Since design was supposed to be about how things ought to be (Simon, 1996), we should engage in devising such desirable realities for ourselves. A critique of society could therefore also be a critique of artefacts in its widest sense, meaning everything constructed by the human race, tangible or intangible.

**Critical Practice**

Critical practice can allow new ways of thinking and practising design. Designers need not only engage in solving problems but can also take a holistic perspective questioning the reason for a problem, for whom it is a problem, and why it is a problem. Asking questions like this tends to produce results that critically rethink the parameters of the problem itself, allowing inquiries into existing conventions and norms.

Critical design, most well-known in the field of product and interaction design by the work of Anthony Dunne and Fiona Raby, aims to ask questions rather than find answers and to make complex issues more tangible and therefore more easily debated. In recent years, there has been increased attention on what critical design should be critical of (Mazé, 2009) and there have been voices raised questioning the political accountability of the field. It has been accused of having a perspective entrenched in first-world privileges, often failing to acknowledge issues of class, race, and gender (Prado & Olveira, 2014). Others have questioned its potential as a research approach, arguing its unclear methods are difficult to adopt within HCI research (Bardzell et al.). Despite this critique, critical design has shown potential in drawing attention to the social, cultural, and ethical implications of design, aspects that are usually difficult to see (Dunne & Raby, 2001). As objects find their forms, they become naturalised, cast as tangible myths (Barthes, 1973), and as such they become difficult to break out of, arguably even for the critical field itself. Latour uses the term ‘black box’ to describe a sealed network of people and things: ‘A black box contains that which no longer needs to be considered, those things whose contents have become a matter of indifference.’ (Callon, 1997, p. 185). To open up the black box and visualise the elements, Latour implies that something in the system needs to happen or break down. Critical design could be seen as an approach to make this happen (Ehrnberger et al., 2013).

One way of making ‘it happen’ is through design interventions. All design practice could be said to intervene into the world one way or another, intentionally or unintentionally. The commercial product, the exhibition, and the everyday bricolage are all forms of interventions. These interventions can be done with different intentions, for example, a research intention. Also here, the work of Anthony Dunne and Fiona Raby provides a well-known example. In their book *Design Noir*, they describe the Placebo project where conceptual design artefacts were placed in households (Dunne & Raby, 2001). The objects were designed to ‘elicit the secret life of electronic objects’, deliberately made to be open, vaguely familiar but still with an unknown use. The participants had to host the artefacts in their homes and then describe how they interpreted and made use of them. The designs were open-ended, meaning that the objects did not clearly solve a well-defined problem. By producing working design prototypes that can be tested in real settings, the discrepancy between design intentions and actual use allows for a deeper, more refined articulation of socio-technical relations that can be difficult to understand by mere observation. By perturbing existing ecologies, the ‘design probe’ provokes and exposes relations that
would otherwise remain hidden. The open and provocative aspect of an artefact can therefore be intentional on the part of the designer as a way of understanding use, meaning-making, and how material newcomers might be incorporated into the already present ecology of things in the household (Routarinne & Redström, 2007).

In this thesis the design experiments are situated in different contexts, levels of uncertainty, and critical examination — something that is meant to create a tension, further spanning the design space of exploration. A multitude of approaches and contexts can here be a strength in that they permit a more nuanced and better understanding of the space explored, allowing for a multiplicity of different views and standpoints. To name just one example of differentiation, the sketch, the exhibition, and the study all have different points of entry, inquiry, and evaluation. Just as light rays take different, sometimes intersecting paths depending on the entry point and angle in to a prism, existing information can be divided into multiple readings — perspectives — that overlap each other depending on the point of entry. Originally describing a physical phenomena of how light spreads in different angles when, for example, passing through a prism, feminist technoscience studies scholar Donna Haraway uses this as a metaphor to describe critical practice for knowledge making (Haraway, 1996). This is different from general notions of reflexivity, which Haraway argues do not go far enough to attend to effects that are relationally produced. Diffraction, on the other hand, allows multiplicity and differences and enables critique, thus clarifying which differences matter, how they matter, and for whom (ibid.).

The design theorist Håkan Edeholt proposes a blending of reflective practice (Schön, 1983) with Haraway’s concept of diffraction, a merging of reflection in the now and how things ought to be (Edeholt, 2004). This runs along the same lines as ideas proposed by Christopher Frayling, mentioned above. By using design to support critical reflection, it is possible to gain valuable knowledge about how to design future systems of products, places, and services (Frayling, 1993).

In this way, the materialisation of concepts and theories becomes an integrated part of the designed object, allowing for a form of internal evolution of theory and knowledge as opposed to external construction (Mazé & Redström, 2007). Also, tacit knowledge embodied in discursive artefacts, artefacts used as materialised arguments in an on-going conversation (Buchanan, 1985; B. M. Tharp & Tharp, 2009), can create a basis for more nuanced discussions and reflections leading to a clearer understanding of and valuable insights into some of the numerous small and large design decisions that were not as clearly articulated at the time of conception. Standing in ‘the swamp’ of everyday practice, immersed in confusing but critical situations where experience, trial and error, and intuition come into play, it is unlikely that all design decisions can be articulated and reflected upon right from the beginning (Schön, 1995).
Interaction Design

This thesis can be viewed as being a part of the field of interaction design (Moggridge, 2006). Historically, interaction design can be said to have emerged from two different intellectual strands: human-computer interaction (HCI) and the discipline of design. HCI, originating from experimental psychology and computer science, has traditionally focused on the usability and usefulness of digital products and services in predominately work-oriented situations. The focus has mostly been on the performance of the individual user. The design-oriented tradition on the other side is a combination of disciplines like graphic design, industrial design, and architecture, which increasingly incorporate digital and interactive materials into their practices. In addition to this, participatory design (Ehn & Kyng, 1991), with its strong focus on the user, can also be seen as an important influence on the field of interaction design. Even though there is a convergence of these research fields, there exist differences in the intellectual traditions that still influence interaction design as a practice. These dissimilarities mainly revolve around how the practice of design and design research is approached, the types of questions that are asked, and the types of outcome. In other words, the differences can be said to be in the degree of interest in aesthetic and ethical qualities, defining and re-defining the goal (and the question) throughout the process versus a more pre-defined goal, and the variation in importance ascribed to making ideas explicit throughout the process (Löwgren, 2010).

The definition of interaction design is still not entirely settled, although the focus on digital materials is largely agreed upon. On the other hand, there are those that disagree also here:

There is a common misunderstanding that interaction design is concerned fundamentally with the digital medium. It is true that the new digital products have helped designers focus on interaction and the experience of human beings as they use products. However, the concepts of interaction have deep roots in twentieth-century design thinking and have only recently emerged from the shadow of our preoccupation with ‘visual symbols’ and ‘things’. As they have become a growing focus of attention in the design community, the implications have emerged with force, changing many features of design practice and design education. This is arguably the centre of design research in the United States today, taking a variety of forms but always turning toward questions of action. How do we plan an action, how do we create the concrete form of experience, and how do we evaluate the consequences of action? (Buchanan, 2001, p. 11)

In this line of thinking, interaction design would be about the shaping of all kinds of products, services, and environments with a special focus on use rather than form only. ‘Like many other design fields, interaction design also has an interest in form but its main focus is on behaviour’ (Cooper et al., 2007, p. 610).

A more pragmatic argument for the coupling of interaction design and digital materials has also been suggested, emphasising the connection to the production of digital software, electronics, and the telecommunication
industry (Löwgren, 2010). As the fields of interaction design and industrial design converge, the borders certainly become blurrier. It is my impression that the majority of practicing interaction designers, at least in Sweden, work predominantly with screen-based types of design, such as user interface design in mobile applications and websites.

In relation to these traditions, I hope that the work described in this thesis might provide some interesting examples of how interaction design can encompass both different scales, from hand held devices to architectural installations, and different contexts ranging from the private to the public, and different extents through the use of digital technology as a design material. When claiming that the research in this thesis is practice-led, the ‘practice’ is interaction design done in a research context and with a critical design inquiry.

2. Programme

Moving on from a more general discussion about design research and the contexts of critical design and design research practice, we will now look closer at the research methodology.

Conducting my PhD work to a large extent at the Interactive Institute, an experimental IT and design research institute in Sweden, I have had the opportunity to become part of a research context where there has been an on-going development of a research methodology that strives to engage and cultivate design as part of the research encounter (Brandt et al., 2011, p. 9). At this time, Interactive Institute housed several artistically driven studios where I participated in some exhibition productions as a freelancing interaction designer. Prior to this, I had also conducted my master’s thesis in this environment. Later, being employed as an interaction designer in the Aware project conducted at the research studio Power*, I was also immersed in an on-going discourse around how design research could offer new perspectives on energy use in everyday life (Redström, 2010). This research constitutes the starting point for what is presented in this thesis. But before giving a more detailed background of the circumstances of this, I will give a more general description of the methodological approach of an experimental design research programme.

Successful in acknowledging ‘designerly’ ways of working in order to produce new knowledge, the practice-based approach of experimental design research proposed by Johan Redström and colleagues has gained popularity in recent years.

* Later renamed to Energy Design.
They suggest the use of design programmes to act as a foundation and a frame for carrying out series of experiments, acting as examples, that allows for critical dissemination of what could be done and how (Binder & Redström, 2006; Brandt et al., 2011; Koskinen et al., 2008). The programme is provisional and acts as a hypothetical worldview, a leitmotif that is relevant to the overarching research question. The experiments, by themselves, act as exploratory probes testing what the programme can entail, while the combination of programme and experiments address the underlying research question (Brandt et al., 2011). In their book Xlab, Eva Brandt and colleagues (2011) state:

We interpret the program through experiments. Through the way we set up the experiment, we present a certain perspective on the program. Using the metaphor of a design space opened up by the program, we might say that we use the experiment to explore this space, positioning us somewhere to be able to say ‘this is what the design space looks like over here’. (p. 35)

Thus, the programme is dependent on the experiments to materialise and make tangible this hypothetical world-view and the experiments are dependent on the programme to set out frames and direction for a directed form of material exploration.

A programme can be instigated, for example, as a reaction to certain key objects made in the tradition of the ecology of existing product typologies, or it can be formed based on an earlier design experiment stemming from another programme. In this way, new programmes can be formulated as a reaction to design experiments from older programmes as a form of internal progression or external elaboration on the ideas of other design researchers. These new programmes offer different perspectives — design spaces — where old design experiments can be seen in a new light. The new programme, a reaction to a previous design experiment, can be formulated in a way that better encompasses what is important versus what was achievable with the old programme (ibid.). This has been the case for my own research process and I will explain this in more detail below.

Initial Design Research Programmes
I will now look closer at the initial design research programmes that this work sets out from and build on. This will continue with an account for the emergence of a new programme constituting the central part of this thesis.

The Static! project
As mentioned in the introduction, this thesis takes its departure from two different design experiences set within both research and practice. Focusing here on the research practice, we will start off from the Energy Aware Clock, one of originally six design experiments conducted within the
research project Aware, carried out between 2006-2008. Even though this was my first contact with the field of energy and design and my first research project, this was not the first project at the Interactive Institute in this area of research. In 2004, the Static! project had initiated the investigation of energy and design (Mazé, 2010). The project received a lot of attention and recognition both from the research community and public media and paved the way for the development of a research studio and several consecutive projects within the same area. Static! was set up as a programmatic inquiry with the goal of developing a deeper understanding of energy as a design material, focusing on its expressive and aesthetic potential ‘thus locating issues related to energy use at the centre of the design process in terms of both form and material’ (Mazé & Redström, 2008, p. 59). The programme was formulated as:

Aesthetics of energy as material in design: working with energy not only from a technical but also from an aesthetic point of view. (ibid. p.59)

Reflective use: treating use not only in terms of utility and ease-of-use but also in terms of critical reflection through the objects at hand. (ibid. p.59)

With this formulation, the programme focused both on exploring how designers can engage with energy as a material rather than an ‘abstract and invisible technology’ and it also focused on the deployment of design to the users in order to express issues of energy use as everyday things (Redström, 2010, p.17).

The formulation of the research programme is significant in directing the process of experimentation. In Static!, the programme was formulated quite openly with the intention of being suggestive in nature to drive the programme forward and to be able to open up potential and inspire the programme’s participants. This form of openness is quite different from alternative types of framing, for example, through a question like ‘How can we make people more aware of their energy use?’ (ibid., p. 22). Whereas this formulation is directed more towards an instrumental understanding of design to come up with solutions, the one that was used for Static! is more directed towards the use of design as a way to think outside an existing regime.

The Static! project had great success in developing a rich set of design examples that, through their appearance, instigated many interesting discussions and reflections on our relation to energy in everyday life. To exemplify how well the project managed to propagate these questions even outside the research context, both the Flower Lamp, developed in collaboration with the Swedish design group Front, and the Power Aware Cord serves as good examples; they were in different years independently nominated by Time Magazine.
for the award ‘Invention of the Year’. The materiality of these discursive artefacts of course are much more accessible and easy to react to by the public than a traditional research paper which also serves as yet another good example of the persuasive influence of design.

The discursive artefacts from the project were not done as quick mock-ups to show proof of concept; on the contrary, much time and effort were put into making the examples as realistic as possible, resembling real commercial products.

Many of them were also fully functional. This grade of realism very often made people believe that they indeed were actual products that could be bought, something that often resulted in heated debates around these ‘products’. When it comes to cultural expressions such as books and movies, critical awareness among the public seems to be much higher than when it comes to reflecting on material culture; it appears to be more taken as a given.

**The Aware project**

After Static! came the Aware project that in many ways continued on the same path as its predecessor, operating within the same programme, but through its experiments exploring other realms in a design space of possible material expressions. The project was initiated with a qualitative data collection phase consisting of a set of stakeholder interviews in the domestic context. The goal was to get an understanding of energy use as a socio-cultural phenomenon in the home for both the ethnologist and the designers who worked side-by-side in this process. One important reason for this setup was to give the designers first-hand experience of the home environment to bring into the design process that was initiated alongside the interview phase. To reflect the openness of the design programme, the questions put together for the interview guide not only reflected on the use of energy but also on concepts such as beauty, well-being, and everyday life, questions that could still implicitly yield answers related to the topic of energy and design. Nine interviews were conducted with informants of varying ages, family situations, and kinds of housing. The interviews lasted for around two hours and were followed by a tour of the home with discussion and photographing. The interviews were then transcribed and analysed using methods such as meaning concentration (Kvale, 1997) and affinity diagrams to inform both the design process and later reflections and interpretations on the experiments. Within the design programme, it is not just the programme that determines the outcome. Just as the programme creates a frame for experimentation, the experiment itself creates a frame for the design work. When we work with a particular experiment, apart from our individual ideas about the design programme itself, our lived-world experiences as designers and other matters also influence the design outcome (Brandt et al., 2011).

Out of around thirty conceptual ideas that were generated, six were collectively chosen for further refinement and prototyping (Broms et al., 2011). Of these six, three are accounted for
in this thesis, namely: Energy Aware Clock [4.2], Share Aware Light [4.3], and Aware Laundry Lamp [4.4]. Just as with the discursive artefacts produced within Static!, the design experiments from Aware received a lot of attention in many different contexts spanning from research to exhibitions and the press. The Energy Aware Clock continued as a design intervention in nine households for three months in a follow-up study and has also resulted in a commercial product.

The Switch! project

Already within the Aware project, inspired by the experiences from making the light installation Colour by Numbers, an interest for a discursive engagement between people and things that evolves over time had started to grown on me, even though not well articulated at the time. By ‘discursive engagement’, I here mean the user’s engagement in an on-going dialogue of meaning-making in relation to an artefact, turning series of events into a meaningful narrative. Participating in several subsequent projects within the field of energy and design, it became clear to me that this had been an interest that I brought with me into the design phase of the different research projects. It became part of another energy display called the Energy Plant [4.5] done within the project DEsing SMart Energy (desme) initiated by Western Finland Design Centre Muova,* where the Interactive Institute participated in the design-related parts of the project. The project Switch! conducted at the Interactive Institute helped form the idea of Interfering Statistics [4.6], shaping everyday life through tangible statistics.

Starting in the year 2007, Switch! continued the inquiry into the aesthetics of energy and reflective use that was initiated with Static!. But whereas both Static! and Aware focused more on isolated people–product relations and the actual use of objects as the point of intervention, the research programme within Switch! turned its attention towards larger spatial scale and longer-term aspects of energy use with a more macroscopic perspective (Mazé & Redström, 2008).

The project was guided by a series of collaborative sessions where each session focused on different aspects of the overall programme to establish a common conceptual and practical background for the project participants. This was done, for example, through presentations and readings as well as hands-on workshops and collaborative analysis. Through the course of these events, smaller workgroups formed around briefs originating from ideas that grew out of complementary research questions, areas of interest, and expertise in relation to the programme. Some examples of these briefs explored were Energy Futures (drawing on future studies to develop critical design for transitioning urban cultures to future scenarios), 3Ecologies (developing interactive visualisations of the ecological complexity of product life-cycles to make the futures produced through consumption choices more tangible), and Telltale (accompanying transitions in energy use within families through a piece of furniture that collect traces of energy). Interfering Statistics was a series of concepts developed within a brief that we named Ab|Norm, a series of sketches that were used as props in participatory workshops querying norms of energy design and use in the public realm (Mazé, 2013).

Adjacent projects

The following projects, including desme, were conducted within the same framework of research as Static!,

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* A research and development organisation that is part of the University of Art and Design in Helsinki and the University of Vaasa, Finland.
Aware, and Switch!, but were not run with a clearly articulated design programme due to varying research traditions within the studio. For example, two projects that I participated in had a larger focus on the investigation of behaviours associated with energy use in work-related practices. By using design interventions, IndustryWise turned our attention to factories and employees working on the factory floor, while InCharge focused on offices (Katzeff et al., 2013). The experimental artefacts used in these projects, Watt-lite [4.7] and Watt-lite Twist [4.8], drew on the design experiment Interfering Statistics but now as something explored further within the workplace context.

Parallel to the realisation of the aforementioned design experiments within the area of energy and design two projects have been carried out within the framework of my own interaction design practice, namely Colour by Numbers [4.1] and Gradient [4.10], as well as another, Fyrfärg [4.9], a result of an internal commission from the Royal Institute of Technology where I had been conducting the later part of my PhD education. These external projects were also influenced by, and then themselves influenced, the experiences made within the practice of design research.

Towards a New Programme

Working on the experiments from the research projects as well as the aforementioned work conducted within my own practice as an interaction designer has given me the ability to collect an extensive repertoire of what design coming out of, or in relation to, the initial programmes can be like. Reflecting on the design experiments and their design processes has allowed me to consider alternative perspectives that have grown clearer over time, allowing for the articulation of a new design programme. As mentioned earlier, a new programme has the potential for design experiments to be viewed in new ways, possibly eliciting important aspects that would be difficult to do within the original programme. In this way, the experiments guide the formation of the new programme in order for the programme to tell us more precisely what it is about the experiment that is important (Brandt et al., 2011). In the case of the examples included in this thesis, they make relevant contributions in exploring the original design programmes relating to energy and design but they, when viewed from another perspective, have also begun to map out aspects of meaningful experiences and the construction of everyday narratives. This is something that has relevance both to the original programme and to the sustainability discourse in general, as well as other areas where an exploration of meaning-making through narratives in relation to artefacts can be of value.

I have chosen to call this new programme Storyforming. This name is both provisional and hypothetical, suggestive, and open to interpretation, and is meant to be evocative and bring images to mind of what this word could imply. As described in the context chapter [2], people ascribe meaning to objects and events, and objects are often perceived as more meaningful if they have been part of significant events. How can the design of artefacts allow for these series of events to occur in order to create meaningful experiences? Storyforming is the conceptual framing that sets out a new creative direction for a design space exploration based in earlier experiments. The word story paired with forming is deliberately suggestive in order to generate ideas through the design process about how artefacts can be used to afford meaningful stories to arise in one form or another. To better see this new direction, I
will first look at the already existing experiments in detail to be able to discuss their commonalities and what binds them together in relation to the new programme.

In the experiment chapter [4], I will therefore discuss a selection of ten experiments. Through their physical and temporal form, these objects investigate different ways that we can create artefacts that can be part of a programme investigating discursive engagements between artefact and user, aiding in the construction of meaningful experiences. After going through the experiments, with respect to stories and forming, I will begin to synthesise the experiences and formulate the new design programme in more detail.

3. Papers

The following section includes short descriptions of the papers included as part of the thesis. They were selected out of a total of eight publications produced during my PhD studies as being the most relevant to describing the progression ending in this thesis. Since the papers were written with the perspective of their respective research projects, they are done in slightly different writing traditions and with different research emphases. Looking at the sum of papers as a whole, they all contribute by adding knowledge to the overall progression of the ideas presented in the thesis.

Here I will summarise and point out the most relevant parts from the papers in relation to the thesis.

Exploring sustainable practices in workplace settings through visualising electricity consumption.

This article points to the challenge of how future workplaces should accommodate productivity needs and personal comfort levels whilst striving to reduce energy use. Two different prototypes for visualising energy use, *Watt-lite* and *Watt-lite Twist*, were inserted as design probes in different types of workplace settings, factories and offices, and then evaluated. The paper briefly accounts for the design process of the two design experiments but focuses mainly on the study and its results. In the chapters describing *Watt-lite* [4.7] and *Watt-lite Twist* [4.8], as well as Interfering Statistics [4.6], we will go deeper into the design process.
As the second author of this paper, I had been working closely with the first author and contributed to several sections of the text, especially those describing the design processes, the intentions for the design experiments, and all design related aspects of the research process.

**Becoming the Energy Aware Clock – Revisiting the Design Process Through a Feminist Gaze.**
nordes ’13: In the proceedings of Experiments in Design Research, the 5th Nordic Design Research Conference, Copenhagen, Denmark.

In this paper, we explored how feminist theory may be combined with design research as a strategy to break away from a gendered interpretation of technology that influences our design decisions. We did this by revisiting the design process of the Energy Aware Clock using feminist technoscience studies scholar Donna Haraway’s theory of the cyborg in order to clarify useful concepts that can be derived from feminist theory and that can act as important tools for designers engaged in creative processes. When designing the Energy Aware Clock, although not articulated at the time, a feminist perspective was used when discussing, for example, the significance of place in the household in relation to design. The gender perspective, looking at how the gendering of artefacts has become normalised and invisible, has many similarities to the concept of energy and has therefore been a very useful approach when working with all the energy-related design experiments.

For this paper, apart from an overall involvement in the discussion of the paper, I contributed with ideas on how to further connect concepts from feminist theory to aspects of the design process. I also did substantial parts of the writing.

**Coffee Maker Patterns and the Design of Energy Feedback Artefacts.**

This paper takes it starting point from smart energy metres and stresses the importance of acknowledging the social implications of design when conceiving them. It then reflects on the design of the Energy Aware Clock and discusses it in relation to how it was domesticated in nine households for three months. It describes an initial field study that was made to inform the design process, the design workshops, the design of the experimental artefact, and the intervention study in the households. The three themes that were identified as problem areas in the field study — complexity, visibility, and accessibility — are revisited both in the following article, and in the chapter in this thesis called Unpacking storyforming [5.1] (Ehrnberger et al., 2013). They have also been influential in many of the following design experiments. This paper contains much of what is presented in the chapter about the Energy Aware Clock [4.2].

This paper was very much a team effort even though I had the main responsibility of writing it and putting it together. Continuing the reflection on the design process, for which I had written a previous paper together with three of the co-authors (Broms et al., 2009), it adds the work of a field study carried out and reported by the remaining authors. Together with the second author, I compared the design intentions with the results from the field study and reflected on the results.
Persuasive Engagement: Exploiting lifestyle as a driving force to promote energy-aware use patterns and behaviours.


This paper looks at how aspects of lifestyle-thinking can be used in design as central driving forces that can lead to changed behaviour. It builds on the idea that behavioural changes related to energy use might be successfully carried out when people are offered desirable alternatives that are engaging and that do not impose a perceived extra burden in their everyday life. Aware Laundry Lamp [4.4] and Energy Plant [4.5] are used as examples. Even though the paper has a quite instrumental approach to design for behavioural change, from this perspective it approaches the idea of ‘engaging narratives’: ‘objects and services could have a narrative so engaging that the user feel urged to change behaviour in order to actively participate in its use. The appearance of the artefact could focus on enhancing this story, providing clear visual information that is easy to grasp and interact with’.

I was responsible for initiating the process of writing the paper, making an outline, selecting the design cases, and writing an initial draft. However, being my first paper, I received a lot of input from my co-writers and this steered it in a slightly different direction than if I would have written it today.

Apart from the papers included in this thesis I have also been engaged in several others listed below:


4. Experiments
In this chapter, I will give a thorough account of the design experiments with respect to stories and forming. That is, the process of form-giving* as well as both speculative and real stories of use relating to each experiment. This is done as a way of critically examining the design experiments in light of the forthcoming Storyforming programme in order to better understand what this changed perspective can entail for the formulation of the new programme itself. In what ways do the experiments act as catalysts in the construction of meaningful narratives when interacted with by users? The design experiments in this way enable an investigation of different aspects of strategies to create and sustain discursive engagements that bestow a sense of meaningfulness.

The experiments are selected out of a larger quantity based on their relevance to the concept of Storyforming. As mentioned earlier [3.1], they have been conducted in different contexts—both within the area of research but also within my own interaction design practice. Within both these contexts, I have been engaged in design processes done in collaboration with people with different backgrounds such as design, architecture, art, and engineering, to mention the most well established. Also, apart from being conducted in different environments of practice and with people with different backgrounds, the experiments differ in other aspects as well. Some are only sketches while others exist as functioning prototypes, some have been shown only in exhibition contexts while others have been evaluated in field studies over months and even years. They range from the private household to public spaces and from handheld devices to architectural installations. The reason for these variations are

* I will begin with forming for the sake of chronology.
connected to both interest and opportunities and limitations related to both my research and design practice. The context — academic and private practice and the traditions of inquiry, the field of HCI and design, and methods of evaluation — through practice, exhibitions, workshops, and field studies, adds up to a patchwork of overlapping methodologies and traditions. Projects conducted from within my private practice have made the realisation of ideas possible with different stakeholders (with different demands), different contexts, and different forms of validation, as compared to carrying out work in my role as a researcher. Research projects with a more open critical inquiry made it possible to create a collection of different design experiments that opened up many different paths to explore further, some of the results of which carried on to become part of this work. Other research projects had a larger focus on behavioural aspects allowing for a comparison of discrepancies between the design intention (an envisioned use) and the actual use, providing interesting knowledge of how design ideas resonate in reality. These differences in conjunction enable us to create a larger tension in the interaction with the programme where similarities and differences have a potentially higher chance of emerging as more redolent and evocative.

For all the experiments reported in this thesis, I was involved in and contributed extensively to the design process. My thoughts and experiences have, together with different team members, co-shaped the outcome, resulting in the physical objects. Apart from my own ideas and input, these objects wouldn’t have been the way they are without these collaborative efforts. Ideas get mixed and move along from project to project, influenced by the people you meet and work with. With this in mind, the selection of experiments described here, and the way in which I have chosen to present them, are still a reflection of my own research interest and my own design process. Other project members could highlight other aspects, assemble other types of collections, and perhaps suggest other design programmes in order to reflect their own research agendas. What I have chosen to focus on in this thesis reflects my own contributions in this larger context. Project members and collaborating designers that have in different ways contributed to the results are credited in the acknowledgements.
1. Colour by Numbers

*Colour by Numbers* is an interactive light installation installed in a 72-metre high, unused telecom tower at Telefonplan (Telephone-square), part of the suburb of Midsommarkransen in the south of Stockholm. Built in 1948, the building was originally used by the company LM Ericsson to house experiments with micro-wave technology and later used for early mobile telephony. The company, one of Sweden’s biggest, had at the time a large influence on the area, from the name of the subway station ‘Telefonplan’ to the whole infrastructure of the suburb that grew up around it, including homes for workers and cultural facilities. The tower was like a finger pointing out the company’s territory (Bydler, 2006). Over time, the corporate suburb ‘has become a typical city collage where the architectural form didn’t reveal anything about its function, and flexibility and pragmatism are the watchwords [...] The tower was left behind, uncommunicative, its sides like blank pages. Here was a visible area, but no one to take visual control over it’. (ibid., p. 1)

In 2006, when contacting Ericsson, still somewhat present in the area at the time, an interest in making a new use for the tower was nonexistent. The property owner on
the other hand, as well as the ‘Telefonplan group’ (an interest group for promoting the area, constituted primarily of property owners), saw a potential of using the light installation as a way of promoting Telefonplan as a new cultural centre in Stockholm. Konstfack, an art and craft school, had just moved in to the old phone factory two years earlier as a way of escaping the high rents that came with their old location in central Stockholm. A ‘house of design’ was also planned, but never realised. The proposal for the installation made by an artist, Erik Krikortz, Milo Lavén (an architect), and me (an interaction designer), was good timing indeed and the necessary funding was granted for a temporary installation. Colour by Numbers was first inaugurated on October 23, 2006.

Forming

With the help of touch tone, a technology developed in the 1960’s that allowed a keypad to replace the rotary dial when calling, the vision was that anyone with access to a phone could call a simple computer placed in the tower. The computer was then connected to a DMX-interface, often used for stage lighting and similar applications, controlling what in the end turned out to be 40 LED-lamps — four on each floor — pointing in every cardinal direction. The computer was programmed to play pre-recorded instructions on how to use the keypad as a simple interface allowing the user to send signals over the voice band. A user starts by selecting which floors to colour by pressing the digits zero to nine, zero being the bottommost floor, and nine the topmost. Basically, any colour can then be created by mixing red, green, and blue. The digits 1 and 3, the top row of numbers on the telephone, controls red. Pressing the 1-key gives less red, and 3 more. The middle row controls green, where 4 subtracts green and 6 adds more. On the bottom row, the user can control the colour blue in the same way — 7 results in less blue, and 9 more. By adding and subtracting red, green, and blue from different selections of floors endless combinations can be created. Only one person can call at a time and in the end it was decided the call had to be limited to five minutes to allow others to call.

The final design came out of several different ideas: the intention to create a constructive comment in the debate about who has access to send messages in public and the idea to, instead of creating a type of interaction that allowed for only a limited set of outcomes, like a game or something similar, instead provide a platform allowing for many different kind of expressions. The technical solutions resonated well with the history of the area and using old technology allowed many
people to use the installation. We believe we created a simple
democratic interface, allowing for remote controlling creative
expression on an architectural scale — so simple that there was
no need for any type of censorship, yet complex enough to allow
endless variations to explore.

Stories

*Colour by Numbers* materialised from idea to concrete
form, carefully crafted and installed in the old unused telecom
tower by using basically only a set of lamps, a small computer,
and lots of diffusing film for the windows. What began as a
design vision, overnight plunged into real life and then into the
minds of thousands of people.

The inauguration, with Stockholm’s mayor lighting up
*Colour by Numbers* officially for the first time, earned publicity
in media and helped spread the news about the light installa-
tion and the phone number. At first, the message conveyed by
the PR firm hired by the sponsors put the focus on the political
agenda of Telefonplan as a cultural centre but soon more and
more attention was focused on the actual installation and what
you could do with it. News of the installation and the unique
opportunity for the public to influence the public space were
promoted and recommended on blogs and net magazines all
over the world, which was also noticed in the traffic to the
website. We had installed a web-camera in a nearby flat, filming
the installation, that also made it possible to call and control
the colours from any place in the world. This generated more
media coverage not only in Swedish television but in Germany,
Russia, and Canada as well. Aftonbladet, Sweden’s largest
evening newspaper, published step-by-step instruction on how
to go about colouring the tower. Local radio had a feature on
the event and the property owner contributed by mounting a
giant banner on the site advertising the installation and the
phone-number. All these things in combination helped spread
the word about *Colour by Numbers* and how to use it.

In the beginning, the colours changed constantly — people even had problems getting through — but after
some days some colour combinations could last for longer
periods of time before someone called and altered it. You
could never know for how long your specific colour combi-
nation would last after the call was ended. Subsequent callers
started of with the existing set of colours and therefore had
a choice of simply making small alterations to the already
existing colours, or of creating something completely new.
For example, one could select all floors and only add more red
to an already existing pattern, making it more warm but still
reminding viewers of what the previous caller created. This
was not an intention that we had discussed in detail; it came
about as a result of numerous small and big design decisions,
but as soon as we became aware of it, we considered it an
important component of the installation. As people explored
further what you could do with it, thousands of minds
quickly explored and surpassed what we as creators had
imagined. Despite the installation allowing for expressions in
only one spacial dimension the ways that people discovered usages were a positive surprise.

Contrary to my own belief, in an interview study with six users, four of them had discovered the installation by themselves oblivious to the information about the project distributed in media:

At first, I didn’t understand what it was. I thought it contained a pattern changing over time. But as I get up at the same time each morning, and saw it each evening, I noticed that there was no pattern relating to the 24 hours of the day, or through the week. And then I overheard someone talking about it, and I understood that there was some kind of interactivity. I then surfed the net, found their page, and called.

Another respondent stated:

At first, I didn’t understand that it was changing. But oh, it’s so cool that the tower shines! But then, with time, I realised that it didn’t have the same colours, and once when my girlfriend and I were watching, because it is such a nice view, it changed in front of our eyes. Cool! So then I started to suspect something was fishy.

Linda Ryan Bengtsson, at the time carrying out a PhD in media and communication studies examining the blurred borders between media interfaces and the physical environment due to the introduction of digital technology, followed almost the whole process of contriving Colour by Numbers as well as how it was received in public over time. She interviewed six people living in the area who showed interest in the installation by e-mailing the official e-mail address. Of these six, five were male and one female, and ages varied between 30-55. I will here give some excerpts of Ryan Bengtsson’s work—a much more thorough account is given in her thesis (Ryan Bengtsson, 2012).

Ryan Bengtsson points out that, after some initial difficulties in understanding how to control the lights, the respondents felt directly connected to the lights where the phone itself became a tool that they used automatically, almost like a remote control. This was something that I noticed myself doing, unconsciously raising the telefon towards the tower just as you would when wanting to change a channel on the television. This even happened to me once when only having access to the real-time video provided by the website. The need to focus on the technical aspects disappeared and the focus shifted from ‘how to do it’ to ‘what to do’.

After the respondents had mastered the controls, it seemed important to find a purpose with the design they created according to Ryan Bengtsson. For example, they developed their own unique patterns signaling ‘now I am here’, another user set the lights to mimic the colour of the sky hoping that someone would notice this and yet another respondent even utilised his five minute time frame to put on a show that he hoped would catch the eyes of the passengers passing by in the subway train:

I felt like taking part in the production when the metro passed. Okay, it isn’t me that built the
Apart from the creative expressions, the social dimension was a central factor in the interaction with *Colour by Numbers* — to feel the presence of others and to be seen. Just as drawings, pictures, texts, or any other creative outcome is rarely kept to oneself, the users hoped that someone else would appreciate their creations and understand what they tried to communicate. Finding ways to communicate and also satisfying the needs of fun, excitement, and expression were central, according to the interviews Ryan Bengtsson conducted.

I experienced several times, I don't know if it was the same person, but it happened several times with different patterns. If you can call a person a pattern, several individuals were present. It could have been the same person constructing several different patterns, but that is not my interpretation. My interpretation is that there were several people that I was communicating with by changing my signature, just as they had their signature. That was the feeling anyway. I don't know if this was true or not but I like to believe so. I really want to believe so because it feels quite nice I have to say.

Another interviewee stated:

My girlfriend got totally into it and wanted to change it. Then another user would change it back. They were kind of duelling, it was like a battle. The person that my girlfriend was fighting would only colour the top four floors. My girlfriend thought maybe they could only see the four top floors from their house.

Also, along the lines of continuing on the creation of a previous caller by making small changes, one informant said:

Once when I had uploaded a design with one [window] in an unusual colour, magenta, it stayed through several... When I looked later all windows had been changed except for the window with the unusual colour.

Another respondent made a habit of calling in and subtracting all the green from the windows allowing the previous caller to set the boundaries for his own expression.

The installation itself was also given a kind of life of its own as users gradually developed a relationship with it over time. Users felt a sort of responsibility for not making the installation feel lonely. As expressed by one informant:

Sometimes I would think, oh no, now it has been like that for too long, now I'll call it and make a change.

Another user compared the light-installation to that of the presence of a goldfish. The respondents were of course aware that the installation was only a piece of technology and stated that they felt stupid and childish having this experience.

These sorts of emotions were something that developed over time by those who lived in the area. Ryan
Bengtson also had a small focus group that used the installation for a shorter period of time and that did not live in the neighbourhood. They did not develop the same strong attachment to Colour by Numbers.

People living in the area felt proud of having their own landmark. They showed it to friends and family and tried to located it from different places in town:

As I knew where it was and that it was tall and changeable I would try to locate the tower wherever I was. Then I could also identify my home. I could see the tower from Essingeleden [highway] at quite a distance and also traveling on tvärbanan [public transport]. And also coming from the south towards the city. I could see it from many places, and I did actively look for the tower.

Seeing it every day developed bonds and created a strong connection. Users were connecting with each other and with the installation itself. When it was taken down the first of April 2007, we soon received numerous emails from people living in the area expressing sadness that Colour by Numbers had disappeared. Later in 2007, Colour by Numbers played a central part in a best-selling crime novel called Himmelsöga by Arne Dahl (2007) and three years later it figured in the youth-novel Här ligger jag och blöder by Jenny Jägerfeld (2010). The character in the book has some problems controlling the installation:

The voice on the phone said that you could get all colours by mixing red, blue, and green, but I didn’t really understand. How could you get yellow? I almost got possessed in trying to get yellow. I called and called, mixed and mixed and it became green and red, and cerise and purple but not yellow.(p. 193).

In the beginning of 2011, the installation became a permanent feature at Telefonplan and as of this writing, Colour by Numbers still averages 24 calls per day boosted by occasional coverage in different media. The engagement with calling has endured over time and the installation has become a symbol of the area, appearing in all sorts of contexts. As of this writing, the latest additions are a company using the tower with coloured windows in its logotype, and for Christmas a video of a DIY project with an interactive gingerbread Colour by Numbers replica was uploaded to Youtube.

To make the installation more accessible, we recently developed a smart-phone application that allows the user to select floors by pressing on a live-feed of the tower and mix colours by spinning red, green, and blue wheels. I recently tested a version of the app on a six-year-old boy who had never interacted with the installation before. He almost instantly took the phone from my hands, selected some floors by pressing on the picture of the tower, and eagerly started to colour it. He later told others of this experience and comments on it regularly when passing by. I can see that the installation has started to become meaningful for him.
4. Experiments
Colour by Numbers was also installed in the Perigodes Tower in Seville, Spain, as part of the Seville Bienal in 2008, before becoming a permanent installation at Telefonplan in 2011.
2. The Energy AWARE Clock

The *Energy Aware Clock* is a display for showing electricity consumption. Instead of being something hidden in the basement, the garage, or a cupboard, we designed this electricity metre to stand out and relate more directly to everyday life. The *Energy Aware Clock* was developed as a research prototype, it has been used in several user studies whereas one is accounted for here, it has also been shown in several exhibitions and it exist as a commercial product.

**Forming**

With an external shape resembling a two-dimensional house and a front covered with a dark, transparent, acrylic sheet mounted on top of the colour display, the design was made to encourage a central location mimicking the materials of brown-ware equipment like television sets and stereo-receivers. The idea was for it to be easily seen when at home and also to have a strong identity of its own. Connotations were also borrowed from the kitchen clock, a central time-piece that is often glanced at throughout the day. Just as when a clock displays the time, the *Energy Aware Clock*
also displays electricity consumption — now and earlier. The metre visualises the daily electricity rhythms of the household, by default, a 24-hour clock-face. 24-hours were finally decided on after some discussion to allow for the days to layer on top of each other. This made it possible to, as the day progressed and the dial moved forward, compare today’s consumption with yesterdays and the day before yesterday before they faded away in the background. The length of the dial represents the present consumption and as the dial moves forward it leaves a trace behind lasting for three days. One touch-button was added to change time-scale of one turn ranging from one minute to a whole year and another button where implemented to allow for numeric values to be switched on and off.

At the time of the initial study, the only feedback on electricity use was the electricity bill that came once a month or even quarterly making any type of comparison hard to do.

With the Energy Aware Clock, we wanted to work with relations, allowing the users to experience and explore their electricity-patterns instantaneously and over time, sort of like a diary. Removing numbers all together would have made the electricity metre more provoking as an experimental artefact but then again, switching the numbers on and off made for an easy comparison with the relations between different electrical appliances whose patterns could be seen on the circular graph, putting the abstract numbers into perspective.

The Energy Aware Clock was deliberately designed in opposition to a traditionally male technocratic style where interfaces to the energy system were made to advocate ‘pure function’ and resembling apparatuses from the factory floor. Based on results from the field study, three areas regarding how the energy systems were connected with the social aspects of life in the households were singled out as being of particular interest to address. They were: complexity, visibility, and accessibility — all in their way relating to the problem of either grasping information about electricity consumption or not being able to see it (ibid.). The complexity theme focused on the problem of understanding one’s electricity use, even when wanting to. In the study informing the design process, there was a senior informant, 81 years old, who had an electricity diary in which he wrote down the current position of the electricity metre every day at noon. By doing this routine he could keep track of the consumption from day to day going down in the basement and writing down the numbers. He was the only person in the field study with this kind of dedication. Second, the topic of ‘visibility’ brought forward the fact that the electricity system often was found hidden behind covers and assimilated to the background surface, for example painted white. And finally the ‘accessibility’ theme focused on the fact that interfaces to the energy system were located in places isolated from the everyday living areas. The gendering of spaces in the household were related to this. Women still take the main responsibility for the household and children, whereas men are responsible
for the maintenance of the house. As a result of this, women and children have different movement patterns and mainly move around in the part of the home where little of the electricity system is shown, while the male domain is in the garage, the workshop, and the basement where the electrical system is more visible (ibid.; Ehrnberger et al., 2013).

With the *Energy Aware Clock*, we wanted to make a simple interface, moving away from the numbers and units standardised by the industry for communicating electricity consumption. The circular graph still needed to reflect the electricity usage throughout the day in all its complexity, giving users the possibility of exploring this hidden world. Television sets switched on in the evening, toasters and micro-wave ovens turned on for short intense use, freezers, fridges, and floor-heating going on and off, water heating up after showers, and much more—all electrical appliances overlap to create an intricate pattern to reflect on. No single answer is given, and no behaviour is affirmed or dismissed; electrical patterns are presented as a reflection of real life patterns in all their complexity.

**Stories**

In 2007, when we presented an early concept of the *Energy Aware Clock* in a research project looking for an electricity display to try out in-situ in a number of rental apartments, some participants, mainly a group of property owners and people working in the energy field, got upset. The sketches with the circular graph enclosed in the house-shape were so different from what they had expected that they left the meeting early in an upset fashion. ‘We have worked so many years to make the customers understand the concept of kilowatt-hours, do you seriously mean that we should throw those efforts overboard?’ was one reason given*. It became apparent to us that leaving the tradition of the design aesthetics reminiscent from industry was not entirely unproblematic for the industry itself. In households on the other hand, this shift in style did not seem to be very provocative. The new electricity metre was seen as something entirely new and not compared to what had previously been hidden away or communicated through the electricity bills.

As a design intervention, the *Energy Aware Clock* was developed into a set of fully working prototypes installed in nine homes using a domestication probe methodology (Gaver & Dunne, 1999; cf. Routarinne & Redström, 2007). With this method, the proto-

* Quoted as I remember it.
at the end of a three-month period (Broms et al., 2010). One major finding from the interviews was that the Energy Aware Clock went through at least two phases — an exploration phase and a confirmation phase. In the first phase, participants explored the household to map out the amount of electricity used by different appliances. Appliances were turned on and off to see what the effects were on the metre. After approximately two weeks, the participants gradually started to use the display more and more for confirmation, to check if everything was ok. As stated by one participant:

In the beginning we had fun looking at it and then you could run to switch something on and then go and look [again]. But once you’ve done this for a while, [...] you’ve become aware of [how much electricity] everything uses.

And described by another informant:

You just check it. It’s like looking at the oil gauge in the car. You just take a quick glance [to] see that everything’s OK. That’s how you use it when you’ve gotten used to it.

During the exploration phase, the detailed information provided allowed for quite nuanced reasoning about, for example, different dishwashing programmes. One respondent said:

You run the eco-programmes. [...] I have compared these to the regular programmes on the dishwasher and the washing machine. [...] I like seeing that less electricity actually was used [for the eco programme].

After a while, during the confirmation phase, the electrical patterns were also connected to everyday life events:

After a while [of having the Energy Aware Clock], we could see very clearly [...] when we go to work and when we get home [...] lights are switched on and the TV is on [...] everything is on maximum. And then, you notice how it drops [...] you see how everything is switched off.

We could see that thinking about electricity had resurfaced into everyday life activities.

Over time, some respondents learned how to recognise electrical patterns related to certain appliances:
Yes, like right now, this is fun. That pattern is the coffee maker, you recognise it immediately [...] before it could be switched on the whole Saturday before lunch, but now when you see this you are reminded of how darn much effect [it uses].

Here we can see that we put on some coffee [...] or the washing machine. Yes, yes, yes, the dishwasher was on when I got home, so it probably is that caused this [pattern].

The patterns drawn on the display of the Energy Aware Clock encouraged exploration and reflection over time. Relations between what happened during the day and what you could see on the display were not something that was always figured out straight away but gradually evolved over time.

Even though most households appreciated the Energy Aware Clock, these feelings were not mutual for all participants. The central placement was expressed as a problem by one household:

It was just too present, [...] and we felt that we can’t affect our energy use that much [...] I mean, to use the dishwasher and the washing machine as much as we need to. It has kind of a high priority now when we have children and limited time and so on. So we felt that [the clock] added unnecessary stress. Because we try to keep it [the electricity consumption] down as much as we can anyway. So, really, it was quite negative.

Despite trying to present the information as neutral as possible, visualising the use of electricity was not without problems as can be seen in the quote above. The perceived quality of life was in conflict with acts of electricity conservation. Resurfacing electricity use on a cognitive level is not without complications since it imposes different kinds of real and perceived burdens that somehow have to be motivated. Threatening what is considered the good life is not a popular alternative. Some informants even talked about ‘giving up life’. In some cases, these feelings projected on to the electricity display were so strong that the will to engage further with it became very low while other households engaged enthusiastically exploring and discovering relations between their actions and the electricity use. The narrative proposed with the Energy Aware Clock, focused on the act of measuring, led to feelings of unease in some of the informants.

Next we will look at some other design experiments that explore different ways of proposing narratives around electricity use.
2. The Energy AWARE Clock
2. The Energy AWARE Clock
### 3. Share Aware Light

The *Share Aware Light* is a portable reading and ambient light connected in pairs or more through a wireless ad-hoc network. As implied by the name, a constant amount of available light is shared between the round and organic-shaped silicon shapes by twisting aluminum knobs located at the top. If one lamp is made brighter by twisting the knob counter-clockwise the others are dimmed proportionally by an equal shared amount. The distribution of light is up for debate among the users. The *Share Aware Light* was made into three fully working prototypes but not studied in real life settings.

**Forming**

The *Share Aware Lights* were designed to have almost life-like properties. The opaque silicon case encloses a rechargeable battery and small circuit board holding a powerful warm-white LED-light along with several additional RGB-LEDs that are able to produce almost any colour desirable. Apart from being able to dim the white light up and down the additional coloured LED-lamps are meant to be used to convey simple messages: Lamps connected to the same network are assigned a specific colour that are used to communicate when pairing, flashing briefly, or when running out of batteries (the warm light is then replaced by the specific colour showing that it is time to recharge). When charging, the lamp slowly pulsates in warm white to produce a feeding effect. Future versions were envisioned to have the charging cable connected through the top of the knob to make further resemblance to a feeding animal but for the prototypes this was never realised.
These aforementioned design choices were made to explore the idea of turning a limitation, sharing a set amount of light, into part of the object identity using different metaphors and in the envisioned use, to allow for new types of situations to arise — for example, negotiations of sharing. Instead of allowing electricity to blend in, being purely a commodity as we are mostly accustomed to, we wanted to make the limited energy part of the very essence of the object’s identity. For battery-powered devices like mobile phones, laptops, and such, this limitation is also present, such that one often has to relate to it, but contrary to the idea with Share Aware Light, battery drain would in these cases not likely be described as a positive feature. Making a battery that never runs out and putting it inside a mobile phone still makes it basically the same, just without the need to think about charging taken out of the equation. If you instead turn each Share Aware Light into an independent light source with an endless supply of electricity, it would become something entirely different. Now they would be more like ordinary lamps — the limitation is central to the object identity. This restriction also makes it interesting as an active instigator of narratives around the distribution of light. Turning it on initiates a negotiation stretched out over space, mediated by radio-waves. In cases where Share Aware Light would be used by a single person it would still allow you to use the light where needed the most — a clever use of light, an ‘intelligent’ lamp.

Stories
When sharing light, having it taken away might be provoking but also engaging — connecting you with someone else. Just as with Colour by Numbers, this way of connecting and communicating without using words has many interesting implications. It acts as a platform that allows users to invent their own uses and their own meaning and therefore also the possibility of exploring and making up their own stories that they fill with meaning. Short messages can easily be constructed and connected over the Internet, light can be shared over long distances, making for a more ambient way of communicating and negotiating presence.

Interacting with the three prototypes in the office was an exiting experience, the circumstances of which I wish would have allowed me to explore further. Turning the knob
up to increase the light of the lamp I held in my hand while seeing two other lamps further away instantly dim down was a surprisingly strong experience, just as when changing the lights of *Colour by Numbers* with a mobile phone for the first time. Using the lamps only for a short while put the imagination in motion thinking of the ways one could use them.
Experiments 3. Share Aware Light
4. Aware Laundry Lamp

The *Aware Laundry Lamp* is the third and final result chosen from the Aware project. It is a fusion between a lamp and a drying rack giving its owner the possibility of hanging clothes to dry as part of an aesthetic expression, instead of simply tossing the clothes into a tumble dryer that is often placed in the bathroom or the laundry room. Drying the clothes in a more sustainable way also becomes a much more social experience.

**Forming**

Inspired by a participant, hanging clothes to dry in his apartment during the initial field study in the Aware project, the idea for the *Aware Laundry Lamp* was born. By combining a drying rack with a floor lamp and turning it into a laundry lamp built on the idea of combining the act of hang-drying clothes with that of home decoration. Tumble drying is one of the most intensive electricity-consuming activities in a home and it was therefore interesting to reflect upon how alternative practices could be encouraged. The home as an expression of the self, has in recent decades become more and more similar to fashion design, leading to more rapid replacement of furniture that was previously owned for a lifetime. Makers of low-cost furniture, like IKEA, have also made this economically feasible. With the *Aware Laundry Lamp*, the idea was to instead make a piece of interior decoration where the use also allowed for a continuous flow of expressions, making the user an everyday designer of sorts. Hang-drying clothes is also a common image used in advertisements for freshness and cleanli-
ness — blue skies and a warming sun — connotations we did not mind associating with the laundry lamp. Could this way of drying clothes appeal to our desire for beauty, self expression, and environmental consciousness as opposed to the more modernist ideals of speed, efficiency, and convenience? Made in both a floor and a ceiling version, users can make a statement with what kind of laundry they put on display blurring the border between what is to be left private and what is to be shown. Also, since tumble dryers are traditionally often stowed away in laundry rooms and basements, the Aware Laundry Lamp instead encourages placement in a more central location through its form, just as with, for example, the Energy Aware Clock. The act of hang-drying clothes could therefore also be a social act, adding the possibility of the ambience of warm light shining through different coloured laundry drying slowly.

Stories
A total of three Aware Laundry Lamps were produced — two floor versions and one ceiling version. The first floor version was taken back for two weeks to the one household that had given rise to the original idea. This household had already been using a laundry rack at the time for the field study and during the interview it was standing in the room full of only white clothes. This led us to reflect on the aesthetic expression of clothes drying.

Perhaps not so surprising, the participant that had left his clothes out to dry in the apartment during the first interview had no problem with having clothes on display using the laundry lamp:

I don't think one should try to hide things; it is a home after all [...] I enjoy coming home to people and you can see that things have happened [since the last visit]. It is something personal.

The changing states of friends’ homes were seen as something positive, a sign that life was happening there, and the ability
to change the way the laundry lamp looked was seen as a reflection of this. This participant also pointed out that on a rainy day he could toss a jacket over it to dry and he wouldn’t mind experimenting more with what you could use it for. He mentioned Christmas decorations and pieces of coloured textile as examples.

Using laundry as an aesthetic element in exhibitions seemed more provoking. The laundry lamp has been extensively shown in exhibitions around the world and raised many eyebrows from visitors. More on a side note, the Swedish minister Birgitta Ohlsson questioned the amount of female underwear hanging on the laundry lamp when visiting one exhibition with the Aware Laundry Lamp. Drying laundry had become politics when moved from the tumble dryer to an exhibition.

Whether in exhibitions or the home environment, the visibility and centrality of the Aware Laundry Lamp seemed to put thoughts in motion, making people reflect on its presence and how laundry could be put on display. Compared to the more hidden spinning of clothes in the tumble dryer, the laundry lamp made drying them a shared, debated experience.
5. Energy Plant

The Energy Plant is an alternative version of an electricity metre where use of electricity is translated into the shape of a growing plant. Exploring the design space of how information about electricity use could be communicated on an everyday basis, the design was developed out of a gardening lifestyle analogy (Brons et al., 2009). On a transparent LCD display, the electricity consumption of a household is embodied in the form of a growing plant. The Energy Plant has not been developed further than a non-functioning model.

Forming
The idea behind the concept was to connect the use of electricity with that of gardening, making nurturing the Energy Plant synonymous to reflecting on the use of electricity over time. Modest electricity consumption would result in a fast-growing healthy plant, while over-consumption would make the plant slowly whither. We already know that taking care of plants is regarded as a meaningful and rewarding activity by many. Jonathan Chapman writes regarding our relation to plants: ‘The amorphous transience found in plants demands a degree of patience that for some strange reason is readily accepted by consumers and is found rewarding by most, an emotional commitment so rarely encountered in the made world’ (Chapman, 2005, p. 113). He also brings up the reflective traces left in the plant witnessing the invested care and attention. The complexity of a growing plant is therefore an important reason for this enchantment — exploring how it will grow and develop into something yet unknown and hopefully beautiful that
reflects the transient states of a household. Also, this type of development spans a longer period of time allowing for a stronger commitment to develop.

To give the *Energy Plant* the complexity more resembling a real, growing plant, the digital plants were made from mathematical L-systems, a form of formal grammar developed in the 1960’s by theoretical biologist Aristid Lindenmayer to model the growth process of plant development (Prusinkiewicz & Lindenmayer, 1990). The branching structures that can be made from L-systems are strikingly similar to real organic structures, but can also be made more or less symmetrical creating an interesting tension between the organic and the digital. Variations are endless, allowing many interesting and beautiful patterns to develop and there is the possibility of continuously affecting the outcome by changing some parameters.

The inverted shape of a flowerpot together with the digital plant shown on the display were meant to convey the story of a growing plant. Two buttons located at the front of this shape were an info button and a history button — similar to the layout of the *Energy Aware Clock*. The info button was meant to toggle extra numerical information on and off, while the history button could take you back and forth between the different months and their resulting plants.

**Stories**

Each new month, the user was imagined to ‘plant’ a digital seed that would start to grow slowly on the screen, not moving visibly when looking directly but noticeable over time — just like a real plant. The new seed was envisioned as creating some feelings of excitement to see what it would grow into with the right care — also just like a real plant, it would have an unknown starting DNA. Over time, each month would generate a new addition to a growing collection of plants. Placing the display in a window or any other place like an ordinary plant would allow for some nice possibilities. On sunny days, if placed in a window, the digital plant shown on the display could cast a shadow that would wander through the room as the day progressed. In this way, using little or no electricity ambient information could be transmitted in a very visible way using the sun as a projector. With just a quick glance, the *Energy Plant* would potentially engage users in constructing meaning by associating electricity consumption with taking care of a digital plant.

Using L-systems, many different kinds of geometrical shapes can be generated and continuously alternated depending on parameters such as electricity use.
With the *Energy Aware Clock*, we could see that the display spurred discussions among the participants around what electrical appliances caused what patterns on the display. Some patterns emerging on the screen became recognised as in the case with the ‘coffee-maker-pattern’ (Broms et al., 2010) [4.2]. Electricity became more present in the daily narratives as informants constructed explanations for what was happening in their domestic environment and what was happening on the screen. With the *Energy Plant*, the possibility of exploring an individual appliance’s electricity consumption would be much less obvious. Here, the visibility of the plant would be more of an overall symbol reminding users of the state of the whole household. The narratives that could occur around the *Energy Plant* would ideally relate to and strengthen this symbol driven by its presence. Visualising the overall electricity use more as a symbol might not be as far-fetched as one might first think. With the *Energy Aware Clock*, a few statements from the household members related to the metre based on its symbolic value as a reminder to save electricity. For example, the participants that moved it to the laundry room felt pressured just by observing it. The *Energy Plant*, arguably a more positive symbol than the *Energy Aware Clock*, could potentially engage the user’s imagination around electricity use in a less direct way, even though there is a chance for rejection even here. The aesthetic and algorithmic beauty of a digital plant has to compete against feelings of ‘giving up life’ as were expressed by one participant in the study with the *Energy Aware Clock*. This is also an overarching challenge when exploring the design space around how to create a captivating object that can potentially instigate more sustainable narratives around electricity that feel sensible and meaningful.
6. Interfering Statistics

Interfering Statistics is a concept based on the idea of introducing statistical information in the public space in a tangible way, allowing for ‘statistical interventions’ that would influence the very reality it is set to measure. The concepts exist only as sketches, but some of the ideas have been developed further in other projects.

Forming

As an interaction designer, I had for quite some time developed an interest in the visual qualities of statistical information, — information aesthetics. The Energy Aware Clock was one of the first attempts that surfaced from this interest. Wanting to operate as much as possible in the physical space as opposed to, for example, the virtual space, and thinking about how statistics could be made accessible in an aesthetically intriguing way, I felt it was compelling to constitute a more integrated part of a design. Perhaps the statistics in itself could co-shape the physical space affecting the outcome of the very patterns it was set to visualise. I had a feeling that this strategy could have potential for many interesting applications. These thoughts found a place to be cultivated in the research project Switch! among many others with relation to energy use in public (Mazé, 2013). Setting out from a series of collaborative and experimental sessions revolving around different aspects of the overall programme, Switch! was based on six sub-projects driven by smaller project teams. Interfering Statistics emerged as a result of one of these sub-projects. As stated earlier in the Process chapter [3.2], Switch! directed its attention towards a larger spatial scale and longer-term
aspects of energy use and in our sub-group, called *Ab|Norm*. As a result, we decided to look closer at the naturalisation of energy use and how to disrupt these kinds of cultural norms through urban interventions. Starting with rediscovering the city looking for places and situations connected to electricity use, considering related values such as security, ambiance, beauty, tradition, identity, and conviviality, we aimed to turn these ‘normal’ situations into ‘abnormal’ ones (ibid.). The collected places and situations were used as material for a series of analysis and ideation sessions leading to a number of themes where the embodiment of statistical information was one. In the sessions, the sketches were done rapidly in a rough manner in order to quickly convey concepts and ideas to the others in the group and several concepts around statistical intervention were done in rapid succession. One idea was that of devising a lamppost that could act as a giant timer. Turning on a dial mounted on the side of it would activate the lamp projecting a pie chart gradually having pieces of projected light removed as time went on. Another similar idea was to use the projected circle to display statistics about the local energy use in one form or another. Just as with *Colour by Numbers*, there seemed to be promising potential in the possibility of allowing the user to intervene and control the parts of the public space, either directly by being able to wind up the street-light or indirectly by contributing to the statistics projected on the pavement. In a similar line of thought, a semi-transparent roof could be rolled out in coloured segments to depict statistical information and at the same time provide coverage from sun and rain to different extents depending on the statistical data. As with the Energy Plant using the sun as a projector, when light would fall through the roof material, the ground underneath would be coloured differently allowing for a more ambient alteration of the atmosphere of a plaza or similar. On the other hand, the intervention could be made more dramatically by, for example, using large rotating panels to alter walk-paths depending on real-time data allowing navigation to become part of an embodied interpretation of the statistics people themselves were part of creating. In time, the path most well-trod could emerge by, for example, the grass becoming more worn down in some places more than others thus leaving visual queues of historical use and the resulting positions of the panels. Another idea was a concept with two adjacent doorways changing in size with respect to how many people were passing through them and yet another idea was based
Experiments with tall apartment buildings as large scale bar-graphs depicting the electricity use for each building respectively.

The sketches of Interfering Statistics as well as other concepts acted as props for discussions both in internal sessions as well as in workshops with others in Switch! As a form of rough ‘rapid prototyping’, the sketches evolved by being revised and discarded and acting as placeholders for ideas and discussions (ibid.). They worked so well that we decided to use some carefully selected sketches in a workshop with external stakeholders in the energy and design sectors to provoke hands-on and high-level discussions around the situation depicted.

**Stories**

The workshop was set up with the intention of engaging the participants both as energy users and as experts with knowledge from their respective fields that could be brought into the workshop. There were six participants from energy engineering, product and service design, art, architecture, and landscape architecture (ibid.). Starting from the personal perspective, participants were asked to describe an ordinary day in their lives:

Think about a typical situation or happening in your everyday life that takes place in a public space. For example, it might be when you are taking your children to kindergarten, visiting a friend, or taking a long walk on a Sunday. [...] Tell the story in three steps. What details are important in the story? Who is there? What does the environment look like? How do you feel? [...] Write down some key words and illustrate this through drawings or diagrams if you would like. The story should not focus on energy nor be work-related. The story does not need to have a good ending or a punch line.

The participants were given time to write down and illustrate a personal story of their own that they shared with the group. The intention of this was to elicit meaningful stories anchored in real, personal experiences with many details about social, material, and emotional factors that would be useful in the next stage of the workshop. Next, the participants were
matched into pairs that were decided beforehand to mix different backgrounds and perspectives. The participants were given four cards with one design concept on each. Three of the cards were related to the theme of *Interfering Statistics* and the groups were then asked to choose one story from the previous exercise and insert two of the concepts into it:

Choose two of the concepts that you think work best within the situations that you described in the first activity. Now, create two new stories combining the concepts and the situations by asking yourselves ‘Where is energy present?’ [...] Here are some things you might consider as you make up the stories: How does the situation change if the concept is intervened into it? How does it affect the location and the people? Short-term, long-term? Positive and negative aspects? What is interesting or exciting with this concept? Where is it placed and why? How can the concept be changed to fit into the setting? Is there a place where it would fit better? [...] Draw a map or scenario of where and how your story takes place. Document your discussion on the worksheet.

The purpose here was for the groups to, while still immersed in their ‘ordinary day story’, think and reflect on the implications of the new concepts as they were immersed in this familiar setting, creating a new type of fictional story rooted in their own experiences. In this way, the sketches were functioning more as conversation pieces than traditional design proposals or solutions (Mazé & Redström, 2008), pushing the participants’ imaginations in certain directions. The concepts were adapted in different ways, sometimes quite radically, as they were merged with the existing stories. For example, inspired by the concept of the rotating panels, a trip to a specific grocery market where one participant was provoked by all the large suvs was transformed into a story of how drivers could get different kinds of real-time feedback on the parking lot. Cars were controlled and steered in different directions depending on factors such as the intensity of cars, creating a narrower passage as the number of cars increased, and the difference in car weight, giving smaller cars access to more attractive parts of the parking lot. This new story shows in a good way how the participants were able to develop stories rich in details and personal meaning while still containing some thought-provoking elements from the original concepts. The workshop generated interesting discussions around public space and how energy could be presented in public, both from a private and a professional perspective. The discussions
tended to lean more towards questions of form than the social and political implications of the narratives, as was our original intention. Still, coming up with narratives anchored in private experiences but revolving around new types of practices in relation to the concepts proved very fruitful when thinking outside present norms around energy use in the public space.
7. Watt-lite

The Watt-lite is an electricity visualisation made for the factory environment. Consisting of three over-sized flashlights used in conjunction, a number of 30 fully working prototypes were made and placed in eight factories over a four-week period.

Forming

In the project IndustryWise, targeted to factories and employees working on the factory floor, the goal was to develop a tool that could motivate personnel to reflect on excessive use of electricity in their workplace. Eight industrial companies, producing things such as cutlery and steel pipes, were included in a study to inform the design process. During the visits, a series of direct observations was recorded through notes and photographs. Information about the work environment were gathered through a questionnaire posing questions concerning attitudes, activities, and energy efficiency. Based on this information, as well as on previous research and design experiences, the idea of a circular light-projection
from *Interfering Statistics* was transformed into a new context, changing the street pavement to a concrete floor and the lamppost to an oversized flashlight (Jönsson et al., 2010; Katzef et al., 2013). The idea was further developed within the project in the end, resulting in a set of three flashlights that could change the radius of the projected light circle. By sending data about a factory’s electricity use wirelessly to the torches, they were intended to convey this information in a more tangible way. The dimension of the light circle expanded and contracted to depict the increase and decrease in use of electricity for the whole factory. If the light circle were small, the electricity consumption at the company would be low and if the circle were large the electricity consumption would be high. One Watt-lite was made dark grey, showing real-time electricity use in white light by loading new information every 30 seconds, providing close to immediate feedback on the electricity use for the whole factory. In addition to this dark grey flashlight there were two in a lighter-grey colour equipped with a blue and an orange cord projecting blue and orange circles respectively. The torch with a blue beam and blue cable would visualise the smallest amount of electricity used during the day. The other one would use an orange beam and orange cable to visualise the highest amount of electricity used during the current day. These two flashlights were meant to constitute points of reference for the white projection, enabling comparison and reflection. The real-time consumption could easily be compared with the maximum and minimum usage during a day. In this way, the energy statistics were meant to become literally more concrete. By grabbing a flashlight, users were envisioned as interacting with the information by, for example, making notes on the floor and by overlapping the different projections, exploring the electrical patterns of the factory projected through the torches.

*Watt-lite* would be an unfamiliar object to the staff in the factories, but the shape of a torch was thought to give a hint of treating it as an exploratory device, a detective’s tool that could show what might otherwise be hidden. By adding a handle we sought to reproduce the impression of a tool that could be carried around and survive being bumped.
into things. It was consciously designed to be larger than a standard torch, relating to the scale of measurement — the whole of the factory. By specifying use through material and shape, while leaving the meaning of the electricity statistics to be determined by the users, our intention was for an exploratory type of engagement where the user tries to grasp both the system and its situation of use (Jönsson et al., 2010).

Stories
Thirty Watt-lite prototypes were manufactured in total and 24 of these were installed in eight factories over a four-week period. Just as with the Energy Aware Clock, the placement greatly influenced the engagement from the employees. For the factories, these kinds of decisions were more often taken at a managerial level as opposed to choices made in a private household. Watt-lite’s placement in locations already used for social gatherings, like next to the coffee machine, received much more attention than those placed in a corridor not passed on a daily basis. One participant stated:

I like that they are by the coffee machine [...] then everybody can see how much we are consuming at the moment. [...] We talk about the different sizes of the projections.

In this type of social location, the direct feedback from the torches sparked discussions and reflections among the employees while queuing up for their coffee on their brakes. These kinds of reflections in relation to the information provided by the projections enabled the employees to reflect on and make sense of working practices in relation to electricity use. The discussions touched on a variety of issues including what event that where responsible for the circles’ sizes, how to influence this, deviations from a ‘normal’ state of electricity use and the size of the circles in relation to the factory’s production. These discussions were sometimes supported by physical interaction with the Watt-lite projection:

I tried to draw marks on the floor where the MAX [for the white circle] is. You can then draw a diagram [showing] where the border of the circle is supposed to be during breaks [when production is supposed to go down]

The Watt-lite also clearly articulated the use of electricity in relation to the actual production of the factory, which was not without conflicting emotions:

We want the orange one to be as big as possible [...] We want a lot of production. Everyone is happy when the orange is large.

The same participant stated a bit embarrassed that he under-
stood these feelings as defeating the purpose of the Watt-lite since it was not meant to measure profit but in his words, ‘as a way to save the planet’. Still, unnecessary electricity consumption was spotted thanks to the flashlights according to the same person:

Last Friday, Neil actually went back into the workshop after noticing that something was out of balance. He saw it on the light circles. [...] It took him half an hour to find out what was left switched on, and before he could go home.

All in all, while sometimes creating conflicting emotions around the factory production, making money, and ‘saving the planet’, it is clear that the Watt-lites engaged the workers in exploring their workplace through the lens of electricity use, enabling them to see and reflect on issues that had previously been hidden. By being so visible and easy to access, for example, hanging by the coffee machine, deviations from the normal ‘balance’ of the factory were spotted, giving rise to at least one reported story of an electricity hunt.
Based on design ideas of a projected pie chart from *Switch!* and the oversized flashlight in *IndustryWise*, we continued to develop another version of the torch with a wind-up timer that could measure an amount of energy, in kilowatt-hours, instead of just the present effect in Watts. Also here, the design process was accompanied by a field study allowing us to contrast the design ideas within the present context of the office setting. In the *inCharge* project came also the opportunity to utilise separate measuring.

**Forming**

Just as with the *Watt-lite*, the new version of the oversized flashlight, called the *Watt-lite Twist*, built on the idea of making energy statistics more tangible and to encourage an exploratory, open-ended, and social type of interaction.

Being that informants interacted spontaneously with the *Watt-lite* and also based on findings that exploratory learning is enhanced by physical interaction (Klemmer et al., 2006; Marshall et al., 2003) it seemed like an interesting opportunity to devise an
object that had to be engaged with more tangibly. By using individual sensors, the flashlight could now measure from many different power outlets instead of only central power. The front part of the torch could be rotated and wound up to a desired amount of kilo-watt-hours (kWh). After a bit of testing, it was finally set to be adjustable between 0.1 kWh to 2 kWh. The flashlight was lacquered in bright red with a thick power cable similar in colour to make it stand out as an extraordinary object, to be used in the case of ‘electrical emergencies’ of uncontrolled electricity use. When the torch was twisted to set the amounts of kilowatt-hours to start the countdown from, the user could feel the physical resistance from the mechanism. The idea behind this was to encourage an understanding of the otherwise rather abstract notion of electrical energy and to make kilowatt-hours more ‘graspable’. When doing this, winding up the *Watt-lite Twist*, the area of the projected circle grew in size. Once an amount was set, the torchlight began its countdown by gradually removing pieces from the projected full circle as electricity was being consumed. This data is transmitted from the sensors plugged in at the different power outlets. Once the amount of energy is used up, the circle becomes empty, and the sound of a bell is played. Inside the circle the total time it took to consume the electricity is written out.

The flashlight has only one button that can be slid forward to display additional information. In this mode, instead of showing the amount that is left, the projection is inverted showing what each individual sensor has used so far. The colour on the different sections in the pie chart corresponds to the colour of a specific sensor plug. When letting go of the button, the pie chart reverts back to its normal state showing the white pie chart again. Just as with the *Watt-lite*, the *Watt-lite Twist* was meant to be placed on a flat surface or hung from the ceiling.

Even though the two different versions of torches had many similarities, when it came to interacting with them, they had crucial differences. Whereas *Watt-lite* was more of an ambient installation modestly inviting users to do some small notations on the projections while recording different states of consumption, the *Watt-lite Twist* demanded a more active type of use. Without winding it up, nothing would happen. It was more of a tool used for acts of precise measurements in time.

**Stories**

Four *Watt-lite Twists* were installed as design probes in four different offices for five months to study how they were used and appropriated. The flashlight was demonstrated and installed together with a smaller group selected by the companies. Constructing the new flashlight had proven significantly more difficult than with the *Watt-lite*. For the new prototypes, wireless transmission of sensor data ran into difficulties resulting in data that couldn’t be transmitted all the way to the torch. An extra cable had to be bundled together with the power cord and a small box keeping track of the data.
was therefore forced to be placed right next to the *Watt-lite Twist*, making it harder to move around. Also, the small laser projector embedded inside the torch was prone to overheating and not suitable to be left on around the clock. As a result of these limitations, one caretaker, who would be responsible for switching the flashlight on and off and reporting any problems, was appointed in the group.

Based on knowledge from both the study with the *Energy Aware Clock* and the *Watt-lite*, the time that the *Watt-lite Twist* was out in the offices was divided into two periods with different arrangements. The first phase was set up to allow for continuous exploration, where the participants were thought to discover their office in a more open fashion. The torch was thought to trigger people’s reflections and discussions in a playful way, relating to their own activities in relation to the electricity consumption of individual appliances. For the first phase, the instructions given to the group emphasised the freedom of use and importance of using the *Watt-lite Twist* in a way that suited them best. They were told to place it in a spot that they found appropriate and were also encouraged to move it around if they wished. The group were given eight sensors that they could plug into any electrical outlet of their choice, measuring any device within wireless range of the flashlight, and were encouraged to explore freely as they desired. After some discussions within the research group, the sensors were not marked with their corresponding colours to encourage participants to actively try to figure out this information themselves by trying out electrical appliances in the office.

The first round of interviews were conducted after six to eight weeks. From the open-ended questions we asked, we could tell that the *Watt-lite Twist* was engaged by the whole group for the first couple of weeks but the interest in exploring gradually decreased until only the person responsible for the torch dutifully carried on starting and winding it up every morning. Two of the four offices systematically tried to figure the colour scheme for the sensors by testing them one by one:

What we first did was to try to figure out those different colours. We put the main sensor on the coffee machine and this is how we discovered that it consumed very, very much just in no time [...] Then, we went on very enthusiastically [...] two afternoons I think we spent on this. All my colleagues ran around moving the sensors and we thought that we had it almost figured out [...] Then, after a few days it turned out that things weren’t the way we thought
after all and then we started to move [the sensors] around [again].

In the third office, one respondent claimed that they hadn’t been able to figure out which sensor had which colour while another respondent claimed they figured it out easily. Seemingly not collaborating within the group could be one possible explanation of the different stories. In the fourth office, there was no attempt at all in exploring the relationship between the colours and the sensors. The participants expressed frustration that this information had not been given to them and stated that they did not have the time to try to figure out this relationship by themselves, even though this was the intention of the study. It could be added that this office was disappointed with the design of the prototype from the beginning since they had envisioned something else when they agreed to participate. Unfortunately, the version that this office got also proved to have the most technical problems, which did not exactly make things better.

At the end of the period that the companies had the Watt-lite Twist in their possession, we introduced an event where the groups could use the flashlights in a more playful setting, competing in two teams with one flashlight each. For example, the teams competed in getting two different appliances of their choice to consume an equal amount of electricity in the shortest time possible. These playful events were appreciated and the teams got very active in their attempts to win by understanding the amount of energy certain electrical products used. After this event the torches were returned to the places they were taken from in the offices but the interest in using them after such a long time remained low and they remained largely unengaged.

The context in which a design intervention is placed influences the way it is interacted with to large extents. Practices common in the work environment differ greatly in the domestic or public context. In offices, the participants had little time to set aside for non-work related practices and this was generally not encouraged at the management level. Certain company cultures seemed to be more open to setting time aside for discussion, playfulness, and exploration; others expressed that there was no time at all. In general, the Watt-lite Twist had more problems in the offices than the Watt-lite did in the factories. Where the former required almost constant engagement, the ambient character of the latter allowed for a more passive type of interaction, glancing at it when passing by or while on a coffee break. The Watt-lite behaved similarly to the Energy Aware Clock, transitioning from a more intense exploratory period into a state more marked by sporadic confirmation. Since this was not really possible with Watt-lite Twist, it was simply left in the same spot where it was placed when it arrived, even though it was possible to move around. Similarly, the different wireless sensors were mostly left connected to the same appliances as they were after the initial two weeks.
Electricity exploration was not engaging enough to sustain interest for any longer period of time. The winding up of the flashlight required an effort that after a while became more like a burden. In more targeted and shorter events, like in the initial introduction or the playful competitions, the Watt-lite Twist seemed to work much better. Also, individuals in the offices and the factories had more limited possibilities to affect the use of electricity compared to the context of the home but re-surfacing and visualising electricity use in the everyday environment gave rise to a higher consciousness and active reasoning among employees.
8. Watt-lite TWIST
9. Fyrfärg

Fyrfärg is a light installation with a Swedish name that can be interpreted in two different ways. Fyrfärg translates to ‘four colour’ or ‘process colour’ meaning the subtractive colour model used in printing. More importantly, ‘fyr’ also means lighthouse, signifying a central aspect of the light installation now permanently located at the top section of the ‘kth building’ at KTH, Royal Institute of Technology.

When the house was run by the Red Cross, this small tower originally housed a large water tank that provided water pressure for the rest of the building. Now, the large tank has been removed to make room for the lamps used in the installation. The Red Cross Hospital had owned the building between 1927 and 2010 when Akademiska Hus, the property owner for academic buildings in Sweden, bought the house to make it available to rent for the university, which needed more space. Now, the building is to host the administrative arm of the university and a total remake of the interior and exterior parts was initiated to suit its new purpose.
Using artistic expressions and physical form, our PhD group within product and service design were commissioned to work with the vision of the university, inspired by ongoing research on campus in relation to our own research, and embody this in several installations contributing to the overall impression of the renovated building. *Fyrfärg* was one of two installations I did within this context that I will now put in relation to the Storyforming programme.

**Forming**

In the tower, a number of LED panels had been mounted, pointing in the four cardinal directions. Around the campus within visible range of the tower, three-metre high poles were placed to act as an interface. Each pole, with a lamp on top, was assigned a unique colour inspired by the process colours and were equipped with heat sensitive motion sensors in all directions. The sensors not only detect presence but also distance and direction; approaching a pole makes it dim down its colour as you move closer. At the same time the lights in the tower light up and start to shine stronger and stronger in that specific colour. The light seemingly moves between the pole and the top of the building as someone moves closer or passes by, both intentionally and unintentionally. By passing by within the range of the sensor, the tower lights up with a burst of colour visible not only within the campus but over large parts of Stockholm. *Fyrfärg* alternates between lighting up in different colours and going dark giving spectators discrete information about activity around the campus. How many are moving around and on what places? The movements of visitors, students, and employees of the university are reflected in the lights of the tower connecting on-going activities to the interactive light installation.

**Stories**

As of writing this, the permanent installation is in its final stage. Two poles are mounted in a neighbouring park, close to the มหาวิทยาลัย building. A third pole is planned to be a bit further away and hopefully more poles will be added along the way, covering the large campus pole by pole. Just as with *Colour by Numbers*, *Fyrfärg* has the potential to add another
type of narrative layer to the campus environment, as well as from certain places in Stockholm as the top of the KTH building is visible from many points in the city. If relations to the installation grow over time, Fyrfärg can provide ambient information about activity on campus from up close to long distances. As people pass by the poles with different frequency the light on top of the building flashes accordingly. When someone stops close to a pole the light in the tower remains lit only to fade again as soon as one moves away. With Colour by Numbers people expressed a feeling of connection to other callers in the vicinity of Telefonplan. With Fyrfärg, there should be a good potential for the same thing to happen. The visibility of the installation, the easy access to the poles and the complexity of ways to interact with Fyrfärg should allow future users to explore its meaning and how it can be used, potentially allowing for individually crafted narratives to evolve over time.
10. Gradient

Gradient, the last case presented in this chapter, is a collection of seven concepts developed by commission in 2007/2008 together with architect Milo Lavén. Operating in the cityscape, these large-scale installations were meant to embody different natural sources of energy — sun, wind, and water — connecting these in a visual way to human culture. The installations were, due to various reasons, never realised and exist only as photomontages. I will here go through a selection of these concepts, namely the ones relating to wind, for the purpose of further spanning the space of storyforming.

Forming

For this project, done within the framework of my own practice, the client had initially asked for an interactive installation to celebrate the one-hundredth anniversary of a large Swedish organisation working with nature and environment issues. In this light, and from previous experiences working with energy awareness where we often got...
the question of how much electricity different prototypes consumed, devising a range of installations where self-propulsion would constitute the central identity of the artefact felt like an interesting path to explore. The aesthetic value would be essential and closely connected to the construction and function of the installations. The purpose of the collection would be to emphasise natural sources of energy in the cityscape rather than any actual useful production of electricity, the installations would sustain nothing more than themselves.

Whereas the availability of electricity can be said to have disengaged us from the practice of attaining energy, leading to a separation of electricity use from electricity production [2], the idea of the installations was to, on a symbolic level, narrow this gap. Instead of designing something according to the well-established bifurcation of ‘nature’ and ‘culture’ (Haraway, 1991), we wanted to bring these concepts closer together using, in semiotic terms, metaphors that mixed symbols of nature and the aesthetics of human culture. Care for the environment can partially be related to people’s relation to nature and researchers have pointed towards the importance of developing an emotional bond to nature for environmental engagement to transcend into environmentally sustainable behaviour (Johansson & Küller, 2005). Gradient was an attempt to strengthen this bond through design in a spectacular way.

As an example, using wind as a power source, four installations were to be built on the complex patterns made by wind (nature), filtered through clusters of turbines and LEDs (culture), expressing wind in a more ‘tangible’ way. One concept envisioned visualising streams of wind by spanning a net with many small wind-turbines attached, each driving a single LED-lamp, under a bridge. Another idea was to make an artificial reed by attaching plastic rods of different lengths anchored underneath the water. The wind would slowly power up a wind turbine at
the top of the rod powering a xenon-flash inside each strand emitting short light-bursts along the waterline at night and during the dark winter season. With increased wind, the sparks in the artificial reed would occur more often. Thinking along the same lines, we came up with a concept of a physical vector field laid out over the water made out of tubes acting as wind cones, swivelling towards the wind and also glowing in the dark using LED lamps and wind turbines. It would be almost like a meteorological weather chart of wind directions and corresponding strengths but laid out on the water in the physical world. Looking back at the project, the forth and final installation based on wind intrigued me the most. With Vindklocka, Swedish for the Wind Clock, we sketched another clock manifestation*, propelled entirely by wind but where the large digits were made out of small wind turbines constituting its glowing pixels. Here was a typical symbol for modernist ideals — timekeeping — in the hands of the whimsical wind — a force of nature.

Stories
The idea was for the Wind Clock to go on and off, sometimes shining stronger and sometime glowing very faint as the wind rushed through its ‘pixels’. While the other wind installations were exploring the potential of utilising the wind in the cityscape from purely an aesthetic viewpoint, the Wind Clock become something more by also performing a clear function — telling time. Including time in a very concrete way also made it possible to become part of other types of narrative experiences. Thinking about time while looking at the Wind Clock could potentially cast another light on the daily experience as a whole. Time flickering in the wind generates new types of narratives as people carve meaning out of their daily life. Just as the Energy Aware Clock resurfaced electricity as a phenomena into everyday narratives, the Wind Clock would introduce the wind when telling time, making for a new type of narrative where an artefact offers a more complex type of behaviour allowing for new and varying types of experiences.

These words conclude this section of the design experiments and I will now move on to the articulation of the Storyforming programme.

* Compare to Energy Aware Clock, [4.2]
Experiments 1-0. Gradient projekt av Milo Låven och Loove Broms för Stilt AB

- Concrete Weight
- Steel rod
- Dynamo
- Capacitor
- Xenon flash
- White, semi-transparent plastic tube
- Propeller

Vindblixt, principle drawing

Vindvektor, principskiss

Vindvektor, top view 1:10 (A3)

Vindvektor, side view 1:10 (A3)

Vindvektor, front view 1:10 (A3)
5. Towards Storyforming

One cannot design meanings into artefacts, only provide the affordances of meaningful interactions to arise.

Klaus Krippendorff, talk on the key concepts of his book The Semantic Turn at Konstfack University Collage on Arts, Craft and Design, Stockholm, May 2012
In previous chapters, I briefly sketched out the design research methodology leading up to Storyforming and then moved directly on to the design experiments, approaching them through this perspective. Both the processes and their outcomes were then examined from the viewpoints of *stories* and *forming* with the intention of allowing a closer articulation of the characteristics and implications of this design space. Based on these experiences, this enables me to attempt to more clearly articulate the *Storyforming* programme.

I will go about this by de-assembling the word into two smaller components – *story* and *forming*, defining them as follows:

**Story:**
A discursive engagement between people, things, and environments.

**Forming:**
through seeing and accessing designs, exploring and expressing complexity, and sharing experiences and negotiating use.

From the perspective of the user, the suggested form-related leitmotifs therefore investigate ways of affording these alternative types of discourses that evolve and manifests themselves over time creating new values and meanings. Seeing and accessing; exploring and expressing; and sharing and negotiating all signify the act of an envisioned user engaged in a narrative, though this is in the mind of the practicing designer. In actual use, the user might engage in the discursive artefact or reject it, as with all designs.

Based on this proposition, I will continue to unpack the emerging structures of this design space sketched by the programme by going through the experiments and experiences one more time on the basis of the concepts used in the definition of the programme.

The *story* constitutes our material at hand, a discourse between human and material, or semiotic, actors where people attempt to create meaning by connecting events from the past, the now, and the future into narratives to create order. Here, narratives are not only defined as the written or spoken account but as part of a design rhetoric involving artefacts. As designers, we have the ability to indirectly *form* these narratives by designing artefacts that, through their physical and temporal gestalt, can act as catalysts in the construction of meaningful experiences.
1. Unpacking Storyforming

Drawing on the experiences from the design experiments, I will now begin to unpack Storyforming. As stated earlier, this word is not a definition but a projection, not a concept but a name. The programme enables me to point out a direction of exploration and since there already exists a substantive number of experiments conducted that are relevant to the new programme, I can already begin discussing how they resonate together. The Storyforming programme is intended to work like an engine building up inertia to propel the design process towards the aim of affording narratives through interaction with the design experiments. In some of the cases, there is proof of narratives forming very clearly—even of the fictional kind as with Colour by Numbers—while in some of the other experiments the narratives are more loosely represented.

Clearly, stories are connected to the design process so let’s begin by discussing the leitmotifs connected to the process of forming: ‘seeing and accessing designs’, ‘exploring and expressing complexity’ and ‘sharing experiences and negotiating use’, as they are sketched out by the programme. These generative propositions will help to ‘unpack’ Storyforming and to see in what ways one can begin to understand how the design of artefacts can provide affordance for discursive engagements to occur. Again, when going through the leitmotifs, it is important to keep in mind that these themes are not exclusionary categories or analytical distinctions but instead, generative in the sense that they are set up with the intention of suggesting new directions for exploring the possibilities of, and unpacking, the design programme.
Seeing and Accessing

One reoccurring consideration throughout the work with all the experiments has been related to form decisions regarding an artefact’s visibility and placement. Remembering the discussion on how people carve meaning out of their belongings from the Context chapter [2.2], how a person becomes attached to and values an object or place — how it becomes meaningful — is dependent on the lived experiences with it. These types of meaningful experiences have the ability to connect the past, the now, and the future producing a feeling of order in the mind according to Mihaly Csikszentmihalyi (Csikszentmihalyi, 1991). Seeing a cherished object has the potential to bring these feelings to mind. Therefore, the first encounter, seeing an object for the first time, and the subsequent encounters that may evolve into a narrative, starts off with reflections on visibility.

I see visibility and accessibility both in the sense of physical visibility (being present) but also in a semiotic context (what the artefact communicates). For example, the Energy Aware Clock is visible through its placement in the kitchen, but it is also visible in the way it presents itself by, for example, attempting to speak with one voice instead of many. Through its gestalt, it is meant to both encourage a central placement for easy access on the one hand, and on the other, it was designed to radiate significance by attempting to differentiate itself from other artefacts. In this way, artefacts can act as platforms for narratives by first encouraging greater visibility and accessibility through form.

The Energy Aware Clock has, along with a plethora of other smart electricity displays, been introduced on the commercial market. Some of these allow the user to do many other things, not related to communicating electricity use. In one model, one can, for example, read certain messages like commercial offers, do time booking for the laundry room, look at the weather forecast, and much more — mere electricity information alone was perhaps not deemed interesting enough, or maybe insufficient to motivate the total cost of making the display. These speculations aside, I would argue that this multifunctionality risks diluting the narrative qualities of electricity in its own right and, as an extension of this, how people engage and assign value to it. There will be less room for engaging discourses around electricity use if the information provided becomes just a feature together with other types of information. Also, the physical object becomes less related to the digital content since any screen would do, and therefore the physical artefact risks failing to become a visible symbol for electricity.

With the Energy Aware Clock, we wished for the narrative to be reflected in the shape of the electricity metre — both physically and in the graph projected on the screen — communicating as one entity.

Moving on to another example, with Colour by Numbers, the location and visibility of the tower were also central — the sheer size helped in reaching out. Despite a lot of coverage in media, many of the users living in the neighbourhood discovered the interactivity of the installation by observing the changing lights of the tower. Seeing it from day to day allowed for a continuity, which is also an important aspect of visibility that allows for narratives to develop. Through its presence and the changing colours in the windows, the light installation seemed to evoke curiosity. The same will probably hold true for the second light installation, Fyrfärg.
The *Share Aware Light*, the *Aware Laundry Lamp*, and the *Energy Plant* were, just as with the *Energy Aware Clock*, designed with materials and shapes meant to visually afford more accessible placement in households. Additionally, we designed them with the intention of standing in opposition to current regimes of electricity use in the home, contrasting their appearance to the present ecology of household appliances and furniture. The *Share Aware Light* and the *Aware Laundry Lamp* use light to create visible expressions while the *Energy Plant* extends its presence through the shadow that wanders over the floor as the sun passes in the sky outside. In the work environment, the *Watt-lite* and *Watt-lite Twist* take this visibility further, projecting on adjacent floors and walls. The latter of the two was given a red coating to stand out as much as possible against the other interiors of the office. Of course, this type of accessibility and strong presence is not a guarantee for user engagement; the *Watt-lite Twist* was left untouched after some time and the *Energy Aware Clock* was banished to the laundry room by one household that felt pressured by its appearance. To take place in the everyday life of people requires skilled crafting of artefact presence and the reactions are often hard to predict. In the study with the *Energy Aware Clock*, the nine households participating were very similar demographically but the reactions to the design probe were, despite this, very different (Broms et al., 2010). For the design experiments exploring how to resurface energy awareness, the extra cognitive burden imposed by communicating electricity has been a challenge to motivate.

Nevertheless, acknowledging that such basic things as placement and visibility affect who and how one will potentially engage in a narrative is not without significance. In the case of the *Energy Aware Clock*, we discussed the gender coding of spaces in relation to the design of the display (Ehrnberger et al., 2013). But also in the study with *Watt-lite*, the placement turned out to be crucial for how and how much the torches were interacted with [4.7] (Jönsson et al., 2010). Space has its politics and artefacts have ecologies that are constantly negotiated in, for example, the domestication process [2.2] (Silverstone & Hirsch, 1992). Other design experiments also claim their space, making visibility a central aspect. *Gradient* aspires to inspire alternative types of narratives through its form highlighting a different kind of relations to arise within the cityscape. *Interfering Statistics* is on the same page as well, wanting to move statistical information out into everyday life, even letting data literally push us in different directions. Also here, the continuity of the presence of these objects are important in evolving narratives.

As a first step in unpacking *Storyforming*, wanting to invite users to engage in certain kinds of discourses, based on the experiences making the aforementioned design experiments, attention to placement and the visibility of artefacts in everyday life resonate within all the experiments. This visibility is related to both physical presence and visual communication. Artefacts occupy a stage like actors inviting people to interact with, relate to, and reflect on their presence. Just as human actors in a play or movie rarely stand mute for any long period, artefacts designed for story building should engage the user’s imagination through their design, producing experiences that become building blocks that can lead to meaningful narratives that evolve over time. The visibility and continuity of this presence is therefore also important. Artefacts here need to stand out from ‘a silent and unnoticed part of the physical surroundings’ (Attfield, 2000) [2.1]. The design
experiments have explored this in different ways affording central placement and visibility through their form.

Exploring and Expressing

The second leitmotif of the programme builds on designing layers of complexity into artefacts, affording narratives of exploration or creative expression. Complexity allows for a more evolutionary experience that evolves over time, enabling users to create rich and individually crafted relationships with objects (Chapman, 2005). According to Jonathan Chapman, a lot of products today are consumed much in the same way as stories, movies, and gossip. In society as a whole, there is a strong emphasis on ‘uncovering the mystery, reaching the end and, ultimately, knowing all there is to know about a particular place, thing, or occurrence’ (ibid., p. 120). If the mystery is too quickly unveiled, the discursive progression between user and object stops, and the product risks quickly losing its attraction. Instead, objects can be designed with a narrative stamina that allows their stories to unravel over periods of years instead of just over a few days (ibid.).

The implementation of complexity in design is not in conflict with any principles of usability. The first is related to the experience while the second is focused more on use. In terms of experience, it is often complexity rather than simplicity that is sought and appreciated (Norman, 2004; Stolterman, 2008). The most meaningful artefacts in our lives are most likely not those that are simple in their communication, but they can still be simple to use.

Continuing to open up the Storyforming programme, when looking back at the design experiments discussed in this thesis, I can see that they have more or less directly been designed as platforms for catalysing complexity over extended periods of time. In some cases, their complexity lies more in a prolonged exploratory type of use, while in others the complexity for the user lies more in creative expression.

When entering the lifeworld of a person, objects are subjected to an exploratory phase. In the case of the household, it has been accounted for through domestication theory (Silverstone & Hirsch, 1992) [2.1]. As a new object is incorporated in the ecology of household goods, they undergo a phase of exploration that after some time passes as the artefact becomes domesticated. Aside from this first phase, there is also a potential for, through design, inviting users to participate in narratives for continuous exploration of the object itself and, through it, the relationship to some types of external phenomena that give further depth to the experience. This mode of exploration can become part of the artefact experience, and not simply a transient phase.

With the Energy Aware Clock, as it entered a process of domestication, it went through the initial phase of exploration until after around two weeks when the interaction with the metre gradually progressed into something that was more like confirmation, checking to see if everything was normal. Still, even after this transition, the electricity metre could still be regarded as allowing for a continuous type of exploration of the home through its form. Even when confirming the already known, there is the possibility of exploring if the information presented is complex enough for new types of events to occur and overlap (Ehrnberger et al., 2013). Two types of known events might intersect creating a new pattern that only one with knowledge of the original two patterns might decipher. Everyday life is filled with reoccurring events that soon become familiar, but in these events there are also complex patterns hidden that, when reflected
through the artefact, open up possibilities for new interpretations to occur. These occasions can in turn help shape daily life narratives, aiding the creation of experiences that feel meaningful. Designing the \textit{Energy Aware Clock} to lift the veil from the hidden world of electricity allowed new types of narratives to form, as can be seen from the stories told in the study. Instead of just telling time, it also told stories of electricity use with the promising potential of engaging household members in continuous exploration and reflection. The branching structures of the \textit{Energy Plant} allowed for exploration of other kinds of patterns. Whereas the circular graph of the \textit{Energy Aware Clock} reflects the complexity of real life event, the \textit{Energy Plant} instead creates a new form of slow algorithmic complexity. Although also possible to explore for longer periods of time, the connection to electricity use is more abstract.

Related to exploring and the inclusion of complexity in design, expressive elements allow for people to demonstrate creativity in the shape of the artefact in a way setting their own parameters of what it should be. With \textit{Colour by Numbers} this creative part is central. The tower was turned into a canvas for anyone with a phone to utilise. Despite only consisting of ten floors, the possibilities for creating various patterns are high and people came up with imaginative ways of combining colours and bestowing meanings in them that we had not been able to anticipate. The ability to catalyse the creativity of the user makes \textit{Colour by Numbers} exiting to explore and the complexity gives enough room for self-expression. As expressed by Linda Ryan Bengtsson (2012):

\begin{quote}
The artists defined the technology and form of the installation, but they did not specifi-
\end{quote}

cally define how it should be used. They only explained how to use it but not why or for what purpose. (p. 122)

Similar to \textit{Colour by Numbers} but on a different scale, the \textit{Aware Laundry Lamp} also allowed for creativity. Combining a drying rack with a lamp, the laundry lamp superimposed the metaphor of lamp aesthetics onto that of hanging clothes to dry. Even though it has a more clearly defined use than \textit{Colour by Numbers}, creativity is also encouraged here as the laundry becomes part of the user’s own design. The laundry can be used to transform the lamp visually, turning hang-drying clothes into a creative experience.

With \textit{Fyrfärg}, the spatial possibility for creative expression is limited to one window — one colour — changing over time. One might believe that such a limitation could not allow for any greater complexity to explore, but the movements of people in the area reflected in the light on top of the building still allow for complex patterns to arise that can be read and interpreted if one learns to decipher the signals from the top of the building. The colour of the light tells the location and the frequency of the activity in that specific location. Also here the complexity stems from people interacting with the installation, filling it with content and meaning that can encourage a strong subject-object relationship to develop over time. Similarly to, for example, the \textit{Energy Aware Clock}, interpreting the expressions of the installation allows for a continuous type of exploration that evolves and give the installation identity much in the same way as expressed by some respondents with \textit{Colour by Numbers} when they stated that they felt obliged to take care of it.
Just as with *Fyrfärg*, the information from the three simple circles presented by *Watt-lite* produced a rich complexity that echoed the behaviour of the factory workers. The lack of numerical representation forced the employees to take notes themselves, for example, by making marks on the floor in order to make more sense of what the circles communicated and ‘uncover the mystery’. An unusually large white circle after work hours, showing electricity use in real time, set an employee out on an expedition in the factory to locate the machine that had been left on. This form of exploratory loop, where the artefact through its form echoes the behaviour of its users, appears to have potential as a way to allow meaningful stories to arise in the everyday. Catalysing this complexity in a successful way is still a challenge. For *Watt-lite Twist*, the exploration was intense in the beginning but faded quickly with time. The constant winding up of kilowatt-hours did not work well as an ambient interface and, if no one pushed the information button on the body of the torch, the pie chart did not offer very much complexity to dive into if one was just passing by. The amount of effort needed to explore with the *Watt-lite Twist* appears to have been too high compared to what came out in the other end. With decreasing amounts of interaction as time passed, the narrative experiences with the artefact also came to a standstill.

The *Share Aware Light* affords negotiations of amounts of light catalysing the possibility of a multitude of different narratives arising around this imposed limitation. Having both an organic shape and animal-like behaviour, for example, metaphorically associating charging with feeding, it allows users to read in complex properties that extend beyond the technology itself. The complexity can therefore here be said to lie both in the interaction with and the interpretation of the object, making a limitation — the lack of light — into an identity that can be explored and evolve over longer periods of time. This way of adding ‘temper’, adds complexity in the way that the artefacts stop being subservient material actors that only deliver a commodity on demand. Utilising sun, wind, and water as sources of complexity, the installations in the *Gradient* project do not involve people directly in the act of either exploration or expression. Still, the varying intensity of the wind propelling the *Wind Clock*, to pick one example, would change over the course of the day and between the seasons adding a layer of complexity to keeping time, turning what would traditionally be seen as a limitation into the object identity that could be related to over time. Left to itself, the *Wind Clock* might be of peripheral importance as a timepiece, but when attention is paid to it, there would be something more than time being communicated — a complexity that could also be discovered and related to over time.

In summary, unpacking *Storyforming* through the leitmotif of ‘exploring’ and ‘expressing’, the possibilities of evolving narratives by designing layers of complexities become available in a wide variety of ways. Through designs inviting users to, in one way or another, input information, which adds layers of complexity to the artefact, allows both narratives of exploration and expression to arise. In addition to this, design experiments like the *Share Aware Light* and *Gradient* show that imposing limitations as an entry point for design can impose restrictions on use that have the possibility of building object identities in ways that can be explored and evolve over longer periods of time. I will elaborate more on this in the following section.
Sharing and Negotiating

In the final leitmotif called ‘sharing’ and ‘negotiating’, I will look at the design experiments from their potential to encourage social interactions as a way to allow engaging narratives to emerge throughout daily use. Through user alterations of artefact expression, the changed states can be re-interpreted and acted upon, connecting people through the use of a particular object. Let’s go through the design experiments reflecting on these properties.

With *Colour by Numbers*, as illustrated by some of the quotes, users developed different degrees of attachment to the installation, some of which were quite strong. People cared about it, like a pet, a plant, or a goldfish. We noted this affection also by how any technical problems were swiftly reported to us by anxious users sending e-mails, and once, when the tower was given the exact same colour-pattern for extended periods of time by a mysterious caller, people contacted us expressing annoyance and frustration. They did not appreciate that type of misuse. The tower had clearly gained in emotional value as opposed to when it existed as an empty structure. Also, when asked, respondents could tell stories of situations where *Colour by Numbers* had become a very present actor in their lives. It was looked after in different places in town and even if not actively calling, the knowledge that other people did, made it more interesting, as stated by one respondent. Through everyday encounters, these kinds of bonds grew stronger. The additional focus group that Ryan Bengtsson put together, composed of people who did not live near the site and only used the installation for a shorter period of time, did not express the same feelings of attachment as those who lived around it and saw it every day. Central to the leitmotif, one respondent stated that the bonds to the installation would not have existed if the changing of the colours in the windows were simply the work of a computer. The fondness grew out of the knowledge that the colour combinations shown were the effort of others; *Colour by Numbers* became like a friend in the dark night, something that was cared for in a collaborative manner by those living around it. In this sense, the installation acted like a conduit for sharing presence for the people living in the neighbourhood. When connecting in this way, allowing for expressions to be stripped away from some of the traditions, norms, and preconceptions associated with physical social encounters, the installation seems to allow anonymous relationships to form between the people living near Telefonplan. These kinds of relationships, connecting with someone unknown, in combination with collaborative experiences with friends and family, gave rise to many different kinds of narratives leaving impressions in peoples lives. It appears to constitute an important part of the essence of *Colour by Numbers*; it was present in many of the stories reported by the respondents. By sharing the experience, people using the installation negotiated its meaning collaboratively.

Several other design experiments also built on similar social experiences related to sharing and negotiating. For example, *Fyrfärg* was designed to connect people around the university campus. Here, the space for creative expression was not as open to the user as with *Colour by Numbers*. Instead, the windows in the *Fyrfärg* tower lit up in a single colour, with the strength of the light varying depending on the distance of people interacting with or just passing by a light pole. The interactions could be conscious or unconscious, but the idea of communicating with other people in
other locations is still central. Instead of using an artefact at hand, like a mobile phone, the whole body is involved when controlling the lights of *Fyrfärgr*. It is reasonable to assume that, most of the time, the interactions are going to be of a more passive nature than is the case with, say, *Colour by Numbers*, to which respondents felt connected even if they did not call the installation themselves. After some time, students and employees at the university will probably learn that the flashing light at the top of the kth building reflects the activity on different parts of the campus and that the colour tells them where this activity is taking place. Then there would be the potential for anonymous connectedness just as with *Colour by Numbers*. Experiences are shared among people at the campus and the exact use of the installation is up to its users to negotiate.

On another scale, the *Energy Aware Clock* encourages, through its design, social interactions between householders. Acting like a real-time electricity diary, providing information related to the electricity-consuming actions of its users, the clock does not merely report data about electricity usage; it tells stories about what has happened throughout the day and further back in time, allowing users to reflect and discuss questions like ‘What events caused certain patterns?’ Connections are in this way made back in time, to oneself and to others. Who came home and turned on the dishwasher? Was someone at the house during lunch? Stories are laid out over time, connecting both actions to the household members and user to user as information gets imprinted, interpreted, shared, and negotiated between the inhabitants. The *Energy Aware Clock* was designed with the intention of participating in everyday life by visualising the flow of electricity so that it could be reflected upon and made debatable. Similarly, the *Energy Plant* and the *Watt-lite* reflect this on-going process as well, making electricity use a more tangible and sharable experience.

With the *Aware Laundry Lamp*, sharing takes place through the laundry in the combined drying rack and lamp. Social connections are thus made throughout the day both by hanging laundry, which shares an experience, and by the ways the laundry is set to dry on the lamp, which shares an expression of creativity. The idea of the central placement further amplifies the social aspects.

In the office environment, the ambitions for social interaction were increased a few notches with the *Watt-lite Twist* as a design intervention. Despite this, we know that the engagement did not last as long as hoped for. This time, electricity exploration in itself did not sustain interest for any very long time and the collaborative experience was not as powerful as with *Colour by Numbers*. Judging by the answers of the respondents working in the factories, the *Watt-lite* was used more regularly. Just as with others of these design experiments, but without the winding up of the *Watt-lite Twist*, active engagement was voluntary. *Watt-lite* was an experience shared by the coffee machine that could be reflected upon from day to day. The connectedness to the social context expressed through the artefact is engaging in itself and, as can be seen in many of the experiments, this more passive form of engagement was enough to continuously evolve the narrative.

Differentiating itself from the other design experiments, the *Share Aware Light* relies more notably on the idea of instigating negotiations of use. Designed originally to critically explore how we take a seemingly endless supply of electricity for granted, the *Share Aware Light* expressed
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5. Towards Storyforming

1. Unpacking Storyforming

our desire to investigate how an imposed limitation could become a more central aspect of a product identity, thus catalysing the possibility of a multitude of different narratives arising around this playfully imposed limitation. Contrary to modernistic ideals of efficiency and commodification, the lamp is an attempt to reflect on how to create meaningful experiences that work in the other direction. The _Share Aware Light_ is about making the negotiation over light feel magical and wondrous in the minds of the users. On another scale, the _Wind Clock_ in the _Gradient_ project also imposes a limitation that becomes central to the day-to-day experience of telling time. The biggest difference from the previous example is that the negotiation does not take place in the actor-constellation of user-artefact-user but instead in that of nature-artefact-observer, making the negotiation in this case one that is more a shared experience in relation to time and wind.

In this final theme unpacking aspects of the _Storyforming_ programme, I have elaborated on aspects of social interactions through artefacts as a way of allowing engaging narratives to emerge. This has proven to be central to many of the design experiments. We have seen this in both the shared experiences of use and in the on-going negotiations that drive narratives forward. Connecting to other human beings in one way or another will always be a crucial aspect of life. The lived experience with an object or place therefore can increase in value if interacted with in relation to others. These experiences with friends and family, as well as shorter social encounters, help inscribe meaning into artefacts, creating bonds between the user and the artefact, the past, the now, and the future [2.2] (Csikszentmihalyi, 1991). Central here is the inclusion of these aspects already in

the design process, manifesting themselves in the physical and temporal properties of the designs as a way to assist narratives. Connecting back to the leitmotif of ‘seeing’ and ‘accessing’, the placement of an object also relates to aspects of the sharing and negotiation of experiences. I will discuss this relation and more in the concluding remarks below.
6. Concluding Remarks
In the introduction of this thesis, I began with a few words on human-artefact relationships, acknowledging the fact that artificial things make up our lifeworld. We both create them and understand ourselves through them. Through the everyday stream of impressions, we connect past and future events to the now, composing narratives that create meaning as we navigate our lives.

Becoming part of a research context regularly using experimental design programmes to investigate how to, by using design to support critical reflection, offer new perspectives on sustainable energy use in everyday life, I have been immersed in a larger conversation around what a sustainable life might be. Introduced by Johan Redström and colleagues, design programmes offer a methodology for the construction of a foundation and a frame for carrying out design experiments that have the potential to allow critical dissemination of what can be done and how (Binder & Redström, 2006; Brandt et al., 2011; Koskinen et al., 2008). The experiences from the design experiments situated within this sustainability context, as well as some projects within my own interaction design practice, led to questions about the ways one can design narratives that feel engaging and meaningful. A better understanding of how to afford discursive engagements that form alternative conceptions of reality might be of interest within the sustainable interaction design discourse among others. Originating from these questions and experiences, I have proposed a new design programme called Storyforming.

This new provisional programme aims to examine how to create alternative experiences that feel meaningful by making artefacts that afford certain narratives between people, things, and environments. Storyforming also suggests discursive engagements through three leitmotifs: ‘seeing’ and ‘accessing’; ‘exploring’ and ‘expressing’; and ‘sharing’ and ‘negotiating’. Unpacking the Storyforming programme from these perspectives, I re-visited already existing design experiments drawing on the leitmotifs to see in what ways they could offer insight in how to afford meaningful stories to form.

Based on the experiments, placement and visibility emerged as essential conditions affecting who may engage in a narrative and how one would do it. Materials and shape relate to this, affecting how an object becomes interpreted, appropriated, and used. For example, when designing the Energy Aware Clock [4.2], we considered these aspects in detail. Here we abandoned the traditional industrial expression of energy metres for one of brown-ware, such as televisions and stereos, to afford a central placement.

The aspects of seeing and accessing can also be related to Borgmann’s concept of the device paradigm. According to the device paradigm, modern technology deconstructs things and reconstitutes them as devices deprived of a natural centre. Therefore they also lack a social and ecological context (Borgmann, 1999)[2.1]. In the example of the Energy Aware Clock, we attempted to re-introduce such a centre — a ‘focal thing’ — related to the use of energy. The clock was given the shape of a house to further enhance this relation.

This aspect of centrality also connects to the leitmotif of sharing and negotiating by highlighting the potential for encouraging social interactions as a way to allow engaging narratives to emerge throughout daily use. Moving on to another example, the light installation Colour by Numbers [4.1] acted as a ‘focal thing’ — on an architectural scale — to gather around for the people living in the neighbourhood, building relations through the changing colours of
the windows. Similarly the Aware Laundry Lamp [4.4], a combined lamp and drying rack, has the potential to become a focal thing, asking for central placement through its form and thus making hang drying clothes a more socially shared experience.

These first two leitmotifs of Storyforming in this way both relate to Borgmann’s concept of focal things as it has been used in design practice. The theme of exploration and creative expression could here be viewed as the third layer of a focal unit. Even though narratives of exploration and creative expression do not necessarily have to be shared within a social context, they most likely are. The mysteries of a discursive engagement easily become more complex if interactions occur within not only user-object but user-object-user types of relationships, as can be seen in many of the design experiments. We enjoy sharing our discoveries and we like to show our creative expressions to others, as was evident from the design experiments that were field tested. The suggested leitmotifs for forming stories, in combination, can therefore be said to encourage practices that are characterised by their engaging capacity — a key characteristic of a focal thing.

Within the programme, one can continue to investigate other ways of evolving the narrative that allow an engaging capacity to emerge. For example, one such new theme relating to sustainability can be taken from a perspective of human ecology (Young, 1974), affording narratives where the individual feels part of a social and ecological context.

Our environmental engagement can be connected to different spheres — the personal, the social and the biosphere (Corbett, 2005) — and narratives connecting all three of these spheres stand a higher chance of being perceived as meaningful. In some ways, the Gradient project, as a public installation that on a symbolic level connects ‘nature’ with that of human culture, can be viewed as an initial experiment in this direction.

Reflecting on how to afford the construction of alternative stories through design has relevance for how we perceive life and assign significance to different kind of practices. In today’s hyper-commercialistic and market-driven society, there exists an abundance of streamlined consumer products and spaces designed in a way that affords an extremely resource-intensive kind of consumption. One approach to curb high consumption is the use of information and knowledge as basis for changed behaviour. Unwanted behaviours have been attributed to lack of knowledge, leading to the belief that if only people knew more about the effects of their behaviour, they would change their actions. Some of the design experiments in this thesis are also attributable to this tradition of ‘serving information on a plate’ — for example, the Energy Aware Clock. Contrary to this popular belief, information by itself seems unsuccessful in changing behaviours. For example, mass media campaigns on energy savings have resulted in an increase in attitudes and knowledge (Staats et al., 1996), but there has been no evidence that they have resulted in any reductions of energy use. In narrative psychology, human experiences are explained as being ‘filled’ by meaning and stories rather than controlled by logical arguments [2.1]. The behavioural changes seen in the study of the Energy Aware Clock can therefore be explained by other factors relating to things such as the social context, relevance, and occurrences of meaningful experiences. Artefacts and practices are closely connected (Ingram et al., 2007) [2.1], and answers to certain undesired behaviours should therefore be sought in the actual design of products and spaces, and what roles they play for us.

As pointed out by Bill Gaver, less purposeful, more
exploratory, and playful engagements are poorly served by current technologies. In response to this, he proposes designing for *homo ludens*, people as playful creatures (Gaver, 2002; Gaver et al., 2006). This connects to a similar discussion within the field of Interaction Design and HCI, where the perspective of the focal thing has been suggested as a way to move away from the focus on efficient use and instead move toward a discussion of meaningfulness (Fallman, 2009; Verbeek, 2002). Others in the design and sustainability discourse have pointed to the importance of narratives as a way to increase the durability of relationships established between users and products (Chapman, 2005). It is possible to devise new orders and meanings in the spatio-temporal compositions between humans and artefacts — new types of assemblages supporting new kinds of practices [2.2]. We, as humans and as designers, choose what should be hidden and what should be made visible and meaningful.

In the light of these discussions, the potential for exploring the design space of engaging narratives through the *Storyforming* programme seems promising. The use of design to engage the user’s imagination through daily interactions has been examined within the field of critical design, for example, in the *Placebo* project (Dunne & Raby, 2001)[3.1], but there are many areas in sustainability discourse and interaction design that can be investigated further.

Remembering the quote earlier [2] in which Bruno Latour draws parallels to the ‘angel of destruction’ and the modernist, he summarises the human predicament in an illustrative way:

> It is only recently, by a sudden conversion, a metanoia of sorts, that He has suddenly realized how much catastrophe His development has left behind him. The ecological crisis is nothing but the sudden turning around of someone who had actually never before looked into the future, so busy was He extricating Himself from a horrible past. There is something Oedipal in this hero fleeing His past so fiercely that He cannot realize — except too late — that it is precisely His flight that has created the destruction He was trying to avoid in the first place. (Latour, 2010, p. 485)

This fleeing a ‘horrible past’, which materialised in the construction of a reality reflecting our deeper aspirations and dreams of personal fulfilment, has caused the ecological crisis in ways that we slowly are just now coming to realise. Because of this, ecological sustainability is not primarily a ‘technical problem’ but more a problem of the human condition. It cannot be solved by technical solutions alone without also looking at the construction of our ideas of human self-fulfilment and how this is manifested in our material culture. Today, life itself, and the artefacts in it, push in the prevailing tradition of consumerism where meanings are sought from environmentally unsustainable consumable objects and experiences.

Focusing on the design of artefacts that afford engaging narratives forming through user interaction, I have in this work explored how one, as a designer, can move from questions about rational consumption to questions about meaningful experiences. Making engaging narratives that involve sustainable practices allows the possibility of overcoming user-artefact resistance for change in this matter. According to Aaron Antonovsky, when emotionally engaged, we feel as though that part of life is worth investing energy in and
that it becomes meaningful for us (Antonovsky, 1987)[2.1]. In this thesis, I have therefore explored alternatives to the dominant ‘Hollywood blockbuster’ (Dunne & Raby, 2001)[2.1] of consumerism creating discursive artefacts that attempt to afford alternative narratives that provide meaningful experiences to users in the course of everyday life. The different contexts of academic and private practice, the traditions of inquiry spanning HCI and design research, and the different kinds of evaluation through practice, exhibitions, workshops, and field studies have helped create a variety of design experiences with diverse outcomes to reflect on.

In future work, I intend to explore additional leitmotifs within the Storyforming programme, for example, the connection of the personal, social, and ecological contexts, the relation to focal things and how stories may be formed around these relations from a design perspective in order to afford significant events that produce meaningful experiences.

The story constitutes our material at hand, the possibility of creating discursive engagements between people, things, and environments. As people create meaning by connecting event from the past, the now, and the future, there exists an opportunity in reflecting on the implications for design to co-create the making of meaning through these events to afford beneficial and sustainable life stories.
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The Papers
Exploring sustainable practices in workplace settings through visualizing electricity consumption

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People's domestic habits are increasingly being targeted to reduce levels of CO₂ emissions. Whereas domestic energy consumption has received a lot of attention with several reported studies on sustainable practices, there are very few studies on workplace practices. Nevertheless, these are considered as having much potential for reducing energy consumption. This paper presents the findings from two field studies where two different types of prototypes for visualizing electricity use were designed, implemented and evaluated in different types of workplace settings – factories and offices. The studies used design probes to explore how visual feedback for electricity use was interpreted and acted upon by employees in work settings. A striking observation was that it is very difficult to get people to change to more pro-environmental behavior and practices in a workplace environment. The paper discusses why this might be the case.

Introduction

Research on people's use of energy has focused primarily on domestic consumption [Schwartz et al. 2010]. In contrast, there have been very few studies that have examined how workplace practices can be changed through technology intervention, despite having much potential for energy conservation [Trygg 2006; Bruce 2008].

Efficient use of energy in the workplace can result in considerable economical savings and the reduction of CO₂ emissions – given the size of offices and other industrial buildings. However, whereas individual householders can change their energy consumption behaviors directly (e.g. turning the heating down) and benefit personally from this (e.g. reduction in energy bills), office and factory workers may not have the same degree of control over their environment (e.g. unable to turn the heating down) or financial incentive (e.g. they do not pay the bills). This presents a different set of challenges for how to change worker's behaviors (e.g. to individual householders).

Different types of interventions can be used to influence energy use in industry. One is the use of legislation and policies to encourage or require businesses to increase energy efficiency and to decrease taxes on process related electricity or to provide support for energy intensive industries in making energy efficient investments. This type of top-down intervention is directed towards industries at a management level and can play a significant role in making industries more energy efficient [Lindén and Carlsson-Kanyama 2002]. However, it can only go so far in reducing energy consumption, since inefficient energy use also arises from people's habits, routines and practices in the workplace. Hence, there is potential for other types of interventional strategies to address these at a group level, including the use of shared displays, peer pressure and social norms. Little is known, however, as to which is effective in encouraging and simplifying workplace energy conservative behavior.

This paper presents a design probe methodology for exploring pro-environmental practices in the workplace. It involved deploying experimental artifacts (critical objects) in the workplace to provoke and facilitate reflection among users around everyday routines. Specifically, the method examines people's everyday work practices and habits by introducing unfamiliar elements, promoting reflection about their use [cf. Mazé and Redström 2007]. Critical objects are meant to act like carefully crafted questions in material form, that when placed in a real world setting, stimulated a discourse around a topic. They are not intended to answer questions about user desires or needs, or to solve specific every-day problems, but for reflecting – in this case on sustainable practices in a workplace environment – in a holistic manner and in a research through design tradition [Frpływ 1993/4]. Moreover, the method is meant to create new meanings and situations that can uncover prevailing practices that might otherwise be difficult to reveal.

Two field studies are presented, where two different types of prototypes for visualizing electricity use were designed, implemented and studied in different types of workplace settings. The aim of each study was to investigate the role of the design and presentation of feedback for electricity use in these settings. The questions asked were: (i) how do issues of information presentation relate to user context and differences between user contexts, and (ii) how do physical attributes and location of the visualization relate to context of use? A number of findings are presented, including a striking observation that it is very difficult to get people in the workplace to change their everyday pro-environmental behaviors and practices. The paper discusses why this is and suggests a number of design and research implications.

Background

A number of studies have been reported that have investigated energy consumption and behavioral change in domestic settings. One of the earliest studies - the Twin Rivers project – investigated residential energy usage during the energy crisis in the 1970s [Seligman, 1978]. As part of the study, the effect of feedback was examined on the householders’ behavior. Specifically, information was provided daily about their electricity consumption. Results showed that the householders who received this kind of feedback reduced their electricity consumption up to 16%. Other studies, where various forms of feedback have been provided in the form of visualizations based on social norms and relative changes over time, have also shown savings ranging from 5 to 15% [see Darby, 2006, 2010; Fischer [2008] suggests that this kind of feedback may change people's behavior when they realize how their behavior can help reduce energy consumption and they reflect upon how to change their behavior.

Sustainable interaction design has become a topic within HCI [Blevis, 2007; DiSalvo et al., 2010; Pierce and Paulos, 2012]. The Interactive Institute’s design research program, Switch, also discuss the aesthetics of energy as a material in a critical practice tradition [Mazé and Redström 2008]. Tactics employed by designers include making consumption visible to prompt awareness or to highlight and reward preferred behaviors or consumption patterns [DiSalvo et al. 2010]. This is exemplified in ambient energy awareness artifacts, such as the Power-Aware Cond [Gustafsson and Gyllensvård 2003], Energy AWARE Clock [Brøms et al. 2010] and the Wattson [Diykyroto 2008] – that present dynamic information that aims not to be distracting or obtrusive. The design of feedback to make users aware of the environmental factors is sometimes referred to as eco-feedback. Froelich et al. [2010] presented a comparative survey, drawing from the environmental psychology literature, noting how several eco-feedback studies have not measured behavioral change. Some eco-feedback studies have also designed games for teenagers as a way of engaging them in changing their energy consumption [Bång et al. 2007; Gustafsson et al. 2009]. However, Brynjarsdóttir et al. [2012] have criticized the prevailing approach of sustainable and eco-feedback, arguing that it has lead to a limited framing of certain aspects of sustainability and human behavior, whilst neglecting other influences on behavior.

Many of the studies on energy consumption and behavior change have been run for relatively short periods and have not engaged users in their design. The few that have done so have found that doing so can increase interest and subsequent changes in behavior. For example, a domestic eco-feedback application, EnergyCoach, was designed with participants before being evaluated in homes for a six-month period [Katzeff et al. 2011]. The long-term deployment showed a strong engagement during the first period of use, which decreased towards the end of the six-month period. Yun [2009] also designed and deployed an energy consumption display in eight households for three weeks. Their findings showed that users were able to reduce energy consumption by identifying high-power devices in their home and by setting conservation goals. Brøms et al. [2010] designed and implemented the Energy AWARE Clock and ran a study for three months in nine households. Ethnographical interviews were carried out at the end of the three-month period and these showed that the Energy AWARE Clock played a significant role in drawing householders' attention to their electricity use and
in spotting high- and low-consuming products. The clock became a natural part of the household and conceptions of electricity became naturalized into participants’ everyday language. Their results showed that the householders relation to the clock went through different phases, including a phase of exploration of the electrical landscape of their home and a phase of confirming and checking that everything was normal.

Bird and Rogers [2010] also showed a 15% reduction in electricity consumption for the Fudy Street project, where participants joined together as part of a community effort to reduce their energy relative to the rest of the city. A large-scale visualization of the street’s electricity usage was sprayed as a visual display on the road surface using chalk spray. For the first three weeks of the project it was updated each day, based on the participants providing a daily reading of their electricity meter. This was combined and averaged to show how the electricity usage of the street compared with the city’s average.

The few studies of energy consumption in the workplace suggest that it is more challenging to engage people in their workplace compared with at home, where they have an invested personal interest (e.g. reducing their electricity bill). For example, an ethnographic study of environmental behavior change in an office setting was conducted over a period of nine months without any additional technological intervention [Hargreaves 2011]. The findings identified a number of problems that employees faced when wanting to change their behavior. One difficulty had to do with the uneasy feeling of “checking up” on colleagues’ non-environmental behavior, such as wasting paper. Another problem was encountered when pro-environmental practices challenged professional status, competence and personal success. The conflict of pro-environmental practices with workplace policies, such as health and safety policies, also caused problems.

Our own initial workshops were carried out with employees in a factory to identify key themes for design interventions [Jonsson et al. 2010]. A major theme that arose was how to engage employees in an intervention. The same theme was identified in a similar study [Foster et al., 2012]. Other themes dealt with the critical role of communicating an “energy awareness” message, the kinds of visualization and the important role of leadership in facilitating change. Simon et al. [2012] have also suggested using a persuasive persuasive game targeting electricity reduction in an office setting. Their design process explored whether a persuasive pervasive game would be appropriate for office spaces and whether the game would motivate people to save energy. The game was tested for two weeks in an office environment and sensor measurements demonstrated various energy-saving behaviors. They suggest that such a game needs to be unobtrusive, have a group focus and respect worker’s privacy. They concluded that when participants are aware of this information as well as towards their colleagues, they may engage in such persuasive game. However, it also needs to be able to be integrated into that corporate culture.

The findings from these preliminary studies suggest people’s electricity consumption in the workplace is likely to be different from their electricity consumption in their own homes. As employees don’t pay the electricity bill at work, the power to influence their behaviors is likely to be more difficult in the workplace. Their relation to ownership of and control over electrical equipment is less clear and more anonymous in the workplace. These differences between householders’ and workplaces’ electricity consumption, together with whether they have to pay for their energy, suggest further research is needed to examine whether and what kinds of shared energy awareness artifacts can be designed that can engage worker’s awareness of their electricity usage in ways that can draw attention to them and ultimately change their work practices.

Methodology
We used a design probe methodology to explore electricity consumption in an office and factory setting. Various prototypes were designed and explored by the employees in the two settings in order to provoke debate around how they might be used or not. It should be stressed that our aim was not to optimize the research artifacts, themselves. Rather, the purpose of this methodology is to raise questions about their use, and for reflecting on sustainable practices in the workplace, in a holistic manner. By perturbing existing ecologies that would otherwise remain hidden, the design probe provokes and exposes relations that would otherwise be hidden. This way of thinking around hidden systems is very much related to Latour’s term black box referring to a sealed network of people and things [Latour 1987].

The aim was to reveal workplace practices and hidden structures through prototypes designed to visualize electricity use. We looked at how employees interact with the prototypes in terms of their behavior, attitudes and practices in different types of work environments. Our goal was to examine the prevailing conventions and, in turn, consider how they might impact upon more sustainable practices in the workplace. The approach comprised three phases:

A field study of different workplace settings to
inspire the design phase
Design of different working prototypes for
communicating electricity use
Ethnographical study of context and use of probe prototype
It should be emphasized that the purpose of the design probes is as research artifacts and not primarily as commercial products. Even though the design probes have been designed to look and feel like real products, they have not undergone the same rigorous product development needed, such as design of usability, interfaces, construction, and electronics. A total of 12 companies participated and a similar methodological approach was used for both settings. The companies were small production industries with employees ranging between 20 and 100, the mean number of employees equal to 48. First, field studies were carried out to collect knowledge on shared practices within the factory and office settings. Simultaneously, a design process was undertaken, developing probe prototypes for mediator energy-related practices. After implementing the probes in the two settings, a second set of field studies was carried out. These focused on existing practices and on the emergence of new types of activities mediated by the probes.

Study 1 – The Factory setting and Watt-Lite prototype
The first field study was carried out in Sweden involving 8 industrial companies to inform the design process. The companies manufacture a diversity of commodities, e.g. cutlery, steel pipe systems, and newspaper printers. To begin we examined the physical layout and differences between the companies. Information about the work environment was collected through questionnaires. Cultural camera probes [Gaver, Dunne and Pacenti 1999] were also used, as a starting point for two workshop discussions.
key ideas explored in the design of the Watt-lite prototype were:

- Making energy statistics more tangible
- Transferring connotations of use
- Encouraging an exploratory, open-ended and social type of interaction

First, we wanted statistical energy data to materialize and enter the physical space of the factory workers. By turning the results of electricity use into something more physical and highlighting the constant flow of energy, the work related behavior at the factories was envisioned to become more interconnected with energy use and thus easier to act upon. The design was intended to project into the physical space acting as an ambient information source. By doing this, we intended the data to be appropriated and integrated into the social interplay between the factory workers and their environment.

Secondly, we built on the idea of directing users interpretation and interaction with a new artifact, by re-using shapes and forms from objects already well-known to them. By doing this, we intended to lower the initial threshold for engagement when potential users attempted to engage with a new artifact. The shape of Watt-lite was designed to be like a large torch, suggesting an explorative device like a detective tool that can show what might otherwise be hidden.

We deliberately designed it to be larger than a standard torch, relating the scale of measurement to the whole of the factory.

Thirdly, encouraging an exploratory, open-ended and social form of interaction was intended to support active engagement in which users could make their own personal assessment, reflection and decisions. The size of the prototype and their visual appearance were meant to draw attention, create curiosity and to encourage a type of discovery that could develop over time and in dialogue with colleagues. Unexpected patterns and situations could be reflected upon and discussed when passing by the prototypes that were intended to be placed in a prominent position. We also wanted to avoid charging electricity use with values of what ‘good’ or ‘bad’ energy use might be, and to leave it open for the participants to decide.

Figure 2 shows the torches and respective beam projections. The size of the light beam projected from the torches indicates the company’s electricity consumption as it changes during the day. The dimension of the light circle expands and contracts to depict the increase and decrease of energy usage of the factory. If the light circle is small, the electricity consumption at the company is low; if the circle is large the electricity consumption is high. The dark grey "master" Watt-Lite, is a real-time electricity meter that loads new information every 30 seconds, providing almost instant feedback of electricity usage. Each flash from the original meter is detected by an electronic pulse reader that is wirelessly sent to a processor that delivers the electricity data to the final destination of the Watt-Lite. The projected light circle stems from a standard fitted high power LED-lamp.

The two other torches are used as reference points to be able to compare the sizes and usage of the circles. The torch with a blue beam and orange cable to visualize the electricity usage. Each flash from the original “master” Watt-Lite, is a real-time electricity meter that loads new information every 30 seconds, providing almost instant feedback of electricity usage. Each flash from the original meter is detected by an electronic pulse reader that is wirelessly sent to a processor that delivers the electricity data to the final destination of the Watt-Lite. The projected light circle stems from a standard fitted high power LED-lamp.

The prototype Watt-lite was installed in the 8 companies over a four-week period. The torches were installed in places chosen by the companies in consultation with the researchers. The visualized data was aggregated and then depicted as screen savers and websites on the personal computers of the workers. In most of the factories, the torches were placed in a central location, which the employees walked passed. However, in two factories they were placed in areas not all workers passed through. Unfortunately, this was beyond the control of the research team.

The experiences of using the Watt-lite prototype were assessed through interviews with 6 employees (a company manager, two office workers and three factory workers) from different factories. The participants were aged between 35 and 62, with a mean age of 46 years. The interviewees commented on how easy the information represented by the projection from the torches was to understand. Five out of the six participants had used only the torches and one just the screen saver. Two participants had used both the torches and screen saver. The use of Watt-lite required time from the participants and presupposes that the torches are installed in a space easily accessible for the target group. However, production and business had highest priority for the factory workers and this affected their engagement with Watt-lite. Not surprisingly, in the factories where the Watt-lite prototype wasn’t placed in central locations there were fewer interactions with them: "They are placed in the entrance mainly used by office workers. The rest of us go straight to the changing rooms before entering the workshops. You only walk past them if you are going to talk with someone at the office." [Participant 5]

Conversely, in the factories where they were placed in physical places where workers spent time or passed through, use was facilitated: "You throw a glance at it when you pass by" [Participant 4]

There was a clear relationship between where the Watt-lite torches engaged the employees and where they were installed (see Figure 4). When they were placed in social spaces they invited engagement. As one of the participants describes it: "I like that they are by the coffee machine… then everybody can see how much we are consuming at the moment." (…)"We talk about the different sizes of the projections." [Participant 2]

The Watt-lite torches’ physical position next to the coffee machine allowed for discussions and group reflections of energy usage among the employees while queuing up for their morning coffee. Having direct feedback became compelling and sparked contemplation about their actions. Being positioned in an already actively used social space encouraged both playful engagement and led to some direct actions.

The places where the participants considered the Watt-lite to be positioned in a suitable place, triggered their engagement with the energy statistics:
...and how it relates to the use of individual appliances, the interaction design involved multiple modalities. This design decision was based both on observations that users spontaneously interacted physically with the projections of Watt-lite, and on findings that exploratory learning is enhanced by physical interaction (e.g., Klemmer et al., 2006; Marshall et al., 2003). An initial field study revealed three main categories of electrical appliances that were common to all office workplaces: work tools (computers, printers, photocopiers, machines and line), appliances used during breaks (refrigerators, microwave ovens, coolers and coffee machines), and appliances used for the comfort of the workplace (heating and cooling systems and lighting). The physical layout of the offices was either open spaces or individual rooms; connected to each other. Kitchens and other areas for coffee and lunch breaks were attached to the office spaces. Other spaces included rooms for printers and photocopiers. The physical environment of the office workplaces, thus, differs from the factory environment. Instead of being filled with big production machines, the workspace is dominated by desktop computers and connected appliances, like printers and photocopiers. The smaller kinds of equipment (e.g., lamps, PCs, phones), whose electricity consumption could be measured individually. In this physical context, we see the role of visualisations is to trigger people's reflection and discussions in a playful way, of their own activities in relation to the electricity consumption of individual appliances.

**Design of the Watt-lite TWIST prototype**

The Watt-lite TWIST (WLT) was designed as an extension of the Watt-lite TWIST (WL T) as a way to save the planet.
The WLT consisted of a small, built-in, laser projector and a wireless receiver. These were placed inside a case, shaped like a traditional, but oversized flashlight. The sensors communicate with a central router relaying the collected information to the WLT. The dimensions of the WLT were 190 millimeters long and 120 millimeters in diameter. It was colored red with a thick red power cable to make it stand out.

The front part of the torch can be rotated and wound up to the desired amount of kilowatt-hours (kWh). It was set between 0.2 kWh to 2 kWh. Figure 7 shows starting and ending projections from WLT. This design was tested in a household setting and participants found it easy to understand (BeAware project).* It uses the metaphor of a mechanical egg timer, whose function is familiar to most people [Spena et al., 2011]. When the torch is twisted to set the amounts of kWh the user can feel the physical resistance from the mechanism – the idea was to encourage an understanding of the otherwise rather abstract notion of electrical energy in general and the kWh unit in particular.

When winding up the WLT to a specific amount of kWh, the area of the projected circle increases proportionally. Once an amount is set, the torchlight begins its countdown by gradually removing pieces from the projected full circle as electricity is being consumed. The consumed data is transferred from the individual sensors plugged in at different power outlets in the surrounding environment. When all kWh is used up, the circle becomes empty and a bell sound can be heard. In addition, the amount of time taken to use the set amount of energy is also displayed.

On one side of the WLT is an information button. At any time, when this button is pressed and held down, the projected image changes from showing the amount of kWh left to the amount used. Furthermore, information about individual measuring points are displayed and assigned different colors on the pie chart. The color on the pie chart corresponds to the color of the plug sending the information wirelessly to the Watt-lite TWIST. When letting go of the button, the pie chart reverts back to the original stage. WLT may be placed on a flat surface, projecting onto a vertical surface such as a wall. In addition to WLT being an instrument for exploration and understanding kWh, it was intended to be a tool for exploration. It requires active participation of users with regular intervals. The actual experience of seeing the projected pie chart decrease over time opens up for the possibility to learn through an every day experience. How long does it take to use one kilo-watt-hour?

The WLT was introduced in each office to a target group. A background to the design of the prototype was given as well as an explanation of its use, technical problems which might arise and how to communicate with the research team. WLT was demonstrated and installed together with the target group. Instructions emphasized the freedom of use and importance of using WLT according to the wishes of the group and in the way that suited them best. Thus, they could place WLT in a spot they found most appropriate and could also move it around if they wished. The only requirements posed by instructions were that somebody should be responsible for the care of WLT and that WLT should be switched off when people left the office.

The group was also given eight sensors, which they could place on an electrical appliance of their choice not far from WLT. Finally, the group was encouraged to test their own ideas and explore as freely as they wished. A color key for the different sensors was intentionally not provided. The reason for this was to encourage participants from the start to actively engage in exploring the electrical appliances in their office.

* www.energyawareness.eu/beaware/solutions/wattlight-twist/
Influence and Power to Control

Electricity Use

Similar to study 1, the participants mentioned being frustrated in not being able to influence their electricity consumption at work as they wished to. The feedback they were provided with was actionable only to a certain extent. They were able to influence minor things, such as switching off lights. Some also felt that even if they switched off their own lights, this wouldn’t make a big difference:

“You may switch off your desktop lamp and you may switch off the computer when you go home… but in the winter time you may pass this building and you know that there’s nobody here… still the lights are on and that’s quite bad…” (participant 2, O3)

Also, some participants felt that actions which would make more marked differences were beyond their control. One reason was that they were not in a position to take decisions concerning the purchase or the company’s electrical appliances and, thus, didn’t know whether these were the most energy efficient or not. For instance, IT-equipment was in general purchased by the company’s IT department. The following was the way they felt this inability to contribute to energy conservation:

“Things that consume the most [electricity] are difficult to do something about: the coffee machine consumes [electricity]… and you need to open and close the doors to get your coffee down. But that feels a bit… and you could give up using printers and things like that… but I mean… you need to do this for your everyday work. On the other hand, you could probably think about avoiding unnecessary printing and copying of papers” (Participant 1, O3).

Coffee machines, printers and photocopiers machines are considered necessary for this participant for carrying out her work. These reflections might be used to scrutinize the general office practices, which then would make them work even harder. Having coffee breaks at work is a practice deeply rooted in many cultures, which makes it hard to change. However, the provision of coffee machines at work is something that might be replaced:

The importance of leaders is emphasized in order for practices to change. One of the participants told the story about the influence of a strong environmental officer in the organization:

“We don’t have the power to change computers or computers to use. Things like that are handled by the IT-department: most things we use like computers, displays and printers – through the ‘IT-department’” (participant 2, O3).

One participant argued that people’s actions in an office can affect others in unfortunate ways since they are not always aware of who might be using specific appliances. Thus, you might refrain from switching off appliances rather than spoiling something for somebody else. The inability to influence office practices is exemplified by the workplace of O1, which through a refurbishing process had been stuck with a heating and cooling system actually intended for the previous physical environment. One participant said that the building previously had individual rooms. When walls had been torn down to accommodate for an open plan office they were faced with practical problems. For example, there was a longstanding battle among the staff about the indoor climate – some were too cold and some too hot: “I prefer a cool temperature, because I dislike to work in a freezing climate. But then, a wind blows at the person behind me and she must put her jacket on.” (participant 1, O3).

Changing to Pro-environmental Practices

Reflecting upon what types of practices would be open for changes, participants differed in how they viewed their ability to affect the workplace practice to become more pro-environmental. Some saw the necessity of using specific electrical appliances as quite fixed:

“Well, I think you could probably give up drinking coffee… but that feels a bit… and you could give up using printers and things like that… but I mean… you need to do this for your everyday work. On the other hand, you could probably think about avoiding unnecessary printing and copying of papers” (Participant 1, O3).

These are all things that people might be able to change if they wished to. The feedback they were provided with was actionable only to a certain extent. A difference between the two settings was in how the employees related electricity use to production. The factory workers expressed an explicit and strong association between electricity use, company production and turnover, whereas the office employees did not express this association as strongly. Office staff, on the other hand, emphasized the use of their computers and printers for carrying out their work tasks efficiently. At first glance these foci might seem different, but the underlying reasoning indicates a similar train of thought and striving towards a similar goal – the goal of their business.

The employee’s interaction with the two prototypes – Watt-lite and WLT – differed between the two settings. The factory prototype, Watt-lite, was more cherished than the office prototype WLT. This was probably partly due to the unfortunate technical shortcomings of some of the WLT prototypes. More specifically, though, it was likely also due to the ambient character of Watt-lite compared to the non-ambient character of WLT. The participant also describes how visitors of Watt-lite made the feedback of electricity use easily available for a large group of people, who did not have to go through an active process of switching it on. They passed by it or glanced at it while having a coffee break. In contrast to Watt-lite, WLT was not ambient to the same extent but instead demanded an active interaction from users. This design was directed towards engaging participants to switch it on, wind it up and to actively measure specific appliances’ consumption of kWh. This was successful for a few weeks, during which participants explored their electrical appliances through moving the wireless sensors around. After this initial period, however, WLT was perceived as the employees’ job. Its use relied upon active initiatives of employees and this requirement proved to intrude on the work of participants. It was left in the same spot where it was put when it arrived, even though it was possible to move it. The lack of accessibility of the wireless sensors communicating energy use were mostly left connected to the same appliances as they were after the initial two weeks. As a tool for more targeted use, as in for example a learning
environment, the WLT would probably be easier to accept.

Design and research implications
Our approach to investigating how energy consumption could be reduced in the workplace was deliberately intended to be exploratory, and in so doing, did not explicitly set out to formulate criteria on how eco-feedback systems should be designed. The two studies showed how the design probes were able to reveal hidden workplace practices through discussion and reflection, and to some extent encouraged some behavioural change. The studies also gave rise to several insights concerning the value of introducing new kinds of eco-feedback artifacts in the context of a workplace.

Our findings suggest more research is needed to consider the relationship between organizational structures and processes, with a focus on the interplay between the organization, workplace practices and the artifact. The implementation of an eco-feedback artifact in an organization must be regarded as an organizational change similar to the implementation of any new technical system into an organization. Consequently, a successful implementation ought to apply established knowledge in the domain of the implementation of organizational change. Based on the findings of our studies we suggest the following implications for research:

• Environmental champions responsible for changing existing practices around energy use and consumption. Stronger champions are important when setting up change initiatives. These should be both top-down and bottom-up. A change to more pro-environmental behavior, habits and practices in a workplace environment encounters severe challenges for the organization and its culture. They can have input into selecting ‘environmental champions’ whilst also being role models.

• Implementing processes for group discussions of feedback
A change in workplace practices should engage active participation of employees. There needs to be slots set aside in the daily work for employees to be able to discuss issues that arise in relation to their electricity consumption. Even though new kinds of eco-feedback can trigger discussions spontaneously during coffee breaks, this may not be enough. These could take the form of action plans, goal setting and seminars where the feedback, historic data and trends on electricity use are reflected upon.

• Balancing production and electricity conservation
The goal of saving electricity can conflict with the company’s production goals. How tension is resolved needs greater transparency and for the eco-feedback to not be seen in terms of ‘production’ or ‘profit’ but in terms of possible savings.

• Traceable and actionable information
The artifact should provide information on events from which they originate. This is important for the employees to make sense of the information and for being able to act on it. Then, a reflective and reasoning process may start in how to deal with the events. Data on historic trends may also be useful for supporting this kind of reasoning. If this kind of data would be available for employees to explore, it may form a basis for changes in workplace routines, for example being discussed at scheduled meetings.

• The role of eco-feedback devices for eliciting discussion
Technology interventions that provide feedback on how much energy the company is using can trigger discussions at different times of the day that can result in behavioral change. The more the device requires user involvement the more likely it will trigger discussions and reflections among the employees. However, user engagement will drop off after a while. In contrast, an ambient feedback display, that does not require active engagement on behalf of the users, can act as a reminder to pay attention to electricity consumption.

• Changing comfort levels
Pro-environmental practice demands people to change habits that provide comfort. Work breaks, such as lunch and coffee breaks can support such activities. People, who bring their own lunch boxes, usually heat their food in microwave ovens. This equipment appears to be the electrical equipment most frequently used for lunch breaks. Other necessary electrical equipment for lunch and coffee breaks are kettles, dishwashers and refrigerators. The role of coffee breaks is mainly to give new energy for returning to work tasks by the computer or factory machines. But they also use a lot of electricity. Another example is the battle between employees concerning increase and decrease of indoor temperature. Comfort levels includes practices relating to indoor climate and office lighting.

Conclusions
Design is about making sense of things [Krippendorff 1995], and imposing meaningful order in our lives [Papanek 1972]. In this way, artifacts act as “knots of socially sanctioned knowledge” that define a social order and direct how activities are carried out [Pareda, 1999]. Different types of practices, rituals and behaviors are connected to, and embodied in, the world that in many ways constitutes what we perceive as normal. Workplace environments such as factories and offices are no exception. Implementing new eco-feedback artifacts into two different work environments revealed both challenges and opportunities for future research. More active types of engagement with energy reduction in work settings may soon become regulated. How future workplaces can be designed to accommodate productivity needs and personal comfort levels whilst striving to reduce energy consumption will become a big challenge. Our research has shown how larger social and managerial issues deeply rooted in everyday societal norms are much in evidence in the workplace. The participants had little encouragement in setting aside time for environmental practices as these actions were often treated in a superficial way. It should be said that all the companies in the studies had an interest in participating both for environmental and monetary reasons, but in the end they still have to compete within an existing economical structure. Similar to households, appropriate feedback on electricity use gave rise to more grounded reasoning among workers. But in contrast to the context of the home, it was harder to make changes in the workplace environment, leaving employees with habits of powerlessness. This also indicates a larger structural problem within the workplaces, limiting individuals to affect their surroundings.

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References
Yun, T-J., 2009. Investigating the Impact of a Minimalist In-Home Energy Consumption Display. CHI’09, Spotlight on work in progress, 4418-4421, ACM.

Author statement about previous research
The work described in the submitted TOCHI article builds upon data from two research projects carried out at the Interactive Institute in Sweden. As work in progress, a small part of the work reported in Study 1 was previously reported in,
The prototype Watt-lite Twist is also described on the website http://www.energyawareness.eu/beaware/solutions/wattlight-twist/
The results from the ethnographic study in Study 2 have never been published before.
Becoming the Energy AWARE Clock – Revisiting the Design Process Through a Feminist Gaze

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Abstract
This paper explores the border between technology and design (form giving) from a feminist perspective. Looking at the energy system and how it has been integrated in the household, we want to address the underlying structures that have been built into the ecology of electrical appliances used in daily life, preserving certain norms that could be questioned from both a gender and a sustainability perspective. We have created an alternative electricity meter, the Energy AWARE Clock, addressing design issues uncovered in an initial field study. In this paper, we will make parallels to these issues. We also use feminist technoscience studies such as Donna Haraway’s theory of the cyborg in order to clarify useful concepts that can be derived from feminist theory and that can act as important tools for designers engaged in creative processes. From our own experience with the Energy AWARE Clock this approach has great potential for questioning and rethinking present norms within sustainability and gender, from the viewpoints of design research and design practice.

Introduction
Constructivist technology studies argue that those who design technologies are, in the same stroke, designing society (Latour 1988). We agree, and in this paper argue that it is important for Feminist Technoscience Studies (FTS) to incorporate a design perspective. In addition, we emphasize the potential of knowledge transfer in the reverse direction, i.e. acknowledging the fact that design research may benefit from knowledge within FTS.

As an illustrative example we re-visit a design-case of an experimental artefact, the Energy AWARE Clock (from now on referred to as EAC), an alternative electricity meter that was developed using a research through design approach (Frayling 1993) to explore how the notion of electricity as a commodity can be reformed, so that a more conscious usage becomes the norm. In line with the focus of the discussion within FTS, many researchers view research through design as a designerly inquiry, focused on the making of artefacts with the intended goal of societal change (Binder & Redström 2006).

The EAC was a design experiment resulting from a larger research project called AWARE. The project resulted in several fully working design prototypes that explored different angles in the use of electricity from a design perspective. One of these designs was the EAC that was later evaluated for three months in a user study in nine households just outside Stockholm, Sweden. The results from this user study, as well as the initial field study and the design process, have been covered in depth in a previous paper by the authors (Broms et al 2010).

We have previously discussed how the traditional feminist interpretation of form follows function is visualized in the form language of technological artefacts that contributes to the division of domestic labour (Ehrnberger et al 2012). In this article we explore these relations in further depth and examine the very border between what we perceive as design (meaning the form given artefact) and pure function, and how this distinction affects our values in everyday life.

As the practical context for this discussion we will look closer at the energy system and how it has been integrated in society and the household in particular. Inspired by the feminist discussion within FTS, we want to better understand how design contributes to the division of roles in the household and how this relates to the energy system. For example, how are different spaces used and what physical properties of things reinforce and constitute present norms and traditions? Understanding these relations is important for new practices to form, creating new objects and spaces adding to the present ecology of household products, tools and services.

Drawing on themes derived from the field study informing a design process (Broms et al 2010), we make parallels to arguments in Haraway’s cyborg theory. By doing this we want to highlight how feminist theory may be integrated in the creative design process and how concepts from feminist theory may act as important tools for a designer. Connections to feminist theory were insights that continuously grew and expanded through the design process for the EAC, and by analysing this process in retrospect we can gain valuable insights about some of the numerous small and large design decisions that were not as clearly articulated at the time.

The first author already had experience of incorporating a feminist perspective into a critical design process from a previous project. Experiences from this process influenced the design work of the EAC as well even though a feminist perspective was not explicitly set out within the research program.

Next, we will look more closely at the history of gender roles in relation to electricity in the household. Then we will expand on some theoretical starting points related to feminist theory. Finally, we will use these to analyse the design process of the EAC and conclude by discussing the results and potential of this method.

The Gendered Energy System
In this section we will look more closely at how gender roles in the home have developed throughout recent history, how this development is linked to the shape of places in the home and how they are populated by technology in different ways. We discuss non-places and non-things, man caves and the conceptual integration and design of the energy system into the household.

Gendered Division of the Household
Feminist critique of design states that since Modernism, the view of women as belonging to the private sphere and the man belonging to the public sphere has been crucial to how artefacts are designed (Sparks 1993, Antfield & Kirkham 1989, Ahl & Olsson, 2002). Often, the focus for this discussion is the dichotomy of home versus work. Less discussed is the fact that this dichotomy in the post-war period became threatened when the family was in crisis due to the fact that the war women had left the home to work. The 50s was a decade where enormous amounts of cultural capital were invested in the ability to reconstruct the nuclear family and live out a set of highly structured gender roles in the home (figure 1).

Women went to their household duties while men were encouraged to take over chores previously done by professionals, like plumbing, electricity work and reparations of the home. The housewife and the “handyman” became symbols for the dichotomy that the family and the household were built upon (Gelber 1999).

Although recently there has been some movement across gender domain boundaries, the gendered division of domestic labour still dominates. Thus, of the technologies present in the modern household, only a small number are used equally by women and men: those used in the routine tasks of cleaning and cooking are more commonly used by women and girls, whilst those used in the non-routine tasks of home maintenance and gardening are more commonly used by men (Sullivan 2000, Phrat 2004).

Non-spaces, non-things
The division of domestic labour has led to the fact that spaces in the home have become gendered. For example, the kitchen is still...
considered a female sphere while the garage is considered a male sphere (Massey 1994, Pihl 2004). The anthropologist Marc Augé writes about urban non-spaces, meaning spaces that are not designed with everyday activities in mind – for example parking places, wasted slots and airports (Augé 1994). Similarly, our homes have spaces that are reserved for storage, technological devices or just passage. Spaces like the garage, the attic or the cellar are not seen as a part of the household sphere since they are not a part of our daily life. While the kitchen, the living room and the bedroom have become targets for interior design, the non-spaces have been left untouched and isolated from our daily life. As previously mentioned, power tools are reserved for masculine tasks. Consequently, spaces in which gender roles are created, maintained and reproduced (Pinto 2006). Research shows that the technical artefacts play a central role in this, as they are a part of a social system that is directly linked to gendered places and activities. As previously stated, the form language of these artefacts helps perpetuate this understanding (Ehrnberger et al 2012).

The Energy System in the Household

Today, the energy system has become a natural part of the machinery of the house, and the technological interfaces to this system are perceived as pure function with no correlation to aesthetics values. A clear example of this was thinking was an advertisement from 1998 by the Swedish energy company Vattenfall where the energy was described as just “two holes in the wall” (Löfström 2008). However, looking back in history, we can see that representations of the energy system have been far from just two holes in the wall. During the industrial revolution, electricity as well as gas monolithically became a part of the house (Callon & Latour 1981, p. 285). A black box contains that which no longer needs to be considered, those things whose contents have become a matter of indifference. To open up the black box and to visualize the elements, Latour means that something in the system needs to happen or break down. We mean that design could be a tool to make things ‘happen’.

Frieda Attfield and Janice Kirkham (1998) and Spurke (1995) state, the form language of these artefacts helps reinforce this understanding (Ehrnberger et al 2012). Donna Haraway's cyborg theory states that design could be a tool to make things 'happen' (Donna Haraway 1992).

For a designer, gender in technology and gendering of artefacts by association should not be distinguished from each other, since they intersect. The way an artefact is technically constructed often affects designers in their form decisions (the material embodiment), which in turn affects people's associations. This agrees with the feminist interpretation of form follows function, where the machine (the man) takes priority over the body/the form (the woman) (Attfield 1989, Sparke 1995, Ahl & Olsson 2002). Ehrnberger et al describe an illustrative example of this where a drill and a mixer switch followed function (material embodiment). The switch revealed how people's associations were fixed to the particular product language that in turn was connected to ideas about gender and technology (Ehrnberger et al 2012).

The Cyborg Theory

The energy system is a sociotechnical system, meaning that it consists of technical artefacts and processes as well as actors, organizations and institutions that are linked together in the utilization of energy. The view of energy as a sociotechnical system implies that knowledge, practices and values also need to be taken into account to understand the process of change in such systems. This approach derives from Science Technology and Society (STS). However, in this section we will first make a short account of the Actor Network Theory (ANT), in order to explain the theoretical direction of this paper. ANT is distinguished from many other theories within STS for its distinct material-semiotic approach. We will then continue by focusing on the theory used in this paper, the feminist cyborg theory by Donna Haraway, which derives from ANT.

FTS and DESIGN

Feminist design critics have discussed design from a sociotechnical point of view, pointing out the correlation between design, technology and social change (Attfield 1989, Attfield & Kirkham 1998, Sparke 1995) but there are few design experiments that present design strategies for such change (Ehrnberger et al 2012). The critique within FTS touches design issues, often referred to as material embodiment (Cockburn & Ormeod 1993, Wajcman & MacKenzie 1990). For example, Wajcman and MacKenzie describe how household spaces become targets for interior design, while the garage is considered a male sphere (Massey 1994, p. 83):

...a metaphor describing a room inside the house, such as the basement or garage or attic or office, or outside the house, such as a tool shed or a workshop, where “gays can do as they please” without fear of upsetting any female sensibility about house decor or design.

As the definition implicates, these spaces are reserved for masculine tasks. Consequently, the artefacts connected to these tasks or activities are intended for men. As previously mentioned, power tools and electronic equipment are traditionally considered ‘male’. But there are also other artefacts connected to these spheres, artefacts that are not even considered artefacts but just regarded as representations of a technical system. The boiler station, the electricity fuse box and the energy meter are just some examples of these devices. But they are artefacts, even if of a different kind. The first category is concrete tools connected to the male space and these may be used for carrying out male activities. The second type are tools that are not necessarily used. Instead they represent a connection to the technical system. Together they constitute systems that operate the social stage of the house, but, just like the spaces they operate in, they have become invisible

(Ketola 2001). Sometimes it is necessary to interact with these artefacts, for example when a fuse needs to be changed or when the boiler is overheated, tasks that are performed predominantly by the man in the house – the handyman (Pihl 2004). It is in the home where gender roles are created, maintained and reproduced (Pinto 2006). Research shows that the technical artefacts play a central role in this, as they are a part of a social system that is directly linked to gendered places and activities. As previously stated, the form language of these artefacts helps perpetuate this understanding (Ehrnberger et al 2012).

In the former case [in technology], gender relations are both embodied in and constructed or reinforced by artefacts to yield a very material form of the mutual shaping of gender and technology. In the latter [of technology], the gendering of artefacts is more of an association then by material embodiment. Here, it becomes quite clear that a more profound design perspective is needed. For a designer, gender in technology and gendering of artefacts by association should not be distinguished from each other, since they intersect. The way an artefact is technically constructed often affects designers in their form decisions (the material embodiment), which in turn affects people's associations. This agrees with the feminist interpretation of form follows function, where the machine (the man) takes priority over the body/the form (the woman) (Attfield 1989, Sparke 1995, Ahl & Olsson 2002). Ehrnberger et al describe an illustrative example of this where a drill and a mixer switch followed function (material embodiment). The switch revealed how people's associations were fixed to the particular product language that in turn was connected to ideas about gender and technology (Ehrnberger et al 2012).

The Cyborg Theory

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Actor Network Theory

Actor-network theory is an attempt to explain how material-semiotic networks tie together to act as a larger whole. The clusters of different actors that constitute this whole can be both material and semiotic, both human and non-human. These networks are rarely static entities. Instead, the network can be seen as a state of making and re-making. Since the networks are constantly changing, the social relations within are constantly performed and negotiated otherwise the network would dissolve.

Bruno Latour uses the term black box for any sealed network of people and things. For example, the energy system in the household can be seen as a sealed network. As previously mentioned, it consists of representations that contain components, but we only interact with the designed (form given) artefacts of this system such as lamps or domestic appliances. Latour states (Callon & Latour 1981, p. 283):

A black box contains that which no longer needs to be considered, those things whose contents have become a matter of indifference.

To open up the black box and to visualize the elements, Latour means that something in the system needs to happen or break down. We mean that design could be a tool to make things ‘happen’.

Donna Haraway's Cyborg Theory

FTS scholars have long identified the ways in which socio-technical systems are constructed not only in physical objects and institutions but also in symbols, language and identities. In line with ANT, humans, scientific facts and technological artefacts are treated simultaneously as semiotic and material.

In our analysis, we have foremost been influenced by feminist theorist Donna Haraway. Of all the FTS scholars, she and Sandra Harding have the broadest notion of technoscience as a material-semiotic practice (Harding 1998). Haraway's term natureculture (Haraway 1991) refers to the interaction of different sciences in order to fully understand how they influence each other. Also, as with the norm, she sees science as a process and argues the importance of instability and uncertainty in ensuring constant movement in research. As the field of design research is growing, establishing concepts such as discursive design, critical design and conceptual design and this view of knowledge making interesting.

In this article, we apply an interpretation of Donna Haraway's cyborg theory as an analytic framework of the design process described
(Haraway 1991). Haraway deploys the metaphor of the cyborg to offer a strategy to break loose from power structures. Haraway means that the world is built upon dualism, which creates boundaries and restricts our capacity to think in other categories than the dominating. The cyborg is a symbol for paradox; it is a hybrid between organism and machine. It is a creature of social reality and at the same time a creature of fiction. Haraway suggests using the Cyborg as "a figure of thought" in order to stop the separation between binary divisions such as nature/culture, science/society, private/official, masculine/feminine, man/machine and so on. We find these arguments applicable in this study, since our research content deals with the dichotomy of the household and the border between design and technology.

Drawing on the three interview themes as described in previous work (Brons et al 2010) we make parallels to three selected arguments in the Cyborg theory in order to clarify useful concepts that can be derived from feminist theory and that can act as important tools for a designer engaged in a creative process. These concepts are diffraction, the male gaze and metaphors.

Diffraction
Haraway proposes the notion of diffraction as a critical practice for knowledge making (Haraway 1989). The diffraction metaphor could be likened to a prism, where a light ray can take numerous different, and sometimes intersecting, paths depending on the entry point and angle. Similarly existing information can be divided into multiple readings—perspectives—that overlap each other. This is different from general notions of reflexivity, which Haraway argues do not go far enough to attend to effects that are relationally produced. Diffraction, on the other hand, allows multiplicity, differences and enables critique, thus clarifying which differences matter, how they matter and for whom.

The Male Gaze
Feminist theorists argue that the world is perceived from the perspective of a white, middle aged, heterosexual man. Donna Haraway calls this the male gaze. She rejects the power that the male gaze organizes as it (Haraway 1988, p. 181): (...) thereby inscribes all the marked [that is, female] bodies, that makes the unmarked category claim the power to see and not to be seen, to represent while evading representation.

This means, that males act, females appear; females watch themselves (through the male gaze) being looked at. The concept of the male gaze has been influential in feminist film studies and media studies, discussing how the camera and the male gaze engaged in a creative process. These concepts are consequently used as tools in order to challenge cultural borders and categorizations. As already mentioned, the cyborg is an example of a visual metaphor. However, the cyborg is not simply material, but an embodied material-semiotic actor that is constructed and marked by understanding and categorizations. As already mentioned, the cyborg is an example of a visual metaphor. (Haraway 1988). Examples of lingual metaphors by Haraway are manmachine, mananimal and manwoman.

Metaphors
Donna Haraway is often mentioned as a metaphor theorist. In her work, both visual and lingual metaphors are consequently used as tools in order to challenge cultural borders and categorizations (kW) and also the historical consumption over time (kWh). A complete rotation on the clock-face can represent anything from a minute to an hour, 24 hours, a week, or a month depending on which view practice Haraway is engaged in. The display is only one other button, placed to the left, that toggles a numerical kW representation on and off. The angle of the pointer on the display represents the current time whilst the length of the pointer shows the energy being used at that specific moment. When an electrical apparatus is switched on it shows up on the display immediately in terms of a longer pointer. As time moves on the pointer leaves a trace showing the historical electricity use. The shape of the resulting graph indicates what has happened during the course of the day. Previous turns fade away slowly and the consumption of the current day is drawn on top of that of previous days, making it possible to compare the current electricity consumption with that of the day before and the day before that. Data about electricity usage is sent wirelessly to the display from a small unit attached to mains fuse box.

Reflections on the Design through the cyberg theory
Starting from the cyborg theory we will now reflect upon the design process of the EAC.

Field Study
The start-up of the design process consisted of several activities, such as overviews of the energy field, workshops with stakeholders and word association. In conjunction with these activities a field study was conducted in order to inform the design process and to gain an understanding of the individual households’ living spaces and context. For this we used qualitative methods and collected data through home observations, photographs and interviews with members of households. Our queries evolved mainly around three topics – the home as the material framing and context for everyday actions; savings and energy efficiency as driving forces and activities; and finally electricity consumption, how and where it is used. A total of nine households were interviewed, each selected to reflect different living conditions and lifestyles. Each interview took about two hours and was followed by a walk through the house while discussing and photographing things of interest for the study. The interviews were then transcribed. Notes and photographs were categorized in order to subsequently analyse and identify general topics and ideas. Three major design themes were identified. These themes were clearly salient and stood out from the collected data: complexity, visibility and accessibility.

Complexity
The feedback our informants got on their electricity consumption was primarily through two communication channels: the electricity bill and, in some cases, the energy meter. This did not provide enough feedback, as information from both channels was perceived as too complex (Brons et al 2010). The language for communication with the user could be argued as being technocratic and male-oriented. They were designed from the point of view of electricity as a commodity, communicating out of the non-spaces of the house and in the one-dimensional technical lingo of kilowatt-hours.

Visibility
Representations of the electrical system in the household are more or less successfully disguised; hidden behind covers and assimilated to the background surface, for example painted white in an effort to neutralize any visual impact. In the study, one informant had more or less successfully covered an air pump that was deemed visually unpleasant behind a set of antique chairs (figure 2). In addition to this the electricity is produced in large-scale power plants that usually lie far away, separating production from use and making it less natural to reflect upon. Electricity is an invisible norm that these days is rarely thought about unless it for some reason, ceases to function away, separating production from use and making it less natural to reflect upon. Electricity is an invisible norm that these days is rarely thought about unless it for some reason, ceases to function – for example in a power outage.

Accessibility
The energy meters were often placed in ‘non-places’ (Augé 1995) like in the basement or the day before and the day before that. Data about electricity usage is sent wirelessly to the display from a small unit attached to mains fuse box.
Complexity and Diffraction

The theme of complexity from our field study may be broadened by linking it to the concept of diffraction. With the EAC, we set out, in one sense, to make it easier to understand and react on feedback regarding electricity use. But rather than simplification and abstraction of the information to be displayed, we instead strove for complexity in lines with the concept of diffraction. This is because in terms of experience, it is often complexity rather than simplicity that is sought and appreciated (Norman 2004, Stjernfelt 2005). The most meaningful artefacts in our lives are not necessarily those that are simple in their communication. On the contrary, they may open up for a multiplicity of interpretations and uses in a similar way as we found with diffraction. Instead of using one-dimensional numbers and units accepted by the industry for communicating electricity consumption, we created a circular graph reflecting the usage throughout the day. The graph is not a map, but gives clues about the electricity used in relation to a specific time or activity, it also, on a higher level – similar to the concept of diffraction – ties together the visualization of many events – similar to a diary. It is very important to move away from the instrumental form language of the traditional energy meter that was associated with invisibility and pure function (the male gaze, if we apply our interpretation of Haraway), and instead try to make it aesthetically compelling so that it would encourage metaphors in regards to place. We chose the shape of a house, a semiotic related decision to symbolize the household as a whole, where the circular graph and the electricity patterns become central to the house. The EAC was made with the intention to visualize information about the electricity system in a way that broke away from the present norm of a hidden culture that is hard to reflect upon.

Accessibility and Metaphors

Just like the form language, the very word “energy meter” has bearing upon which context it will be placed and categorized in, bringing forth connotations to non-places in the home. As previously mentioned, instrumental objects in the household are often covered or hidden from the daily life. In order to break loose from these connotations and transcend into a another set of product metaphors, we used the image of the clock object and called the new meter the Energy AW ARE Clock in order to further strengthen this new marriage between energy visualization and the procedure of daily timekeeping. The power of language over thoughts and acts cannot be underestimated. Here, the usage of metaphors has a great influence on our way of thinking, acting and talking (Lakof & Johnson 1980). The clock metaphor is intended to signal to residents to put the EAC in a central, shared space of the household – just like an ordinary wall clock - in order to engage all residents in reflecting upon the use of electricity, and establish a relationship to the electricity system in more accessible areas of the home. The choice of materials further enhances this.

Conclusions

In this paper we have explored how feminist theory may be combined with design research as a strategy to break away from a gendered interpretation of technology that influences our design decisions. We have applied concepts from the cyborg (Haraway 1991) to analyse interview themes from fieldwork that were initially carried out to with a focus on energy visualization. The energy visualization artefact was developed with the intention to make electricity consumption a conscious part of everyday life for all householders. Attending to the interview themes that constituted the areas of inquiry – complexity, visibility and accessibility – we have applied concepts central to the cyborg theory – diffraction, the male gaze and metaphors, respectively – to clarify how feminist theory can be used in relation to the design process, using the EAC as an example. Looking at the energy system as a whole, making no division between what should be allowed to be designed (form given) and what should be pure function, a more open and inclusive approach could be used in the design process. Based on our results, we believe the discussion within FTS and the design field could more easily approach each other if we reflect upon and define the very word “design”. While FTS scholars often use the word design addressing more technological characteristics such as facilities or features in the technology, designers use it in terms of aesthetic characteristics, the form language (Ehrnberger et al 2011). We suggest seeing these two meanings as one, mutually transforming each other. To follow STS scholar Donna Haraway, they “become with” each other in a social process (Haraway 2008, p. 4). This approach would not only offer the possibility of learning more about the relationships between technology, design and gender but would also open up negotiation between them and, through that, engender a societal change.

In the subsequent three month EAC user study one of the results was a higher and more even engagement between men and women concerning electricity consumption (Broms et al 2010). However, this is just one of many potential benefits when using concepts from FTS in design research and practice, allowing approaches that question all kinds of norms and encouraging new ways of thinking. At the time of writing this article, a commercial version of the EAC, called simply Aware Clock, has become available which make the authors hopeful of having produced research results that initiate real change.

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References

energianvändning. Lindköpings University, system och individ- respektive artefaktbunden hushåll- Avdomesticeringen av sociotekniska

Feminism, Cornell University Press.

Kraftteknik, Lunds universitet. perspektiv, Lund, Institutionen för Värme- och Energianvänding ur ett kulturanalytisk

Press.

Metaphors We Live By. University of Chicago

University of Minnesota Press.

The Prince for Machines

and the Design of Energy Feedback Artefacts

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Åsa Nyblom

Sara Istedt Hjelm

Karin Ehnberger

Abstract

Smart electricity meters and home displays are being installed in people’s homes with the assumption that households will make the necessary efforts to reduce their electricity consumption. However, present solutions do not sufficiently account for the social implications of design. There is a potential for greater savings if we can better understand how such designs affect behaviour. In this paper, we describe our design of an energy awareness artefact – the Energy AWARE Clock – and discuss it in relation to behavioural processes in the home. A user study is carried out to study the deployment of the prototype in real domestic contexts for three months. Results indicate that the Energy AWARE Clock played a significant role in drawing households’ attention to their electricity use. It became a natural part of the household and conceptions of electricity became naturalized into informants’ everyday language.

Introduction

People’s behaviour is commonly pointed out as an important factor in reducing problems caused by increasing levels of CO2 emissions. Households are responsible for approximately 15-20 percent of total energy related CO2 emissions and this proportion is expected to keep rising (Biesiot and Noorman 1999). Since the seventies, the use of electricity in Swedish households has increased with about 30 percent and behaviour patterns are considered responsible for a major part of this increase. A change in households’ energy related behaviour might, thus, contribute to a more sustainable society.

In focusing the role of design and technology for promoting energy efficient behaviour, the human computer interaction community may play a significant role. Sustainability in interaction design has recently been pointed to as an important field of research (Blevis 2007). Even a low-tech experiment from the 70’s – The Twin Rivers project – illustrates the role of interaction design for encouraging energy efficient behaviour (Seligman, Darley and Becker 1978). Although its major focus is not on design, it lifts issues on visualization of feedback and how these issues relate to a reduction in electricity consumption. Participants in the study received feedback of their electricity consumption from a manual presentation each afternoon on their kitchen window. Results showed that households receiving feedback reduced their electricity consumption up to 15.7 percent. Feedback decreases the experienced gap between the production and consumption of energy. Electricity is produced in large-scale power plants and consumed in the small scale through electrical appliances in the daily life. Before the production became centralized, people had a more direct relation to the use of energy. For example, through the very act of chopping wood they experienced the effort involved in the production of energy for heating and cooking (Borgmann 1987).

Effects of feedback on energy conservation behaviour have recently been the focus of a considerable amount of research (Darby 2000, Chetty, Tran and Grinner 2008). Darby concludes that the norm for savings from direct feedback – from a meter or an associated display monitor – ranges from 5 to 15 %. In addition, a recent public survey conducted by the Future Foundation in the UK for LogicomCMG found that 82% respondents would consider changing their energy behaviour if they had a “screen telling the homeowner how much energy they are using at any one moment” (LogicomCMG Energy

Toward and Integration of Micro- and Macro-


**Automatic Meter Reading**

State agencies are now implementing a set of strategies to reduce excessive electricity consumption. A major step in this direction is the development of energy-efficient technologies that are important parts in this work as well as information dissemination and fostering beneficial change. With a focus on the latter state agencies in the UK and in Sweden, are now implementing legislation resulting in new types of electricity meters with Automatic Meter Reading (AMR). With the AMR data, measurements on electricity consumption are sent to the power company regularly. This yields adequate bills based on actual measurements. Most households in Sweden now have AMR meters installed. Some of these have displays showing the household how much electricity it is consuming. The underlying assumption of introducing this technology into the home is that the feedback it provides will lead to behavioural changes and reduce energy consumption. However, research on the presentation and design of feedback for ambient interfaces to energy feedback shows the amount of energy passing through it by glowing patterns produced by electroluminescent wires moulded into the transparent electrical cord. An ambient interface to energy feedback that is integrated within the electricity system is a home environment. To better understand the design space for this class of artefacts, the user study explores users' behaviour when living with EAC in their homes for three months. The reported work is carried out within a research-through-design framework (Frayling 1993). Important in this process is the concrete hands-on work with prototypes that foster reflection and new ideas (Schön 1983).

**Methods**

The following sections describe the design process of the prototypes and how they were developed as an instrument for exploring psychological and social dimensions of household energy consumption. Thus, the goal of the design process is twofold: Insights into the nature of psychological and social mechanisms of households' relationship to energy consumption in their home.

Creating a concrete example of an artefact substantiating and exploring identified critical aspects of this relationship.

These two goals are interdependent. The creation of the prototype is the central and it plays an active role before, during and after its concrete construction. The design process is a vehicle to drive the exploration of the problem forward. We will explore the nature of households' relationship to energy consumption in their home from one perspective before the creation of the prototype and from a different perspective when the constructed prototype is placed and empirically studied in its intended context.

In the following sections we describe the phases of the process. Phases and their respective purpose are overviewed in Table 1.

**The present study**

The present paper approaches the problem of behavioural change from a design perspective. Previous research shows that providing people with feedback on their energy behaviour under appropriate conditions will lead to a reduction in energy use (Darby 2000, Abrahamse, et al. 2009). However, little is known about specific characteristics of these conditions. For instance, how do issues of information presentation relate to user context and individual differences between users? How do physical attributes and location of the actual display relate to users' everyday context of users?

The paper discusses a novel design for visualizing electricity consumption – the Energy AWARE Clock (in the rest of the paper referred to as EAC). By this, the paper aims to contribute to knowledge on the design of interfaces to energy awareness. One display was the "Energy Curtain" and the other the "Erratic Radio". How do prototypes relate to user characteristics of these conditions. For instance, how do issues of information presentation relate to user context and individual differences between users?

The present study focuses on the design of ambient interfaces: a class of user interfaces bridging the gap between the physical and the electronic world (Wisneski, et al. 1998). Ambient devices – also referred to as calm technology (Weiser and Brown 1996) – embed digital information into the objects and environments that surround us. These interfaces provide the user with information in the form of sound, air pressure, motion, light, smell, and other media that complement the full range of our human sensory modalities. They are designed to work with our peripheral senses, where they provide continuous information without being distracting or obtrusive. One example of this is the Power Aware Cord (Gustafsson and design group 2005). It is a redesign of a traditional power strip that displays the amount of energy passing through it by glowing patterns produced by electroluminescent wires moulded into the transparent electrical cord. A redesign of a traditional power strip that displays the amount of energy passing through it by glowing patterns produced by electroluminescent wires moulded into the transparent electrical cord. Redesign of a traditional power strip that displays the amount of energy passing through it by glowing patterns produced by electroluminescent wires moulded into the transparent electrical cord. Figure 1 shows the Power Aware Cord. However, since ambient displays are fairly new interface technology, there are few devices available on the market. One energy related example is Wattson, an electricity-monitoring device that has been praised for its style and simplicity (d'kyotfo 2008). By clamping an external wireless sensor to the home energy supply (mains fuse box), this device shows the running total in real-time of the wattage output as well as the cost. This is represented in a digital readout on the Wattson display or with ambient light.

Figure 1: The Power Aware Cord

In a recent study, Routarinne and Redström introduced two different prototypes of ambient energy artefacts in the homes of eight different families to see how they where domesticated in households (Routarinne and Redström 2007). Households' responses were then compared with the designers' original intentions of increased energy awareness. One display was the "Energy Curtain" and the other the "Erratic Radio". How users would receive these prototypes and how these new objects would fit into the ecology of the household were other questions addressed. The open-ended character of the domestication probes put the respondents' mind to work in trying to make sense of how the new objects should be related to and used (Gaver et al. 2006). Results showed that users reflected upon their values and attitudes in a way that highlighted the complexity of saving energy.

### Table 1: Overview of the design process

<table>
<thead>
<tr>
<th>Design phase</th>
<th>Purpose</th>
</tr>
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<tbody>
<tr>
<td>Construction of prototype</td>
<td>To synthesize findings from the field study with design knowledge and results discussed throughout the design process</td>
</tr>
<tr>
<td>Construction of prototype</td>
<td>To gain an understanding of the specific design context by material properties and an envisioned use</td>
</tr>
<tr>
<td>Contextual study of users' context and use in nine households</td>
<td>To gain a contextual understanding of the specific design context and to relate back to design and domestic living conditions</td>
</tr>
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</table>

**Field study**

The goal of the field study was to inform the design by gaining an understanding of the individual households' living spaces and context. For this we used qualitative methods collecting data through home observations, photographs and interviews with members of households. Nine households in Stockholm, Sweden were selected for this purpose. The constellation of the group was intended to reflect different and divergent living conditions and lifestyles.

Each interview took about two hours and was followed by a walk in the house while discussing and photographing things of interest for the study. Interview questions revolved mainly around three topics: The home as the material framing and context for everyday actions; motivations for energy conservation and efficiency; and how and what use electricity.

Interviews were transcribed and observation notes and photographs were categorized. These data were then, analysed to identify general topics and ideas.
Results Field Study

Three major design themes were identified. These themes were clearly salient and recurring in the data: complexity, visibility and accessibility. From a socio-technical perspective, they can be seen as indications of how the home energy system is intertwined with social aspects of everyday life.

Complexity

One of the central aspects for understanding how to save electricity in the home is to be aware of when and how the household is consuming electricity. The electricity bill and the present meters did not provide enough feedback although these were primary communication channels of on electricity consumption to the informants. Thus, energy related feedback on activities in the home was delayed until the arrival of the electricity bill every third month. This is too long a period for being able to remember what activities had lead to the level of energy specified on the bill. Moreover, information on the electricity bill was too detailed and too difficult to comprehend. The unit of measurement used on bills was kilowatt-hours, a concept which most of the informants were not able to explain or relate to, neither in terms of energy or money.

Information on the meters was also difficult to understand. This confirms the results from several other studies on feedback (Darby 2000, Abrahamse, et al. 2009). None of the informants had a smart meter installed and no one accessed any information about their electricity use over the Internet. The most senior informant, 81 years old, had an electricity diary where he wrote down the current position of the electricity meter every day at noon. With this routine he could keep track of the electricity consumption from day to day as he went down to the basement to write down the numbers (see Figure 2).

Other than the electricity bill, there were no other identified feedback channels for electricity consumption. Like the aesthetic expression of these devices is not particularly important. However, due to the placement and, partially, how residents move around, certain members of the household will be granted access and control of this technology. Engagement in electricity consumption, thus, would be easier for these members than for those who have little or no access to spaces where the technology is installed. Our homes consist of different areas and places that are implicitly coded to different activities and (thus) give access to just some members of the household. Gender seems also to play a role in this. Women still take the main responsibility for the household and children, whereas men are responsible for the maintenance of the house. Hence, women and children have different movement patterns in the home and mainly move around in the part of the home where little of the electricity system is shown, while the male domain is in the garage, the workshop and the basement where the electrical system is more visible. Movement pattern has implications for accessibility, which in turn is connected to engagement. It is hard to become engaged in electricity consumption of your household when information concerning it is difficult to access (Figure 3b).

Figure 3b: An electricity meter uncovered in the basement.

Conclusions and Implications from Field Study

Clearly then, the field study reveals problem areas in households' understanding of their energy consumption. Reasons behind these problems may be summarized as:

- Lack of direct feedback on energy related activities
- Complexity of concept of kilowatt hours used on electricity bills
- Complex presentation of electricity consumption on electricity meters
- Many electrical appliances has a "hidden" consumption of electricity
- Inaccessible or unknown location of electricity meter
- Lack of engagement in electricity consumption

The results of the field study cover the first steps in dealing with the complexity of electricity consumption. The next section describes the properties and function of the EAC. Subsequently, we account for how themes from the field study were addressed in the design.

Properties and functions of EAC

The EAC is a new kind of energy display that uses a time (i.e., analogue clock) metaphor to visualize a household's consumption. Just as a clock, the EAC may be hung on the wall. By further connecting to the clock metaphor we wanted to get away from the concept of a meter and to wash away technological references to the discourse used in electricity metering. Another intention was to facilitate transfer of some desired behavioural patterns of the ordinary wall clock such as glanced at regularly. The overall idea of EAC was to make electricity use more concrete in relation to ordinary activities as well as being a tool that could encourage discussions about electricity consumption in the home. The EAC wirelessly connects to an AMR meter in the home. The refresh rate is several times per second and it requires less than 5 watts to operate. Hence, it can be run on batteries or be connected to an outlet using a power adapter. Figure 4 shows the EAC.

Figure 4: The Energy AWARE Clock in the 24 hour view, showing the electricity consumption for the whole day and two days back in time.
The outer shape of EAC resembles a house with a dark acrylic front. Behind the glass there is a colour display. This display shows a circular graph that portrays the home's present use of electricity (kW) and also the historical consumption over time (kWh). A complete turn represents 1 minute, 1 hour, 2 hours or one week, depending on which view is selected. The angle of the dial represents the current time – similar to an analogue clock – and the length of the dial represents the amount of power used at that specific moment (i.e., kW). When an electrical appliance is switched on this can be seen on the display immediately in terms of a longer dial (Figure 4).

As time progresses, the dial leaves a trace behind on the display and this area depicts the historic energy consumption (i.e., kilowatt-hours and kilowatts for specific time points). The previous graphs gradually become darker as they are “moved back” for every complete turn. The areas for several days can be seen and compared in this way. Three overlays can be seen at the same time, which represents three days in the 24-hour view.

We added two touch-buttons to control the clock: One button with an icon depicting a light bulb that makes it possible to toggle between additional information such as time, watts, acquired kilowatt-hours in the present and past and consumed electricity for specific time points. The second button with an icon shaped like a clock changes the time scale for one complete turn between minutes, hours, days and weeks.

Addressing Complexity and Visibility

In an effort to ease the understanding of electricity use and reduce the complexity in gathering and interpreting information, we wanted to create an artefact that communicated more directly the amount of electricity used at a specific moment as well as historically. Direct feedback has proven successful in several studies as a way to decrease electricity use (Darby 2000). The comparison between present and past consumption was meant to facilitate for the understanding of how much electricity individual electrical objects in the home consumed. Since kilowatt-hours is a complex concept we wanted to move away from this, and focus on relations in a more visual way: By getting feedback both from the circular graph about how much electricity the household is using at that specific moment we thought it would be easier to compare and understand the historical patterns. The “overlay effect” also strengthened this concept allowing for comparison two steps back in time. The idea that the user would discover and learn about the electricity patterns over time was essential to the EAC concept.

To approach the problem of electricity being hidden, the EAC was designed to stand out as an object in its own right making electricity ubiquitous and tangible. The energy clock is shaped like a house to symbolize the household as a whole, where the circular graph and the electricity patterns become central to the house. The mere presence of the artefact was meant to act as a reminder and a strong symbol for energy awareness. It was important to try to make it interesting and aesthetically compelling so that it would be visible and placed in a central location in the home. The display was also intended to be ambient in the sense that a quick glance at it would indicate if something were out of the ordinary. The shape of the graph would indicate what had happened during the day.

Addressing Accessibility

In an attempt to engage the whole household in reflecting upon their electricity use and establish a relationship to the electricity system in central areas of the home we again used the metaphor of the clock object. The clock metaphor is intended to signal to residents to put the EAC in a central, shared space of the home. A small button on the clock plays the role of a tool for learning. It also seems to trigger a playful attitude in users motivating them to explore electricity in their household. The EAC apparently appeals to homo ludens – the playful creature (Huizinga 1958).

The study was carried out in a recently built neighbourhood in a suburb to Stockholm, Sweden. Households in a block of nearly identical terraced houses were systematically approached by the research team until 10 households were recruited for the study. Finally, nine households (one fell out due to technical problems) took part in the main, qualitative interview part of the study and were equipped with an EAC placed centrally within their home for three months. The meter was installed in such a way that it would only measure electricity use from appliances in the household. Measurement of heating was excluded with the exception of floor heating in bathrooms. The purpose of this was to keep visualization feedback simple. Young families mainly inhabited the neighbourhood. Eight of the nine interviewed households were families with adults between 30 and 35 years and one to two small children or babies. The eighth household was a couple around 60 years with no children in the house. All families had moved into their homes a year prior to the study. Data from the 9 families who tested the EAC were collected through qualitative in-depth interviews at the end of the three-month period. Interview questions were based on a guide targeting major themes of households’ experience, behaviour and learning in relation to the clock. Interviews were free in their form, allowing the interviewer to follow the informant and the development of the conversation. Interviews were one to two hours long and made alternately with both or just one of the adult members of the household.

Results User Study

Interviews were transcribed and transcripts analyzed. Themes were then identified describing behaviour and experience in relation to the EAC. This paper we focus on the following emergent themes: Patterns of use and behavioural change; Awareness of electricity consumption; High and low consumers; Interpretation of direct feedback; and individual differences. Below, we present excerpts from interview protocols to illustrate each theme.

Patterns of use and behavioural change

Interview data indicate that households’ use of the EAC travels through at least two phases. In the first phase the electricity consumption of electrical appliances in the home is explored. This phase is characterized by a playful curiosity and driven by a goal to map out the amount of electricity used by the appliances of the home. This exploration phase lasts for 3-4 weeks. The following quotations illustrate:

Anna (35): “…in the beginning we had fun looking at it and then you could run to switch something on and then go and look [again]. But once you’ve done this for a while…you’ve become aware of [how much electricity] everything uses…when you get up you don’t even notice how the clock plays the role of a tool for learning. It also seems to trigger a playful attitude in users motivating them to explore electricity in their household. The EAC apparently appeals to homo ludens – the playful creature (Huizinga 1958).

After a few weeks with EAC, usage enters into the second phase - the confirmation phase. In this phase EAC provides the user with information needed to check that the household’s electricity consumption is normal. This phase is characterized by a checking behaviour and by
EAC being domesticated into the household (Silverstone and Haddon 1996). The role of EAC during the phase of confirmation seems to be that of a traditional clock on the kitchen wall – an artefact you throw a glance at now and then to relate to the current situation. As these informants put it: Gisela (30): “…It’s become more of a habit. It’s like looking at an ordinary kitchen clock” Claes (30): “…You just check it. It’s like looking at the oil gauge in the car. You just take a quick glance… see that everything’s OK. That’s how you use it when you’ve got used to it…” Several households seem to have identified their “normal” consumption levels and connected this to the ongoing activities and the appliances running. The EAC also made some informants feel that they had more control over their electricity use: Claes (30): “Yes [the watt-number is on] because it gives a good picture of the present and then, in the evening, when everything is calm and only the TV is on, it can drop down to 500...Then you know, since it follows a pattern, then you have control that… everything is normal.”

Knowing what phase the power use is in, at the exploration phase is thus, used as a stepping-stone to understand the normal electricity consumption for the household at a given moment and to control that consumption is normal. In this second phase the clock was also used to modify one’s own behaviour to become more energy efficient: Berit (62): “…I say… ‘Wow, it’s on 2000 – what do I do now? Ahha, the washing machine…’ I think… did I fill it up or should I fill it even more… or I think that [the washing] could wait a while until it’s full…”

Awareness and insights of electricity consumption
According to informants in all households, the mere presence of EAC contributed to an increased awareness of electricity consumption. Consumption became visible in a more direct way than before. A recurring observation from interviews is that EAC through visible feedback is a reminder of electricity consumption. Consequently, it also serves as a reminder to households to switch off things that don’t need to be on. EAC seems to have increased the visibility of electricity use in households who say that they haven’t used the clock that much. Although one informant, Erik (30), replies “no” to a question on whether he believes EAC has changed anything in the family’s view on energy consumption, he later says: “But you’ve become more aware of… you see when you run the micro wave for example that [the effect you get up]…”

The role of EAC as a reminder is particularly interesting for electrical devices that are consuming electricity in a “hidden way” like floor heating for example.

According to Gisela (30), some guests automatically interpreted the visibility of electricity use as an urge to lower consumption. If you then think that you cannot lower it without “giving up life”, this visibility is interpreted as interfering and negative. She continues: “Then we say that ‘it doesn’t have to be a surveyor, you just see better what you use’.”

High and low consumers
EAC has also generated insights to households concerning the electricity consumption of specific appliances in their home. High consumption was discovered in tumble dryer, washing machine, spotlights, TV, floor heating and coffee percolator. Also, one household discovered that the digital TV box consumed electricity in its stand-by mode and thus, switched it off manually:

Anna (35): “We noticed that the TV, DFD and the box… if they were on they used pretty much...in when we switched them off. So we started to switch them off at night”.

In some households EAC was also instrumental in the discovery of low-consuming devices, such as the Christmas tree illumination:

Claes (30): “We could see that the Christmas tree illumination didn’t matter… there was no deflection against daily levels of electricity related activities. Figure 6 shows typical patterns of the clock during a day and the quote below is an example of its interpretation:

Gisela (30): “…After a while [of having EAC] we could see very clearly... when we go to work and when we get home... lights are switched on and the TV is on… everything is on maximum. And then, you notice how it drops... you see how everything is switched off…”

Claes (30) makes an illustrative comment: “Yes, now it goes from 500W to... over 1000, so it [the coffee maker] adds 500W. […] That is something you don’t think about otherwise. I had no idea that it used 500W, that is quite a lot. […] It is more than the television. Yes, the television we can see, it uses 200. So we have understood how much different things use…”

Individual differences
How the users interpreted and used the information from the clock varied from one household that understood and used all of the information provided by the circular graph to another household, which did not understand it at all. Berit (62) calls the clock a glowing painting: “But I would like to be able to make a diagram or something, and see like… yesterday… at what times are we using the most electricity? And kind of connect this with that I did the washing or the dishes or something”.

Interpretation of direct feedback
For interpretation of electricity consumption, the Watt number was the primary feedback used. Households used the Watt number in the exploration phase as well as in the confirmation phase. It is used in order to determine normal consumption of the household, and to check against daily levels of electricity related activities.

Figure 6 shows typical patterns of the clock during a day and the quote below is an example of its interpretation:

Gisela (30): “…After a while [of having EAC] we could see very clearly... when we go to work and when we get home... lights are switched on and the TV is on… everything is on maximum. And then, you notice how it drops... you see how everything is switched off…”

Claes (30) makes an illustrative comment: “Yes, like right now, this is fun. That pattern is the coffee maker, you recognize it immediately... before it could be switched on the whole Saturday before lunch, but now when you see this you are reminded of how darn much effect... [it uses]!”

For this couple, the graph was the most important source of information. For them, the numbers were secondary but used to create meaning in relation to the graph.

Despite the fact that the user group was very homogeneous, with similar ages and family constellations, the feelings towards and interpretations of the clock were surprisingly different. This is probably partly explained by previous knowledge and experience. Often, these different interpretations where polemic: Aesthetic ornament or tool? Pretty or ugly? Surveying or simply visualizing? Was it a clock or a meter? Erik (30) clearly categorized it as the latter: “I think that the number there… for my part it could have been just a small display with only the kilowatt number”.

Cecilia (30) and Claes (30) were much more positive to the design and used it for exploring their own electrical patterns. Cecilia (30): “Here we can see that we put on some coffee… or the washing machine. Yes, yes, the dishwasher was on when I got home, so it probably is that that caused this [pattern]!”

Significance of place
One household perceived the EAC negatively and was so stressed by its presence and appearance that they moved it to the laundry room quite early.

Isabella (35): “It was just too present, [...] and we felt that we can’t affect our energy use that much... I mean, to use the dishwasher and the washing machine as much as we need to. It has kind of a high priority now when we have children and limited time and so. So we felt that [the clock]
added unnecessary stress. Because we try to keep it [the electricity consumption] down as much as we can anyway. So, really, it was quite negative.

In one household with two younger children, Anna (34) appreciated the placement of the EAC in the kitchen:

"...because you are a lot in the kitchen, with the kids... Then you can... look at the clock quite... often."

She also said that when she happened to pass the energy clock and react on what it showed, she started to think and perhaps experiment – for her it was not something planned. But she also added:"It is nothing that bothers you that it hangs there... If you would have it permanently it would perhaps not be as prominent as in the kitchen, even if it looks good. Then you would perhaps have it in the... laundry room perhaps?"

Discussion

How did the implicit design intentions correspond with what happened when the clock was immersed in real domestic life? First, the EAC obviously made electricity use more visible for households. Results from the user study demonstrate that EAC played a significant role in drawing households’ attention to their electricity use. It became a natural part of the household and electricity became naturalized into the informants’ everyday language. During the three-month domestication period the deployment of “...influenced to alter their behaviour in a more engaging way."

The clock’s accessibility made both men and women aware of the household’s energy consumption. This should be contrasted with the field study which pointed to electricity being a matter for a single individual – typically a man. Merging the concept of a meter and a clock did not just transform connotations that were beneficial for understanding but also added confusion on how to read and understand the circular graph and the overlapping of different layers. Contradictory to our design intentions, few our design intentions and made use of the circular graph. This may have to do with previous experience and knowledge of the informants. Informants who understood how to read and interpret information provided by the clock also put more effort into the learning process. These informants were also more excited to use the clock. Appreciating the EAC as an individual object seemed to have motivated a higher engagement.

The clock metaphor and circular graph were not used to its fullest potential as envisioned in the design process because many informants found the graph hard to understand and preferred the numbers. One reason for this could be that the EAC was not drawn as clearly as intended in the original design due to various practical problems in the construction of the prototype. This addresses interesting issues regarding the significance of good craft, the importance of details and its relevance for the overall interpretation of a new design. Also, some informants didn’t understand the information as consumption over time since they were unfamiliar with the concept of a circular diagram. Some households did not like to have the energy clock so centrally located and were not charmed by its visual appearance. There were ambivalence and contradictory emotions. The intended neutral way of displaying information was sometimes perceived as surveying and giving the users bad conscience. In psychoanalytic terms, these users probably project the pressure they felt onto the EAC.

It is interesting to note some further observations from the user study reflecting social issues concerning a tension between quality of life and the need to conserve energy. For instance, one informant mentioned floor heating as an unnecessary luxury. In the early 20th century energy companies were looking for ways to increase consumption during daytime and a series of kitchen appliances were invented in rapid succession that helped achieve this goal. The dishwasher, electric stove, toaster, kettle, iron and many more enabled an easier, more efficient lifestyle that erased some of the more strenuous daily tasks that had been a part of the reality before. Building on this, it is clear that resurfacing our use of electricity is not without complications since it imposes different kinds of burdens that have to be motivated somehow: Compromising on quality of life is not a desired alternative as exemplified by one informant who talked about “giving up life”. Perceived added values such as usefulness, aesthetics and joyful types of interaction could act as motivators to change behaviour.

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Reference


Persuasive Engagement: Exploring lifestyle as a driving force to promote energy-aware use patterns and behaviours.

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Abstract
Electricity consumption has been rising significantly in the western world the last decades and this affect the environment negatively. Efficient use and more energy conservative usage patterns could be ways to approach this problem. However, electricity has for a long time actively been hidden away and it is rarely thought of unless it ceases to exist. From the perspective of critical design, we have been working to find methods to visualise electricity and electricity consumption in everyday life to promote environmentally positive behavioural change.

In this paper, we are looking at how aspects of lifestyles can be used in design as central driving forces that could lead to changed behaviour. Attempts to promote behavioural changes related to energy consumption might be performed when people are offered desirable environmentally friendly behavioural choices. We also believe that critical design can be taken as a tool – people are not always aware of that their actions can have environmental side effects. Moreover, in the midst of activities – when they use a tool – people are not always aware of that their actions can have environmental side effects. It seems that green alternatives and behaviours are pushed down the list of priorities and impose bad conscience and stress. It is therefore highly desirable to find new design approaches that promote positive behavioral changes and methods that change people’s views. For example, by moving environmental decisions away from mundane tasks into actions associated with positive values central to the consumer.

In this paper we focus on sustainable design that departs from the traditional lifecycle thinking. We explore alternative design strategies that combine persuasive design (Fogg 2003) with a lifestyle approach and user-centred design. This gives rise to a tension since persuasive design aims to motivate users to change behaviours and user centred design aims to follow existent behaviours and norms. The aim of the paper is to contribute to knowledge in methods for sustainable design in a critical design tradition. The idea behind critical design (Dunne & Raby, 2001) is to provoke discussion and reflection on a topic rather than to achieve utility and mass production. For example, a picture of a design object that is published in media can foster debate about an issue in the same way as an article in a newspaper.

Frayling describes three fields of design (or artistic) research; research about design studies design products and processes from an outside perspective; research for design develops methods and tools to improve design work and research through design is about exploring problems and developing solutions about how the future could be improved by means of creating artefacts. Our work should primarily be regarded as research through design to envisage attractive and innovative concepts that could change mental images, serve as living examples in debate, future research and education. This type of research is clearly needed to provide alternative designs that, due to lack of time and resources, might not be considered in commercial design work.

In our previous work we have developed a series of objects working with energy as a design material with the goal of making electricity more visible (Backlund, et al. 2006). Everyday behaviour is filled with habits, norms and unconscious choices and to raise awareness of these habitual behaviours we need to make them less familiar and automatic. One way of achieving this is to add something new, strange and odd to everyday objects. In this paper, our project was reinterpreted in order to communicate energy consumption through artefact-use and aesthetics. For example, the Power-Aware Cord is a re-designed electrical power strip in which the cord is designed to visualise the energy rather than hiding it (Fig 1). The use of electricity is represented through glowing pulses, flow, and intensity of light emitting from the cord. Expressing the presence of energy through light can inspire people to explore and reflect upon the energy consumption of electrical devices in their home. Another example is “The Element”, an electric radiator consisting of 35 light bulbs of 60 watt, each designed to deliver heat equivalent of 2100 watts (Fig 1). The fact that a bulb provides 95 percent heat and about five percent light is something most of us know on an abstract level but might not grasp fully. Thus, this radiator makes us realise these physical laws in a direct and practical way.

As we have said, redesigning objects into polemic prototypes can be an efficient tool for raising questions about everyday energy use. Hence, they can also be used to raise interesting questions that can propagate to the general public through media and exhibitions. The general awareness of energy consumption in relation to the environment is thus hopefully increased even though it is difficult to measure. On the other hand, several studies show that awareness and knowledge do not necessarily result in consistent behavioural changes (Abramse, et al. 2005). Therefore, it could be interesting to study aspects that motivate people to change their behaviours and habits and incorporate these into design of objects to foster positive change.

In this paper, we discuss how designers can move environmental decisions and actions partly away from the everyday mundane tasks of the users into actions motivated with more positive values. Our goal was to build, to raise awareness of energy consumption and to gently afford the user to change behaviour by adding on to already existing lifestyles and behaviour. We present two examples where we applied lifestyle thinking in the design phase. The Energy Plant is an example on how one can visualise the electricity use of a household in a way that is easy to understand and interact with. The AWARE Laundry Lamp and the Energy Plant, which are examples on how to increase people’s energy awareness and offer them means for reducing their energy consumption in the home. Both prototypes are inspired by current trends in lifestyle as well as actual observed user behaviour.

Introduction
It is widely acknowledged today that technical solutions alone will not solve environmental problems like energy provision and global warming. Behavioural and societal changes are also required to approach these pressing problems. For example, studies have shown that electricity consumption can be reduced about 20-30% by changing daily routines in the home (Carlsson-Kanyama and Lindén 2002). However, a problem still is that most people do not think about these issues; they do seldom switch of the light when leaving a room and do not choose the more environmentally friendly alternative when shopping. One possible reason why people are not particularly engaged in environmentally friendly behaviours could be that they perceive extra burdens and choices negatively. Moreover, in the midst of activities – when they use a tool – people are not always aware of that their actions can have environmental side effects. It seems that green alternatives and behaviours are pushed down the list of priorities and impose bad conscience and stress. It is therefore highly desirable to find new design approaches that promote positive behavioral changes and methods that change people’s views. For example, by moving environmental decisions away from mundane tasks into actions associated with positive values central to the consumer.

In this paper, our project was reinterpreted in order to communicate energy consumption through artefact-use and aesthetics. For example, the Power-Aware Cord is a re-designed electrical power strip in which the cord is designed to visualise the energy rather than hiding it (Fig 1). The use of electricity is represented through glowing pulses, flow, and intensity of light emitting from the cord. Expressing the presence of energy through light can inspire people to explore and reflect upon the energy consumption of electrical devices in their home. Another example is “The Element”, an electric radiator consisting of 35 light bulbs of 60 watt, each designed to deliver heat equivalent of 2100 watts (Fig 1). The fact that a bulb provides 95 percent heat and about five percent light is something most of us know on an abstract level but might not grasp fully. Thus, this radiator makes us realise these physical laws in a direct and practical way.
Lifestyle-inspired designs

The Energy Plant

The Energy Plant is an ambient transparent LCD-display that shows the electricity consumption of the household in the form of a growing plant (Fig. 2). The device is connected wirelessly to the domestic electricity meter. Each month, a new type of digital seed is “planted” and starts to grow on the screen. Modest electricity consumption results in a thriving fast growing plant and heavy consumption makes the plant wither and this is shown on the transparent screen. The idea is that the display can be placed in a window like an ordinary plant or elsewhere. The inspiration for the design was taken from two existing lifestyles: gardening - the fascination of making real plants grow, and the gaming lifestyle where one, for example, is trying to enhance online characters in a game. Taking care of the Energy Plant involves thinking about your electricity consumption while enjoying the reward to see the plant grow.

The transparent display of the energy plant serves several purposes. During sunny days it can cast a shadow of the plant that wanders through the room drawing attention back to the display and its message. It also serves the purpose of enhancing the information shown on the display instead of the display itself. The inverted shape of the pot together with the information shown on the display conveys the story of the growing plant.

Fig 2. The Energy Plant. Top left to right: The plant is growing as the month progress. Bottom left and middle: If electricity use causes the plant to wither. Bottom right: Browning through previous months’ plants.

The Energy Plant has only two buttons located on its front; an info button and a history button. The info button toggles environmental awareness and formed all together a pattern of metaphors and associative threads. This was the starting point for one of the concepts; The AWARE Laundry Lamp.

Lifestyle-inspired designs

The Energy Plant is an attempt to break away from the traditional screen-based type of interaction in the context of energy metering – it is an ambient display that provides information with little effort from the user. A quick glance at it should be enough to tell if the home-consumption is low or high and it should also give a hint on consumption figures previous days. Moreover, it can be said to be an attempt to move away from the general PC to small specific computational devices (Weiser 1991) in an effort to make it more understandable and usable for the consumer.

A lifestyle-inspired design might be a seed metaphor and planting it every month serves several ends. First is the aforementioned idea of starting with a seed and seeing it grow. The users’ electricity behaviours alter the way the plants grows much as a real plant is affected after it gets more. Moreover, starting with a new seed every month creates curiosity about what is about to come and a chance to start over in case last month’s plant didn’t turn out as desired. The user can thus be sure that another seed will come out of a certain seed. The seed could, for example, be distributed from the energy company and communicated through the invoice and also shared between the consumers.

AWARE Laundry Lamp

The AWARE Laundry Lamp is a combined drying rack and a lamp (Fig. 3). It affords people an easy and attractive way of hang drying clothes in the flat instead of using a tumble dryer. The laundry lamp is inspired from two existing lifestyles; the trend for individual decoration and design of everyday objects and hang drying of clothes in the homes and the positive values associated with that activity. Tumble dryers are one of the greatest consumers of electricity at home. Increasing standards in cleanliness of clothes has turned the washing machine and tumble dryer to constant...
partners in our daily lives. According to the Swedish Energy Agency a tumble dryer uses 1 kWh/kg laundry and an average household uses about 2 000 kWh on a year on laundry. To tumble dry the clothes consumes about three times as much energy as it takes to wash them. Tumble dryers are fast and comfortable to use, but sometimes we do not use them, e.g., when the clothes are sensitive and shrink in the dryer, or the laundry room is too far away or is booked by other tenants.

In our field study we saw several examples of exactly this; for example, on individual had a laundry hanger full of white clothes in his living room and others had hangers full of baby clothes. Hence, hang-drying clothes in the apartment are an everyday behaviour, not always caused by energy saving intentions. But laundry hangers are considered awkward and bulky and fit better in a laundry room than in the living room. Many people choose therefore to hang clothes to dry on things that are at hand like chairs and doors etc. Aware laundry lamp is designed to inspire and facilitate for people to hang-dry laundry in their home. Laundry is part of our domestic routine and there is no reason why it should not be better integrated in interior design of the home. The aesthetics qualities of the laundry itself could be used and hang drying become a creative activity.

We were also inspired by the recent trend of decorating our homes and the abundance of do-it-yourself programs on TV. The user can take an active and creative role in changing the appearance of the object by decorating and displaying different kind of laundry. The action of hang drying your clothes, continuously changing the style and mood of the Laundry Lamp, helps differentiate and modify the overall expression. The Laundry Lamp is engaging the user in an ever-continuing design process that set out a path towards a sustainable way of living is one way to do this. In this paper, we have argued that designers can employ lifestyle analysis and make use of already established behavioural patterns in a lifestyle to gently persuade people to change behaviours. The idea was to offer desirable and usable objects within a lifestyle and also encourage efficient behaviours through their form. We exemplified our approach in two designs; the Energy Plant and AWARE Laundry Lamp. These designs are still on an early stage and we need to evaluate and test them further to see if they have the intended impact.

The AWARE laundry lamp was launched in 2007 and has figured extensively in media and at exhibitions worldwide. Thus, it has fulfilled one of our aims; to act as a materialized discussion and placeholder. Nevertheless, a sustainable future needs to be seen as an attractive and desirable path and not another burden on everyday life. Designers have here an important role to play and design research would benefit to investigate these issues in greater detail.

Fig 3. AWARE Laundry Lamp

AWARE Laundry Lamp is also an interesting design example from a technological standpoint despite the fact that the presence of modern technology is completely non-existent in this object. Modeled out of metal tubes, cable, an electric cord, a lamp socket and a lamp, it is a physical manifestation that modern energy conservation does not necessarily have to involve new technology. The focus is on offering new use patterns through design instead of reinforcing the same patterns with more efficient technology. Energy efficient appliances do not necessarily result in lower energy use on a larger scale (society). People instead tend to use them more often resulting in a rebound effect with higher electricity use as a result (Abrahmsen, et al. 2005).

Conclusion

Our work is devoted to make energy consumption more apparent in everyday life with the goal of promoting behaviour change towards more efficient consumption patterns. This paper suggested an approach to include lifestyle thinking into design practice. Positive behaviour change is difficult to achieve and even motivated people that have knowledge about these issues do seldom change their energy usage patterns. Providing attractive alternatives and designs

that set out a path towards a sustainable way of living is one way to do this. In this paper, we have argued that designers can employ lifestyle analysis and make use of already established behavioural patterns in a lifestyle to gently persuade people to change behaviours. The idea was to offer desirable and usable objects within a lifestyle and also encourage efficient behaviours through their form. We exemplified our approach in two designs; the Energy Plant and AWARE Laundry Lamp. These designs are still on an early stage and we need to evaluate and test them further to see if they have the intended impact.

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References


