DESIGNING FOR ENERGY AWARENESS
- THE POWER-AWARE CORD

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Abstract

Design shapes our everyday material world, thereby inihibing some actions and affording others. During the 20th century, design has been used successfully to increase our energy consumption through the creation of electrical appliances. The paper argues that designers should now use their powerful ability to transform everyday life and behaviour in order to better support awareness of energy use and efficiency. As an example, we present the 'Power-aware cord' a re-designed power strip that visualises the amount of electricity that flows through to the appliances that are connected at any given time.

Keywords

Product design, energy, interaction design, eco-design.

INTRODUCTION

Use of energy is increasing all over the world and particularly in Western countries. In Sweden, households have doubled their energy consumption in the last 30 years. While industry, to some extent, has been successful at efforts to optimize their usage, no such advances have taken place within the domestic sphere. We are instead, at a rapidly growing pace, buying more products for our homes, items such as entertainment and household appliances, personal information and communication products, computers and accessories. Product design has had a crucial role to play in this trend ever since the days when the German electrical firm AEG began designing household appliances to increase their customers' use of electricity.The design of home appliances not only encourages us to buy items, it also tends to keep the energy use in products explicitly hidden. There is little to reveal if a stereo or freezer is active or not, nor how much energy it consumes. Not everyone realises that the mobile phone charger uses electricity even if the phone is disconnected. In itself, electricity is both invisible and intangible. We can see, feel, hear and even smell its effects, but we can not really grasp it. As the effects of electricity in our everyday life (light, heat and so on) are taken for granted, electricity becomes even more invisible.

This paper argues that design should be used as an integrated tool to raise awareness of energy consumption in everyday products. We propose a design agenda that investigates interaction and product design as a way of visualising energy consumption and to stimulate changes in behaviour. Critical design prototypes may be used as a basis for discussions, as well as to support awareness of design issues related to energy use. As an example of how to design for energy awareness, we will present the 'Power-Aware Cord', an augmented[1], electrical power strip, in which the electricity running through the cord is made visible.

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[1] Mackay, W., *Augmenting Reality: Linking real and virtual worlds. A new paradigm for interacting with computers,* In: Proceedings of AVI'98, ACM Conference on Advanced Visual Interfaces, New York: ACM Press (*1998*).

Figure 1. The modern home; littered with electrical appliances while electric meters and fuses, from a design viewpoint, still are at a very immature stage of representation. Images from the interviews.

DESIGN AND ENERGY – A BACKGROUND

The success story of the 20th century is intimately connected to technological development and artefacts associated with this 'progress'. In the beginning of the century, the archetypical designer Peter Behrens started working for AEG, or Allgemeine Elektrische Gesellschaft. AEG was a company that primarily produced electricity and had just begun to enter the consumer market. The problem for many electricity companies at that time was that amounts of usage were spread unevenly during the course of the day. There were peaks during the morning and evening hours, but during the day consumption fell to almost zero. In order to meet demand, the companies had to sustain the same high capacity at all hours. This was obviously not profitable, and many shrewd men were wondering how to increase the demand for electricity during the daytime. One of the most successful ventures turned out to be kitchen appliances. Just to name a few, the electric stove, mixer, toaster, washing machine, kettle, heater, and iron were all developed in quick succession. A hundred years later we can see that AEG and Peter Behrens were highly successful. Electrical artefacts seem to have marched into homes in ever increasing numbers. During the last 30 years, Swedish households have doubled their energy usage and there is no sign of the trend slowing down. One important factor in this development is industrial design. Design is what forms these products to new, attractive and desirable objects that we fill our homes with. Besides being a useful tool in product development and marketing, design is literally what shapes the material environment of our everyday life thus enabling or disabling human activity and behaviour[3].

What people think about energy

We conducted a series of semi-structured interviews with 10 people of various ages, background and housing to gain rich materials and insights concerning people's understanding and use of energy and as inspiration for future work. As expected, electricity in many cases seemed to be taken for granted, for example most people had no clue as to how much electricity they use, on the other hand they usually had a quite good idea of how much they paid. Questioned on how much electricity they consumed, some answered:

> "I have no idea, but the bill from Fortum (The local energy provider) is usually 200 kronas each month".

[3] Sara Ilstedt Hjelm, *Making Sense – design for wellbeing*, Doctoral dissertation KTH, Stockholm 2004

> "Not a clue, I have higher bill now than before…I payed about 1,200 a year before, but now they raised it so last bill was 700 but that was one of those….you pay more the last time, so it might be about 2,000 kronas per year…well maybe not quite…."

In addition, none of the people living in flats knew where the electric meters were situated nor how to access information on their energy consumption. The only way to get feedback on their use was via the electricity bill, which many felt was very difficult to interpret. The 'watts and volts' on bills or labels seemed hard to relate to the actual use of a lamp or a washing machine. Electricity was described mainly through its various effects. Informants answered that they knew that the power was there because there was "sound and light", or "you could see it on the bill". One woman said.

> "You see if the house is electrified…well if there are electric lights in a cottage in the countryside you see the telephone cables so to say…"

Modern life is highly dependent on electricity and we were constantly reminded about this from the respondents. A middle-aged woman reported on the cause of a power failure:

> "Well, it's catastrophe. The radio is quiet, you can't cook, the radio clock needs to be reset…one gets totally…you can't do anything…"

To summarize, the interviews showed us how abstract the phenomena of electricity is to people and the difficulty they have to understand and relate to it. It is hard to describe what energy is, merely how it is displayed and were it is situated. Understanding is further obscured by incomprehensible bills and hidden electricity meters.

Energy as design material

Making or not making technology visible is a long debated issue in industrial design and architecture. One of the main criticisms by the modernists in the beginning of the 20th century was the inconsistent use of material, styles and ornaments during the preceding century. Honesty in form, function and material became one of the new mottos. Redström argues[4] that in order to create a meaningful presence for technologies in domestic environments, we need to consider them as design materials. What then are the design properties of electricity? How could design methods be used to explore the aesthetic values of energy?

Product design and aesthetics is what literally *expresses* the product. A product may be read as a text that conveys a number of semantic messages. In his book Mythologies[5], Roland Barthes explains the way myths work and the power they have on the way we think. Taking a lot of examples, Barthes shows how seemingly familiar things signify all kinds of ideas about the world. As Forty remarks: "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." [7] One such myth is that the power fuelling these household appliances seems to appear out of nowhere. All we have to do is to pay the bill the energy company sends us. Electricity is invisible, abstract and the amount that flows through our cables is not for us ordinary users to see or control. And yet – we can not manage our modern lives without it.

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[4] Johan Redström, *Designing everyday computational things*, doctoral dissertation, Göteborg University 2001
[5] Roland Barthes, *Mythologies,* Hill and Wang, New York 1967.
[7] Adrian Forty, *Objects of Desire*, Thames and Hudson, London 1986
[9] Anthony Dunne, *Herzian Tales*, RCA, London 1999.

Product designer and researcher Anthony Dunne[9] argues that mainstream industrial design uses its powerful visualisation capabilities to propagandise desires and needs designed by others, thereby maintaining a culture of passive consumers. He suggests that design research in the aesthetic and cultural realm should draw attention to the ways products limit our experiences and expose to criticism their hidden social and technical mechanisms. Central to the work of Dunnes and his partner Fiona Raby is a consideration of the imperceptible electromagnetism that surrounds us and attempts to visualise this invisible radiation.

THE POWER-AWARE CORD

If product design is one reason for our high consumption of electric appliances and thus of power usage, could design also take part in helping to break this trend? Could design be used consciously to make people aware of energy use and offer alternatives? Redström offers one approach when he suggests that technologies such as computation and electricity should be explored as design materials, thus raising our awareness of its presence. To inform users of power, how much and when it is used, is certainly one of the first steps in such a quest.

The 'Power-Aware Cord' is a working electronic prototype and an example of how to design for energy awareness. It is basically a re-designed electrical power strip, developed as a working electronic prototype, in which the cord is designed to visualize the amount of electricity used. Thus, the user interface of the Power-Aware Cord is the same as for any ordinary electrical power strip, with the addition of a dynamic visualization along the cord where the current use of electricity is represented through glowing pulses, flow, and intensity of light. The entire cord acts as an ambient display to inform users of electrical current passing through en route to electrical appliances plugged into the extension sockets. The interface of the Power-Aware Cord invites users to plug in different appliances and experiment with how these relate to each other in terms of energy. With the Power-Aware Cord, users' actions, such as plugging or unplugging electrical devices into sockets, immediately result in a response from the cord, giving the user direct feedback and the feeling of both seeing and interacting with electricity. This approach might inspire users of the Power-Aware Cord to explore and reflect upon the energy consumption of other electrical devices in their home. Since this design has no added interaction or functionality, it does not become 'yet another gadget for the home' but a product people already buy.

Representing the amount of electricity with light, rather than a numerical display, creates a display where information can be accessed at a glance. This enables the interface to be accessed from anywhere in the room in which it is situated, and thus provides constantly available, subtle information on energy usage, something often referred to as ambient displays[10] in human-computer interaction. This could be useful in order to change awareness and thus usage behaviours over time, or to detect unnecessary stand-by consumption.

The prototype

The lighting effects in the Power-Aware Cord are achieved through the use of electroluminescent wire. This wire contains a phosphor layer that glows with an intense blue-green light when an alternating current is introduced. Due to the color of the phosphor, the wire appears to be white when unpowered and adds to the surprise when the device is powered and starts to glow. Since the cable will shift in colour when going from unlit to lit mode it will also make it easier to detect low intensity levels. Three electroluminescent wires are bound together with ordinary copper wires for electric conduction. The wires are twisted

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[10] Ishii, H., Wisneski, C., Brave, S., Dahley, A., Gorbet, M., Ullmer, B. and Yarin P., *ambientROOM: Integrating Ambient Media with Architectural Space*, Conference Summary CHI 1998, ACM Press

together to improve the flexibility of the resulting cable. Twisting the wires also gives the possibility to create an effect of motion through the cable by powering each of the three luminescent wires in turn. The whole structure is coated with a layer of transparent silicone.

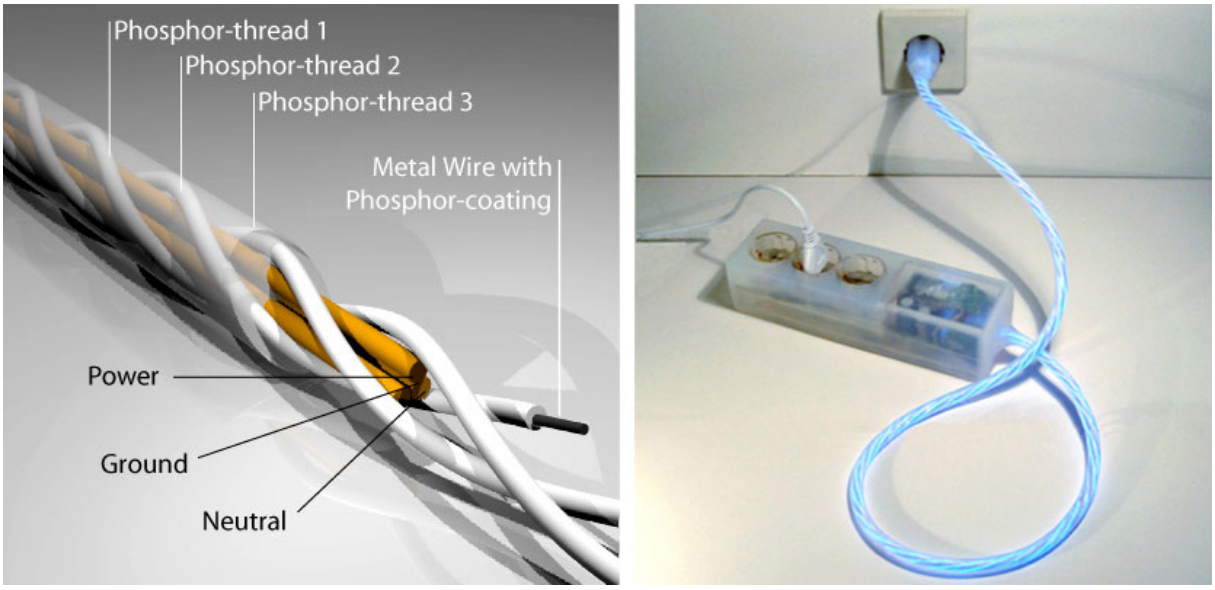

Figure 2. To make the light inside the cord simulate a flowing motion, the three threads are lit one at a time. Silicone protects all the wires .To the left is the working prototype.e

In the Power-Aware Cord, we wanted to display a wide range of information values, from (0 – 2000 Watts). Ideally a user should be able to recognize small differences like that between a 40W and a 60W light bulb (20W) and also be able to distinguish among effects observed on one day compared to those observed another day.

User feedback

Fifteen people (4 women, 11 men) between the ages of 15 to 55 took part in an initial user test of the implemented prototype. Three different forms of light feedback (static intensity, pulsating intensity and moving intensity) were each tested on groups of 5 people. The following results were obtained. All 15 people reported seeing the blue light in the cord. 13 of these perceived the blue light as a representation of the electrical current.

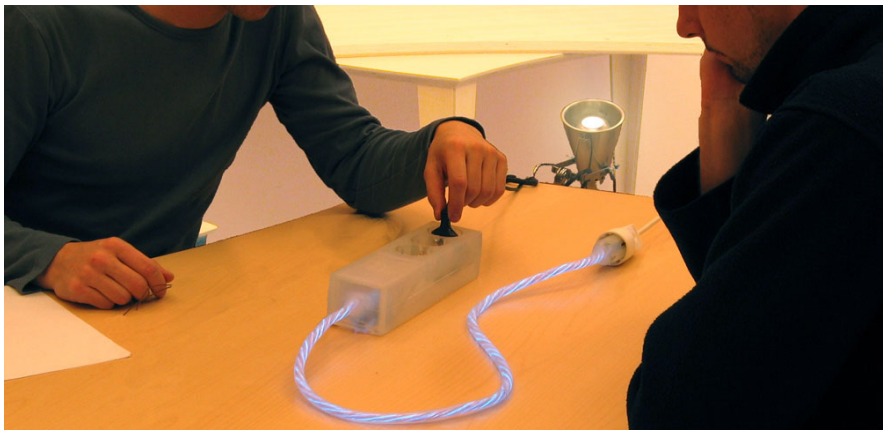

Figure 3. Different appliances, such as lamps, were plugged in during a user test scenario. The test persons were then asked to explain what they experienced.

The two people that did not connect the light to the electrical current were both shown the static intensity program. The flow or moving intensity was, as expected, easier to interpret than the static intensity. Something that was not predicted, however, was that pulsing intensity was also easier to interpret than the static intensity. One person remarked he felt something being transported when the cord was pulsating compared to when it was shining in a constant level of intensity. The overall response to the Power-Aware Cord was very positive. Most test participants seemed to easily grasp its functionality and immediately came up with examples of how they would use it. One woman explained how she would use it to teach her children about electricity. Others reflected on how it could be used to test stand-by products. Our test participants clearly saw the need for a device like the Power-Aware Cord. They also seemed to appreciate its pedagogical properties.

Whether the users could perceive the light as actual electricity is more difficult to tell. One woman clearly did, as she explained: "I think this is what power cords look like on the inside. You have just made it transparent!" Most people, however, thought there was something more to it. This notion often seemed to derive from the fact of the socket box being bigger than usual. One person thought the light looked too harmless in order to be electricity. Another person compared the Power-Aware Cord to a bicycle dynamo – "the faster it goes, the more it glows" – while someone else compared it to a heart – "it pumps the electricity at different speeds". All except one of the participants were positive about having a Power-Aware Cord at home. Some saw themselves having several Power-Aware Cords in their homes, while others expressed that they might not use it as an everyday product but rather as a reference from time to time.

DISCUSSION

During the last century, design has been a used as an innovative tool to create household appliances and thereby raise consumption of electricity in the home. But the actual use of energy has been hidden both in products and in the domestic surroundings. With increasing use of energy in Western countries, it is important that we create awareness of how much electricity we use and how this could be reduced. We propose design to be both a useful tool and an approach to this issue.

The Power-Aware Cord is an experimental prototype and a tool for learning about people's perceptions about electricity. Initial user testing has proven the Power-Aware Cord to be a intuitive and intriguing objects with an overall positive response from the test subjects. The actual usage of the cord remains to be seen. Which devices will people choose to power with the cord and when? In depth user studies in domestic environments would therefore be the next step to take. At a more developed stage, our hope is that the Power-Aware Cord can be introduced as a home application to visualise electricity use. A critique of the Power-Aware Cord might be that the prototype in itself consumes electricity. We argue that if a user increases his or her awareness of energy consumption and understanding of relations between electrical devices, it is worth the small amounts of extra electricity used by the cord. In the long run, our hope is that the information given by the cord and the increased awareness will result in a more optimized consumption of domestic energy[11]. If so, the cord's own consumption can be justified.

Design is a powerful tool that allows values and cultural codes to be materialised into actual objects, thereby making them a 'natural' part of the world. Design can also be used to criticise and deconstruct such values, but because design finds itself operating within a commercial

[11] Matsukawa, I., *The effects of Information on Residential Demand for Electricity,* The Energy Journal, Vol. 25, No 1. (2004)

framework this rarely occurs. In the design of household appliances, there is usually very little time for explorative design research and critical aesthetics.
In the light of the discussion in this text, it seems a dubious approach to continue to make electrical usage invisible. Our increasing energy consumption is too problematic to be hidden objects and buildings. Something hidden or invisible will not only exercise power, it will also be impossible to understand and interact with. Instead of hiding technology, we should use the power of design to visualise and express these issues.

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