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**VISUALIZING ENERGY IN HOUSEHOLDS:
THE POWER AWARE CORD AS A MEANS
TO CREATE ENERGY AWARENESS**

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Visualizing Energy in Households: The Power Aware Cord as a Means to Create Energy Awareness

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ABSTRACT

In this user study, a fully functional prototype of an energy visualizing product - the Power Aware Cord - has been tested. A modified version of 'The moral economy of the household' by Silverstone et. al., is used as an analytical tool in order to understand the domestication of technology, i.e., the Power Aware Cord, as a way of structuring the empirical material.

The study shows that the Power-Aware Cord is an accessible and intuitive mean for better understanding energy consumption. However, its effects are not consistent if the method is not combined with other energy-visualizing methods. The potential for combining the method with for example energy guidance, information campaigns and other Ambient Information Displays of electrical equipment, the effects of human behaviour in connection to it, as well as visualizing the heating and/of electrical system itself is encouraging. The combination of these methods need to be investigated further. The learning potential of the Power Aware Cord has been shown to be good and its possibilities of becoming a successful product on the household market is high. This is, however, mainly due to its *design* and that it is perceived as being

something more than a common electrical power strip. Future studies should include further development of the mapping between load and visual pattern. Its potential in teaching situations at schools and day care centers should also be investigated.

Introduction

In order to support increased consumer awareness regarding energy consumption, new ways of representing and interacting with energy in electric products intended for domestic environments are being developed. In this user study, a fully functional prototype of one such product, i.e. the Power Aware Cord, has been tested in five households. the study has been performed during a period of three months, and two in-three studies in combination with the writing of time-diaries have been performed. The households chosen for this study are also part of another study concerning the implementation of an alternative heating system in the households' everyday life. The households are therefore *not* biased in the sense that they have shown interest in the product *per se*. The intention of this paper is to answer the twofold question of *if* and *how* the Power Aware Cord can be used to increase energy awareness in households. Which are its pros and cons?

“The ‘Power-Aware Cord’ is a re-design of a common electrical power strip that displays the amount of energy passing through it at any given moment. This is done by dynamic glowing patterns produced by electroluminescent wires molded into the transparent electrical cord.”
(Gyllenswård and Gustafsson, www.tii.se/static)

Purpose and Methodology

This paper presents a view on how the inhabitants of the residential area, where the study has been carried out, are experiencing the Power Aware Cord, how the new technology is being received, and how the interaction between the technology and the residents functions. The purpose is to investigate how this type of Ambient Information Displays of electrical equipment is implemented, or domesticated, in people's everyday life. Domestication is used as an analytical tool for describing how technology is gradually becoming a natural part of the everyday life of the domestic sphere; a process that takes place whenever a technical commodity is bought and owned by a person or persons (Silverstone et. al. 1992a). The main point of this theory is that a technology is not a ready-made product when it enters the domestic sphere, its meaning is not stated, but rather that it is—through four different phases which are described later in this paper—continually being redefined and renegotiated within the household. *In other words, phases of domestication must take place before a new technology is properly domesticated.*

The interviewees, consisting of the members in six households, were given assumed names in the text beginning with the same letter as the households' alias letter. The interviews were recorded using an MP3 player and were transcribed in their entirety; hence, the quotations do not only show *what* the informants said, but *how* they said it.

The Domestication of Technology – Results from the User Study

The “domestication of technology” has been successfully used as a theoretical framework where studying the process of a new technology entering and gradually becoming a natural part of the private sphere (see, for instance, Aune 1997, Silverstone et.

al., 1992a and Silverstone et. al. 1992b). This theory offers a concrete and accessible tool when handling large amounts of (interview) data. In this study, “the moral economy of the household” has been used as an analytical tool when analysing the interviews. Silverstone et. al. (1992) primarily use “the moral economy of the household” to analyse the domestication of *information* technology, but they have also expanded this framework to analyse different kind adjustment has been made in order for it being possible to analyze a technical prototype that is lent to the households using the domestication theory.

Silverstone et. al. describe the domestication of technology as a process consisting of four phases. Four nondiscrete elements or phases are identified—*appropriation, objectification, incorporation* and *conversion*—in the dynamics of the households' moral economy and that constitute an analytical model (Silverstone et. al. 1992, p 20 f). I will first describe the four phases of domestication *as used in this study.*

Appropriation is the process through which the commodity is made physically and mentally accessible for the household. This phase takes place when the object is bought and owned; hence, it is given meaning by the buyer. According to Silverstone et al you never buy an entirely complete product, but rather something that becomes a part of the identity of the buyer. Hence, an 'object of distinct meaning' is created. In the case of 'the Power Aware Cord' the appropriation phase is different due to the fact that the prototype is not a commodity for sale on the market, it creates a meaning of the household becoming an object of study. In the appropriation phase the households' first impression of the prototype is in focus as well as the way it is being received. What kind of object is the prototype initially

perceived as? It is important to be aware of that the prototype was handed over by a researcher that the households have already, in previous interviews, established a mutual understanding and trust in. A contract concerning the treatment and security of the prototype was also signed when handing over the prototype.

This phase is followed by *Objectification*, which concerns how the appropriated coodity is displayed, where, geographically, it is placed in the household. In the case of the *Power-Aware Cord* the concept of objectification is applicable without major adjustments. However, the prototype is *easy to move* and, hence, it doesn't demand a permanent placement in the household. It can also be used in combination with a variety of different technical equipment. In the objectification phase the experimental use of the prototype is in focus. How do the different households talk about the more initial, experimental use of the prototype?

Third comes *Incorporation*, which is the process through which the object is incorporated into the routines of daily life, i.e., how it is being used in the household. In the case of the Power Aware Cord the everyday use of the prototype taking place after the experimental phase is in focus.

Finally, the last phase of domestication, *Conversion*, takes place in the boundary between the public and the private within the household. In this study, the in-depth interview between me, the researcher, and the household members constitutes a dominating part of the conversion phase. Part of this phase is also the contact between the household and others, for example visitors, co-workers etc. Naturallt, my part of the conversion phase, makes me part of the analysis and I hence become a considerable factor in the analysis.

Below I have structured my analysis after the four phases of conception. I also explain further the meaning of the four phases and discuss them in relation to the results of my interviews.

The Appropriation Phase

In the Appropriation phase it can be stated that all the households in the study understand the prototype as being some kind of electrical cord with I approprieringsfesen kan konstateras att samtliga hushåll uppfattar sladden som ett slags elsladd med a different of fun extra function. This is probably due to its, for them, familiar design. When not connected to an electric socket, hence not glowing, the prototype looks like an ordinary electrical cord with four outlets. It has a familiar form and this probably, together with the fact that it is being introduced to the households by a, for them, familiar person, contributed to the willingness to sign the contract that was handed out together with the prototype. The contract had to be signed for the households to be able to test it in their homes.

Since I have described the function of the prototype with a minimum of information and encouraged them to test it on different home equipments it is hardly unexpected that the cord gives rise to a certain amount of curiosity when handed over to the households. Even though one person, Hans, is pending and sceptical towards a cord with a "new" function this is not an obstacle for it to be introduced in the domestic sphere. It is, overall, obvious that the households are more than willing to test the prototype together with its function.

For the households who immediately when the cord was handed over to them, start to test it, it gives rise to an Aha!-experience.

The cords' visualization of electricity has shown to challenge the very concept of electrical cords in the home, where many households strive to hide the cords. It is obvious that the prototype challenges the concept with electrical cords by deliberately visualizing – hence, striving to be seen – differentiating itself from ordinary electrical cords. Even though not all households actively strive to hide their electrical cords, it is probably few who intentionally strive to make them more visible.

"... you knew that you could not hide it." (Disa)

"All other cords are hidden, so it would look funny if something was glowing behind a cabinet or something." (David).

In this aspect, the Power Aware Cord is a challenging product, and one that actively strives to visualize something that is usually invisible, namely electricity passing through an electrical cord. This contributes to make the cord even more visualizing than it would have been if it had been a product that usually is visible, as for example lamps, that are often designed to be seen and where the electricity is visible in the form of light.

The Objectification Phase

Apart from one of the households, household F - which two household members are both civil engineers - none of the households in the study discuss the cords' technical function *per se*. Hence, it is clear that the households seem to accept the prototypes' function without questioning or speculating about the reasons for it to function in the way it does. The 'Power Aware Cord' is self-evident in the way it functions. This is possibly due to its resemblance with an ordinary electrical cord, which is a product that is already out on the market. Maybe it would have been more questioned if it had been designed to

have another form, for example a round box attached to a cord that glows? Instead, the prototype design has been created to resemble an ordinary household product in combination with a new technology. This has shown to facilitate the acceptance for the cord, inviting the households to experiment with it. Its familiar form facilitates the households experimenting with its function.

The experimentation phase, i.e. the Objectification phase, has contributed to a better understanding of what electricity is and how different household equipment uses energy. The households have also shown an increase in awareness of the connection between their own everyday behaviour, namely their use of household equipment, and electricity used in the household. Only in one case where the household in question from start holds a very high knowledge about electricity and electrical constructions the household has instead experimented to see how the cord is *programmed to react* on different amounts of effect passing through it. This household, household F, is also the one showing least confidence in the prototype as such. This household are of the opinion that "to measure is to know" and therefore reject the very basic idea of the 'Power Aware Cord' as a product designed for their particular needs. The lack of figures is their main objection to the prototype. Apart from this household, only one other person in the study, Hans, mentions the cords' absence of figures and asks for such a function. The remaining households are clearly accepting the cords' function. Even though it does not show the energy used using figures, the households have confidence in it correctly measuring and visualizing electricity use. Interesting is also that the cord seems to result in a "guilty conscience" even amongst persons who claim to not be interested in saving energy. Göran, in household G, talks about the cord

as being something that creates a guilty conscience. He also describes it as a snake, hence, something living, reminding him of his use of electricity.

It creates a guilty conscience (...) it lies there glowing all the time like a snake, saying, "now I am working and using electricity, eating your money" " (Göran)

Possibly the connection between living objects and energy holds an inherent potential that could be used in future projects in the strive to visualize energy?

All households except two, namely households B and D, discuss the economical cost for electricity in the Objectification phase. This indicates that the prototype, even though not showing figures, strengthens the connection between electricity and economical cost. Possibly this connection is weaker than it would have been if it had also visualized energy use in figures. If so, it could be that figures would weaken the connection to other aspects of energy use then the economical, i.e. environmental aspects.

The Incorporation Phase

It is clear that the prototype becomes different products with different placements in different households while two of the households, D and G, have given the cord a constant placement in their households - a placement it was in fact already given in the Appropriation phase - it has in the remaining households, except for household F which has rejected the prototype altogether, become an experimental equipment which is used when household members wish to see how much energy the use of certain equipment results in. It is interesting to note that the prototype that resembled a regular electrical cord in the Appropriation phase, has been given a

whole new meaning in the households. As one of the informants, Disa, puts it in the Appropriation phase:

"You do not move around an electrical cord once it has been placed somewhere" (Disa)

this quote illustrates how the almost regular electrical cord becomes a measuring device. It has continued to be mobile in the households where it has been used for experimenting on different locations in the household.

In all cases the prototype has caused reflections concerning energy use amongst the households. Furthermore, this seems to be something the households would appreciate to be made aware of also in the future. They would like to keep the prototype as an energy visualizing product. Even in household F, who rejected the prototype, it has given rise to the appropriation of another product that already is on the market, one showing energy use in figures, which has been incorporated into their everyday life:

Fabian: This one has figures.

Interviewer: So you trust that one?

Fredrika: The one with the figures, yes.

The Power Aware Cord has definitely awakened a need to measure and see user- and artefact bound energy use.

The Conversion Phase

Generally, it can be stated that none of the households - except for the technically interested household F - reflect about how the prototype technically is constructed. However, they have expressed opinions on its aesthetical characteristics. Its function is accepted as a natural visualization of electricity as such and in one case, it is being

compared to how you see water running through a hose.

"It is more like a water hose, if you use coloured water, so that you see the flow" (Bertil).

Hence, we can conclude that the Power Aware Cord constitutes a successful visualization of electricity, that is considered as having high credibility as well as being 'self-evident'. The households have opinions and ideas concerning how the prototype could be improved to better fill their own needs. Many have opinions about its colour and the Power Aware Cord could possibly benefit from being made available in different colours. Some are also concerned with its calibration – it could very well be made more sensitive to different effects. It has also been noted that the prototype does not seem to glow at all in daylight, which could be a problem worth attending to.

All households except one associate the Power Aware Cord to christmas- or decorative lights, which additionally indicates that the prototype is dominated by its aesthetical characteristics. This supports the prototype in its intention to constitute a visible as well as visualizing product.

Conclusion

The fact that the Power Aware Cord, when not connected, thus not glowing, more or less looks like an ordinary electrical cord probably facilitates its introduction in the household. The cord has shown to immediately, when tested, visualize electricity. Its visualization of electricity challenges the very concept of electrical cords in the household, since it is common that many people strive to hide their cords. In this aspect the Power Aware Cord is, already in the Appropriation phase, a

challenging product, actively striving to visualize the otherwise invisible electricity. This means that in this phase it is even more visualizing than it would be if it had been a product that normally is "visible", as for example lamps which are designed to be seen. The Power Aware Cord is visualizing partly due to it deviating from the function that its design usually is associated with in the households in the study generally accept its technical function and its construction is seen as self-evident. This is interesting since it deviates from the expected function associated with its design. The prototype has also shown to invite the users to experiment with it, which at least partly could be due to it having a familiar and 'safe' design. The households are familiar with its basic function but at the same time curious about its unfamiliar functions, i.e. its visualizing characteristics. The experimenting with the cord is an important part of the prototypes' visualizing effect, the households see the relation between their own everyday activities and the use of electrically driven equipment as well as the use of electricity itself. The households are given a better understanding about what electricity is and how electrical equipment and their energy use works. Even though some ask for it to show figures it is obvious that in most cases it is seen as a reliable means to measure the use of electricity. It is also interesting that the prototype has caused a 'guilty conscience' even amongst persons who claim not to be interested in saving electricity. The cord possibly, due to it not showing figures, accentuates energy as something 'living', something natural, and thereby stresses the fact that electricity is a natural resource; this could explain the 'guilty conscience'. It simply emphasizes the use of natural resources, which is otherwise hidden in the everyday use of electrically driven artefacts. This could probably be used in future projects for

visualizing energy. Even though the cord does not use figures it still manages to strengthen the connection between electricity and money. Question is if this connection would override the connection between electricity use and for example the use of natural resources if it was to be equipped also with figures showing the cost in money of simply the amount of energy used. Visualizing electricity and its economical cost is, of course, also both necessary and interesting, but what makes the Power Aware Cord unique is its ability to, in an intuitive way, show stress the connection between the use of home equipment and peoples' everyday behaviour. Therefore, it might be a mistake to include figures in the Power Aware Cord. The prototype has shown to be a successful visualizing product which is understood as having high credibility and is even seen as self-evident. The fact that most households associate it to christmas- or decorative lights indicates that its aesthetical characteristics dominate the impression. This supports the Power Aware Cord as a product that is visible as well as visualizing.

References

Official website of Interactive Institute, www.tii.se/static

Aune, M. 1997, Nøktern eller nytende. Energiforbruk og hverdagsliv i norske husholdninger kr. Report 34/97, Trondheim: Senter for teknologi og samfunn, Norges teknisk- og naturvitenskapelige universitet.

Gyllensward, M., Gustafsson, A. (2005) The Power-Aware Cord: Energy Awareness through Ambient Information Display. In: Proceedings of CHI, Portland USA.

Silverstone, R., Hirsch, E. and Morley, D. (1992a) 'Information and Communication

Technologies and the Moral Economy of the Household', in Silverstone, R. and Hirsch, E.(eds.) *Consuming Technologies*, Routledge, London.

Silverstone, R and Hirsch, E [eds.] (1992b) *Consuming Technologies: Media and Information in Domestic Spaces*, London: Routledge

Three in-depth interviews with six households: Interview 1: 2005-12—2996-01, Interview 2: 2006-03, Interview 3: 2006-05.