

Watt-Lite; Energy Statistics Made Tangible

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ABSTRACT

Increasing our knowledge of how design affects behaviour in the workplace has a large potential for reducing electricity consumption. This would be beneficial for the environment as well as for industry and society at large. In Western society energy use is hidden and for the great mass of consumers its consequences are poorly understood. In order to better understand how we can use design to increase awareness of electricity consumption in everyday life, we will discuss the design of Watt-Lite, a set of three oversized torches projecting real time energy statistics of a factory in the physical environments of its employees. The design of Watt-Lite is meant to explore ways of representing, understanding and interacting with electricity in industrial workspaces. We discuss three design inquiries and their implications for the design of Watt-Lite: the use of tangible statistics; exploratory interaction and transferred connotations.

Keywords

Energy conservation, interaction design, product design, sustainability, engagement, workplace

ACM Classification Keywords

H5.m Information interfaces and presentation (e.g. HCI): Miscellaneous

INTRODUCTION

The potential for reducing electricity consumption in Swedish industry is over 50% [15]. Reduction in energy consumption may partly be accomplished through technical solutions, but these alone will not be sufficient in creating a more sustainable environment. In addition, changes in people's behaviour are needed [2], [6]. Previous studies relating to the importance of design and behaviour to the conservation of energy have mainly been carried out on households. An overview of the field of sustainable HCI is provided by DiSalvo et al. [7]. This overview shows that the majority of the papers in the field target users conceived of as individual consumers. However, there seems to be a lack of research directed towards people in a workplace context. Although this target group naturally includes

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individuals, these are individuals whose attitudes and behaviour are coloured by their professional roles and their workplace environment. The project presented by this paper is aimed at the context of industrial production in small factories. The focus is on the exploration of design as a tool to evoke interest and engagement around the topic of electricity in this particular context. By understanding the implications of designing information that is more tailored and physically present, we see a possibility for more sustainable behaviour among the target group; that is, people working in a industrial environment.

The milieu of industrial production imposes a dichotomy of the notion of electricity consumption. On the one hand the electricity consumption carries negative connotations such as being expensive or ruining the environment. In the production context, on the other hand, high-energy consumption entails a high production, which in turn means that the industries are making profit and the employees will keep their jobs. Thus, in this particular context, it's important to avoid judging electricity usage as bad, since that might suggest production as something negative.

The purpose of the paper is to describe the design of Watt-Lite – a prototype visualizing electricity consumption in industrial settings. The design process is used as a vehicle to explore factors relating to engagement with reflection on energy use. Consequently, the Watt-Lite is an experimental prototype developed in a research through design tradition [9] where we want to investigate how our design intentions correspond to the real interactions with the prototype in everyday life at the factories. In this paper we start by presenting the rationale behind the design process in an attempt to better understand the relationship between design and behaviour in the field of sustainability. The research questions guiding the design process explore three main topics: a tangible type of statistics, an exploratory open-ended type of interaction, and transferred connotations. The first topic explores how feedback on energy consumption may be visualized to evoke engagement with energy use without passing judgment upon certain behaviour. The second explores how the design may encourage an exploratory kind of interaction and, the third, how previous experience and knowledge of the user group can be embodied in the design to encourage and inform interaction.

We give a brief background to the work and describe the field study informing the design process. Then, we give an

account of the Watt-Lite prototype and describe the design rationale that underlies the design decisions. Finally we briefly account for future work and preliminary results from a study of Watt-Lite carried out in eight factories.

Related work

We need to find new ways of engaging people in potentially serious issues by rethinking how values are embodied in products. Products have a potential to influence both beliefs and behaviour and thus they offer opportunities to mediate social, political and moral relations [13], [3].

Chapman refers to modern products as being “too smart and precise, removing all possible surprise, mystery and, perhaps above all, process of engaging with them” [3]. By engaging with culture at large, artefacts function as mediators of social relationships. In this way products may be seen as objects including experiences, activities or services. In turn, this suggests that the role of designers allows for the creation of and support for meaningful and deep relationships between the object and the user.

The concepts of *objects as mediators* may play an important role in sustainable design. People’s everyday engagement with products reveals details of how they relate to the artificial world. If focus tends to be on negative actions, such as how one does not recycle, or forgets to turn the light off [3], sustainable issues become situated as a constraint in the everyday life.

In this project, we set out to deliver the subject of electricity as an engaging and positive experience. As early as the 1970’s, studies [6] established that frequent feedback had measurable effects on making energy easier to understand and control by making it more visible. Later studies have shown that feedback is necessary but not always a sufficient condition for increased awareness and savings. New concepts such as the *Power Aware Cord* [1] and the *Energy AWARE Clock* [1] have been suggested as a way to raise energy awareness in the home, and energy visualisation products such as *Watson* [12] have emerged on the market. These cases are valuable examples of how to design products that promote sustainable use and reflection upon energy usage targeted at the domestic environment.

Field study

A field study of a total of eight industries in mid-Sweden was carried out in order to inform the design process. During the visits, a series of direct observations was recorded through notes and photographs. The goal was to get a better understanding of layouts and differences between the participating industries. A questionnaire was distributed among employees posing questions concerning attitudes, activities and energy efficiency.

The collected material formed an important input for us to understand the local culture at the factories and as a contextual input giving us clues for how to proceed with the concept development. Our theory, experience from previous research in domestic environments [1], and our fieldwork served as input for a new design concept, Watt-

Lite. Before moving on to discuss our research inquiries, embodied in the Watt-Lite artefact, we will first describe its physical properties and envisioned use.

THE DESIGN OF WATT-LITE

Watt-Lite is delivered as a set of three over dimensioned torches. The size of the light beam projected from the torches indicates the factory’s electricity consumption by expanding and contracting depending on their daily energy usage. Watt-Lite may be hung from the cable projecting the light spot on a horizontal surface. It may also be placed on the tilted handle, projecting onto a vertical surface such as a wall.

The dark grey torch, with a white light beam, is a real-time electricity meter that loads new information every 30 seconds, providing almost instant feedback on electricity usage. If the light spot is small, the electricity consumption at the factory is low. If the light spot is large, electricity consumption is high. The torch with a blue beam and cable visualises the smallest amount of electricity (minimum) used during the day. The third and last one has an orange beam and cable and visualises the highest amount of electricity (maximum) used during that day. By using three torches that shine in different colours, the real-time consumption can easily be compared to the value of maximum and minimum usage.



Figure 1: Two of the authors comparing the real-time value (white) with today’s max (orange) & min (blue) values. The light spots can be arranged and projected in any direction seen fit.

The electricity data is received from a purpose built electronic pulse reader, an LED detector that is mounted on the outside of the original digital electricity meter. Each flash from the original meter is detected by our electronic pulse reader and sent to a server storing the data. The data is collected and finally a wireless transmitter sends the electricity data to Watt-Lite.

In addition to the torches, a web service was developed using the same metaphor of expanding and contracting light spots. The homepage allows the users to compare energy consumption on different days to each other showing an historical overview. The web service can be accessed via computers normally shared among a group of people at the factory and is used to check schedules, workloads and production plans. When the computers are not in use, a screensaver is activated showing the same three light spots as the torches. By placing the physical object directly in the work environment, the intention was to encourage users to visit the website as well.

Design rational

Our overall design approach is to treat artefacts as mediators or agents of key ideas explored, rather than as mere instruments of utility. This type of exploration of the artificial has recently been referred to as discursive design [4] where the function of an object is as a tool for thinking to raise awareness and understanding of issues of concern. The key ideas explored here revolve around three main design inquiries that will be elaborated on further in the following sections.

Statistics Made Tangible

We are used to interacting in the physical space. As babies, we reach out and explore the three-dimensional world around us. We live in an increasingly digital and screen-based world, yet our bodies and minds are naturally designed to interact with the physical. Traditional ways of providing information about electricity, such as through bills, graphs on websites and the like, have a poor track record in achieving energy conservation [6]. Mainly, this is due to the time period elapsed between the actions and the actual feedback provided. However, the question is *how* this feedback should be provided. Broms et al. [1] go through several examples of ambient interfaces with the intention of providing feedback in a non-intrusive way. These are interfaces that embed digital information and alert the user through human senses like sound, motion, smells, etc. The information becomes accessible in the physical space in a more natural way enabling a better understanding of everyday energy use.

Through Watt-Lite, we intended statistical energy data to enter the physical space of the factory workers. We envisioned that the data would be appropriated and integrated into the social interplay between the factory workers and their environment. Consequently, a closer bond would be created between electricity related actions and everyday life. When becoming natural ingredients in the daily work activities the torches would allow for a



Figure 2: The light spots communicates through their size and relating proportions in the present, comparing the white spot with the red and blue historical maximum and minimum. The projection surface acts as a canvas for collaborative note taking.

deeper understanding of electricity [6]. The field study indicated that electricity use at the factories was almost completely invisible. Thus, employees had minimum feedback to relate to. By turning the results of electricity use into something more physical and highlighting the constant flow of energy, the work related behaviour at the factories becomes more interconnected with the energy use and thus easier to act upon. The field study also indicated that many machines would be left switched on during breaks as well as over night. One of the greatest potentials for the staff to reduce energy consumption was by actually switching off these machines when not in use. Comparing the present electricity consumption (white) with today's minimum (blue) and maximum (red) makes it easier to understand and become aware of unnecessary high consumption. Users would be able to draw their own conclusions and thus increase their understanding of the factory's energy consumption.

An Exploratory Open-Ended Type of Interaction

While industry strives towards efficiency in production, people are not always rational in the same way when interacting with technology. Things like happiness, reflection, provocation and desire can also be prevailing factors in the ongoing negotiations between people and artefacts [8]. These driving forces can act as a starting point when designing for new types of engaging interaction. Gaver refers to ludic design as follows [10]. "Ludic design is not just a matter of entertainment or whimsy, but focuses on providing resources that encourage people to explore, speculate and wander, finding new perspectives on potentially serious issues."

Through the field studies we observed differences between factories regarding physical space and social conditions. For instance, some employees' work in small buildings, some work in larger ones. Some socialize in the canteen and some when about to start a shift. Human beings are social creatures by nature and we saw an opportunity for

our design to fit into a wide set of arrangements adapting to the particular conditions of each factory. The torches would become a mediating influence helping human beings to engage with others at the specific space by encouraging discussion and exploration. The user is invited to interact with the information by, for example, making notes on the floor or overlapping the different projections, thus, exploring the electrical behaviour of the factory projected through the torches. The intention is to avoid passing any judgment upon certain behaviour, but instead to let the user interpret the meaning of a given topic. The torches require exploration and bring about questions without saying what is right or wrong. The 'truth' is left for the user to explore and act upon.

Transferring Connotations of Use

The everyday artefacts, their form and function are the results of more or less conscious decisions made during the design process. How we interpret them is determined by the individual's experience where, for example, notions such as class, gender and ethnicity play important roles [1].

Watt-Lite is an unfamiliar object to the staff in the factories, but the shape of a torch gives a hint of treating it as an explorative device, a detective's tool that can show what might otherwise be hidden. A regular torch highlights what is hidden in the dark, whereas Watt-Lite highlights the hidden use of electricity - making the invisible visible.

We sought to reproduce the sensation of a portable and resistant tool. We consciously designed it to be larger than a standard torch, relating to the scale of measurement; the whole of the factory. The added handle suggests that the object can be carried and moved about, inscribing the message of use into the structure of the artefact.

By specifying *use* through material and shape, while leaving the meaning of the electricity statistics to be determined by the users, our intention is for an exploratory type of engagement where the user tries to grasp both the system and its situation of use [14].

FUTURE WORK

The Watt-Lite is set to explore the effects of design related to more poetic and emotional values by acknowledging that function and precision is not enough to engage human needs and desires. During the spring of 2010 the prototypes were deployed in eight factories in mid-Sweden for a total of four weeks. Preliminary results indicate that the torches were treated differently depending on the place positioning. When situated by a shared coffee machine, employees started to leave notations of time and traces around the projected light on the floor when queuing up for a coffee. However, in other factories the torches ended up in less sociable places, like a corridor where fewer individuals stopped to engage with the Watt-Lite. Results also indicate that very few users seemed to have used or even looked up the website despite the presence of the physical artefact. The engagement does not seem to have spread beyond the torches. Future work includes a user study and evaluation of above design intentions.

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