WattsBurning on My Mailbox: A Tangible Art Inspired Eco-feedback Visualization for Sharing Energy Consumption

Filipe Quintal, Mary Barreto, Nuno Nunes, Valentina Nisi, Lucas Pereira

WattsBurning on my mailbox: a tangible art inspired eco-feedback visualization for sharing energy consumption

Filipe Quintal, Mary Barreto, Nuno Nunes, Valentina Nisi and Lucas Pereira

Madeira Interactive Technologies Institute, University of Madeira, Caminho da Penteada, Funchal, 9020-105, Madeira, Portugal

{filipe.quintal,mary.barreto}@m-iti.org, njn@uma.pt, valentina.nisi@gmail.com, lucas.pereira@uma.pt

Abstract. This paper describes a novel art-inspired tangible eco-feedback system. The concept emerged from a workshop with researchers, designers and artists looking at innovative ways to provide more effective eco-feedback that engages users emotionally. The tangible aspect of the system is composed of a set of magnets that users can stick on their physical mailbox outside of their apartment building according to their average energy consumption. The magnets are a total of seven pieces, one for each day of the week. Each piece has a variation of three colors, from green (low consumption) to burning red (high consumption). The magnets are to be displayed in a sequence that represents a typical panorama of local nature. In this paper we report the design and the study we conducted to gauge preliminary results on the system usage and potential. Interviews with participants revealed that none of them felt uncomfortable having their consumption displayed outside. When children were involved in the process they "took control" of the task and pressured their families to perform better.

Keywords: Sustainability; Aesthetics; Art driven Eco-feedback; User Interfaces; Prototyping.

1 Introduction

Individual household consumption accounts for a significant part of the total worldwide consumption. For example, two thirds of the electricity used in the United States, 36% of the greenhouse gasses, and 12% of the fresh water consumption [1]. Most people are in fact concerned about the consequences of their actions, however they are also unaware of the impact of their daily activities and more importantly how they can change their behavior to reduce resource consumption. This gap between peoples concerns and behaviors, led to the creation of eco-feedback technologies. Eco-feedback is defined as "technology that provides feedback on individual or group behaviors with a goal of reducing environmental impact"[2]. A challenge when designing feedback about energy consumption, is to relate current actions with the im-

pact that they can have in the world, commercial energy feedback systems normally present that information as g of CO2.

Pierce et al [3] surveyed several publications exploring the impact of eco-feedback technologies in energy consumption and on consumers' behaviors. The authors found out that the use of eco-feedback technology resulted on savings between 5 and 12% of daily energy consumption. They also concluded that when savings didn't happen the eco-feedback was displayed too infrequently (monthly) and hence was disconnected from the consumption behavior. Furthermore studies have show that the savings can relapse over time as the consumers' interest in the feedback device decrease [4].
Another important finding is that the normal representation of kWh is not informative enough to the majority of the users. Furthermore in [5] the authors argue that this lack of understanding made users remove those metrics from proposed eco-feedback designs.

In fact the entire electricity infrastructure is designed in way that is hidden to most consumers. With WattsBurning on my mailbox, we want to make the household energy consumption somehow tangible to the users and foster a sense of awareness about it through the action of updating it every day and sharing with their neighbors. By adding it to users routines, we plan to explore the accountability felt by the users.

In the remaining sections of the paper we will present the related work and the WattsBurning concept. In the last sections we describe the deployment of the study, its analysis and the following discussion and conclusions.

2 Related Work

2.1 Art inspired and tangible eco feedback

Pierce and Paulos [6] argue that feedback systems are to be designed as some*thing tangible* as a starting rather than ending point for design inquiry and exploration. That raises cognitive awareness and motivates energy conservation behaviors. In order to provide for this lacking experience, the authors developed Energy Mementos, treating energy as a material that is experienced in a unique and meaningful way. The STATIC! Research institute has developed several tangible eco-feedback devices. Energy Curtain attempts to motivate people to use more sunlight by opening the curtains [7]. The feedback is given in colored patterns in a window shade woven. PowerCord, a power aware cord, which was designed to visualize the energy consumed opposed to hiding it. Power Cord glows according to the level of energy that is passing trough [7]. Johnson et all [8] developed Watt-Lite a tangible display of electricity consumption for the workplace. In Watt-Lite, consumption is displayed by the projection of 3 torches to the floor, one represents the real time consumption, while the other 2 represent the maximum and minimum of the day. Using a more abstract approach artists Lena Bllimeier and David Baur, designed the Vision Energy, which is a set of sculptures in order to to "transform the abstract energy consumption process in to a visual adventure" [9]. In [10] digital artist Tiffany Holmes reports on her project projecting the visualization of the energy consumption of households in the

public space of a building hall (7000 oaks and counting). In Holmes case, digital art is used to display hidden data of real time usage of key resources such as electric appliances in order to offer new strategies to visualize energy in the home and workplace. Another relevant work is presented in [11] an art installation in Helsinki, in which the city energy consumption was displayed with lasers projected to the smoke of a coal energy power plant. During 7 days the smoke cloud was projected with green colors (the projection was actually the outline of a cloud), the lower the consumption the larger the illumination. In the final day residents were asked to unplug the devices to reduce consumption, to increase the size of the green cloud. This resulted in a reduction of the peak demand in 800 kVA.

2.2 Socially enabled eco feedback.

Researchers have used motivators such as social praise or peer pressure to motivate in consumption savings [12]. In [13] the authors designed a system to work with the Watson energy monitor[1]. During the study a group of participants were able to consult others consumption while other participants could only view their own. The results showed that the second group managed bigger savings when compared to the fist one, the research team observed that participants were motivated to save energy by the element of competition. A similar study was performed with a mobile energy-monitoring tool, the research team observed that participants that shared their energy consumption with others, exchange expertise and troubleshoot problems between themselves [14]. Users engage in comparing and analyzing the others consumption mostly by curiosity.

Odom and Pierce [15] describe the design and implementation of an eco-visualization design to be used in the Energy Challenge, which was a competition in Indiana University in which students were competing to save water and electricity. The competition resulted in an estimated combined savings of 33.008 KWh of electricity and 724,322 gallons of water compared to baseline consumption. Additionally the research team observed that the consumption behaviors were strongly influenced by their peers, and that social motivation was the key component to the success of the competition.

3 System Description

3.1 Household eco-feedback system

The study present here is part of a larger eco-feedback project, which provided families with consumption information via an android tablet. This research platform implements a low-cost non-intrusive sensing infrastructure that is capable of measuring energy consumption and detecting detailed appliance-level data. The consumption information is then made available in the cloud. It allows users to check their real-

[1] http://www.diykyoto.com/uk/

time or historical consumption data anywhere as long as an Internet connection is available. The system operates in two different modes (see Figure 1), the first one displays real-time data about the consumption (in kWh, €, CO_2 emissions), and the second mode is triggered when it goes to idle mode (normally after there is no interaction with device for more than 2 minutes). The second mode comprises a set of digitally manipulated pictures of a local forest landscape that occupies all the screen of the tablet. The landscape picture can change from very healthy green with rainbows and animals, to very sickening dark with fire and without animals, according to how the current consumption compares with the average of a homologous period.

Fig. 1. Left:First mode of the tablet application; Right: and second operation mode.

4 WattsBurning on my mailbox

The concept used in WattsBurning on my mailbox emerged from a workshop where researchers, designers and artists came together to think about innovative ways to provide eco-feedback beyond the traditional informative kWh or CO2 emission displays. Some of the workshops members had previous experience with public communal eco-feedback, in particular the TidyStreet initiative, which was part of the Change project [16].

The brainstorming session revolved around the combination of public (communal) display and using forms of artistic display connecting the energy consumption to elements of the environmental heritage of the local place. Several ideas emerged from the workshop most of the ideas looked at tangible ways of providing and sharing the eco-feedback from the households. The research team agreed that art and playfulness could play a major role in increasing the emotional connection between people, their energy consumption and the long-term effect on the environment. Starting from these ideas the team looked at public spaces that could be used to share the consumption eco-feedback. Since the system (described in 3.1) was deployed on residential apartment buildings the physical mailboxes provided an interesting place to share the consumption, which was both accessible and visible to the larger community. The mailboxes could act as a placeholder for a tangible display of energy information that was at the same time shared with their neighbors. In order to leverage the connection between the in-house system that was already installed and the new shared eco-feedback, the research team brainstormed on different ways to bring the artistic visualization of the consumption. Ideas ranged from using a portrait of the family with different moods, or use a local newspaper to display the consumption, and were finalized on a specific concept: mapping a forest landscape to physical magnets. For the

mailbox magnets we used the same forest landscape that was used in the tablet eco-feedback application. (see Fig. 1)..The final concept was taken into different prototyping and evaluation cycles before emerging as the final WattsBurning on my mailbox concept.

4.1 Mailboxes Magnets

The system provides an opportunity for family members to share their energy consumption information they already accessed through the android tablet at home, using a shared physical space outside of their apartments. Both eco-feedback visualizations mapped household consumption to the natural endemic forest, which we knew from previous research provided a strong emotional connection in particular with locals and due to several recent extreme environmental phenomena like heavy rain and mud-slides or severe forest fires [17].

The hardware used to implement the outdoor visualization was based on a set of magnets that participants placed in their mailbox according to their daily consumption. Each magnet represents the consumption of a specific day of the week, referring to part of the full illustration of the local forest at three different health stages: "sick", "normal" and "healthy". The landscape depicted here is a horizontal portion of the landscape present in the tablet system which users were already familiar with (See Figure 1 right). In total each family was given 21 magnets, three for each day of the week with the three different health levels. In addition there was also a banner placed above the magnets with the caption for each day (see Figure 3). Since the mailboxes were made of aluminum (the magnets did not stick to it) a small-magnetized rubber ban was placed in the mailbox through hooks so that the magnets could "stick" to it. Figure 2 shows the banner and the three different landscapes that created the set of magnets for the three different consumption levels. Figure 3 shows how the magnets were placed in the mailboxes.

Fig. 2. The 3 different stages of the forest represented by the magnets (banner is on top). 1. Banner with the week days. 2-Forest with low consumption. 3-Forest with medium consumption 4- Forest with high consumption.

5 Evaluation

To evaluate how sharing energy with the mailbox system impacted the perception and energy consumption we selected 4 families for a period of one week to test the concept. The sample families for this study were a sub sample from the families selected for the bigger deployment of the tablet based eco-feedback system (section 3.1). Therefore the families were already used to get information about their energy con-

sumption, and they were aware of how their routines impacted the depletion. All the families were couples with children; in 3 of them the kids had less than 12 years. The families lived in two apartment blocks from the same building complex in an urban area of a small city from a southern part of Europe. The mailboxes were placed in the entrance of each apartment block and visible by passers by and neighbors. Users were informed about this study by phone and then scheduled for an interview later to explain how the mailbox system could be used.

5.1 Methodology

The mailbox study lasted one week, which we knew, from previous research, was enough to span the routines of a family impacting their energy consumption. Each morning at 7:00 AM the participants received a text message with information about their consumption in the previous day. The text message followed the next template: *Good morning Mr/ "Participant name" your consumption yesterday was above/equal/bellow your average for that day of the week, you should proceed to place the magnet assigned for high/average/low consumption.*

Then we expected family members to proceeded and place themselves the magnet in the corresponding position at the mailbox outside of the apartment building. At the end of the afternoon one of the researchers passed by the building to check if the participants had placed the magnets correctly (the participants were not aware of this verification). In the following week, we visited the families and conducted a short interview. The goal of the interview was to qualitatively verify if the metaphor used to represent the consumption was well understood, how the family performed the task, and how families felt about having their consumption displayed outside their houses.

5.2 Analysis

From our afternoon observations we confirmed that only one of the families skipped the magnet placement in one day. However they placed two magnets in the following day. Apart from that case all the families performed the task on time and correctly (the placed magnet was the correct according to the consumption).

All the families found the task of getting the message and placing the magnet simple and reported it didn't interfere with their normal daily routines. They also found the magnets easy to understand. None of the families felt discomfort or concern about having their consumption displayed outside of their apartments and visible to neighbors or passing people: "*It was indifferent… I was not at all concerned*" (House 1 Mother), although the consumption was only broadly exposed through the color of the landscape slice. When asked if they would feel the same way, if actual consumption data in form of numbers were displayed, instead of the forest representation, families again reported minor privacy concerns, but not strong opposition to it: *".. Of course there could be some privacy concerns… but I don't see any negative aspect with that*" (House 3 Father). It is important to note that asking families about a hypothetic scenario, their reaction could be different from their a priori answer once they could actually see the numeric information outside their house.

Particularly interesting reactions to the system came from kids. In one of the apartment blocks the children from the two families that participated in the study were friends, and in both cases they quickly became responsible for performing the task: "*He went there before going to school, he asked me for the consumption, and he went there … I have got the stack with the magnets, he chose it before going to school*" (Father, House 2), "*She went there before leaving to school. She got the magnet from the stack and we stopped in the mailbox before leaving*". (Mother House 1).

These statements suggest that competition arised between kids and that unspoken competition soon became apparent to the adults in the families: "*It seemed that they were competing with each other... every day in the morning she asked who spend more us or them… at the end she told me Who won?. It was more a competition between them, she was the one reminding me to check the message*" (House 1 Mother), "*Normally we don't spend without being necessary, but there was a day with higher consumption. He came to asked me why is that? I had to explain him that his mother was cleaning and so on*".(House 2 Father).

In the other two families (from a different block), the task was performed by the father, (House 3) and the mother (House 4). The positioning of the mailboxes meant that it was almost impossible for neighbors to ignore each other's consumption. This was confirmed during the interviews, 2 of them were actually curious to check: "*I got surprised in the end, our values were close (comparing with the neighbor), but of course since we are comparing savings the actual consumption values could be different)*" House 3 Father.

Fig. 3. Mailbox of one participant in the beginning (left) and in the end of the study (right)

6 Discussion and Conclusions

Eco-feedback is a promising technology to bring awareness to resource consumption. In this paper we reported an ongoing study looking at innovative ways to provide eco-feedback that leverage an emotional connection of people with their consumption and the long-term effects while at the same time making use of some playful strategies to raise awareness. WattsBurning on my mailbox provides an interesting strategy for families to display and share their energy consumption. Our preliminary results show that the task of placing magnets reflecting daily energy consumption outside of the houses was not considered hard or a burden by the families. When given the opportunity children become the gatekeepers for the magnets update, and function as probes and awareness aids of the adults about their consumption. We believe that this can provide opportunities for children oriented eco-feedback systems that are more play-

ful and stimulate communication about routines and energy consumption patterns inside and across families. Additionally the fact that participants didn't show any concerns about publicly displaying their energy consumption suggests that there is space for exploration in public displaying and sharing of energy consumption. These promising results are inspiring the research team to develop the mailbox concept further and planning a larger deployment that could also lead to more statistically significant results in particular for the long-term effects in terms of consumption and awareness.

7 References

1. Wilson, A. & Yost, P.:. Buildings and the environment: the numbers. Environmental Building News 10. (2001).
2. Froehlich, J., Findlater, L., and Landay, J.: The Design of Eco-Feedback Technology. In Proc. CHI 2010
3. Pierce, J. Odom, W., Blevis, E. :Energy Aware Dweling: a critical survey for interaction design for eco-visualizations. CHI 2008, ACM Press.
4. Peschiera,G.,Taylor,J.E., and Siegel ,J.A. :Response– relapse patterns of building occupant electricity consumption following exposure to personal, contextualized and occupant peer network utilization data. Energy and Buildings 42, 1329-1336 (2010)
5. Anderson, W., White: Exploring consumer preferences for home energy display functionality. report to the Energy Saving Trust. Bristol.(2009)
6. Pierce, J. & Paulos,.E :. Materializing energy. In Proc DIS '10. (2010)
7. Static! Increasing Energy Awareness. Retrieved January 2, 2013, from http://www.tii.se/projects/static
8. Johnson, L., Broms, L. & Katzeff, C. Watt-Lite: energy statistics made tangible. DIS '10 (2010)
9. Bllimeier, L.,Baur, D.:Vision Energy. Retrieved December 28, 2012, from http://www.seenby.com/lena-billmeier/vision-energy-fosil-fuels-sculpture
10. Holmes, T. G..:Eco-visualization: combining art and technology to reduce energy consumption. Conference on Creativity & Cognition, (2007).
11. Nuage Vert (2008). Nuage Vert Project. Retrieved December 28, 2012, from http://www.pixelache.ac/nuage-blog/
12. G. Wood, M. Newborough :Energy use information transfer for intelligent homes: Enabling energy conservation with central and local displays (2005).
13. Foster, D., Lawson, S., Blythe, M., Cairns, P.: Wattsup?: motivating reductions in domestic energy consumption using social networks. NordiCHI. (2010)
14. Filonik, D., Medland, C., Foth, M., Rittenbruch, M. :A customisable dashboard display for environmental performance visualisations. Conference on Persuasive Technology (2013).
15. Odom, W., Pierce, J., and Roedl, D. :Social Incentive & Eco-Visualization Displays: Toward Persuading Greater Change in Dormitory Communities. In Proc. of Public and Situated Displays to Support Communities. Workshop at OZCHI 2008.
16. Bird, J. and Rogers, Y.: The Pulse of Tidy Street: Measuring and Publicly Displaying Domestic Electricity Consumption. Workshop on Energy Awareness and Conservation through Pervasive Applications (2010).
17. Nisi, V., Nicoletti, D., Nisi, R., Nunes, N.: Beyond eco-feedback: using art and emotional attachment to express energy consumption. In: Proc. of C&C. pp. 381–382. ACM (2011)