



Value Sensitive Design Approach to Influence Energy-use Behaviour

Rachel Burrows, Peter Johnson, Hilary Johnson

Department of Computer Science, University of Bath, Bath, BA2 7AY, UK

`r.burrows, p.johnson, h.johnson@bath.ac.uk`

Abstract. This paper is primarily concerned with relating energy consumption to other information about a person's lifestyle values through sharing and comparing energy-use data with and between others. The goal is to influence choices and in doing so to stimulate sustainable behaviour changes. The study reported in this paper contributes to the design of a web application that aims to achieve this goal. The website allows users to share their lifestyle values and related energy-saving strategies within an online community, and seeks to stimulate sustainable behaviour changes in and through that community.

1 Introduction

A number of interactive technologies have been developed with the aim of reducing energy demand by supporting pro-environmental behaviour e.g. [3,6] They are often based on popular theories of behaviour change, such as value-belief-norm model [14] or action-behaviour-choice [12]. Theories and models can aid designers in understanding what message needs to be presented to the user, and the message framing. Some approaches collect and monitor energy-use information to calculate potential energy-saving opportunities, such as those presented by alternative home heating and cooling programs. This allows people to weigh up the energy costs and benefits of certain usage scenarios and potentially change their behaviour by selecting scenarios with different outcomes and resource implications. Taking a different perspective, some recent work has focussed on models to support user engagement in energy-aware devices [7] this allows user trust to be facilitated through automatic decision making within the system by controlling the degree of autonomy a user can have.

Designing such a system is multifaceted and complex as energy consumption underlies many everyday activities, and also varies greatly between people. Both people's lifestyles and their preferences concerning support to find energy-saving strategies also vary greatly between individuals. As a result, many technologies are reported to result in a lack of long-term engagement and are criticised for interacting with users in ways that are not personalised or relevant to their everyday lives [9,15].

This paper presents participatory design methodology to engage a community of users in the design of this system. Secondly it investigates the issues of personalisation, sharing and privacy of that information. Finally, it investigates the design of interactions and representations to engage and motivate a user community in creating and sharing their strategies, and subsequently using the system to support a sustainable change in favour of pro-environmental behaviour.

2 Our Approach

Our underpinning philosophy is that saving energy is not always the governing or guiding principle around which everyday lives are organised. Everyday lives are organised primarily due to values, around contexts and ways of living. Software systems that aim at influencing behaviour change therefore need to take into account the complex trade-offs that are made to meet the demands and challenges of everyday life while maintaining the values they hold. Of course the value of nature and the environment is a value that many individuals hold [11] and performing activities with the sole purpose of curtailing energy-use may be instrumental in supporting this value. However, it is important to recognise that this is potentially one of many values that an individual or group hold and strive to maintain.

Our work focuses on understanding values as a basis for influencing pro-environmental behaviour. Value Sensitive Design [5] is a methodology for building software applications that takes into account stakeholder values throughout the design process. A value is something that an individual sees as an important aspect of their life. A primary research aim is to understand how people's values can influence long-lasting behaviour changes. From this understanding it is possible to investigate attributes of software systems to influence people to reduce their high carbon, energy consumption behaviours.

People have many values. They are used to select and justify activities, and to evaluate artefacts and events (including other people and themselves)[11] The values people hold are considered as important influencers and drivers for their specific energy related behaviours [10] Those values may be articulated in rather generalised forms by collective terms. Existing research into the structure and content of values can be seen in work by Schwartz [11] who presents a set of 10 universal value types including security, conformity and tradition among others. Similarly, work by Rokeach [10] also presents work on collective values including a comfortable life, social recognition and wisdom. Each of these types contains subtypes of instrumental motivational

values; for instance the value type of security contains a set of 7 instrumental subtypes such as family security, healthy, social order, and so on.

However, these generalised value forms take on real meaning and influence at a much more personal and individual level. Moreover, the values for an individual are constructed and operationalised through the connections they have with the terms and contexts of their everyday life.

3 Study Design

The objective of this focus group session was to investigate the design of web-based interactions and representations to engage the user community. The activities to be supported were those of searching for, creating and sharing their strategies and subsequently using the system to support a sustainable change in energy behaviour. Thus there are two fundamental activities that are supported by the website that may facilitate users to reduce their energy consumption. These are 1) allowing individual users to create their own energy-saving strategies for the user community and 2), allowing users to search the community energy-saving strategies. Through the activities of this focus group participants generated prototype designs for the web application. It is important to note that the types of users that would be members of the online community remained an open design question. In other words, the participants were free to suggest who would be members of their online community within their prototype designs.

3.1 Sample

The sample of 8 participants, some of whom had been involved in previous sessions, were chosen to represent a variety of energy users in the UK. They were paid £35 in vouchers to participate. The participants had different levels of familiarity with web technology, lifestyles, age ranges, and employment status. Participants carried out two design sessions in pairs, one as the interviewer and one as interviewee. Partners and roles were swapped between sessions. The first design session focussed on contributing their own strategies on the website. The second design session focussed on searching and finding energy-saving strategies of interest on the website.

3.2 Procedure

The methodology follows the a series of participatory design [8] techniques proposed by the D.School at the Institute of Design at Stanford University [4]

The method is grounded in first gaining an understanding of user values and lifestyles, and progresses through to prototype development. System features created during the prototyping phase are traceable back to the design problems they were addressing and also the specific user characteristics that motivated them in the first place.

3.3 Design Workbooks

For each design session, each pair was provided with a workbook containing 9 design questions. They were also given a collection of rapid prototyping materials which included pens, generic user interface shapes, stickers, scissors, colours, highlighters, UI outlines of tables, mobile phones, laptops. The workbooks contained 9 questions, each within one of the following design phases.

Understand (Q1 and Q2): Interviewer was to gain a deeper understanding of their lifestyle, values and also user-specific characteristics that may motivate them to share their strategies and adopt the strategies of others.

Problem Statement (Q3 and Q4): Each pair specified problems that are potential barriers to engagement with the system.

Ideation (Q5): Each pair sketched a selection of ideas that would solve their previously defined problem.

Iterate (Q6 and Q7): Each pair refined their ideas into a single prototype.

Build and Test (Q8 and Q9): Each pair consolidated their design idea into a final paper prototype. They evaluated this prototype.

4 Results

The participants worked in pairs and produced a total of eight design books - four addressing designs to support strategy searching and four to support strategy creation. All eight designs were grounded in an understanding of the participants' lifestyle values and energy behaviours.

The lifestyle-value-driven approach informed many aspects of the UI design. The design ideas were conveyed in drawings of UI designs and annotations on those designs. This included requirements that related to; 1) issues of security and privacy, 2) how content on the website is organised and framed, and 3) how they would want to interact with the website. Final prototype solutions generated by the pairs varied. For instance, one pair drew a process diagram representing the flow of interaction with the website. Others used the given screen templates together with the prototyping materials to

illustrate layout details, while others used the materials to convey certain aspects of functionality. Drawing from the resulting focus group workbooks, lists of requirements, user characteristics and general comments about system preferences were constructed. The following outlines some findings from the workbook answers.

Results from the workbook answers showed how multiple participants had ideas about what kinds of energy-saving strategies they would want to search for and find. Four of the eight workbooks found answers that indicated that it was important to find energy-saving strategies that were relevant to their lifestyle and values. For instance, one pair wrote that they would be interested in sharing strategies with other users where they had "something in common". Other participants wrote how they would be interested in finding energy-saving strategies that had "personal relevance" or that the website content could be "refinable by circumstance".

All the workbook contents suggested a variety of different characteristics of strategies that would motivate them to read a particular strategy. Some of these characteristics were expressed through the drawing of UI menu headings to show visually how the content should be divided into separate parts of the website. Additionally, some characteristics were expressed through written answers. There was no consensus to these characteristics. Some workbook examples of strategy characteristics that would be of interest were: Monetary Benefit; Immediate benefit; Little effort; Funny; New and Novel; Tried and Tested; Recommended by Friends (highly voted for). Due to the lack of consensus on strategy characteristics that users would be interested to read about, accessing content through fixed menu items may not be as effective as allowing strategies to be organised by user-driven labels.

The main motivation for users to share their own strategies was the impact it may have upon their online community. For example, one pair wrote how combined efforts with others would motivate an effort to share energy-saving strategies; evidence of "reciprocity" within the online community was the key to maintaining engagement. Another pair wrote that a benefit of an online community for communicating strategies is that it has the potential to reach many people; they wrote that "spreading the message" would be a motivator.

Some participants expressed concern about what information they would be sharing, which may act as a barrier to engagement. This concern was expressed in many ways. For instance, some participants stated how a barrier to engagement may be due to them being self-conscious about what they were revealing, while other participants explicitly stated that they would be concerned about security.

5 System Design Implications

The design book results from section 4 influence many aspects of the website design. The main challenge was to converge multiple design ideas into one solution that addressed the design issues raised by the participants. This is not straightforward due to the requirement conflicts that became apparent between participant designs and the website goals, and also between individual participant designs themselves.

The website should allow users to visualise how relevant energy-saving strategies are to their values. The visualisation will simultaneously address both participants prototype suggestions of the website content to be personalised at the same time as communicating strategies in a way that will influence users to adopt the strategies they find. For instance, users may be more likely to adopt strategies that support the continuance of highly valued aspects of their lifestyle. Secondly, viewing strategies from other users with similar lifestyle values may lead to a social influence effect causing users to adopt strategies of other users within the online community.

The website should additionally allow users to add further information, in the form of user-generated labels to energy-saving strategies within their online community. This would allow for the website content to be searchable according to those user-generated labels. This design decision was driven by the large amount of variability in the types of strategies that users would be motivated to read about. These categories are typically not currently used in current energy-saving applications, which often use dwelling-related categories of energy-use. For example, existing systems may present users with energy information according to the type of energy that is being used (gas, electricity etc) or alternatively the room in the home (kitchen, bathroom). It does, however, allow users to self-organise website content according to what is of interest which can in turn be used to evaluate alternative behaviour change campaigns and policies.

The website should provide users with the option to vote and comment on published energy-saving strategies to allow for users to prioritise visibility of popular strategies. This design decision is in response to the fact that visible feedback from strategy readers is important to show evidence that the contribution from an individual user is of benefit to the larger community. It is also beneficial to rank the strategies and give priority to high-quality content. This interaction was also justified by two participants who reported to be wary about interacting with the website. These interactions may serve to build confidence in users by providing evidence that their contribution is useful to others.

6 Conclusion and Future Work

These design decisions are an important step towards the first implementation of the website. User values have informed website design in two ways. Firstly, lifestyle values and associated energy-saving strategies are integral to the structure and content of the website representations and interactions; they are a mechanism for searching and creating the user-generated content. Secondly, user values have also informed the way in which searching and creating strategies is achieved. For instance, values of security, community, privacy and reciprocity are also integral in the design of website in order to maintain user engagement.

The next steps are to get that community of users using the website and evaluate both the design for its HCI and the approach for its ability to enable strategy generation, strategy sharing and strategy take up by the community of users. This would then allow us to further evaluate if it produces energy-related behaviour changes derived from the common and different lifestyle values of individuals and the creation and adoption of community-generated energy strategies.

Acknowledgements

Eviz Project. The work reported in this paper is funded by the Engineering and Physical Sciences Research Council (EPSRC) under the Transforming Energy Demand in Buildings through Digital Innovation (TEDDI) (grant reference EP/K002465/1).

References

- [1] Burrows, R., Johnson, P., and Johnson, H. Influencing behaviour by modelling user values : Energy consumption. In PERSUASIVE'14 2nd Intl. Workshop on Behaviour Change Support Systems (2014).
- [2] Carter, S., and Mankoff, J. When participants do the capturing: the role of media in diary studies. In Proc. of the SIGCHI Conf. on Human Factors in Computing Systems, CHI '05, ACM (NY, USA, 2005), 899–908.
- [3] Costanza, E., Ramchurn, S. D., and Jennings, N. R. Understanding domestic energy consumption through interactive visualisation: a field study. In Proc. of, UbiComp'12, ACM (NY, USA, 2012), 216–225.
- [4] DSchool. Design thinking website <http://dschool.stanford.edu/dgift/>. accessed 10th Feb 2015.

- [5] Friedman, B., Kahn, PeterH., J., etal. Value sensitive design and information systems. In Early engagement and new technologies: Opening up the laboratory, N. Doorn, D. Schuurbiers, I. van de Poel, and M. E. Gorman, Eds., vol. 16 of Philosophy of Engineering and Technology. Springer Netherlands, 2013, 55–95.
- [6] Ham, J., and Midden, C. A persuasive robotic agent to save energy: The influence of social feedback, feedback valence and task similarity on energy conservation behavior. In Social Robotics, vol. 6414 of LNCS. Springer Berlin Heidelberg, 2010, 335–344.
- [7] Hammer, S., Winer, M., and Andr, E. Trust-based decision-making for energy-aware device management. In User Modeling, Adaptation, and Personalization, vol. 8538 of LNCS. Springer International Publishing, 2014, 326–337.
- [8] Muller, M. J., and Kuhn, S. Participatory design. *Commun. ACM* 36, 6 (June 1993), 24–28.
- [9] Pierce, J., and Paulos, E. Beyond energy monitors: interaction, energy, and emerging energy systems. In Proc. of the SIGCHI Conf. on Human Factors in Computing Systems, CHI '12, ACM (New York, NY, USA, 2012), 665–674.
- [10] Rokeach, M.: The nature of human values. Free press (1973)
- [11] Schwartz, S.H.: Universals in the content and structure of values: Theoretical advances and empirical tests in 20 countries. *Advances in Experimental Social Psychology*, vol. 25, pp. 1 65. Academic Press (1992)
- [12] Shove, E. Beyond the abc: climate change policy and theories of social change. *Environment and planning. A* 42, 6 (2010), 1273.
- [13] Simon, H. A. A behavioral model of rational choice. *The Quarterly Journal of Economics* 69, 1 (1955), 99–118.
- [14] Stern, P. C., Dietz, T., Abel, T., Guagnano, G. A., and Kalof, L. A value-belief-norm theory of support for social movements: The case of environmentalism. *Human Ecology Review* 6, 2 (1999), 81.
- [15] Strengers, Y. A. Designing eco-feedback systems for everyday life. In Proc. of the SIGCHI Conf. on Human Factors in Computing Systems.