Early Experiences with Participatory Design of Ambient Persuasive Technology

Janet Davis
Grinnell College
Grinnell, IA 50112
davisjan@cs.grinnell.edu

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1 Background

In the face of global warming and other environmental concerns, Grinnell College and many other institutions want to reduce their environmental footprints. Researchers in computer science, too, are concerned with technology's impacts on the environment. For example, just as we insulate buildings to retain heat and install low-flow showerheads, researchers are trying to decrease energy consumption of computer systems [17]. However, increasing efficiency to reduce resource consumption only goes so far. For further resource conservation, changes in behavior are necessary.

Environmental conservation has been a significant domain in the new research area of persuasive technology: "interactive computing systems designed to change people's attitudes and behaviors" [7, p. 1]. In his seminal 1998 paper, B.J. Fogg identifies environmental sustainability as a key domain for persusasive computing, using paper recycling as an example to illustrate different roles of persuasive technology [6]. While a number of researchers have developed web-based and mobile tools to to promote environmentally sensitive choices, such as the SmartTrip errand-planning tool [10], the GreenScanner system for product environmental impact reviews [18], and the Footprints social network tool [12], embedding devices in the physical world has also proved a fruitful approach for providing feedback and information to households and communities.

Several persuasive technology design efforts are intended to make resource consumption visible at the time and place where resources are used. Indeed, researchers in environmental science have shown that feedback, in combination with goal-setting [3, 19] or social comparison [16], is effective for reducing energy consumption by 5–20% [5]. Feedback is most effective when it is immediate, at the time of energy use [5]. The goals of ambient displays—to provide awareness through the physical environment, without demanding attention [20]—seem particularly suitable to providing feedback or reminders in the built environment. For example, the power-aware cord uses animated LEDs embedded in a power strip to show at a glance how much power is being drawn [8]. WaterBot aims to reduce water consumption by tracking and displaying information about water use at the sink itself [1]. Intriguingly, Holstius, et al., use live and robotic plants in an ambient display that shows the balance between trash and recycling in a dining area [9]. These efforts show the area of ambient persuasive technology is ripe for further investigation.

While there has been much work on strategies for persuasion and on design of specific technologies, there has been relatively little attention to methods for designing persuasive technology. Challenges include

bringing a user-centered rather than designer- or technology-centered focus to the design process [11], anticipating unintended consequences of the persuasive technology [2], designing for user acceptance and even ownership, and addressing ethical issues of consent and free will inherent in attempts to persuade [2], which may be amplified by computer systems' persistence and lack of moral judgment [7].

In response to this concern about ethical design methods, I am exploring the use of participatory design methods to develop persuasive technology systems for promoting environmental conservation, tailored to a specific group of stakeholders and context of use. Participatory design (or PD) is a family of theories and methods that involve potential users as full participants in design processes leading to the development of computer systems and computer-based activities [14]. Participatory design methods include workshops, storytelling, role-playing, games, making low-tech models, and cooperative prototyping. Many, though not all, PD researchers and practitioners are motivated in part by a belief in democratizing technology design. Other motivations for using PD methods include mutual understanding on the part of users and designers, user engagement in the design process and ownership of the eventual product, and the development of new ideas drawing on multiple perspectives.

To the best of my knowledge, no prior work has considered participatory design of persuasive technology. Yet participatory design methods show promise in addressing challenges of designing persuasive technology. A commonly cited advantage of participatory design is that it promotes a sense of ownership among the technology users. The design process further benefits from participants' creativity and their knowledge, both explicit and tacit, about the context for technology use. Beyond these usual reasons to employ participatory design, involving potential users in design helps to avoid some potential ethical issues with persuasive technology. Without participatory design, the designer stands outside of the community and intends to change the behavior of community members. With participatory design, the persuasive intent comes in part from community members who want to change the community's behavior from within.

2 Current work

In summer 2008, I worked with two undergraduate students, Timothy Miller and Patrick Rich, to engage Grinnell students as partners in design of a persuasive system to reduce resource consumption in a public location on campus [13]. We used a game-like technique to help participants look for places where resources are consumed, introduced them to sensor and actuator technology through the Phidgets rapid prototyping framework (`www.phidgets.com`), engaged them in building mockups, and invited them to critique early prototypes of several possible designs.

Ultimately, we designed an interactive sculpture to occupy a staircase in the science building, intended to attract people from a nearby elevator to the stairs [13]. The system uses LEDs embedded in hand-sized wire sculptures to evoke fireflies along the walls and railings of the stairs. Some fireflies are equipped with vibration sensors; tapping one of these fireflies is considered a "catch" and triggers a celebratory animation. By pressing a button at the bottom or top of the stairs, the user can race a simulated elevator: the fireflies sequentially light up at the speed at which the elevator travels, showing that most people can walk faster than the elevator. When the elevator call button is pressed, a smaller group of fireflies near the elevator animate to point in the direction of the stairs. As a whole, this temporary installation is intended to draw attention to information posted nearby about the energy use of this particular elevator.

We are currently gathering baseline data on stair and elevator use and preparing to install the system. We plan to evaluate the system with respect to frequency of stair and elevator use, frequency of interactions with the system itself, and self-reports regarding the system's effectiveness in promoting behavior and attitude change.

3 Future work

There is much further work to be done in choosing and developing appropriate methods for participatory design of persuasive technology. Although many of my questions are common to other contexts for participatory design, some questions pertain more specifically to the design of persuasive technology: Just as games can help to articulate tacit knowledge and values, how can PD activities help to reveal resource consumption, which is often altogether unnoticed? How can a participatory design process incorporate baseline data on current behavior? How could goal-setting become part of the participatory design process? Should participants be introduced to psychological research on persuasion, such as that of Cialdini [4], and if so, when? Could techniques such as scenario writing or role playing better reveal reactions to and ethical implications of the persuasive technology? What is the relationship of non-participants to the persuasive technology that is eventually deployed?

I plan to conduct participatory design activities around environmental conservation at two sites: the Grinnell College EcoHouse and another institution or business in the town of Grinnell. EcoHouse will be occupied by a small group of students who are highly committed to reducing their ecological footprint. EcoHouse has recently installed resource monitoring systems, but these systems require users to sit down at a computer to view data; there is no immediate feedback on resource consumption. I plan to work with EcoHouse residents to develop ambient displays to provide feedback on energy or other resource consumption in a form that will help them to adapt their behavior in real-time, incorporating data from energy monitoring systems and possibly other sensor systems in the house. While this work is clearly related to Petersen's recent work on dorm energy use reduction contests [16], a contest is unlikely to be appropriate to this context of use; I will use participatory design methods to help develop suitable motivational elements.

Work at a second site will lead to more generalizable findings, and also allow me to revise and iterate on the design activities. As a business or other institution, this site is likely to be one in which environmental concerns are important but less salient than in EcoHouse.

Participatory design is complementary to ethnographic studies of "bright green" households [21] and intentional communities or "EcoVillages" [15] in that the focus is on design of technology use within a community rather than studying how technology is already used. Where Woodruff, et al. [21], find that households barely use monitoring technology after learning the rhythms of the house's energy use and generation, EcoHouse's student residents will be completely replaced in four years or less, requiring a relearning or renewal of appropriate practices. The research emphasizes not scientific understanding, but change: How can members of the community use information technology to promote more sustainable behavior?

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