A Bright Green Perspective on Sustainable Choices

Allison Woodruff
Intel Research Berkeley
woodruff@acm.org

Jay Hasbrouck
Intel Digital Home Group
jay.hasbrouck@intel.com

Sally Augustin
PlaceCoach, Inc.
sallyaugustin@yahoo.com

ABSTRACT

We present a qualitative study of 35 United States households whose occupants have made significant accommodations to their homes and behaviors in order to be more environmentally responsible. Our goal is to inform the design of future sustainable technologies through an exploration of existing "green" lifestyles. We describe the motivations, practices, and experiences of the participants. The participants had diverse motivations ranging from caring for the Earth to frugal minimalism, and most participants also evidenced a desire to be unique. Most participants actively and consciously managed their homes and their daily practices to optimize their environmental responsibility. Their efforts to be environmentally responsible typically required significant dedication of time, attention, and other resources. As this level of commitment and desire to be unique may not generalize readily to the broader population, we discuss the importance of interactive technologies that influence surrounding infrastructure and circumstances in order to facilitate environmental responsibility.

Author Keywords

Sustainable interaction design, green, environmental technology, domestic technology, qualitative studies

ACM Classification Keywords

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

INTRODUCTION

Growing concerns about global warming, natural resource depletion, and environmental degradation have prompted action by private individuals, governmental and regulatory bodies, non-governmental organizations (NGOs), corporations, and the academic and industrial research community. As eloquently argued by Blevis [6], the CHI community has much to offer in this arena. Human-computer interaction research has a well-established tradition of attention to socially relevant issues [15], including some initial explorations of environmental sustainability, e.g., [22,43]. Elevated interest in this topic has recently led to increased research efforts, as well as reflective discussion of the role of interactive technologies and design in addressing environmental challenges [19,31].

These efforts seek to ameliorate environmental problems by making technologies that are materially more environmentally responsible, and by influencing and helping people to be more environmentally responsible. As Blevis suggests, these designs implicitly choose among or inform choices of future ways of being [6]. But this is a nascent research area, and there is not a clear picture of the *ideal* that is being designed for – when we as researchers say we are trying to encourage people to be "more environmentally responsible," what exactly do we mean?

In this work, we report a qualitative study of "green" individuals in the United States who have made significant accommodations to their homes and lifestyles in order to be more environmentally responsible. Our goal is to inform future design efforts by presenting concrete information about existing green practices and beliefs. Our contributions are as follows: We describe the motivations, practices, and experiences of committed green individuals. We use our findings to inform the space of potential ideals. We discuss how realistic it would be for the broader population to approach the ideal represented by these individuals, and we propose technologies that might bridge differences between committed green individuals and the broader population. We further consider the obstacles that our participants have faced and the strategies they have employed in order to become more environmentally responsible and discuss how these inform the design of persuasive [13] and interactive technologies.

While our investigation covered a wide range of topics, we focused in particular on questions such as the following: How are environmental values enacted in everyday life? What personality factors and life experiences motivate green behavior? What role did technology play in our participants' efforts to be environmentally responsible? Did our participants approach environmental choices rigidly or flexibly? Is being a green a private or a public act?

The remainder of the paper is organized as follows. In the next section, we review related work. We then discuss our participants and method, findings, design implications, and conclusions.

RELATED WORK

A number of research projects have focused on technologies to motivate and enable users to behave in a more environmentally responsible manner, for example by

promoting energy awareness [1,17,42], leveraging social networks to motivate individuals to reduce their ecological footprints [32], or reducing the coordination costs associated with ride sharing [43]. Other work has focused on the material effects of the creation, use, and disposal of interactive or pervasive technologies [6,23]. Our study seeks to inform such efforts through a holistic investigation of environmentally responsible practice and experience.

The participants in our study are representative of a broader trend in environmentalism in which people are informed and inspired by a wide range of affiliations in ways that preclude social scientists from defining their motivations and actions as traditional social movements [16]. Accordingly, unlike previous social research concerning environmentalism as a social movement [2,9,35], we embrace the decentralized and sometimes contradictory character of contemporary environmental action, and situate our participants in terms of social networks that can facilitate environmental communication and action [28,29]. As an extension of this position, we approach activism as only one component of environmental action that is not necessarily (or consistently) central to the identity or values of our participants. Therefore, unlike social investigations of environmentalism that prioritize activism, e.g., [4], our research focuses more distinctly on material culture and domestic practice as vehicles for understanding environmental values. This approach also provided us with a means of considering the role of technology for this population, as well as laying the groundwork for potential extrapolation to broader populations. We view such extrapolation interpretively in terms of experiences and do not attempt to map our findings to United States demographics [26].

PARTICIPANTS AND METHOD

We visited a total of 35 homes and interviewed a total of 56 participants (26 men and 30 women), as well as interacting informally with additional household residents. We focused our initial exploration in the United States because its high rate of resource consumption in proportion to population makes it a clear candidate for technologies to support environmentally responsible lifestyles [38]. The United States was also a strategic choice because the American suburban lifestyle and culture of consumption, which has been extensively critiqued as environmentally unfriendly, has become a worldwide aspiration, contributing to pollution and heavy resource consumption in areas such as China and South America. Within the United States, we chose field locations to represent areas that have strong activity in the green movement, and to represent diverse climatic, cultural, and economic conditions. Accordingly, we visited homes in Portland, Oregon; Bend, Oregon; the San Francisco Bay Area, California; Santa Barbara, California; Los Angeles, California; Taos, New Mexico; and Albuquerque, New Mexico. In addition to the home visits, we also interviewed several experts on topics such as sustainable development, green building and remodeling, and the design and construction of pre-fabricated homes.

We used an organic recruiting process that leveraged contacts in green movements, contacts made at green home tours, and advertising in community email lists. Research participants were selected with an eye toward diversity in socio-economic status, age, gender, home size, amount of experience with environmentalism, and aesthetic preference. Almost all participants were adults, at a variety of life stages. Participants had a range of occupations (e.g., midwife, IT director, traveling bookkeeper), although the sample particularly emphasized people involved with the green building industry (e.g., green architects and builders). The majority of our participants might be considered "bright green environmentalists," who believe technology is a resource for achieving gains in sustainability (as opposed to for example advocating the relinquishment of technology in order to reduce environmental impact) [8].

We selected research participants who had chosen environmentally responsible home systems, features, and/or construction, e.g., use of reclaimed materials, solar panels, automation systems to improve energy efficiency, etc. We chose to focus on such participants because modifying one's home represents dedication: the process requires significant expenditure of resources; the home is strongly connected to personal identity and daily practice [33]; and changes to home systems and structure are generally long-term, as they are not trivial to modify or undo. Further, opportunities for technological intervention abound in the home [18], and green buildings are of high strategic importance from an environmental perspective (for example, [14] reports that the built environment accounts for 48% of United States energy use, as contrasted with 27% for transportation and 25% for industry). The homes were in urban, suburban, and rural areas (e.g., the desert), and were predominantly single-family detached homes, although a few were in affordable rental housing or intentional communities. The homes took many physical and aesthetic forms, from high-end modern structures to off-the-grid Earthships.

We conducted home visits from October 2006 through February 2007. Visits typically lasted two to three hours, and consisted of a semi-structured interview, a participant-led tour of the home, and activities such as drawing and annotating maps of the home, a projective timeline exercise, and/or a photo-elicitation exercise [21]. All visits were video-taped and photographed. All visits were transcribed verbatim, resulting in a corpus of approximately 3,000 pages (900,000 words). We performed an affinity clustering on a subset of the textual data to identify emergent themes [5]. We also performed a visual analysis, informed primarily by discourse analysis, of the approximately 5000 field photographs [39]. Our research team included a social anthropologist, an environmental psychologist, and a computer scientist, so our analyses were informed by these perspectives [45].

FRAMING OUR PARTICIPANTS' MOTIVATIONS

Our study included a highly diverse set of participants, and we found many different motivations for "greening" homes. This wide range of motivations can be clustered around perspectives that predominantly reflect three areas of influence: *counterculture bio-centric activism*; *American frontier self-reliance and rugged independence*; and *trend-focused utopian optimism*. While these clusters do help identify themes, they are not mutually exclusive and often blend and overlap. Borrowing from post-structural identity theory within anthropology, e.g., [27], these clusters can be seen as sets of influences that are representative of larger cultural and historical trends related to environmentalism as a social phenomenon in the United States. Therefore, we might see a participant's identity as the embodiment of fluctuating, multiple, and sometimes contesting cultural influences from which they sample to develop a point of view on the environment.

Among participants who tended to be most influenced by counterculture bio-centric activism, motivations often focused on stewardship of the Earth. This was expressed as a form of respect for the planet, a desire to protect it and keep it free of industrial contamination. Some described this position in Christian terms, and saw environmental adaptations to their home as a form of religious duty. Other participants cited spiritual beliefs that might be categorized as "hippy," "New Age," or neo-pagan (often Celtic and Eastern or Native-inspired cultural practices). Some of these motivations were linked to a general anti-establishment perspective which condemned "mainstream" anthro-centric views of the natural world as a resource for production instead of as a global ecosystem in which humans play a role. Perhaps less obviously focused on spiritual practice, but still influenced by countercultural and bio-centric perspectives, were participants who cited a set of motivations they viewed as holistic: health, environmental conditions, social justice, and personal development. In many cases, this also included a sense of ethical responsibility to future generations and the desire to create a healthy physical environment for one's children.

> *Jay*: "So your occupation currently is teacher?"
> *Cecilia**: "Yeah. Mostly. I mean, steward of life."
>
> **Participants' names have been changed to protect anonymity*

Strong self-reliant tendencies of some participants can be seen in motivations such as frugality and minimalism. These participants tended to focus on limiting themselves to necessary essentials and practicing strict conservation methods. They valued quality and product durability and longevity. For some, this frugality and conservation manifested through an adherence to a Do-it-Yourself (DIY) mentality in which creativity, ingenuity, inventiveness, and practicality were highly valued and were put to use to side-step mass production and consumerism in the interest of the environment. Related to these sets of motivations was a new form of patriotism that has recently merged with environmental concerns. This was expressed in the form of growing aversion toward dependence on foreign oil, which frequently led to a focus on forms of alternative energy.

Finally, some participants were motivated by the desire to set themselves apart from others through trend-setting actions taken in the interest of environmental sustainability. This desire often manifested as bold statements expressed through material possessions such as hybrid cars, high-design houses, or clothes made of organic or recycled materials, and sometimes extended to occupation, hobbies, and other practices. This motivation was identified in some architects, entrepreneurs, inventors, and developers, and could easily encompass the rise of "eco-chic" celebrities.

Many of these motivations are based on values shared with larger segments of the United States population. Consistent with the growing interest in environmental issues (as evidenced for example by the rash of news coverage in the past few years and the success of Al Gore's "An Inconvenient Truth"), this suggests that green practices have the potential to reach a broader population.

LIKE LIVING ON A SHIP

For many of our participants, living in a green home meant constant activity to keep it in tune with nature's changing state and rhythms. Residents of passive solar homes minimized energy use and maximized comfort by constantly reconfiguring windows, doors, skylights, solar panels, etc. For example, at the end of the day, many participants opened strategically chosen windows on lower floors in combination with skylights to create a "thermal chimney" effect that pulled fresh, cool night air in through the lower windows and flushed stale air out through the skylights. Keeping the home in tip-top shape was another strategy to increase efficiency – for example, clean solar panels or clean refrigerator coils are significantly more efficient than dirty ones (cat hair on refrigerator coils can account for the use of a surprisingly large amount of electricity). Consistent with this ongoing configuration and maintenance, many participants directly or indirectly used the metaphor of "living on a ship" when referring to the experience of living in their green home.

> "You have to treat it kind of like living on a ship... You know, you have to batten down the hatches at this time of day and then open them back up at this time of night and, you know, things like that to get that efficiency. You have to close the big thick curtains during this point in time and then open them at that point." – *Jason*

> "That is the price of living in a house like this. You have to be engaged. If you disengage, she will not work for you. She will not do the stuff she's supposed to do." – *Kylie*

> "Now, passive solar is... somewhat of a misnomer. [laughs] It's passive from the point of view of the building, there's no moving parts in the building. But it's not passive as far as the occupants, because the occupants have to be active." – *Tony*

The participants enjoyed actively engaging with their homes and the resulting connection to nature and the local

environment. In learning to time their behaviors to optimally care for the home, participants acquired an increased awareness of daily and seasonal rhythms. Variety was further introduced by many of the homes' strong connection to natural views and light and the resulting sense of "living outside," as well as by the diverse and responsive character of specific places throughout the home (e.g., a floor that absorbed heat and became warm to the touch where sunlight struck it during the day, and released that heat to warm the home at night). These varying natural rhythms, combined with the diversity and dynamism of places throughout the home, had the pleasurable effect of making home life richly textured, engaging, stimulating, and restorative [25]. Many participants developed a new sense of the home as "alive," as a structure that wakes with the sun and is put to rest at night.

> "I called her a she because I feel there's an energy in this space for me. And to me it is a feminine air. I mean I just feel like the Earth is giving me a hug in this house... for me this structure is a living being that is allowing me to live within her. And if I take care of her, she'll take care of me... It's sentient because we're here to help her do what she needs to do. And by helping her do what she needs to do, she gives us what we need... the house is a family member." – *Kylie*

> "We call them [the heavy blankets insulating a 125-foot long expanse of windows designed to heat the home] window coverings, but when we're dealing with them, we call them sails… because it's like raising and lowering the sails… it takes us 15 or 20 minutes [twice a day] with both of us working... It's quite—it actually can be really cool and meditative." – *Kylie*

Active home management, while often pleasurable, plainly required commitment of time and energy on the part of the participants. Participants tended to orient to this endeavor a way of life or a hobby, rather than as an inconvenience.

> "I now do a complete shut down. I turn off the monitor. I turn off the computer. As soon as the computer shuts down, I turn off the power strip and I turn off the power conditioner. I try to cut out every extra ounce of anything. Does it take me a little bit longer? Do I have to get used to it? Well, yeah. But so what? I mean, I can get used to that. That's not a big deal... You know, it takes a little time. But my time is—you know, the planet is worth my time." – *Kylie*

Such investment of time, labor, and attention often characterized other areas of the participants' lives as well. Note that while our sample included a number of wealthy participants, it also included a number of participants of more modest means, e.g., participants who lived in low-income housing, as well as a number of middle-class participants. Many treated green efforts as a high overall priority in their household budgeting, and many also found cost-effective but time-consuming ways to express environmental values. For example, some participants spent extra time to take public transport or to coordinate carpools. Others took the trouble to bring their own Tupperware to restaurants when getting take-out food in order to avoid disposable containers. These narratives often accumulated in the form of green ethical standards, a demonstration of their green values and a source of personal satisfaction. Conversely, simply "purchasing" green did not appear to provide the same credibility as a personal investment.

> "I feel like I am cheating because I did not design it, you know what I mean? So it is like this awesome house and [people] associate it with me and I feel I am an imposter, if you will. But I think, you know, it says I'm cool, I hope… I have a friend that says 'If they don't think you are cool wait until they see your house, and they'll really think you're cool.' [laughs]" – *Jane*

CONSCIOUS CHOICES, CONTINUOUS COMPUTATION

Participants were highly reflective and analytic about the choices they made in their lives. Participants continuously evaluated their behaviors and needs in order to make careful decisions that were respectful of the environment.

> "Mindful is how I would describe myself. I try to at least be aware, be mindful. To consider every thing beyond me. So if I'm unclogging a clog, I want to be very mindful to what I'm putting in there so that I don't kill everything else or myself while I'm doing it. The energy that I use. Do I need to hang it up versus drying it as a means of saving or conserving? Those questions are always in my mind. I don't know. Green is being mindful. That's the best way I can say it." – *Cecilia*

> "It's stupid, tiny little awareness adjustments. It's about being mindful. It's about thinking, 'Okay, I'm making a cake and I need eggs and cream and milk and this and that. And I'm going to open the fridge once, and I'm going to get all that stuff out. And then, I'm going to open the fridge once, and put all that stuff back in.' Instead of... open it up... the energy's just pouring out the door. So, I mean truly, the lifestyle for me is a bunch about just being aware." – *Kylie*

> "We have to weigh the pros and cons of each individual thing. But I mean, in my politics, the only thing we have to vote with in this country that really gets heard is our dollar. And until that changes, every dollar is a vote. Every penny is a vote. And I have to think really consciously about how I do that." – *Kylie*

While participants made decisions deliberately and considered them to have serious consequences, the decision-making process often took on a game-like or playful nature. Participants were engaged by these modest mental challenges, and frequently performed complex analyses to determine their preferred course of action. For example, household members might debate the relative advantages of buying an appliance from a local vendor versus buying it online, coming up with creative pros and cons related to the overall transportation costs for the different options. (It is interesting to note that participants' knowledge and reasoning about the environmental impact of computing devices was markedly less sophisticated than their thinking in other areas such as transportation, home energy use, water use, food purchases, etc. [20].) Participants also derived satisfaction from the cleverness and resourcefulness of their green solutions.

> "That screen in a Prius is addicting. You are trying to maximize every mile and I found that I had to turn it off because I was

trying too hard, and you get very competitive with yourself, and every Prius owner I know is that way. And when we meet each other it's like, 'How many miles are you getting?' 'Oh, I'm getting fifty.' 'You're getting fifty? Really? How are you getting fifty?' 'Well, I've, you know, I've done this and I've done that.' And there are all kinds of tricks and you get really competitive, not only with yourself but with other Prius drivers." – *Shirley*

For many participants, this continuous computation and estimation touched on almost all areas of their lives, from purchasing decisions to mundane activities. Participants were particularly curious to assess how their homes were performing, and were eager to figure out how to operate the systems and features in their homes to maximal effect. Many green homeowners enthusiastically monitored data such as weather readings, amount of energy produced by solar panels, and amount of energy consumed. Tracking the use and generation of resources helped them tune their homes, and records presented concrete evidence of their contributions to improving the environment and allowed them to calculate the financial rate of return they were receiving on their investments, e.g., energy savings on their utility bills. Participants found the data personally motivating and were often eager to share it with others who were considering building green, in order to inform and motivate them. Some participants also described instances in which friends or acquaintances with similar systems would compare data in order to better understand their own performance. Variations in system performance are often related to differences in microclimates of homes (shade from trees, topography, etc.) as well as system size and efficiency, stimulating friendly "competitive conservation" where chance, mechanical prowess, and perceived environmental commitment are all contributing factors.

Some participants became so fascinated with this monitoring that they came to consider themselves "data geeks." Most data logging was done manually, often as part of a daily ritual (we saw many pads of paper with rows of figures in utility rooms). Participants were interested in more efficient ways to track data, but were reluctant to adopt any monitoring system that might involve the use of more energy (for example, they expressed concern about systems that might require them to leave a computer turned on to collect the data).

"It really brings out the inner data geek. Right? I mean, you become a total data freak because now I'm all about... how am I doing? Have I put too many lights on and how much am I using? And I want to really keep track of it." – *Jason*

"In the beginning you look at it all the time, you're like, oh this is cool... When I go to bed, I go and lock the doors. I shut off the lights and I come down here [to the basement] and I log this and I log that and it has just become part of my routine. The end of my day." – *Jason*

"[*Reading the meter on the solar panel inverter*] 8,082 pounds of greenhouse gases we have saved since we've started. We think that's pretty substantial for a little house like this." – *Jack*

Over time, this intense consultation of data was gradually replaced by an innate sense of how the home systems performed under different conditions. After roughly one to one-and-a-half years, the home owners had experienced all the natural seasons and had mastered and internalized the operation of their homes. By this point, their interest in the monitoring systems had often decayed.

"You know, for what we do, we don't have a need [for data logging]. I can almost on a daily basis walk in the front door without even looking at a meter and know how much power we produced just by knowing the time of year, how much sun we got from the day. And you just—you live with it every day, you get to a point where it's like your own little data logging [*points to his head*]. You know, I'll walk in and I'll say, 'Oh, we made about 5 kilowatts today,' and I'll look and we'll have made about 4.95." – *Mitch*

"I can look at my daily usage and see how many kilowatt hours I've generated and how much I've used and, for a while, I was like addicted. I was going on all the time just to see—I'd turn stuff on, I'd turn stuff off, just to see if it was making a difference. I haven't done it in years because I've been here a long time, but it's fun, I think as a learning..." – *Shirley*

Despite the reduced interest in their static, existing methods for data monitoring, participants explained that more advanced data collection and analysis tools would be useful for identifying high-leverage changes that could be made to the homes and for troubleshooting existing systems. Even for these attentive, active and knowledgeable homeowners, problems with the home (such as a poor insulation seal or an inefficiency in the configuration of the water heating system) were often difficult to detect or diagnose.

THE PATH
Participants oriented to green living as an evolving and continuous process. Becoming green was not considered to be a discrete or bounded act, e.g., buying or constructing a green home. Rather, participants had a strong sense of progressively developing increasingly advanced behaviors and strategies, and of striving to become increasingly environmentally responsible over time. Similarly, the homes in which they lived often become more green over time, in an evolutionary or piecemeal fashion [12].

"Don't try and take it all on at once because it becomes overwhelming. You know, that's the problem is it becomes daunting... do it one thing at a time... pick one or two things that are really important to you, and that makes a difference... give people a break... as much as, you know, we want everybody doing the right thing, it takes time." – *Shirley*

"I think of it as a path… in a way it is an apt way to describe it because it makes you more conscious of every step you take. It really does. To start not doing things automatically but doing things as a result of thought and analysis, you know, of what would be a better way to do this." – *Janet*

This evolution tended to take the form of often overlapping phases, each consisting of self-assessment, research, experimentation, and ultimately stabilization of habit. A

given phase tended to focus on a given area such as energy conservation or organic gardening. Once participants had established a certain level of competence and/or they had achieved a specific goal (e.g., they had established water conservation strategies), they would then turn their attention to a new challenge, often a more advanced behavior in an area they had already explored, or perhaps a more elementary behavior in a previously unexplored area. While addressing this new challenge, participants typically fully maintained habits formed during previous phases.

This evolution was often associated with a distinct narrative order, a natural strategic sequencing of modifications to behaviors, activities, and purchasing. Naturally, paths were individually tailored, but certain sequences were considered more logical than others due to factors such as expected environmental benefit and personal readiness. Participants typically had a strong sense of where they (and others) were on the path to more sustainable living, and what the next steps should be (both in the near term and in the long term). As discussed further below, they were highly motivated to teach the path, to take visible actions to inspire others to follow the path, and to illustrate the path by example.

> "You have to eat your conservation vegetables before you get your solar cookies." – *Cory*

> "I just think it's a path and we've been on a path for the last eighteen years since we've been married. And working this way the whole time. What you want to do is get people to step on the path and acknowledge that every decision they make has a consequence. And you can do that in a way that's not guilting people. You just understand... we're making all sorts of decisions that are consequences. But if you're conscious about it, you start to change what you do. And then you never go back... you can ask [questions] about how you buy a pen. Or how you buy a computer. Or where you're gonna—which movie you should go see. You know, kind of go through anything if you want, and say, 'What are the impacts that are going to come from this decision I'm making?' And I think that's what we want people to just start doing. Just be a little more conscious and aware." – *Cory*

Participants generally demonstrated a strong acceptance of where they and others were on the path. They pragmatically weighed different factors (e.g., environmental, financial, and/or aesthetic) when making decisions, and honestly assessed the impacts of the options. Many participants emphasized that it was important to reflect on every choice and thoroughly consider green options, but they accepted the fact that in the end, not every decision was maximally green, particularly at earlier stages along the path.

> *Ken*: "We always asked, in each step of the—every decision we made we've asked the sustainable question, like what can we get that would have more recyclable content? Or what can we get that would be less toxic or, you know—"
> *Elizabeth*: "Or more energy efficient."
> *Ken*: "And we didn't always win the battle."
> *Elizabeth*: "Yeah, right."

> *Ken*: "But we always asked the question and I think we spent months trying to find just the right tile."

> "I wanted to look at every system that we could. How— everything that we're touching, let's see how we can make it green... Just do a thoughtful process and if it's not green, you know, that will be fine, too, but just let's try and make it as much green..." – *Shirley*

> "We made the best choice we could at the time and now we've acquired more information and we'll be upgrading that system... So, it's just evolution. You learn a little, you know—One of my favorite quotes of all times is by Maya Angelou... someone asked her about 'Do you have regrets about decisions you've made in your life?' And she says, 'You do the best you can and when you know better, you do better.' That's kind of a great way to look at everything. Don't beat yourself up for not knowing. You can't see the future. But when you know better, you do better." – *Kylie*

Participants mentored others to stage their behavior appropriately and realistically. They were also eager to construct and advocate green experiences that were sufficiently aesthetic, comfortable, affordable, and convenient to appeal to the "mainstream." They were anxious to correct historical perceptions of green homes as "ugly" or "weird," emphasizing that green buildings can be very beautiful. They were also eager to communicate that being green is not necessarily a sacrifice, offering benefits such as financial savings, or better health through improved food quality and improved indoor air quality.

> "My passion is to figure out how to make these concepts mainstream... you have to be introduced to the concepts at some point before you start exploring them, and so how's the best way of introducing the concepts to the masses." – *Tony*

ACTIVISM BY EXAMPLE

Many participants wanted to bring about broad social change that would benefit the environment. They viewed their personal decisions as a way to influence other people towards more environmentally responsible behavior. They constructed homes and lifestyles that were intended to serve as literal demonstrations for others, and they felt that living by example was an important type of activism. Further, those who had green occupations often felt that they needed to live the cause in order to promote it most effectively.

> "This wasn't a financial endeavor for us. This was a lifestyle... This was really a global decision as far as how we would like to see the world, and how we want to participate and show people that it doesn't mean you have to live in a yurt with certain sacrifices that, I think, some people kind of attribute to solar, though that is changing rapidly." – *Kayla*

> "We got our first hybrid in 2002... When I drove that car, I was doing something right every second and it changed my life... You know, I'm always politically active... We were doing stuff, but suddenly I had this thing that took me into the world, that immediately identified me to anyone who looked at me where I stood. And people stopped me on the street and asked me about my car. And I put information flyers underneath the windshield so people could pick them up. I mean, suddenly, it was like I

was an activist every minute. And it added so much value to my life. It just turned me on. It was like, 'Wow! I'm doing something right every second.' And I have this way to not be screaming about it, but show people that I care." – *Kylie*

Many participants sought instructional roles, for example by teaching classes or by routinely giving tours to teach people about the green features in their homes. Some homes had had thousands of visitors, and some homes even had descriptive labels and signs permanently on display throughout. Some participants also spoke of making choices in their homes that were optimized for influencing others rather than for personal preference.

"It's my duty. I mean that's my calling in my life is to be a teacher and a leader. And once you have the knowledge you can't turn back. So I'm responsible for that. And I can't talk or teach about it without living it. Or else I'd be a hypocrite. So everything I do I try to just promote that..." – *Cecilia*

"Everything here is to learn." – *Cecilia*

"People tend to enjoy looking at the solar. And being curious... Oh, this place is a spectacle. You see people looking all the time. 'What's that?' 'Those are bottles.' 'Oh, what's that?'" – *Cecilia*

In many cases local community members also took the initiative to seek out our participants for advice and instruction. Whether participants were "proselytizing" or responding to requests for information, they had learned to craft strategic messages and to strike an effective tone (e.g., to employ humor or subtlety instead of being "pushy").

"People know that we're, you know, the green beans in the neighborhood and if they have a question about, 'Can I recycle this or not? Is this recyclable?' they usually come to us to ask that question... I mean, we use it in our own lives but we feel really good about being a resource. We almost feel obligated to be a resource to other people. So when people ask us the question we hope we know the answer to it. And so we really try to accumulate this information with the intent to share it... This is how we live our lives. And they think that that makes us credible. Which is great. And I think we've kind of finally, or I've finally—you've been longer at this than I have [*aside to Cory*]. But finally come to accept that ability to play that advisory role." – *Kathy*

In fact, participants who did not initially anticipate such a role often found themselves "thrust into the spotlight" due to the attention their homes drew.

"A lot of people are interested in it. You know, a lot of people stop and stare. And that was... something I never foresaw or really, had never really thought of... Bikes, walk. Whatever... Slow drive-bys and they turn around..." – *Ken*

"... just driving by and they slow down, roll down the window, and stare at the house." – *Adam*

While some participants were somewhat startled by unexpected "celebrity," in general most chose to lead very public lives in order to maximize their influence, and they endeavored to visibly display themselves and their green choices. They did not view green consumption and behavior as private acts, but rather as opportunities to inspire others. Naturally, these acts were strongly tied to identity expression and reinforcement. For example, solar panels and other large green features visible to passers-by were a clear indication of interest in environmental issues.

INDIVIDUALISM

Our participants' lifestyles appeared to require an independent spirit. Many of our participants reported that they had faced numerous challenges in their efforts to become more environmentally responsible, and expressed that support from community, government, corporations, etc. was generally inadequate. For example, the existing institutional hierarchy of financial institutions, contractors, and licensing and permitting authorities often provided poor support for those who wanted to build green homes. The participants fought not only to be more environmentally responsible themselves, but also to change the system. Although they did not win every battle, they were determined, and pushed on in the face of adversity.

"You just have to do it yourself. You're not really getting very much support from the government, or your country or whatever. You've just got to fight. You've got to fight, fight, fight for it... You just gotta stay focused because nobody else is going to come to your aid..." – *Kylie*

Our participants generally felt their efforts were rewarded. Through the process of pursuing their environmental goals and creatively solving problems, participants gained a strong sense of empowerment and a confidence in their ability to accomplish difficult (or even seemingly impossible) tasks. The participants generally seemed optimistic about the state of the world and saw their pro-environmental activities as contributing to the planet's health. The participants also generally seemed happy and exhibited high levels of psychological well-being [40], but it is not possible to establish a causal relationship between these factors and their environmentally responsible choices.

Another benefit for many participants was a sense of uniqueness; many participants had built a distinctive identity based on the fact that they saw themselves as separate from the "wasteful" masses. Many participants also appeared to have a strong drive to differentiate themselves from society as a whole. The adoption of distinctive opinions and the sorts of behaviors demonstrated by our participants are consistent with a higher need for uniqueness than is generally seen in the American population [34,41].

"Most people do what everybody does and we try to make our own decisions." – *Edward*

Because of their ability to nonverbally communicate important aspects of one's self-concept [33], homes are a particularly valuable way to signal uniqueness [3]. The participants' homes were often unique and even exotic due to environmental features and/or site-specific or custom design and construction (sometimes done by the occupants), as well as personalized and deliberate interior decoration.

Participants generally enjoyed the beauty and comfort of their homes and quite a few felt their homes were close to their ideal. Like many of their distinctive choices, the uniqueness of their homes was a source of pride.

> "This is a very atypical family in a very atypical house. I mean, to have built this house twenty-four years ago." – *Sheila*

> "I think [our house is] very much a reflection of how much we thought through it, and I think it also is a real reflection of independent thinking. I am not the type of person to be sucked in with status quo." – *Rebecca*

IMPLICATIONS FOR DESIGN

Our study has a number of implications for the CHI community's efforts to design for sustainability. While space limitations prevent us from discussing all of these here, we hope the findings above can be creatively appropriated by designers, and in this section we focus on some directions which we feel are particularly promising.

Personal Choices

Efforts to encourage individuals to make personal environmentally friendly choices (e.g., turn off lights, take shorter showers, choose energy-efficient light bulbs, use public transportation, etc.) appear to comprise much HCI sustainability research to date. Such efforts essentially assume a fixed set of options, and focus on encouraging individuals (or collections of individuals, sometimes mutually reinforcing each other) to choose "good" options from this set. This approach is well-aligned with traditional HCI perspectives and lends itself well to established design, measurement, and evaluation techniques. Our findings regarding our participants' real-world strategies for successfully influencing their own behavior and the behavior of others have numerous implications for the design of such persuasive technologies [13], for example:

Depth-based Learning. We were struck by the manner in which participants developed competence in a depth-based manner, focusing on specific areas. By contrast, many advice systems (both online and in print) present tips or recommendations for green actions in a breadth-based manner, for example proposing "top 10" lists of unrelated but "easy" actions. Our findings suggest that it would be more effective to provide focused programs that engage users in the motivating and stimulating process of developing expertise. Ideally such programs would be tailored to relate to the users' primary motivations, e.g., a user with health motivations might begin with a program to improve indoor air quality, while a user with minimalist tendencies might begin with a program to minimize the production of material waste.

Past-Present-Future Matching for Mentoring. Mentoring was highly valued by our participants, and is likely most effective when mentor and mentee are well-matched in terms of interests and motivations. One promising option is to provide an online recommender system to match mentors and mentees who appear to be at different points on similar paths, e.g., "You appear to be where Jill was 5 years ago. I suggest you talk to her about some of the challenges she faced at that point and how she worked through them."

Identity Expression. Our participants enjoyed expressing their green identity. Social networking and virtual technologies could be leveraged to allow users to express personal green actions and values, and to make green choices appealing. Making actions and results visible could also engage users in the types of competitive conservation we observed in our participants.

Modest Mental Challenges. Our participants enjoyed creatively identifying and assessing environmentally friendly courses of action. Posing mental puzzles appeared to be more engaging than simply facilitating awareness or prescribing behaviors. Based on our participants' descriptions of their personal evolutions, our findings suggest that persuasive technologies that cleverly pose modest mental challenges and interactive visualization techniques that help users explore the potential outcomes of different actions would be excellent tools for engaging and informing people at different levels of commitment. Also recall that while participants' found their systems fascinating at first, they lost interest over time as they themselves became more competent while the data and interpretative tools remained the same, suggesting these technologies would be more effective if they evolved over time along the same path as the user in order to keep pace with their deepening commitment and understanding.

Changing Circumstances

For our participants, the pursuit of environmental responsibility often became an ardent hobby, or even the fundamental organizing principle in their lives. Due to numerous institutional, infrastructural, societal, and material challenges in the current conditions in the United States, environmentally responsible behavior involved (and was often perceived to require) significant and continuous dedication of time, mental attention, and/or money. While our participants found this pursuit highly rewarding, many individuals in the broader population might have other priorities or might find these practices inconvenient. It seems unlikely that a large percentage of the broader population will be willing to allocate such significant resources to maximizing their environmental responsibility.

Consider for example those who live the "busy" lifestyle that has been extensively discussed as common to many American families [11]. This lifestyle is typically accompanied (and enabled) by a heavy emphasis on convenience and time-saving measures. Many of these measures (e.g., fast food, disposable packaging, not troubling to turn the lights off, etc.) are critiqued as environmentally unfriendly. From the perspective of such busy families, achieving a high level of environmental responsibility is not just a matter of getting more information or making

straightforward behavior changes. Rather, it requires either a profound change in values and lifestyle, or a profound change in the circumstances in which individuals are positioned. Many participants made it clear that being environmentally responsible would be easier if circumstances were different (speaking for example of relatively favorable conditions in Europe), e.g., if better public transportation were readily available, if environmentally responsible products were the default options in retail and grocery stores, if permitting processes for buildings favored environmentally responsible choices, etc. Additionally consider that a large amount of resource consumption is due to a "public ecological footprint" (infrastructure such as highways, etc.), and individuals have no direct control over this significant expenditure of these resources "on their behalf" [Steffen, personal communication]. Finally, consider arguments made by Monbiot and others that urgent and significant change is required in the immediate future, that small changes made by large numbers of people will not be sufficient to mediate the current environmental crisis [36].

These points argue for the vital importance of facilitating changes to the circumstances that *surround* individuals, as a complement to efforts to facilitate change *within* individuals. Our findings therefore support Williams' argument that some of the greatest potential environmental gains for technological interventions relate to infrastructures and the institutions that control them [30,44]. Consider for example the use of compact fluorescent lights. One can design tools to persuade people to use these instead of incandescent lights. Alternatively, Australia and California are exploring legal measures to directly ban the use of incandescent lights [24]. Of course, in addition to prohibiting undesirable actions, regulation and policy can also make positive prescriptions and stimulate innovation that leads to new, positive options.

The CHI community can make substantial contributions to efforts to influence policy, regulations, and infrastructure, by developing interactive technologies that target large-scale systemic and institutional change. Some of the following areas are particularly promising because they offer high returns in terms of real-world impact and they involve significant HCI research challenges:

- *Digital democracy.* How can interactive technologies help people effectively express their opinions to their government representatives? Will electronic letters be taken as serious indications of users' commitment to environmental issues? How can users express commitment and ensure that their contributions are not minimized because it is "easy" to forward an email or sign an online petition? Can content creation tools help users craft compelling arguments to lobby for environmental policy change?
- *Street science* [10]. What would persuade people to analyze and share data in order to influence government, regulatory, and corporate action? What tools can help everyday citizens gather, analyze, visualize, and share

environmental sensor data, e.g., air quality data [7,37]? What collaborative editing tools can be developed to support environmental analysis by local communities?
- *Organized social protest communities.* How are digital tools appropriated by existing activist groups in their pursuit of environmental justice? How can social networking tools help environmental communities organize and coordinate? How can communication technologies provide leverage and help small groups maximize their impact on global issues?
- *Ad hoc social protest.* How can online tools help *ad hoc* groups of disparate individuals effectively communicate with massive institutions? How can technology facilitate group decision-making that leads to high quality proposed solutions, given that collectively developed solutions are often mediocre? What design principles underlie systems that attract people to participate?

CONCLUSIONS AND FUTURE WORK

We have presented a qualitative study of 35 United States households whose occupants have made significant accommodations to their homes and behaviors in order to be more environmentally responsible. We have described the motivations, practices, and experiences of the participants, and we have discussed implications for sustainable interaction design. To complement this work, it would be worthwhile to study individuals with widely varying levels of commitment to environmental responsibility. Further, it would be valuable to study environmental practices in other cultural contexts, such as developing regions and Europe. These regions are understood to have different perspectives on sustainability, and practices in such cultural contexts will almost certainly lend additional insights for sustainable interaction design.

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