International Journal of Child-Computer Interaction 3–4 (2015) 14–22

Contents lists available at ScienceDirect

International Journal of Child-Computer Interaction

journal homepage: www.elsevier.com/locate/ijcci

Kids and thermostats: Understanding children's involvement with household energy systems

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ARTICLE INFO

Article history:
Received 4 April 2014
Received in revised form
11 September 2015
Accepted 17 September 2015
Available online 21 September 2015

Keywords:
Thermostats
Children
Families
Homes
Design
Environmental sustainability

ABSTRACT

We present a study of family practices around the use of thermostats to control residential heating and cooling systems. Our analysis is focused on the role of children and adolescents and factors that affect their participation in the management of household energy consumption. As "smart" technologies become more common in homes, our goal is to understand how we might involve parents and children together in learning about issues of environmental sustainability. Based on interviews with families, thermostat installers, and a thermostat designer, our findings suggest that thermostats tend to be adult-only devices. Children rarely (and sometimes never) adjust the temperature or program settings, and there appears to be limited opportunity for youth to become more involved as they get older. We encountered variation in family practices along dimensions such as age, economic situation, environmental attitudes, and type of heating and cooling equipment. Despite this variation, however, there was a pervasive lack of interest and awareness on the part of children, even among those who reported adjusting thermostats on occasion. Based on these findings, we discuss how this situation might be changed through the design of new technologies to raise awareness while creating more active and distributed participation.

1. Introduction

The technologies that families use to control household heating and cooling systems are increasingly "smart", interconnected, and distributed. These changes are helping move user interfaces off of walls and onto the screens of smartphones and tablet computers. With these changes come new opportunities to help families do a better job managing energy consumption while saving money and staying comfortable at the same time. There are also new ways to help families reflect on issues of environmental sustainability and the role of individual consumption in relation to global climate change. Despite these opportunities, the promise of new technology often remains unfulfilled, in part because designers fail to fully understand the complexities of existing socio-technical systems. Habits, social norms, and interactions among family members can all shape behavior in unexpected ways [1–3]. The presence of "smart" technology alone does not necessarily translate to increased knowledge or motivation to reduce wasteful consumption.

In this work we are interested in the role of children and adolescents in helping families think about energy consumption. In particular, as technology changes, what opportunities will there be to help children learn about how energy is used in homes? Going further, how might we involve youth as active co-participants with parents and other family members in leading more sustainable lifestyles? In trying to answer these questions, we argue that it is important not only to look to the future, but also to look to the present (or near past) to understand family practices around existing energy infrastructures as a way to inspire designers while avoiding pitfalls of the status quo.

To this end, we present a qualitative study of family practices around the use of residential thermostats in the United States Midwest. One of our key findings is that children and adolescents rarely (and sometimes never) adjust the temperature or program settings. This finding might seem obvious given that the management of heating and cooling systems is often thought of as a dangerous and costly activity. However, in this paper our aim is to develop a deeper understanding of *why* this is the case. As Shove has argued, mundane and routine aspects of everyday life merit scrutiny precisely because social constructions of normality have contributed to a ratcheting up of demand for energy-intensive services and lifestyles [4]. In other words, energy-intensive products and services that were once considered luxuries are now seen as necessities of everyday life. With these changes come corresponding shifts in the roles that various participants in family life are

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http://dx.doi.org/10.1016/j.ijcci.2015.09.002
2212-8689/

expected to play. A reason to study "normal" practices is that expectations about who can and should participate can change over time and that interaction design is one powerful way to bring about such change. This does not necessarily mean that kids should be responsible for controlling central heating and air conditioning systems – although this is not out of the question – but mobile and connected technologies offer new ways for kids to be involved in helping learn about energy consumption while influencing family decisions across a range of household infrastructures (beyond just central heating and air conditioning).

In this work we adopt a view of learning as a transformation of participation in a community over time [5–7]. For our purposes this means that children learn, in part, by becoming more active collaborators with adults in consequential activity. With these changes come corresponding shifts in identity – how children view themselves and their role in the family – over time. With respect to household energy management (and the use of thermostats, in particular) this perspective orients our analysis to pay attention to how the role of children and adolescents might evolve as they get older.

Studying family practices around thermostats is not a trivial concern; heating and cooling accounts for roughly 30% of domestic energy use in the United States and other developed countries [8]. More than that, however, as we imagine a future of ubiquitous household technology, are we making implicit assumptions about our target audience? And, if so, are we needlessly, and perhaps detrimentally, excluding the participation of children and youth?

2. Background

2.1. Technology and sustainability

We consider thermostats to be an instance of a broader class of technologies used to manage consumption of household resources such as natural gas, water, electricity, and heating oil [9]. Some of this technology (often described with the term *eco-feedback* [10]) is explicitly designed to promote environmental sustainability by raising awareness of consumption in terms of its magnitude and impact. While research in environmental psychology has studied eco-feedback in various forms for the better part of thirty years [10], more recent work in human–computer interaction has focused on the development of inexpensive sensing technology [11–13], innovative interaction designs [14–16,10,17], and an exploration of economic and psychological models of behavior change (e.g. [16,10,18,19]). The motivation for this research stems in part from the recognition that modern domestic infrastructures have made the generation, transport, and consumption of natural resources largely invisible [20]. Even though resources are precisely monitored and billed, households are largely unaware of the magnitude of their own consumption [20,2,21,3,19].

Along with advances in eco-feedback design, there is also a growing interest in understanding the interplay between technology and everyday social activities in homes [22–24,3,25–29]. This shift in emphasis brings about a corresponding shift in the unit of analysis from the behavior of individuals to the sociocultural practices of communities as mediated by technology [24,25,4]. Technology design from this perspective is understood as more than providing information to consumers so as to close feedback loops. Because artifacts play an integral role in shaping human activity [24,30,31,4], design can be understood as a way to help reconfigure existing practices—a strategy referred to as "practice as a unit of intervention" [25] or as a "practice as a unit of design" [24]. This emphasis on sociocultural practices is useful in part because everyday practices are entangled with cultural value systems and norms that help set expectations about who can and should engage in an activity and what form that participation take [5–7]. These issues become especially relevant when certain groups, who might otherwise be meaningful contributors, are largely excluded from an activity. In the case of children and adolescents this is particularly concerning because youth are not only consumers of natural resources in their own right, but are the next generation of adults who will face increasingly critical and complex challenges related to energy, water, climate change, and the environment. In this we agree with Ballantyne, Connell, and Fien [1] who argue that children are not simply recipients of environmental knowledge transferred from adults, but are active influencers of adult behavior and thought.

2.2. The evolution of thermostats

To understand the interplay of thermostat design and family practices, it will help to briefly review the genesis and evolution of residential thermostats. Our goal is not to provide an exhaustive history (see [32] for an excellent historical overview); rather, we discuss interesting points in the development of a design language for thermostats that has persisted to the present day. Starting in the 1950s Honeywell International released the first of its round thermostats (Fig. 1). Designed by Henry Dreyfuss, the round thermostat was simple and elegant and the same basic design is still in wide use over six decades later [32]. In some ways, however, much has changed. For example, Internet thermostats that allow users to program settings from anywhere in the world are becoming increasingly popular. Products such as Ecobee and Nest are dramatically rethinking the design of thermostat interfaces, and researchers are pushing these boundaries even further. For example, Yun and Gross [33] created the RayMatic, an anthropomorphic thermostat that represents temperature with an animated face displayed on a tablet computer.

Another important moment in the history of thermostats was the widespread adoption of programmable thermostats starting in the mid-1990s. Programmable thermostats are devices that automate temperature regulation in homes, ostensibly increasing efficiency and cutting heating and cooling costs. According to Energy Star, a joint program of the US Environmental Protection Agency and the Department of Energy, "properly using a programmable thermostat at home is one of the easiest things you can do to lower your energy costs. It's as simple as set and save" [34]. Despite this optimistic assessment, there are several shortcomings in the user interfaces of these devices that fundamentally limit their effectiveness [35–37]. As a result, their programming capacities are widely underutilized [8,36,32]. In response to studies demonstrating a lack of energy savings, the US Environmental Protection Agency announced that it would sunset the Energy Star specification for programmable thermostats as of 2009 [38]. A notable evolution in thermostat design was the release of the Nest thermostat in October 2011. The Nest combines sophisticated interaction design, machine-learning algorithms to assist with programming, and wireless connectivity to the Internet. What is striking about the Nest, however, is the continuity of the design language from the Honeywell round of the 1950s (Fig. 1). In a similar fashion, there are clear design parallels between many commercial smart meters and conventional programmable thermostats (Fig. 2), raising the possibility that family practices around the use of heating and cooling systems could be replicated in other forms of eco-feedback technology.

3. Study

Over a two-year period we conducted a series of semi-structured interviews with 23 families in the greater-Chicago area