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# The Importance of Homes in Technology Research

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**Abstract.** This paper argues for the importance of home-related research on technology. Several important differences between researching homes and researching workplaces are described, and several issues in conducting home-related research are discussed in the context of specific research efforts. Ways to advance home-related research as a discipline are presented, including an existing course on technology design with a home focus.

**Keywords.** Domestic technologies, residential technologies, personal computing, home computing, consumers, homes, computer-human interaction, CSCW, media spaces, design.

## 1 Introduction

Computing is being dramatically affected by the adoption of technology by the mass market of consumers and the infiltration of computer technologies into everyday lives—over 50% of American households now own a computer, for example, and the Internet is accessed at least weekly by 40% of U.S. residents.

Yet, technology in homes has to date received little attention within the research community. A quick check of the ACM Digital Library shows that there is at least an order of magnitude more papers about offices and workplaces than about homes and consumers (and the latter totals only a few dozen publications in the last decade).

As the discussant for the CoBuild'99 session on “Networked Home Environments,” I shall argue for the importance of homes in technology research. The two other papers in this session (Junstrand and Tollmar 1999, Kidd et al. 1999, this volume) are the springboard and inspiration for the specific topics discussed here.

The remainder of this paper starts by addressing why homes are an important topic in technology research and the relationship between CSCW and home-related studies. Next, I focus on a few key issues with home-related research that are raised by the papers in this session, and close by describing activities that will advance home-related research as a legitimate and respected research discipline.

Throughout this paper, I draw upon several years of researching domestic technologies and their interaction with family and domestic life, with examples from the Casablanca project, which explored new forms of home-based communication. I also draw upon my experience teaching a seminar on domestic technologies at Stanford University.

The primary goal of this paper is to inspire this community to question our deeply rooted assumptions about what is known about the role of technology and where that knowledge is applicable. Secondly, I intend to acquaint readers with the existing body of work on homes. Finally, I add to that body of work by briefly describing my own home-related work.

## **2 Why Study Homes?**

Why be concerned about homes at a conference about cooperative buildings? I cannot say whether homes are an appropriate topic for any specific research conference. However, I see homes as an important topic for research from a number of perspectives. The first perspective is that homes are, of course, technology-filled buildings. In the United States, there are 106 million households, and they each already contain technology for entertainment, communication and household infrastructure. Most U.S. households will have access to high-speed Internet connections within five years, and industry watchers estimate that 20% will have selected this service by then.

Furthermore, homes and technology are too important economically to ignore, and will become more so. For example, according to the Consumer Electronics Manufacturers' Association (CEMA), the average American household spends \$800 each year on consumer electronics. More and more of these devices incorporate computing technology, and even traditional items such as televisions and stereo components will soon interconnect digitally, thus creating the opportunity for new forms of home networks and consumer interaction generating billions of dollars in revenue.

Another reason to study technology in homes is that it is a rich research field, and has the potential to improve everyday life for millions of users. Also, work and home are intertwined now, and even if workplace concerns are paramount, it is difficult to ignore the work that gets done in homes (Junestrand and Tollmar 1998). Finally, homes are a challenging design venue, and deserve the attention of talented practitioners and innovators.

## **3 The Relationship of CSCW to Home-Related Research**

Even starting from the premise that homes are a worthwhile technological venue, it can be argued that the diffusion path of technology is from workplaces to homes and so CSCW technologies will naturally migrate to the home. In this section, I describe several important aspects of how homes are fundamentally different from workplaces. I hope to provoke discussion of the implicit assumptions of much CSCW research and how they are, or are not, applicable outside of workplaces.

### **3.1 Homes are not workplaces**

It is obvious that houses are not workplaces with respect to construction. Workplaces are designed to accommodate technology. Data networking is built into every component of a workplace. In contrast, houses are not designed for technology, at least not on a large scale. Furthermore, there are no standards for technology infrastructure in homes, though CEMA is working on a technology rating system for residences.

Also, commercial buildings benefit from professional planning, installation and maintenance of technology and its supporting infrastructure. For consumers, these activities can represent significant investments of time and money, and are hurdles to adopting new technologies. Another important difference is that adults of working age primarily occupy workplaces, whereas home technologies must safely reside with babies, children, elders and pets.

### **3.2 Consumers are not knowledge workers**

A key difference between workplaces and homes is that consumers are not knowledge workers. That is, motivations, concerns, resources and decisions can be very different from those found within workplaces. Buying behavior is perhaps the most compelling difference. Consumers make purchases based on aesthetics, fashion, and self-image in addition to practical considerations of cost and utility. In workplaces, buying decisions are driven by productivity concerns. The ways that consumers think about technology are also specific to the home setting (Mick and Fournier 1998).

### **3.3 Families are not organizations**

In the past 50 years, the study of families has been the purview of sociology, and there is a large literature on family dynamics and home life (e.g., Coontz). Family structures are complex and not hierarchical, at least not in the sense that corporate organizations are structured. Decision-making and value-setting are quite different within households.

Until recently, there have been minimal collaborations between computer scientists and sociologists, and technology has received scant attention. John Hughes at Lancaster University in the U.K. has pioneered cross-disciplinary studies (Hughes, O'Brien and Rodden 1998), as has Sara Kiesler at CMU in the United States (Kraut et al. 1996). Some social science methods have been incorporated into industrial research, such as Tony Salvador's highly influential "garage ethnography" efforts within Intel (Mateas et al. 1996). The use of time in households is also salient to technological research (Robinson and Godbey 1997).

## 4 Issues in Home-Related Research

The previous section presents fundamental framing differences between workplaces and homes. In addition, the papers in this session raise a number of methodological issues about creating and studying home technologies. The most obvious issue is where the research is conducted. Interestingly, the approach that we took in the Casablanca project differs from either the Aware Home or comHome projects. Another predominate issue is how to obtain meaningful consumer input and feedback. These issues are discussed in the remainder of this section.

### 4.1 Obtaining consumer input

Workplace technology design and user feedback techniques have received considerable attention over the last decade, and the mechanics of such projects have been refined. Those mechanics have to be modified for projects involving homes, to take into account issues of informed consent, boundaries and safety.

Informed consent is trickier for homes, because of the presence of children and the centrality of children to home life. Children need to be treated with special care in studies. Boundaries and rapport are also more challenging in homes; the social norms of being a guest are at odds with the inquisitiveness required for in-depth home visits.

Once the mechanics of home qualitative studies are understood, the problem arises of predicting how innovative technologies will be viewed by potential consumers. This is especially challenging for unfamiliar applications, as acknowledged by both papers in this session. At Interval Research, the consumer research group has developed techniques for home ethnographic-like interviews and subsequent analyses that have been widely applied to research efforts, both internally and in collaborations such as with HomeNet (Ireland and Johnson 1995).

### 4.2 Designing for homes

After a need has been identified and a solution has been roughed out, prototypes can be created at various levels of fidelity. The issue of fidelity can be very powerful in

home settings. We noticed when deploying an early set of Casablanca prototypes that homes do not easily accommodate the numerous pieces of equipment, cables, phone jacks and electrical outlets required for desktop conferencing, as illustrated in Fig. 1.

While trial users may make accommodations temporarily, good industrial design is a vital component of a serious



**Fig. 1.** An early Casablanca desktop conferencing prototype in a user's kitchen.

prototyping effort. A later Casablanca prototype of an awareness device illustrates this point, shown in Fig. 2.

### 4.3 Conducting participant-observer-designer studies

When a prototype is available, the question arises of how to get experience of it in use. Doing the research in one's own home is one approach to situated trials. The participant-observer approach can be quite informative when the participants are part of the design team (Adler and Henderson 1994). The Adaptive Home project at the University of Colorado was conducted in Prof. Michael Mozer's own home (Mozer 1998).

As we experienced in the Casablanca project, the participant-observer-designer approach has some unique implications. The system under study was derived from mediaspace work (Bly 1993) and featured a custom desktop conferencing application on standard personal computers.

Several issues arose. One issue was introducing housemates and spouses to the formalities of informed consent and intellectual property; the consent form was crafted to be complete yet not intimidating. Another issue is that of dwelling alterations. Making permanent changes for a temporary trial study was discomfoting; the home-owning participants were concerned about resale value and home décor, and the renting participants had to negotiate with landlords.

Having a trial system in our homes caused the work-home boundary to become blurred, though not necessarily in a negative way; housemates enjoyed understanding our work better. As participant-observers we wound up learning a fair amount about each other's home lives, things that we would not have learned otherwise. This may not always be perceived as a positive consequence.

### 4.4 Situating the research

A critical issue in home-related research is where to conduct the work, especially for experiential studies. Previous work has taken various forms, including true ethnographic studies, conventional usability tests in simulated home environments, and situated deployments of prototypes into real homes for limited or sustained trials. The two other papers in this session both approach home technologies in a situated way, though they represent somewhat different philosophies.

The Aware Home project (Kidd, et al. 1999) is taking the step of building an actual house, designed from the outset to accommodate technologies, technology trials and studies of technologies in use. Their eventual goal is to have people actually live in part of the house and have sustained experience with technology prototypes. Building



**Fig. 2. A later Casablanca prototype of a home awareness device.**

a house solely for research purposes is an ambitious undertaking, and will no doubt lead to significant new results. I look forward to seeing updates on the Active Home.

The comHOME project at KTH has quite the opposite intent; their dwelling is, as they state, "... best described as a full-scale model constructed of a number of scenario-like room set-ups," (Junestrand & Tollmar 1999). The IHome project at University of Massachusetts also uses the simulated dwelling approach (Lesser et al. 1999).

#### **4.5 Extending the research to real-world residences**

Neither of the above approaches replicates the home environment of the vast majority of people who live in existing dwellings; these structures do not readily accommodate the built-in technologies envisioned by designers. In the United States, about one million new homes are built each year, less than one percent of the existing housing stock. Existing residences are considerably more difficult places to add infrastructure technologies, such as the sensing mechanisms planned for the Aware Home.

Another concern is the limited validity of single-family residences. Over 20% of American dwelling units are multi-family units, or MDUs. MDUs can be quite different environments for technology, because of the greater density of both people and technology. Privacy, installation, and conflicting technologies can complicate the successful use of many new technologies in MDUs. Sensors and wireless technologies are particularly vulnerable to errors introduced by density.

### **5 Advancing Home-Related Research As A Field**

To this point, I have been arguing for homes as a topic of research, and I have addressed some of the particulars involved in conducting such research. Now, I would like to focus on a few activities within the research community that I believe are integral to establishing home-related research as a legitimate and respected discipline. These activities include integrating homes into educational curricula, building a community of practice around home-related research, and forging strong ties between industrial and academic efforts in this domain.

#### **5.1 Appreciating the multi-disciplinary nature of home-related research**

This field will by necessity be multi-disciplinary; project teams need to be familiar with the history of technologies, the nature of home life, examples of recent work in domestic technologies, and the pros and cons of specific technologies. Other relevant topics include industrial design, home automation and home networking, along with issues of infrastructure and the economics of technologies. Policy and regulatory issues are salient areas, as are home architecture and décor.

I particularly like Aware Home's multi-disciplinary team description. In my own research, the team included sociologists, user interaction designers, computer scientists, engineers, and industrial designers with varied backgrounds.

## 5.2 Teaching design with a focus on homes and consumers

In early 1999, I inaugurated a course at Stanford entitled “The Design of Domestic and Consumer Technology.” This course emphasizes the social context of the home with respect to technology design; other courses have been product design-oriented like one offered at the Royal Institute of Technology, or technology-oriented like one offered at Georgia Tech, or feminist-oriented like one offered at Simon Fraser University.

Fellow researchers presented recent studies of consumers and wired communities, and discussed the methodology behind their work. Topics included the social history of household routines and appliances; demographics; consumer market research (Wostring, Kayany and Forrest 1996); homes and family life (Marcus, Coontz 1992) and interactions between home life and work life (Nippert-Eng 1996). Methodological material included online demographic resources, learning from one’s own experiences as consumers, techniques for doing lightweight situated research, interviewing, structured approaches to data, and how consumer studies could inform design work (Norman 1998).

For term projects, these computer science graduate students conducted small qualitative studies. Project topics fell into four general categories: recreation and technology, communications in everyday life, computers in the home, and children and technology. The projects were successful, and although the small number of interviews limited external validity, the students did uncover original insights.

Students readily came to examine their implicit assumptions about consumers, domestic environments and the role of technologies in homes and everyday life. This experience convinced me of the value of teaching home-related research. This course could be sequenced with a general qualitative methods course; indeed, workplaces, homes, schools and other specific domains could all be options for students to apply general skills.

## 5.3 Converging on a body of practice

There is not yet a consensus within the community as to how home-related research is best accomplished. This issue exists within the CSCW and CHI communities as well, of course, although they have had over a decade of shared experience and have formed norms about what constitutes good-quality work. This leads to the question of how we can share work. There is enough ongoing work, and enough interest, to justify some kind of academic and industry workshop or gathering in the near future, and to justify serious consideration of creating a topic-specific publication venue.

Additionally, there is no textbook or a readily identified body of literature on domestic technologies. For course readings, I drew upon CHI-related work, including CSCW, CoBuild and DIS. I also drew upon sociological and behavioral research, market and consumer research, technological histories, feminist studies and design philosophy.

#### **5.4 Building strong ties between industry and academia**

Over the last four years there have been CSCW and CHI workshops targeted at domestic technologies and studying people in their homes (Scholtz et al. 1996, O'Brien et al. 1996, Tollmar and Junestrand 1998). Many of the participants have been industry researchers; the topic has not achieved a critical mass of interest within the research community.

There are currently a handful of academic research projects devoted to the home, including the comHome project at KTH, the Adaptive Home project at Colorado (Mozer 1998), the Future Computing Environments project at Georgia Tech, the IHome effort at U. Massachusetts, HomeNet at CMU, and the Counter Intelligence initiative at the MIT Media Lab. These efforts do involve industry partners, of course.

However, this is an arena in which industry is well ahead of academia; consumer-oriented companies such as telecommunications firms have been using living-room simulations in consumer research for years. Mainstream personal computer companies such as Microsoft, Intel and Hewlett-Packard have all recently invested significantly in consumer-oriented R&D, even to the point of altering their business organization to focus more on the mass market.

It will therefore be essential that the community form sustained, deep relationships between academic and industry research efforts. This will require outreach and adaptation by all involved. For example, academics will benefit from recognizing the salience of industry trade events such as the yearly Consumer Electronics Show (CES) sponsored by CEMA, with attendance of over 100,000. Indeed, at a CHI'99 informal special interest group on domestic technologies (organized by Beth Mynatt and me), CES emerged as the venue that would be most attended by those present.

## **6 Closing Comments**

In this paper, I have just touched upon the complex nature of home-related research and how it relates to existing bodies of practice and research. I hope that this is just one early example of what will be a long and rich stream of thinking, writing and designing for technologies with the home sphere in mind.

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