At Home with the Technology: An Ethnographic Study of a Set-Top-Box Trial

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The rapid growth and development of the Internet and the resulting growth in interest in access to network facilities highlight an increasing prominence of computer technology in the home. In this article we report on a study of the social organization of a number of domestic environments in the northwest of England and consider the ways in which an understanding of the nature of the home is of interest to the developers of future interactive technology. Thus, in the first half of the article we consider the everyday nature of home life, and in the second half we report on an ethnographically based evaluation of a prototype set top box for the provision of digital services to the home. In addition to reflecting on the nature of activities in the home we conclude by considering the design implications that can be drawn from an examination of these activities.

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1. INTRODUCTION: INTERACTION, TECHNOLOGY AND THE DOMESTIC ENVIRONMENT

Many technology providers have a sound knowledge of the technology they produce but not of the social context in the use of technology [Venkatesh 1996].

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In recent years a consideration of the increasing presence of computing technology in the domestic environment has emerged as an important new arena of study [Hughes et al. 1998; Kraut et al. 1996; O'Brien and Rodden 199; Venkatesh 1996]. This new focus is due in no small part to the targeting of the home by the producers of information and communication technology as the next key site of the consumption of such technological artifacts [Venkatesh 1996]. Such targeting concerns not only the familiar technologies of "home entertainment" but also technologies of the not-too-distant future that will permit a more interactive role for the domestic user in performing tasks ranging from shopping, to banking, to communication, and work itself. Such developments have important implications for HCI: in general, with understanding the relationship between the technical and the social and, in particular, with the extent to which the ideas and methods used to understand work environments can be transposed to investigation of domestic environments.

The view of work emerging from a range of HCI studies of organizational life is that of "real-time, real-world" ordinary, everyday collaborative activity [Bentley et al. 1992; Button and Sharrock 1994; Luff and Heath 1998; Pycock and Bowers 1996; Rouncefield et al. 1994]. When "work" is characterized in this way, the contrast between work and domestic environments is not at all sharp. Indeed, insofar as domestic environments are socially organized—and it would be difficult to think of ways in which they are not—then collaboration and cooperation are likely to be endemic features. Here, then, we see the ways in which HCI might develop a strong interest in the domestic environment as a site for the location of systems for supporting interaction in its broadest sense.

The incursion of distributed communication technologies into the home in ways which may erode the boundaries between work and domestic life constitutes another reason for developing an interest in domestic environments. The growing importance of the movement toward "teleworking"" is indicative of this trend and likely to be reinforced by the advent of interactive systems. Developments in distributed computing and the growing importance of the "customer" (both as a consumer and as an active party to the accomplishment of work) have tended to shift the location of "work" activity toward the domestic environment. Evidence for this comes in the growth of electronic banking, "teleshopping," and other forms of electronic commerce. These devices also point to the importance of the consumer, specifically the importance of the collection and interpretation of multifarious information about the consumer, and its role in shaping work activity. Smart household appliances, (such as the "Microwave Bank" or the "Intelligent Bin" [NCR 1998]), drawing on models of the social and spatial organization of the household and domestic activity, are developing from the trend toward "connectedness" and the embedding of "intelligence" into a wide range of everyday appliances.

The issues raised by an exploration of the role of the domestic environment as a technological environment resonate with many of HCI's long-standing concerns, and in particular engender an analysis of the specifici-

ties of the social organization of the application domain. In previous research [Hughes et al. 1998; O'Brien and Rodden 1997] we have begun to outline some of the issues that have emerged as of key importance to the design of such systems. These studies made use of findings from a period of ethnographically oriented study of a number of households in the northwest of England as a resource for the scoping of design issues related to the delivery of digital interactive services to the home environment. Our previous work has, then, drawn attention to particular activities associated with the social organization of household routines as worthy of consideration when setting out to design systems "for the domestic environment" [Hughes et al. 1998]. This consideration has been based largely on the notion of "scoping" design activities in a fairly broad manner—producing sensitizing concerns for designers to inform the design of systems from the outset. In this article, we wish to continue our exploration of the findings of this research, though with a different emphasis, by focusing more precisely upon the evaluation of a set-top-box (STB) arrangement for the delivery of interactive broadband digital services via the family television. This emphasis enables us to explore further key issues associated with the domestic environment, issues that continue to attract the attention of researchers in this area. We use ethnographically oriented methods to explore, and reflect on, aspects of technology usage and design in the home, focusing in particular upon the evaluation of the means of delivery of digital information.

1.1 Studying the Home

A notable exception among the general absence of studies of the home as a site for the consideration of computing technology is the work of Venkatesh [Venkatesh 1985; 1996; Venkatesh and Vitalari 1986]. Venkatesh has maintained a sustained and rigorous focus upon "home computing" since its emergence as an element of the "microcomputer" boom in the 1980's. He highlights the need for attention to be paid to the specificities of the social organization of the application domain when considering the likely success or failure of a given system or artifact within that environment. He outlines the failure of "home computing" to take root and flourish within the domestic environment as a consequence of its lack of compatibility with the kinds of practices and activities that are to be found within that environment. Venkatesh [1985] builds upon these observations, drawing attention to the importance of the interaction between the technological and social arrangements of the home in building an analytic model for theorizing the potential role of information and communication technologies in the domestic environment. He produces a theoretical model of the household as a technological environment that identifies two key "spaces" within the home:

> The social space, which is constituted by the social structure of the household and the activities performed within the household [and] the technological

> space, which represents the nature of the technological environment within the household.

In drawing out this distinction Venkatesh wants to highlight the fact that these two spaces interact in complex and unpredictable ways, and, moreover, that it is in the nature of this interaction that domestic technologies find their character. He summarizes the argument thus:

> *From the technology side, this conceptualisation shows how computers and new media technologies may be adopted and used; from the user side, it helps identify the internal dynamics of family life that determine successful (or unsuccessful) adoption and use of the technologies. This dynamic can be summed up as the interaction between the social space and the technological space...* We cannot assume that what the technology can do in the household is the same as what the household wants to do with the technology [emphasis added].

This position is, then, one that seems eminently in accordance with HCI's concerns, eschewing notions of generalized assumptions about the nature of the use of computer systems, assumptions generated by crude interpretations of technology's transformative "potential" and caricatures of the social organization of its context of use.

1.2 Methodological Rationale

Recent studies have taken up a number of themes identified in Venkatesh's pioneering work, and an increasing number of studies have focused on aspects of the interaction of technology and home life [English-Lueck and Darrah 1997; Mateas et al. 1996]. Research on the Silicon Valley Cultures Project [English-Lueck and Darrah 1997], for example, traced the effects of technology in the "mundane activities of everyday life" arguing that "we need to know how the many devices entering people's lives are actually used by real people" and suggesting that

> The interactions between information saturated work and networked families are governed by complex rules. These rules are subject to resistance. Exploring the nature of that defiance would reveal much about the workings of family and technology.

Our own analytic orientation is one that strongly favors the use of ethnomethodologically informed ethnographic descriptions as accounts of the social organization of a given domain from the perspective of those who are party to that situation [Garfinkel 1967]. It is our contention that such descriptions are a useful means of generating an understanding of the social milieu within which technological systems will be accommodated. As a consequence, these descriptions are a valuable resource in framing design approaches to particular domains by opening up a "play of possibilities" [Anderson 1994] for work and design that

> enable[s] designers to question taken-for-granted assumptions embedded in the conventional problem-solution design framework.

We see our approach as opening up issues surrounding design for domestic environments through the introduction of a set of sensitizing concerns, just as we have done for the design of systems within organizational contexts [Hughes et al. 1997]. Perhaps, most importantly, ethnographic methods can provide a means for "learning from the field" in analyzing social phenomena, opening up research and, by implication, design agendas, rather than closing them down in advance of that investigation in order to generate a range of formal analytic categories. As Pycock and Bowers [1996] note,

> Ethnographic work can be used as a resource for defining and redefining research agendas in CSCW. While many research problems emerge as significant within CSCW as a result of debates internal to CSCW itself or the disciplines that contribute to it, ethnography can help CSCW "learn from the field"...Ethnographic work, by elucidating *members'* problems and concerns, can influence CSCW researchers in what we take as *our* problems and concerns [Pycock and Bowers, p. 226].

It is, as ever, important to stress that we make no claims that the ethnographic methods we speak of are a panacea to the problems faced by systems design. In the context of this article, we report on our use of the method as a means of offering an evaluation of an STB as the means of delivering interactive digital services to the home. Our sense is that such evaluation techniques, in developing a broad understanding of the context of use and its relationship to the STB, is a pertinent evaluative contribution at this early stage in the development and refinement of such systems. Here we subscribe to Twidale et al.'s view that

> Evaluation can be understood as a process which should saturate and be constitutive of the design process precisely because the context of use is central to the analysis of CSCW systems... Summative strategies, aimed at providing such objective conclusions, are likely to prove inappropriate in domains where the context of use may vary in significant ways, and these domains are likely to be those in which CSCW has an interest [Twidale et al. 1994].

Compared to work environments, how and in what ways domestic environments may be best investigated for the purposes of design remain little explored, although, as outlined above, there is a growing community of empirical researchers who are reawakening the tradition of qualitative methods in this context, including those related to ethnography. The work we report on in this article is, then, firmly based within the principles of such a methodological rationale. In the following section we offer more detail in this regard.

2. THE STB TRIAL STUDY

The STB trial study reported here grew from an on-going strategy within GPT (a UK communications company specializing in the development of novel data networks and services). The company have been involved for a number of years in the various ATM initiatives concerned with providing high-speed network communications to the home. The development of

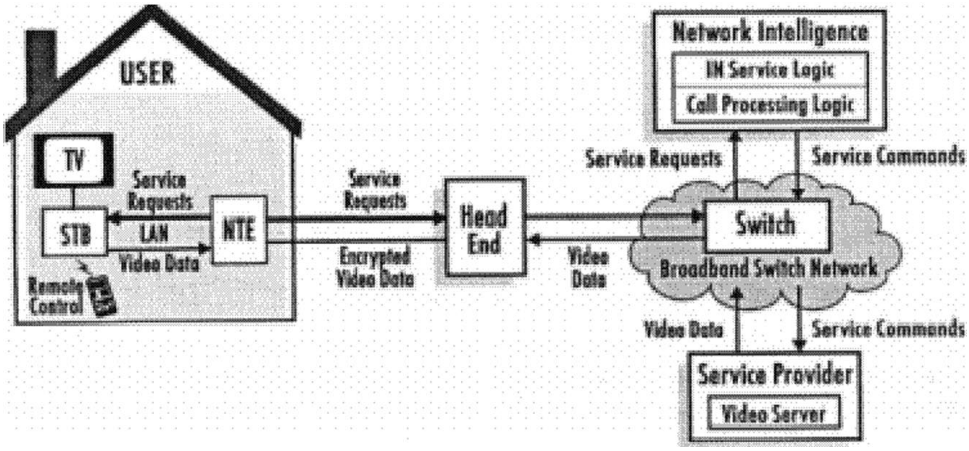

Fig. 1. The network to provide interactive services (from GPT's documentation).

supporting facilities focused on the provision of technologies in order to deliver particular bandwidths to the doorstep (see for example the schematic diagram in Figure 1).

As the company developed the underlying communication mechanisms to provide the necessary bandwidth to underpin ATM to the home, the developers' attention turned to the provision of higher-order services and the need to consider the deployment of networking services within the home. This shift in attention raised within the company a growing awareness that while their knowledge of the networking infrastructure and facilities delivering the network to the home constituted considerable expertise, they had little knowledge of "what was beyond the doorstep." The home represented a new domain of application, prompting an interest in sets of studies to inform development work and to provide a means of exploring a range of possibilities in the design, marketing, and strategic areas of the company's business.

Thus, from the point of view of GPT's development concerns, the main interest was in obtaining in-depth data on the ways in which members of households use communication, information, and other more "traditional" domestic technologies in their ordinary, everyday interactions. Given the time- and resource-based constraints of the project, it was felt that the appropriate field study method to use was one which could, quickly and cheaply, provide useful insights. The concern, for example, was not so much with rates of use narrowly conceived, but with how people, within their domestic environments, used and understood the technologies as part of their everyday activities.

Accordingly, ethnographically oriented methods of investigation were considered that might prove successful in the domestic context, a context typically constituted by small numbers of people bounded by strong personal attachments. It was acknowledged that introducing a fieldworker into such situations could be extremely difficult, even given favorable circumstances and that an appropriate role for the researcher would be

hard to establish for any lengthy period in such a quintessentially "private" environment. These factors, coupled with the practical constraints of time and resources, led us away from extended periods of fieldworker "immersion" within participating households, and toward a study based upon a series of evening visits to participants, taking part in evening activities such as meal times and some domestic chores.

Despite such constraints concerning access, gaining an understanding of the *natural sociality* of domestic environments was still considered vital to the project, i.e., to obtain data, mainly through informal interview and observations during relatively brief periods in each home setting, to allow us to present a picture of the ordinary patterns of interaction within the selected domestic environments. In this way, this study aimed at preserving the main point of ethnographic fieldwork, i.e., studying interactions within their natural "real-world" settings, in a way which would not only minimize disruption to the household but also provide relatively speedy feedback to GPT development work.

It is, then, important to reiterate the purpose of the fieldwork and its relation to the design and development of GPT's networks and related technologies. The study was never intended as a requirements elicitation investigation which would enable the team to draw up detailed and precise specifications for the design of specific technologies. Rather, it was intended to run in parallel with the diffuse design and development undertaken by GPT work and, through regular debriefing sessions, provide a better sense of the "real-world" character of households and, in this way, help clarify the conception and the potential role of the technologies under their early stage of development.

The STB trial was designed to provide insights as to the potential consequences of pursuing one particular delivery mechanism to the end-user. Interest in these insights emerged from strategic thinking related to GPT's technical undertaking; staff within GPT were conscious of the need to contextualize their technical work within a broader understanding of the potential developments in the application domain, and saw the STB trial as a means to explore these issues and thereby develop their strategic considerations.

In short this study was intended to provide a better grounding of design conceptions by sensitizing designers and developers to the character of the "real-world" domains being designed for. More specifically, the study's objective was to do this by highlighting key aspects of the social dimensions of households relevant to the potential uses of new domestic technologies; GPT's residential broadband networks place a new importance on the home as a site of consumption through new technological forms, and accordingly it is important to design these technologies with a more grounded understanding of existing patterns of social interaction.

2.1 Selection of Households

Having established the basis for the ethnographically oriented study of households, it became clear that it was important for the study to obtain

data on a range of households rather than subscribing to the myth that the typical household consists of two parents and their children, or assuming that such households are the obvious users of technologies running over GPT's domestic networks. Further, and to stress the point, the primary aim of the study was to inform design and development quickly by investigating the social organizational aspects of domestic environments which potentially could be supported and enhanced by residential broadband technologies and services.

The categories which eventually emerged in agreement with GPT were made up from a range of 11 households consisting of certain elements, such as

—owner of satellite television,

—owner of computer technology in the home,

—low-tech home (owner of little or no technology),

—a household that has made a significant leisure technology outlay, and

—a household that has gone on-line,

a range of family types, such as

—double income, no children,

—"the nuclear family" ("2.4 children"),

—older householders with teenage/grown up children, and

—single parents,

as well as

—those running a business from home

and a consideration of

—the geographical location of the participants—household in a town/city or more remote, rural setting.

It was agreed that strict representativeness of the population of the United Kingdom was not an achievable goal at this stage of the research (if indeed such might *ever* be achieved). Instead, what was needed was information on the daily activities of household members and how existing domestic technologies facilitated these. The emphasis, in other words, was on understanding the details of the activities of particular households rather than upon presenting a more general picture of aggregated household types.

Nevertheless it was decided that we should look for households which covered the categories listed above, formulated in discussion with GPT in order to provide a reasonable range of household "types." In addition, for practical reasons selected subjects should not be in the throes of divorce or

Table I. A Summary of Participants in the Household Study

Household No.	Male			Female					
	Status	Age	Occupation	Age	Occupation	Children	Ages	At Home	Income
1	MD	43	Surveyor	44	Teacher	2	14, 16	2*	(M) 45K (F) 12K
2	MD	39	Lecturer	38	Teacher	2	8, 11	2	(M) 20K (F) 10K
3	CH	27	Unemployed scientist	29	Student	0	n/a	n/a	(M) 2.5K (F) 4K
4	CH	26	Unemployed cartographer	28	S/emp music teacher	0	n/a	n/a	(M) 2.5K (F) 7K
5	MD	61	Printer	60	Costings clerk	2	24, 29	0	(M) 24K(F) 9K
6	S	n/a	n/a	25	Administrator	no	n/a	n/a	(F) 16.5K
7	MD	36	S/emp mechanic	36	Secretary	2	12, 15	2	(M) 12K (F) 11K
8	MD	47	Software Consultant	45	FE Lecturer	4	12, 15, 18, 20	2	(M) 50K (F) 18K
9	MD	39	Industrial Chemist	36	Mother	3	4, 11, 9	3	(M) 35K
10	S	n/a	n/a	23	Single Parent	1	3	1	(F) 5K
11	MD**	n/a	n/a	50	Teacher	3	13, 18, 21	1	(F) 20K + pension

Key: MD = Married, CH = cohabiting, S = Single
* Boys are at boarding school from Monday to Friday, and return home at the weekend
** Husband deceased in Feb 1987

other domestic calamities. A listing of some of the aspects of the households studies is provided in Table I.

3. UNDERSTANDING TECHNOLOGY IN THE HOME

The remit given by GPT for the study was the need to understand the overall nature of the home in order to inform *broad* strategies ranging from design to marketing alongside an understanding of the nature of *particular* devices and technologies to be placed within the home. Consequently, the study sought both to provide a *broad* background understanding of technology in domestic environments as a basis for considering the implications for a *particular* device. The study was undertaken in two phases: an initial study of the organization of the home and the place of technology of all kinds within that organization, contextualizing the more "focused" study of the STB trial. In the remainder of this article, we outline some of the important aspects of the first phase prior to presenting the key findings of the trial.

We reflect the organization of the study in the structure of the remainder of the article:

—In this section we consider some of the ways in which existing domestic technologies are integrated into the ordinary nature of home life, and we have selected a series of examples of everyday activities drawn from the study.

—In the subsequent section we focus on the findings of the STB trial, and integrate them with understandings emerging from the first phase of the study.

3.1 Daily Routine and interaction

One of the clearest facets of everyday home life that emerged in the studies was the importance in all households of "daily routine," of things "being as they should be" with the majority of such routines being driven by the concerns of work and/or children. These fundamental concerns underwrite the day-to-day existence of householders who organize themselves in order that such mundane yet essential activities get done, as parents must work and children must go to school day in and day out, year on year. Common sense means that sets of actions must emerge which meet these fundamental aims in the least problematic manner; these routines do not "fall from the sky," as it were, but emerge through the daily activities of householders ordering their lives:

> Get up at half past seven, have a quick breakfast. C1 leaves at about 8, runs to the bus. F and C2 leave at about 8:45, and C2 is dropped off at school; and F then drives to Preston. C1 gets back from school at about 4:30, does homework after watching TV programs.
>
> F usually gets back at about 2:30/3:00 p.m. and picks C2 up and then starts "the evening"—she then watches children's TV with C1 when he gets in. Then they eat at about 6:30 when M comes back from work; have dinner together in the kitchen around the table.
>
> If either of the children has anything on in the evening then this routine is fitted around it... brownies or amateur dramatics, for example.

Of particular note here is the extent to which these routines are intertwined with the use of technology. Another family was able to provide a precise run-down of the morning routine and, without prompting, marked elements of that routine with instances of the use of media or "entertainment technology."

> Won't have TV on during breakfast:
>
> *F* "Radio..."
>
> *C1* "... have TV on after we've finished breakfast."
>
> *F* "... after breakfast, yeah. They'll [girls] come in, and she [C2] watches UK Gold"
>
> *C1* "Neighbors"
>
> *C2* "... Watching old Neighbors"
>
> *F* "Yep, she comes in and watches it after she's had her breakfast."
>
> *C1* "I miss it."
>
> *F* "She [C2] usually misses it because she's faffing about in the bathroom."
>
> *C2* "... She'll sit down for five minutes while it finishes."
>
> *F* "In fact as soon as it finishes, we get up and put coats on... we know it's time to go to work then! [Laughs]"

Here then the mother of the family and her two daughters are able to offer a precise account of the close relationship between the use of media technology and their morning routines—the television is not switched on until breakfast is completed and the radio is turned off. At this point two of them watch a soap opera, the end of which acts as an indication that they need to leave for school and work.

While other households might not have routines formulated quite as precisely and explicitly as that outlined above, it was notable across the homes visited that the content and scheduling of television and radio was frequently used in the marking of time within the home, and labeling time as time off. The use of television to mark "time off" was one of the most frequent ways in which participants interleaved media use with their daily routines, as one working mother remarked,

> *K* "There's a program on Sky that's on when I come in from work, and I like to watch that. It's a chat show... talk show, yeah. So I will turn it on then and have a cup of tea, and then I'll start on the kitchen."

One of the significant issues here is that everyday routine activities in the home are so closely interwoven with technology. The technology not only fits within routine but may be used as a means of constructing the very routine of home life. Consequently, interaction with technology needs to be considered in terms of the richer patterns of interaction across the household; designers of interactive systems within domestic environments need to adopt a broad interpretation of interaction in the home.

3.2 Ownership of Space and Managing Interaction

In addition to marking time, the use of television, radio, and a high-fidelity stereo sound system also mark out the "ownership" of space within the home at certain times—householders establish a sophisticated framework of use which speaks to important elements of the social organization of the home. Certain spaces within the home clearly "belong" to particular members of the household at particular times as they use particular pieces of technology, as this extract from one visit makes clear:

> When their son and daughter lived with them, they had TVs in their rooms. Occasionally would watch together, but would come to arrangements if, when daughter was in, there was football—she would go upstairs and watch something else on.
>
> *M* "It was those American soaps. I didn't want to watch them... err those Australian things... she'd go upstairs then! Not being funny but the front room and that telly [points to the min television] was definitely mine in those cases... just like I wouldn't go into her room and tell her what to watch... that's her space, like."

These sets of rights and obligations surrounding the use of domestic technology were seen consistently throughout the range of households visited. While the specifics of which space "belonged to whom" differed from household to household, it nevertheless remained the case that householders'

activities within all the homes studied took some account of prioritized rights of access to technological artifacts; participants frequently made references such as "X always has to sit down and unwind with some music in the front room when she gets back from work" and other similar acknowledgments of routine priority over access to certain household spaces and technological artifacts in tandem. Such routines were invariably taken account of and oriented to by other householders, who tended to respect such temporary "ownership" of certain spaces. (This is not to say that such issues are never controversial. It was not uncommon to hear of instances in which such claims to space were deliberately contravened by other members of the household as an element of some disagreement or dispute.)

Another interesting element of such issues of access to technological artifacts and household spaces emerged in discussions and observations of parenting activities. It became clear that one of the means by which the role of the "good parent" was articulated was through careful control of access to certain entertainment technologies, most notably the television and the household spaces associated with them; younger children tended to have their viewing vetted by adults, and the room in which the television was kept tended to be regarded as an "adult" room after a certain point in the evening. Here these issues relating to access to domestic technological artifacts interleave with broader issues concerning the running of the home and the family, as this mother says:

> "I think you've got to... if you let them watch anything while they're still forming their views and opinions, they can get the wrong idea... I think if you've got children that you've started the right way... that you give certain moral values to, then they can watch programs that are maybe less appropriate or not appropriate, but they've already got the moral basis there on which to make judgments..."

What we are arguing, then, is that householders incorporate domestic technologies into the complex set of routines, rights, and obligations constituted in and through the social organization of the household; indeed we find that these technologies are *accommodated* within this social organization.

What becomes clear even from our initial observations of domestic environments is that interaction with technology is, in complex ways, a *managed* activity in domestic environments, and this management is closely linked with relationships within the home. Thus, as we see in the example above, controlling access to services (e.g., television programs, interactive games) is not merely a matter of providing a simple permission model; rather, it is intimately bound up with the subtleties of relationships within the home.

Designers of future interactive systems need to reflect on the managed nature of interaction with domestic technology and consider the broader context within which technologies are placed. When placed in a domestic environment, technology is likely to be integrated within the interactions

central to everyday life, suggesting that designers need to consider the management of interaction as an issue shared across the household, requiring appropriate access and management facilities. This broadens the consideration of interaction from a focus on the interaction with a particular device to consider the various roles that technology may have in the broader interactional setting of the home.

3.3 Overloaded Space, Distributed Interaction, and the Coordination of Home Life

In documenting such routine activities and their place within the social organization of the household it becomes clear that living and action are *distributed throughout the home*. This is facilitated to no small extent by the ways in which the functionality of certain domestic technologies, so intimately connected with the "routineness" of that living and action, enables householders to coordinate their activities. As is clear from the issues referred to in the previous section, it is important that householders have the means to maintain the routine activities to which they are extremely attached in all manner of significant ways; appropriate functionality is, therefore, required of domestic technologies in order that such accommodation into the social organization might readily be achieved, as we see in the following extract from a visit to one household.

> *M* "There's no conflict [over use of space]. They all do what they're told! [All laugh]... There could be a possible conflict of interest, but it's such a big house, that if you want to do something and find a hole in which to do it... um, the only conflict arises when we've got one television and one hifi stereo system, in a similar area... and that... which is up there... but both of them can actually be plugged into headphones, so if there's only one person wanting to watch Baywatch [R had joked earlier about his enjoyment of this program]..."
>
> *F* "...or wanting to listen to it [laughs]... the rest of us can watch it..."
>
> *M* "...everybody can watch it... which is all we do it for. Really. We don't really listen to any of it! [All laugh]... but, er, they can plug themselves in."

Here, then, we note a technological solution emerging to a problem of household space—this family lived in a house with a large open-plan living room containing the home's only television and a large high-fidelity stereo sound system, an arrangement which presented certain problems when both pieces of technology were required simultaneously. In the above extract the father of the family states that this is one of the few instances where such problems emerge, since the house is sufficiently large enough to accommodate most activities at some point within it.

Interestingly, such points clearly continue to reflect the relationship between technological artifacts and household routine. The functionality of television and high-fidelity stereo sound system technology provide popular entertainment opportunities for household members, but at the same time dictate, to a certain degree, the physical location within which such activities can take place; in turn, this impinges upon the ability of house-

holders to "find a hole" elsewhere in the house in which to pursue their activities without disturbing others. The "pull" of technological functionality into a limited household space leads to tensions such as those outlined above, where the demands of multiple householders "overload" the affordances of the domestic space in question. In the above example, a "technological" solution is employed to ensure that the activities of all family members remain coordinated, despite the concentration of technological functionality within the living room, while it is worth noting, that, to the same end, the majority of households also had mobile or at least portable televisions and stereos in order that their functionality could be distributed at will throughout the household.

Accordingly, we wish to argue that notions of interacting with domestic technologies require a broad understanding of the coordination of home life, and the relationship of technological functionality to that coordination, and further that such insights represent key elements of the "opening up" of design issues in this area. That said, it would be erroneous to characterize such issues of coordination solely in terms of the relationship between technological artifacts and household space, since householders are required to consider the activities of other family members. Thus, the same family also discussed the problems that the open plan of their living room presented them in other areas of their home lives:

> *F* "But there is a slight problem... if either of us wants to have a meeting...you know, for anything we're part of... wants to say to the committee 'Have it in my house this time,' there is... I mean... it's fairly minor... but it does mean that the other person either has to sit here [at the dinner table] quietly doing something... and feeling as if they're intruding, even though they're trying not to and they're not part of it... um, and therefore if we want to, you know, it's slightly more awkward for us to do it. Whereas sometimes I would say to people 'Oh come to our house,' I'd think twice, 'cause I'd think 'Well that's alright, but where's M going to go?' You know, 'What's he going to do?'"
>
> *M* "I mean we ought to sort it out by putting some sort of dividers across here [center of the room]..."
>
> *F* "...we keep talking about perhaps putting some sort of divider..."
>
> *M* "...I mean... I run a Scottish dancing class, and occasionally there's committee meetings. So, if we have a committee meeting that's up in here, it does rather take over the whole space... and M is secretary at the local church..."
>
> *F* "...so I mean [that] there's times when I'd like to, say, come and have the meeting here, and, I mean, we have done, and R does do; but we don't perhaps do it as often as either would like because we know we're inconveniencing the other one..."
>
> *M* "...and the boys are away at school, so during the week we try and arrange our lives so that we try and do those sorts of things during the week when there's not an additional conflict with the boys."

As is clear from the second half of this extract, householders tend, as a matter of practical routine, to orient their activities to those of others

within the home—they are not simply free to do as they please, particularly given the physical constraints of the home as a space for living in. In the above example, we see the problems associated with multiple demands upon a single physical space. As a result, we wish to argue that the use of space and technology within the home is a finely tuned organization which can be "upset," both deliberately and inadvertently. When this organization breaks down, home life becomes highly problematic, as the following extract from a visit to another house makes plain; here the participant explains why she decided to live alone rather than continuing to have lodgers in the house.

> When first lodgers Chris and Paul lived there it was fine on the whole, but when they left [the] new lodger was more of a problem:
>
> *F* "We had various hassles over things, and I guess it might have just been that I'd got to the point where I didn't really want people sharing my house anymore... and I didn't want a studenty lifestyle or whatever... but it didn't work out so well, and it kind of put me off a bit. I got to the stage where, you know, you'd come in from work and you couldn't relax, 'cause you'd sort of unlock the door and think 'Is there somebody in the house already?'... or you know, 'will there be somebody else coming back in half an hour?' Whereas now I just feel as soon as I'm in the house I just completely relax... and I really like being able to do that... which means that I don't have... I always used to feel that I had to be here to sort of stamp myself on the place... have my music on, my radio station in the morning... I don't know... I felt like it wasn't mine unless I was here, whereas now it doesn't matter how little I'm here. I still feel at home when I am here. It's horrible isn't it?... [laughs]... I hate myself! [laughs]"

3.4 Configuration of the Home, the Role of Interaction, and the Status of Technology

In summary, then, we have offered a brief overview of the ways in which the configuration of the household and interaction with the technology within it tend to be flexibly organized in order to enable householders to orient their activities toward those of others. Thus, as we have seen throughout, certain routines emerge by virtue of which certain spaces are seen as "belonging" to certain individuals at certain points in time when they use certain pieces of technology. All these points are neatly condensed into the following extract of a young couple's interaction as they discuss the "status" of the living room of their flat.

> *M* "...Yeah, but you do think of this room as being the relaxing room...?"
>
> *S* "Yeah, I suppose that's true..."
>
> *M* "...because when I'm working in here... sometimes I work in here to have a break from working next door, in the bedroom on, and S wants to put music on and play the guitar or watch the television... and he always has... whoever wants to relax in here has priority, and the person who's working has to leave..."

S "...Yeah, that's true, because we have all the entertainment systems set up in this room... So, yeah, I do see this as a room to relax in... and do all my work in the bedroom..."

Such "rules" have:

M "...emerged explicitly... I mean it's not like we sat down and said 'Oh, this is what it's going to be like,' but then... I mean [to S] you tend to make rules quite explicitly, so you say 'I will not come into the bathroom when you're in the bathroom; don't come in when 'm in the bathroom.' You said 'This room is for entertainment. I have priority at this moment.' ...I mean you said that whereas I tend to do it a different way... I tend to be bolshie or you know, slam doors... things like that... so it's not quite as explicit... I think [to S] you formulate things a lot better than I do."

S "Yeeeah, but I'm actually, sort of, willing to compromise a bit, you know... this makes me sound like a bloody ogre! [Laughs]"

Once again we do not wish to imply that all these sets of activities are scripted and slavishly adhered to: of course the actions of others are interpreted in the light of whatever contingencies might arise and activities, household routines, and the use of domestic technologies are duly reconfigured to continue to afford coordination.

Another intriguing example of such issues can be seen when considering examples from the fieldwork within which we notice the attribution of certain "status" to technological artifacts, "status" that comes into reckoning when considering the place of that artifact within the social organization of the household. So, for example, in many households, objections were raised to having a television switched on when receiving visitors to the house, and labeled an "antisocial" technology, whereas it was far more acceptable, in most instances, for the radio to be left on, or for music to continue to play. In one household this status was foregrounded to the extent that the configuration of furniture within a room was oriented around the television when guests were not expected, and away from the television, toward the more "sociable" high-fidelity stereo sound system technology when they were expected. In the photographs included in Figure 2, we see the central sofa turned away from the television and toward the stereo.

Here, then, we come to the nub of the matter, since the most successful domestic technologies interleave neatly with the full complexity of the social organization of home life; in allowing users to establish their own sets of usage practices—to organize themselves, as it were—such technologies support a range of uses in a range of household situations, allowing for the routine distribution of action, interaction, and associated technology use throughout the house.

One consequence of the constructed nature of domestic environments is the manner in which we perceive the design of interactive systems within these environments. It is clear that interaction with technology takes place within a rich environment and that this environment is designed by those who inhabit it. In addition to general aesthetics, the perceived use of the

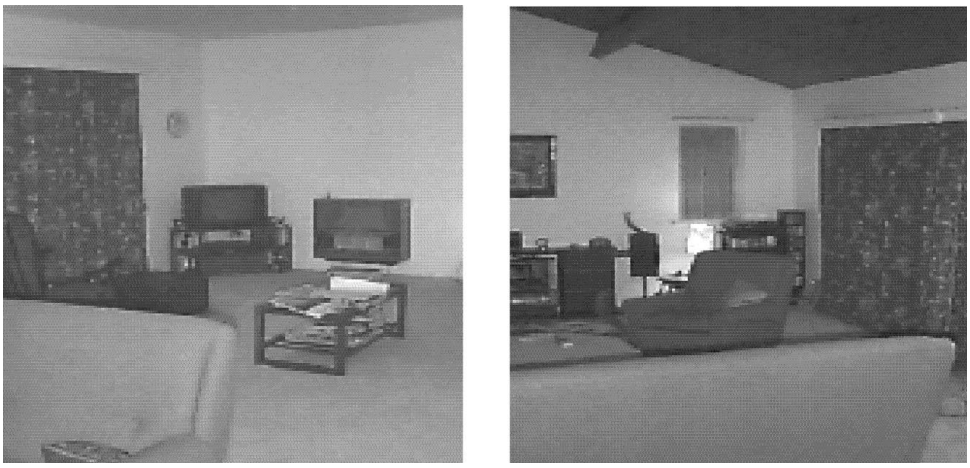

Fig. 2. Configuration of furniture to focus on the stereo sound system.

domestic environment plays a major role in the manner in which it is constructed. Thus, the question is begged as to the relationship between the designer and user of interactive systems. Given that technology and the perceived interaction with this technology play a major role in the broader issues of designing the home as a space for living in the design of this technology takes on a greater significance. Not only is the technology itself a designed artifact it, in turn, is a tool used in the design of the home. In the following section, we wish to focus on a particular piece of technology by considering the reaction of those involved in the study to the trial and placement of a set top box (STB). This technology is indicative of the form of delivery envisaged by those providing high-speed network connections to the home, and it is currently anticipated that future interactive multimedia applications will be delivered to the home using this sort of technology.

4. THE SET-TOP-BOX TRIAL

In the previous sections of this article we have sketched out the broader findings of the ethnographic study in order to contextualize our particular focus: the brief trial of an interactive demonstration STB in each of the households participating in the study. The STB in question was manufactured by a UK electronics firm and was a fully interactive demonstration version of a model acting as an interface to a range of digital services in a full-scale trial elsewhere in the UK. (Limited versions only of the interactive services were available on this demonstration model.) The STB, a black box, roughly the size of a standard VCR, was connected to a household television, selected by the householders themselves, and examples of the digital services on offer were explored by means of a icon-based interface. Selection of icons, confirmed via the use of a security PIN, enabled users to select and download video and audio selections of a range of film, television, music, and radio options, as well as play games, make shopping

purchases, study local information, check public transport timetables and book tickets, meter home appliances, pay bills, and make use of home banking services.

4.1 Aesthetic Impact of the Technology

The importance of the layout and arrangement of space has been stressed by a number of authors, most notably in the case of control rooms [Hughes et al. 1997]. The coupling of the technology's physical arrangement and the activities it supports is often referred to in studies of use. This coupling between the physical nature of the technology and the facilities it provides is even more significant in terms of the home. As we have said earlier, the arrangement and rearrangement of the home is one of the ways in which its occupants stamp their character on it. Consequently, the previous concerns of the HCI and CSCW community are extended to consider the aesthetic nature of the technology.

In evaluating the STB's place in the domestic environment, we wished to explore this issue in relation to the "success" of other "ordinary" household technologies, and so noted the ways in which these technologies were "consumed" within the domestic space. It became apparent that the aesthetic impact of the technology was of central importance, although in complex ways. Certain pieces of domestic technology are consumed "conspicuously," i.e., they are bound up in the "public" face of the household, as well as doing their job of playing CDs, making the toast, or the like. In these cases, the physical effects of the technology on the inside of the home tend to reflect important aspects of householders' aesthetic judgments: technological artifacts can be either foregrounded and attention drawn to them, or "hidden away," blending into other aspects of the home's character. In this latter case, the very fact that the technology can be hidden away becomes part of the conspicuous nature of the consumption of it. Other less entertainment-based domestic technologies can also be consumed conspicuously: in one household which had recently had a new kitchen extension completed the fieldworker was given a tour of all the new domestic appliances.

We should not, however, run away with this notion of conspicuous consumption, since the vast majority of technology within the home was absorbed into the framework of normal daily life and disappeared seamlessly into the background, remaining at hand to be used as and when required in the normal run of daily life. These technologies, such as television, radio, video, and telephone are seen much more as "things that everybody has" and that one by and large forgets about when not in use. In these cases, it is seen simply as a matter of routine that these artifacts "disappear" when not in use, and thus it is important that they have minimal physical effect on the household, and are frequently surrounded by other elements of household decoration, such as photographs, pictures, ornaments, etc.

All participants, bar one, reacted favorably to the STB when trialing it in their homes—it was seen as a "neutral-enough box," very much in the

tradition of television and video recorders which would very much disappear into the background. That said, some concerns were expressed at the thought of conspicuous wiring to the STB. The one participant who reacted negatively had already made a decision not to have a television in the house, seeing it as aesthetically unappealing and likely to waste her time. Although she felt the STB likely to save her time in some instances, she still felt that it was too ugly to have a place in her home:

> *M* "I wouldn't want it my living room... I would not put anything like that in my living room."

4.2 Management of the Technology

A key concern of many interactive systems has been with ensuring that systems mesh effectively with the social organization of the application domain. One important element of this process has been the drive toward providing users with appropriate means of managing the systems that they are presented with. In domestic environments the management of the home is tied up with a host of everyday concerns. One of the most significant ways in which this management is expressed is through the good stewardship of the household income. Consequently one of the ways in which the management and control concerns of the technology within the home are expressed is through a consideration of the cost of the technology. So, in this regard, concern was expressed in all households about billing mechanisms and the control of costs of any home network systems. There were, on some occasions, perceptions that these networked applications might reduce control over household spending rather than providing them with the facility to more closely monitor such expenditure.

> *M* "You feel as if you wouldn't want the thing to go berserk with your bank account and run up a bill of ten thousand, so you'd either want to set a limit on it as to how much it was going to withdraw or... fill it up and let it take it out... but I'm sort of reluctant to have people taking my money off me 'til I've bought the service. So maybe just a warning message."

Here a clear issue arises about the perception of where the control over these networked technologies lies. The participant in the above extract is assuming that metering systems on his household appliances will be automatically deducting money from his bank account. He perceives the new system as removing his "link" in the chain of payment, as it were. Similar concerns were expressed with regard to the STB, with many participants explicitly expressing concerns about controlling the cost of the system.

Interestingly these concerns were expressed in relation to the running costs of the STB, in many cases in explicit contrast to the basic capital outlay. All participants wanted to know clearly and precisely in advance the precise extent of the costs that they would be likely to incur, and found it difficult to grasp precisely what it is that they might be having to pay for. Would they, for example, be paying a fee for the entire time that they were

on-line, or would it simply be a matter of paying a flat fee each time they made use of a particular service? Would they have monthly "line rental" charges to pay, or would they be free to pick and choose service providers independent of any specific line rental charge, going to one provider for films and one for shopping for example? Participants were concerned that cheap sign-up might hide major running costs to "imprisoned" consumers. Typical of such concerns are those expressed by this participant when talking about satellite television:

> *M* "I like watching it, like... I mean... my son used to have it, and I used to go round there; but, I mean, the year after they put it up again, wouldn't they pay so much one year, and the next year it goes up again... shouldn't be able to monopolize it old Murdoch!"

Here then we see the issue of system management recast when we consider the context of use in the domestic environment, making clear the extent to which any successful system must mesh with the concerns of householders' understandings of the priorities of domestic organization. This lends further weight to claims that workplace technologies can be simply "migrated" to the home environment, since very different issues constitute the relationship between the technical and the social. That said, this very complexity implies that an adaptation of principles associated with charting the nature of this relationship as a resource for systems design is likely to prove to be of continuing utility.

4.3 Perceptions and Understandings of the Technology

We see these issues emerge once again when we consider the ways in which such concerns about the management of the technology were compounded by a poor perception of the nature of the technological infrastructure that comprises the residential broadband network. There was considerable confusion as to where all the information lay at any given time. Was it all in "the box" all the time, or was it all being downloaded all the time? If they bought a game, video, or piece of music, where was it stored? What happened to such purchases if their "box" broke? Would they be lost? Would they be able to access them from other people's "boxes"? Would their PIN numbers work on other "boxes"? Would they be able to copy television programs and films that they downloaded over the system?

In one household, participants wondered where all the television programms were stored:

> *M* "Where's it all stored, all the past episodes... is it stored in there?" [Points to STB. Fieldworker briefly outlines the infrastructure]
>
> *F* "So you have got virtually infinite storage?"
>
> *M* "So are you paying all the time on all the services on-line?"

Another family debated the utility of downloading music:

> Wonder what form the music would be stored in when they download it?

F "You're sort of stuck with it there [points to STB]... kids couldn't take owt like that to listen to... so it would have to be that. Wouldn't it...? I mean [that] I'm thinking of when they use their personal CDs and things like that."

Would like to have an actual artifact?

F "If you're paying for it, you might as well have it... [laughs] Mightn't yer? 'Cause you can't get full use out of it if you've not got it, can you?"

These and other similar questions troubled participants as they considered just how the system might actually be working. There are implications, as stated earlier, which arise from such confusion, in particular relating to participants' concerns about payment and security issues. A lack of any detailed understanding of the manner in which the system operates tended to lead to the creation of "worst-case" scenarios in their minds in these important areas:

M [to children] "Well what do you think about shelling your pocket money for a few weeks or whatever for one of these, when next week, for a permanent one of these [selection from CDs] when next month the machine might break down or Dad might throw a fit and chuck it out?" Questions about the ability of the STB to interact with, for example, the stereo system and other entertainment technologies were, however, occasionally raised.

F "Can all this link up to the stereo system? I mean, if you had all this music it's not nearly as good quality...?"

4.4 The Concentration of Functionality

Issues of distributed coordination of activity have been central to HCI for a number of years, and much of the work on awareness has considered the issue of how action is made available as a resource for others. Central to this concern is the distributed nature of activities and the interleaving of these activities within a social setting.

As we have stressed on several occasions in this article, living and action are distributed throughout the home, in order to coordinate the actions of householders and establish and maintain delicate patterns of coexistence. This coordination is facilitated by and reflected in the configuration of the home, and among other particular elements, domestic technologies (particularly those associated with entertainment) are closely woven into this configuration. They are distributed throughout the home and firmly embedded with the day-to-day routines of householders as they orient their activities toward one another's in order that this coordination might be maintained.

When a high degree of functionality is concentrated within a single "box," there is a risk that the distributed nature of the everyday use of such technologies will be made problematic and that the concentration of home life will be disrupted.

M "What if I want to check my bank account while the kids are in the middle of a watch-once-only film? Yeah, and what if I just want to sit in here and relax [while] F wants to do an Open University course?"

The most successful domestic technologies allow users to organize themselves and mesh seamlessly with that organization. The telephone is an excellent case in point, since it sits unobtrusively in the background but is at hand to operate as part of routine contact with family members and friends on a regular basis or in times of crisis. The phone unobtrusively lends itself to all the delicacies of everyday life without imposing a rigid set of explicit practices upon users. This is a consequence of its single functionality and its flexibility within the configuration of the home. It became clear that the STB, by way of contrast, with its massive concentration of functionality did not readily lend itself to such an application domain, and runs the risk of creating problems of coordination, upsetting routines, and threatening the equilibrium of the home.

4.4.1 *Security*. Within HCI and CSCW there has been only limited consideration of system security issues, reflecting the focus on systems within working environments where some basic security measures can be assumed. It is often assumed that such concerns are dealt with as specific elements of organizational practice reducing their need to be considered within the technology. However, the move to domestic environments increases the sensitivities associated with security and the importance of domestic environment as a place of safety and security.

Not unsurprisingly this study of the domestic environment brought security issues to the fore as of specific relevance to our evaluation. Concepts of what constituted a security concern varied enormously from household to household, with those that contained adults alone wanting something to prevent intruders from gaining access to the system from their home:

> *F* "What does the PIN bit do? [inaudible] Is it security that somebody can't break into your home and order loads of stuff [inaudible] as well as your card number...? Cause do you not think, say, that... like, I mean, anyone could get hold of the number. You could type in random numbers effectively, and you're gonna hit on something, and you're going to have lots of stock ordered... it just seems a lot easier to have a card... you know you need your card and a number to get cash out of a machine, whereas with this you just need a number... if someone needs a card and a corresponding number, I mean, the chances are if you put in a random number... you'll get something eventually."
>
> *K* "So that could be a problem with... running up bills?"
>
> *S* "Oh yeah,. You could run up bills. Couldn't yer?"
>
> *K* "It's a bit like the phone lines. The... the numbers [0898 etc.]... you can run 'em up and not really know it... there's no way of, say, the kids come in, and they say to themselves 'Oh, well, we'll watch this' We didn't know we'd actually paid for it, but they'd watched it."

And households with younger children wanted to feel that they could protect them from unsavory media and video game content that might be accessed through the STB. (It is interesting to note that the definition of what was inappropriate differed subtly from family to family.)

F "I was thinking about a PIN number with each... option..."

M "...that's still a lot of PIN numbers to remember. Isn't it?"

M suggests some kind of card arrangement instead. F sees PIN numbers more as a means of controlling access to the services:

F "I wouldn't find it necessary to have a PIN number on the news necessarily."

M "Yeah, but as I said, things like the movies..."

F "...Yes. I'd want a PIN number for the movies..."

M "...And television programs, the back issues of television programs."

F "...programs... and the games... I'd like them to be isolated in one bit of the system... because there could be a film I wouldn't want them to see on the film section. I don't want them to have any chance of flicking out of it...."

Generally speaking, then, a flexible security system that allowed users to organize and implement their own "security system" in association with a combination of PIN and card, or smart-card alone, seems to facilitate the kinds of activities that participants saw as important. What we wish to reflect upon here are the complex notions of security associated with the domestic environment. We stated earlier that an important aspect of the articulation of the role of "the good parent" was through control of young children's access to various media, and in many respects this became the primary means through which notions of security were considered. Notions of security were clearly related to techniques aiding the management of the technology in relation to "good parenting," as this parent made clear when watching her children at playing games on the STB:

F "Well. I don't know really... I mean, we've never had a... Sega or anything like that, but... erm, mainly for this reason, 'cause I couldn't stand the thought of them sitting there staring at the screen... I don't see why you should encourage them to look at the TV... I think what I don't like about this sort of thing in a family is that it's exclusive... it's only really people who are a playing it who are interested... at least with the television you can all watch the same thing at the same time."

5. SOME CONCLUSIONS

The development of network facilities has seen the increased provision of services to the home and a turn to domestic environments as an increasing area of importance for IT. The development of systems for these environments is of interest to HCI, in particular in relation to the projected growth in the use of technology to provide support for new forms of home-working and domestic arrangement. However, we would also argue that an interest in domestic environments addresses many of the concerns of interest to interactive systems design, including issues of flexibility, security, the management of action and interaction, and the situated nature of the use of technology, and in what follows we offer some initial conclusions on these.

5.1 The Importance of Flexibility

Embedding technology in the vast range of household routines requires us to avoid prescriptive models of use. This is particularly important given the role of many items including technologies as a means of configuring the home. Technology was routinely used in a variety of different ways within the home, and consequently we need to consider the development of applications and environments that provide flexible access to functionality.

Central to this flexibility is the need to avoid designing in any preconceptions about the nature of domestic environments. Homes and home life vary considerably, and the cultural norms associated with the home also vary tremendously.

5.2 The Integration of Technology with Home Life

What should certainly be borne in mind is that the kinds of organizational activities undertaken by householders—which again we must stress are being undertaken practically and routinely in the light of everyday contingencies within the home—are distributed throughout the household. Certainly key to this is the importance of portability of device and the ability to provide access to features of the technology from different locations through the home.

The ability to undertake activities within different locations was central to the successful management of the home, and when technology inhibited this it often led to tensions within the home. Perhaps a logical conclusion of this need for distribution lies in the development and application of interfaces that are closely meshed with the physical nature of the home (for example, the provision of tangible bits [Ulmer and Iishi 1997]).

What was significant in the study was the problematic arrangement of the STB. This clearly raises issues when one considers the high degree of concentration of functionality in a single STB, particularly when one considers all the sophisticated and complex issues associated with the "ownership" and "sharing" of space in the home which are currently supported by the distribution of functionality throughout the home (again reported in Hughes et al. [1998] and O'Brien and Rodden [1997]).

5.3 Tailorability and Management

The importance of understanding and managing items within the home was something that emerged from our study of these domestic environments, and the need to consider the development of management facilities was seen as essential as access to the functions provided by the technology. Often the technology was the means by which good household management was demonstrated (for example, in the case of parenting).

However, while management was considered important in these domestic environments it was equally important that some human link was involved in this management. This was particularly important in the case of billing and payment where many members of the household stated they wished to

be informed of the charges to the household in order to understand how the technology has been used.

Coupled with the issues of control and management was a sensitivity to concerns of security. Domestic environments are closely bound up with issues of security and privacy, and these concerns were often read into the technology. Most household occupants wished to have secure systems. However, the manner by which this security was provided was as important as the security itself. People wanted to be able to control these security facilities and to reconfigure these as household arrangements changed.

5.4 The Distributed and Cooperative Nature of Home Life

The fact that living is distributed around the house has become clear throughout the course of the study. This is not, in our opinion, a trivial matter, since it is deeply entwined with the essential activities through which members of the household orient their behavior toward one another, making judgments about who is busy and should not be disturbed, who's relaxing and thus monopolizing use of the television or radio. In essence, sharing a home is a cooperative activity.

Household technologies simply need to fit into this pattern of activity—indeed many technologies are used as coordinating artifacts in establishing the order of the home. It is no coincidence that various media are so closely intertwined with the mundane routines of home life, and that householders tend to have a highly sophisticated and nuanced understanding of one another's activities and associated uses of entertainment and communication technologies. Such "local knowledge" is what is relied on in establishing and maintaining some form of harmonious coordination of the everyday activities of householders.

It is worth noting here that such coordination was observed in all households in the study at all times. The precise nature of the activities might differ from household to household, but the fundamental fact remains that individuals in all households work at maintaining some form of coordination: clearly to do otherwise would make home life unbearable.

In short, technologies that effectively mesh with these organizational routines have every likelihood of succeeding. Those that do not do so are consequently perceived as problematizing the "equilibrium" of home life and tend to be met with resistance, as we report in O'Brien and Rodden [1997]. In significant cases—reaction against satellite television is a good example—participants' resistance to domestic technologies was based entirely on issues concerning the home as a socially organized environment of significance to the householders, having little to do with any technological concerns. These issues are not only of key importance when considering the development of future technologies for domestic environments. They suggest that the issues that make design so difficult are potentially amplified when we consider the home, and that, in this respect at least, ethnographic approaches to understanding the home hold considerable promise.

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