



The social context of home computing

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Computer and Internet use in the home does not only depend on the functionality of available software and services. It also depends in a very practical way on how the computer itself is located, managed and shared between family members. These factors constitute the social context of home computing and form the subject of this chapter. We report the findings of a home interview survey with 35 families in Pittsburgh and Boston, in which family members spoke about the practicalities of using a computer and going on-line. The findings show a variety of ways in which the computer is being domesticated to fit into existing patterns of family life, home architecture and parental control. They also point to the significance of introducing a second computer into this situation, and its similarity to introducing a second television. The implications of these findings for the design of home technology is discussed.

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1. Introduction

1.1 Aims

Most discussions of domestic Internet use centre around the content and benefit of Internet *services*. Indeed, the prime objective of many recent research studies in this area has been to inform these discussions with data on the relative use and value of different services by a sample of families (e.g. Kraut, Scherlis, Mukhopadhyay & Manning 1996). However, in the course of these studies it is becoming apparent that the way families use and benefit from the Internet is not simply a function of what they can do on it. These things are also influenced in a very practical way by the accessibility of the family PC as the primary means of 'going on-line' today. For example, factors like who can get on the Internet, in which room, at what time and for how long in any family, are as important as what they can do on the Internet once they are connected. These factors relate to the social use of computers and time within the family, and have implications for the design of computing and Internet technology in the home.

In this chapter we examine this social context for home computing and its relationship to Internet use. After a review of other studies in this area, we introduce findings from two sets of in-home interviews with 24 Pittsburgh families and 11 Boston families. The Pittsburgh families formed about a quarter of the original families in the HomeNet trial of the Internet (Kraut et al, op cit) while the Boston families were part of an investigation of home PC futures within HP (Frohlich, Dray & Silverman 2001). The findings reveal a rich and complex set of behaviours with computing technology, which are aimed at *domesticating* it within existing patterns of family life.

1.2 Previous types of research

In contrast to the extensive literature on the social context of computer use in the workplace (Baecker 1993), there is little written on the social context of computer use in the home. This is very much a sign of the times and a case of social science trying to catch up with changes in human behaviour resulting from rapid developments in technology. With hindsight we can now look back on the 1980's as an era in which the personal computer entered the workplace and began to modify working practices in fundamental ways - ways that we are only now beginning to appreciate and use in the development of better workplace technology. In the same way we will look back on the 1990's as heralding an era of home computing and Internet use with all its attendant influences on domestic practices and family life. Unfortunately we are far from understanding what these influences are today, and even farther from applying such understanding to the design of home computing products.

Inroads into this area have begun in a number of places and serve to set the context and questions for our current enquiry. Essentially they have been made in three areas relating to the use of time, the use of space and the use of technology in the home.

2. Related work

2.1 The use of domestic time

A large number of studies dating back to at least the 1950's have investigated the use of time using time diaries (Robinson 1988). Subjects in the studies are usually asked to fill in a diary of what they are doing, where and with whom every 15 minutes throughout the day, and these entries are then coded into 100 standardised activities. The activities cover things such as such as paid and unpaid work, caring for children, obtaining goods and services, sleeping, washing, dressing, eating, learning, organisational involvement, entertainment, recreation and communication (see Harvey, Szalai, Elliott, Stone & Clark 1984 for an explanation of methods). Studies are often large national or multinational time use surveys, comparing broad patterns of time use between different parts of the population. Furthermore the same studies are often repeated at regular intervals, perhaps as part of a national census, so that time use trends can be monitored. In the context of this chapter, we are most interested in localised patterns of time use within American households. Robinson and Godbey (1997) provide the best account of this behaviour, although this is based mainly on the analysis of three national US surveys conducted in 1965, 1975 and 1985.

Most time diary studies, including those examined in Robinson and Godbey, show that human activities are organized into recurring patterns or routines. Sleep, personal maintenance, work and recreation (especially TV watching) dominate American adults's use of time. The structure imposed by biology and culture causes some similarity in the cycle of these activities between different people.. Biological disposition affects rates of metabolism and energy levels over a 24 hour cycle. Most people sleep at night and are awake during the day. External institutions such as employers, school and church demand people's presence at particular times of day. As a result, people go to work and school during weekdays, but have more flexibility in spending their time during the weekends. Television networks differentiate their programming for weekday and weekends, and for days and nights, based on predictions of the available audience during these periods. As a result, if working adults watch television, they are especially likely to do it during the prime-time hours of 8-10 PM on weekdays. And so on.

In the face of these broad similarities in schedules across people, there exist large individual differences between people, based on differences in the institutions they are connected to, on personal preferences, and on the composition of the household itself. Households with young children are likely to operate on a different schedule than household with no children or with teenagers present. People set their clock radios at a certain time get up to drive the children to school or go to work. Children have to be home at certain times set by their parents to eat or sleep. Parents have to coordinate their activities with childcare helpers and agencies so that their children are always cared for. In general, both the regular and irregular use of time by individuals is constrained by the number of other individuals they must live, work and interact with. Little wonder that vacations are needed from time to time to break from routine and literally 'get away from it all'!

It is against this backdrop of daily routines and constraints that new technology enters family life. Somewhere within or between these routines, people must find time to use it. Here Robinson & Godbey's calculations of available free time at home are instructive:

"If we characterize sleep and necessary eating and grooming from the 168 hour week for the economically most active segment of 18-64 year-old people in America, what is left are roughly 100 hours a week to divide between work, family care, other personal care, and free-time activities. A little more than half of that 100 hours (53 hours) goes to paid work and family care, a number that is surprisingly close for men and women. Another 40 hours are given over to free-time activities, almost half of which are devoted to the media, most of it to television; again the gender differences are minimal. The remaining 7 hours go to other personal care activities..such as the socializing that often extends meal times, the relaxing bath, or the grooming that is more vanity than necessity. One could also add here playing with children or window shopping, now coded as family-care time", (p293).

All this implies that up to 6 hours of free-time are potentially available each day for home computing and Internet use, although nearly half this time is now spent watching TV and the other half is shared between socializing, home communication, reading, hobbies, outdoor sports and recreation, adult education, religious or cultural activities (see Figure 12, p125 in Robinson & Godbey 1997). Furthermore the distribution of free time across the day depends on daily routines, which may fragment it into small pieces. So within the available free-time of any individual there will only be a finite number of opportunities each day to use the computer and go on-line, and those opportunities must be taken at the expense of time spent on other free-time activities.

Although Robinson & Godbey's book is based mainly on time diary data, they make an excursion into a 1995 telephone interview survey on home computer and media use, specifically to explore home computer adoption (Chapter 10). According to reported time use estimates in this survey, (which are less accurate than time diary accounts), home computer owners reported an average of 40 minutes computer use a day, of which 8.6 minutes was said to be spent on-line. Computer use was inversely correlated with TV use, suggesting that users may be borrowing from time spent watching television to use the computer. A recent Forester study drew similar conclusions after asking 100 PC owners directly how much they use the computer and where they find the time. The average user reported spending just under an hour a day on it, mainly at the expense of TV watching (Bass, Green & Esselink 1996). A recent study by Nie & Ebring (2000) also suggests strong substitution between computer and TV use.

Given the limitations of these findings, and the absence of data on child and teen time use, it would be instructive to try to identify when different members of a household use the home computer and Internet, and what other activities they seem to be sacrificing to do this. In addition, it would be interesting to know whether these periods of computer and Internet use are slotted unpredictably into the gaps between established daily routines, or whether they are themselves becoming a routinized part of family life.

2.2 The use of domestic space

While there is no single research field for the study of domestic space, a number of disciplines throw light on its use from different perspectives. These include archaeology, social anthropology, sociology, social and environmental psychology and Computer Supported Cooperative Work.

Archaeological studies of ancient dwellings show them to have designs which reflect the lifestyle and culture of the inhabitants. For example, it is common to find palaces and temples at the centre of walled cities with roads radiating out to gates at each of four compass points (Wheatley 1971). These links are even more evident in anthropological studies of living cultures where architecture, attitudes and behaviour can be studied together. Typically the arrangement of houses and rooms in a house reflects the social status of groups and individuals (e.g. Levi-Strauss 1963). Furthermore, changes in house design often reflect changes in culture. Modern American and European houses evolved from semi-public medieval structures with a large central hall for receiving and entertaining visitors, cooking washing, eating and working (Fairclough 1992). In the eighteenth century, the open hall began to be partitioned into smaller spaces off a central corridor, like houses off a street. These rooms were named and specialised by function, and arranged according to a series of organising principles such as front/back, clean/dirty, day/night, public/private, sacred/profane (Lawrence 1987). Eventually, a withdrawing room or parlour for entertaining visitors came to be placed at the front of the house near the door, kitchen and private living room areas were placed at the back of the house, with bedrooms and bathrooms located upstairs. These arrangements afforded more privacy to individual family members, and underpin the relatively recent structures of childhood and the nuclear family (Aries 1962).

The same themes of domestic space affecting and reflecting cultural practices and values are also evident at an individual level. People select, design and furnish their houses to support a current range of behaviours and interests pursued within the house. They also design to reflect their personality, and to present a variety of facets or 'faces' to outsiders (Goffman 1959). Spaces and objects in the house therefore have a mixture of functional, symbolic and sentimental value, all working together to make the house into a home (Csikszentmihalyi & Rochberg-Halton 1981). When behaviours and personalities change, domestic space and objects must be reorganised to accommodate new requirements. This leads to a situation where buildings tend to grow with their inhabitants (Brand 1995). This phenomenon is particularly evident throughout the life stages of a typical family, who begin with modest requirements for space which increase as children are born and grow up. This often leads families to extend or move 'up-market' to a bigger house, although Friedman (1998) has shown that this could be avoided by building more flexible housing. His development of 'Grow Homes' in Montreal comprises town houses organised into 3 tiered cells. Each cell has a large open interior which can be flexibly partitioned with mobile walls and furniture. As families grow, they can re-arrange interiors and lease new cells in the house.

One particularly important use of domestic and other kinds of space is for social interaction. In fact space can be seen as a medium for interaction in much the same way as the telephone and email can. Like these other media, space exerts considerable influence over the kind of interaction that can take place through it. At the most basic level, Osmond (1957) has observed that some spaces are more conducive to interaction than others. Some *sociofugal spaces* like railway waiting rooms tend to keep people apart. Other *sociopetal spaces* like street cafe tend to bring people together. Osmond, who ran a large health and research centre in Saskatchewan, commissioned a psychologist called Sommer to examine this phenomenon in his institution. Sommer (1959) conducted 50 observational sessions of conversations held around rectangular tables (36" x 72") in the cafeteria, noting who spoke most to who across the 6 possible seating positions. He found that corner situations with people at right angles to each other produced 6 times as many conversations as face-to-face situations, and twice as many as between people sitting side-by-side. Osmond and Sommer applied these findings to the arrangement of furniture in the hospital wards and dayrooms, by moving in small square tables to provide a place for reading materials, and maximise corner conversation. This resulted in twice as many conversations overall and three times as much reading by patients, with associated improvements in well being.

As a side effect of Osmond and Sommer's intervention they encountered great resistance by patients to the movement or removal of 'personal' chairs. This illustrates another feature of the use of space for social interaction: **territoriality**. Like other animals, humans have a tendency to take ownership of spaces and defend them from others. This was vividly demonstrated in another study of the use of chairs in old people's homes in South Wales. Lipman (1967) logged the proportion of time dayroom chairs were occupied by their 'owners' as opposed to others using the room. Chairs in regular use were found to be occupied by their owners an average of 93% of the time. Occupants of the home actively chose to remain in familiar chairs despite opportunities to move to more comfortable positions out of the sun or in better view of the TV, and sanctioned others who moved into their chairs. This kind of territoriality also extends to the distance people keep between themselves and others. Hediger (1955) coined the term *personal distance* to refer to the invisible bubble of space people maintain around themselves in interaction. He calculated this distance at between 1.5 and 4 feet, which would place the other person within reach or at (2) arms lengths away. Hall (1966) has subsequently expanded the concept of personal distance to include four distance bands, including *intimate distance* (contact to 1.5'), *personal distance* (1.5 - 4'), *social distance* (4'-12'), and *public distance* (12'-25'). Although the social significance of this classification is unclear, Hall is right to observe that as distance between people increases, basic changes in speech, hearing, gesture and vision take place which may affect the tone and character of their interaction in complex ways. In a more modern context, Heath & Luff (1992) confirm this in their studies of videoconferencing tools which effectively reduce the size of someone's perceived face and body on a TV screen. The character of conversation is subtly affected by lack of visible feedback from facial expressions, and regular users of the equipment learn to exaggerate expressions and gestures to compensate.

Finally, Heath (1986) has also shown that the character of social interaction is dramatically affected by the presence of computers. In several studies of doctor patient interaction he found that the introduction and placement of a PC monitor on the doctor's desk led the doctor and patient to behave quite differently towards each other. If the monitor was angled towards the doctor and away from the patient the doctor tended to orient his or her attention towards the screen at the expense of the patient. If the monitor was positioned so that both parties could see the screen, the doctor and patient could coordinate their attention to the screen and each other more effectively. These kinds of effects are now the subject of a number of studies to understand the role of physical artefacts of all kinds in social interaction, including paper, whiteboards, displays, and furniture (e.g. Luff, Hindmarsh & Heath 2000).

All these studies begin to show that finding space in the home to operate a computer and go on-line is likely to be a complex matter for any family. Not only must its location fit in with cultural and family norms regarding the use of different rooms in the house, its appearance and image must be consistent with the decor of the room and the personality of its users. Furthermore, on a more practical level, putting the computer in a more private space will give the owner of that space privileged user status, and discourage others from sharing the device and talking to the user. Likewise, placing it in a more public area will encourage greater sharing and interaction around the device, especially if the orientation of the monitor allows others to draw close enough to read text on the screen. This in turn may lead to lack of privacy for individuals, and contention for use.

Given the lack of data on these topics it would be interesting to explore where exactly families choose to locate computers for Internet access in the home, how they come to these decisions, and what experiences they report with operating the computer in different locations. Because of the concern raised in earlier parts of the HomeNet project with Internet use leading to increased social isolation, it might also be productive to explore the reported effect of computer placement on patterns of social interaction within the family.

2.3 The use of domestic technology

A great deal of technology fills the home of the average American family. Washing machines, fridges, telephones, and televisions are all pervasive today - noticed more by their absence than their presence (Birnbaum 1997). The same is not yet true of the computer which is still missing from over half the households in the US, and remains a mystery to many. Birnbaum (op cit) argues that the computer will ultimately be domesticated in the same way that electric motors have been domesticated; as a component of numerous home appliances which help people to do a well defined task very simply. In his view, the general purpose home computer with optional Internet access will give way to a variety of focussed function Internet appliances which derive their functionality from 'information utility' companies which dispense software and content in the same way that power utility companies now dispense electricity or gas. An alternative view is that as PC prices continue to fall, more households will buy more attractive home computers. Given the current importance of this debate for technology providers and ordinary citizens alike, it is surprising that so little is known about how

previous information technologies became pervasive and whether the home PC and the Internet are moving along the same trajectory. What clues there are come from research on the telephone, the television and a handful of studies on home PC use.

A number of historical accounts of telephone adoption stress the fact that the device came to be used in ways the inventors never imagined. For example, Bell's early demonstrations of his invention involved the relay of live musical performances from one place to another, without any dialogue in the opposite direction (Aronson 1977). This radio model of telephone use was subsequently incorporated into a more suitable broadcasting technology, while the telephone itself became used for two-way conversation. Even here, the social value of telephone use was underestimated by service providers and consumer groups alike. Phone users were initially trained to use the phone as efficiently as possible for business transactions, and idle chatting was actively discouraged. Domestic use of the telephone for small talk was a later use which emerged despite rather than because of the promotions of telephone companies. Other aspects of these promotions stressed utopian notions of the telephone abolishing the effects of distance and removing class and gender stereotypes. In practice, the effect of the telephone, while massive, has tended to be less revolutionary than this, largely replacing the practice of letter writing for keeping in touch with distant relatives and friends, but not removing the need for local contacts or for face-to-face meetings (c.f. Welman & Tindall 1993). As for gender stereotypes, the telephone appears to bring them into sharp relief; with women using the phone as a recreational tool for chatting and socialising and men using it as a tool for work and making social arrangements (e.g. The Planning Partnership 1993).

TV use has been more extensively researched. Gunter and Svennevig (1987) draw together many of the findings from a variety of studies of using set meters, viewing diaries, interviews and video observation. TV adoption has appeared to move through three stages, where TV watching starts out as a community activity because of the scarcity of sets. As sets become more affordable, viewing becomes a family activity in the home, until prices fall so far that multiple sets can be purchased for the same household. Additional sets tend to be placed in adult or child bedrooms turning TV-watching into a more solitary activity, although adult-adult and child-child viewing remains prevalent (Bower 1973, IBA 1987). Both parents and children in the US and UK tend to watch about 3 hours of TV a day, but viewing different programmes at different times (Ehrenberg 1986). However, this figure disguises the fact that about an hour of this time is spent doing other activities concurrently. These activities include talking, eating, sleeping, reading and exercising (Bechtel, Achelpohl & Akers 1972). Thus the TV moves from being the centre of attention for all the family at routine times throughout the week, to a background noise which exerts little influence on surrounding activity (Lull 1980). In between, the TV can be a source of conflict and contention if family members cannot agree about what to watch next, or if parents and children disagree over the timing and suitability of certain programmes. In these cases it has been found that fathers tend to act as final arbitrators of viewing decisions, but will often defer to the wishes of their children (Bower 1973, Lull 1982).

PC use on the other hand has tended to evolve from a more solitary and specialised status in the home. Interviews and observations in the early 1990s conducted with 20 families in the south east of England showed that their computers, if they had one, were used either for work or game-playing by just one or two individuals in the family (Silverstone 1991). Alternatively they had fallen into dis-use for want of appropriate expertise and interest. This situation has been changing rapidly in recent years with the increased penetration of computers into the home, the explosion of available software, and the advent of the Internet. Venkatesh (1996) is one of the few researchers to have tracked these changes in home PC use in America, through large-scale telephone surveys and in-home interviews. He claims that whereas home computers in the 1980s were used primarily for word processing, telework and children's games, home computers in the 1990s are being used for a wide number of household functions such as child and adult education, family communication, family recreation and travel, shopping and domestic finances. Furthermore, more members of the family are now engaged with computer use. Many of these findings are played out in detail in the HomeNet study itself which shows widespread use of Internet services by each member of the family.

In exploring home PC use further, Mateas, Salvador, Scholtz & Sorensen (1996) show that many of the household activities now supported by the PC are normally distributed throughout the house in time and space, and may be carried out jointly rather than individually. Having to go to a single location, one at a time, to perform these activities, constrains the value of the computer and its ultimate domestication into family life. This leads them to recommend the fragmentation of the PC into a network of home appliances: "*ubiquitous computing in the form of small, integrated computational appliances supporting multiple collocated users throughout the home, is a more appropriate domestic technology than the monolithic PC*", (Mateas et al 1996, p284). Similar sentiments are echoed by O'Brien and colleagues from a series of home visits to 10 PC-owning families in the North West of England. They observed an 'overloading' of the space occupied by the computer with activities normally distributed around the house, leading to competition for access and control. This led them to recommend distributed or portable computing technology for the home (O'Brien & Rodden 1999).

All this suggests a number of questions for the current analysis. The issue of overloaded space is important to understand further since it appears central to the domestication of the computer in the home. In particular, we might ask how do families regulate conflicts for use of the PC and Internet when they arise? It is also interesting to note in this connection, that PC adoption may be going the same way as TV adoption where households are beginning to bring additional PCs into the home (keeping older models) to meet increasing demand for use. We wonder how these second PCs are being used, whether they solve the overloaded space problem, and which PC is used for Internet access? If two is not enough, will the further domestication of the PC involve one for each member of the family?

3. Methods

To address some of the questions raised by previous research, we have combined the comments from two distinct home interview surveys. The first set of interviews was carried out in the homes of 24 families in Pittsburgh Pennsylvania between 1996 and 1998. These interviews were part of the HomeNet trial, which was designed to examine how a sample of households were integrating the Internet into their lives, during a period when the Internet was first moving out of research laboratories and academia and being used by the general public. Families were given or loaned a Macintosh computer, given instructions on how to use electronic mail and the World Wide Web, and were given a free telephone line and Internet access. (See Kraut et al, 1996, for further details of the trial methodology). At least two researchers interviewed each of the HomeNet families to provide more qualitative information about use of the Internet to compliment the quantitative data collected through questionnaires and by logging Macintosh and Internet use. In particular, the visit interview schedule was designed to probe for typical patterns of Internet use in each household and provide opportunities for participants to tell stories of when and why they went on-line. Interviews lasted two to three hours, started with a group interview around the kitchen table and then individual interviews as family members engaged an Internet session, commenting on the people they communicate with and web sites they visited. This paper is also based on interviews with 11 families in the Boston area in 1997, conducted by the first author. They were designed specifically to examine the location and use of the home PC by different members of the family. All families owned a multimedia PC and had children living at home, but represented a spread of income levels (between \$20-100+k per year), housing types (private house, condominium, apartment) and locations (urban, suburban, rural). Eight of the 11 families had an Internet connection.

Transcripts of both sets of interviews were coded to indicate discussion of topics relevant to the dynamics of computer and Internet use. The resulting topic collections were surprisingly large for both studies, indicating that families had a lot to say about constituent issues such as the location of the computer, and the way it is shared and managed within the family. In the following sections of the chapter we step through the major findings in this collection as they relate to the groups of questions raised in the previous section. Where necessary, we cite relevant quantitative findings to back-up the qualitative analysis. We preserve the same ordering of issues and questions as before, addressing the timing, location and shared use of the home computer in turn.

4. Results

4.1 Temporal organization of family computing

4.1.1 Routine timing

Figure 1 shows the pattern of daily Internet Mac use by teens and adults within the HomeNet population. The pattern is dramatically different for weekdays versus

weekends. On weekdays when home-life routines are dominated by school and work attendance, Mac use and therefore Internet access is more intensive, and concentrated in the evenings. This concentration is especially pronounced for teens, who use it most frequently between 2 and 5pm, immediately upon returning home from school, and then successively less until they go to bed. In contrast, adult weekday use peaks later at 8pm, but at a much lower overall level. These peaks correspond roughly to 'prime time' TV for children and adults, and lend some confirmation to the findings of other studies that PC time is being taken from TV time. On weekends this prime time effect disappears, with teens and adults using the computer and Internet more evenly throughout the day at much reduced levels.

Within this overall framework, we found ample evidence of regular patterns of individual use. The most routine uses of the Internet centered on checking of email. As the following quotes shows, this is often done first thing in the morning after waking up or when returning to the home after school or work. Each quote is attributed to one of the Pittsburgh or Boston families by a reference number. Speakers in the Pittsburgh corpus are identified by initials, while speakers in the Boston corpus are identified by their role in the family or interview (M=Mother, F=Father, S=Son, D=Daughter, I=Interviewer). Pittsburgh 14

BK: I get up, I turn the computer on and then I go, while it's heating up, I go and put water on for tea and then I call up my macmail, which is usually...

LW: Six or eight messages, all from her boyfriend...laugh...

Boston 10

F I usually around seven in the morning I'll check e-mail between 7 and 7.30 and then I will go to work and then when I get home at about 7.30, 8.00 I'll usually go on and design a couple of ads on publisher and then I'll close up around 9 - 9.30 and usually check the website to make sure its up and running because its been crashing a lot and then I shut it down about quarter to ten and that's me. The weekends I try to stay off it just because I don't want to see it.

Boston 6

F In the evenings I come and check my e-mail and probably sometimes to do a translation um quick translations from a few works or um on the weekend at least four hours on the weekends to edit an article....

I Right does that vary in the day when on a Saturday or Sunday?

F Sometimes usually

M Usually do it early

F Saturday mornings

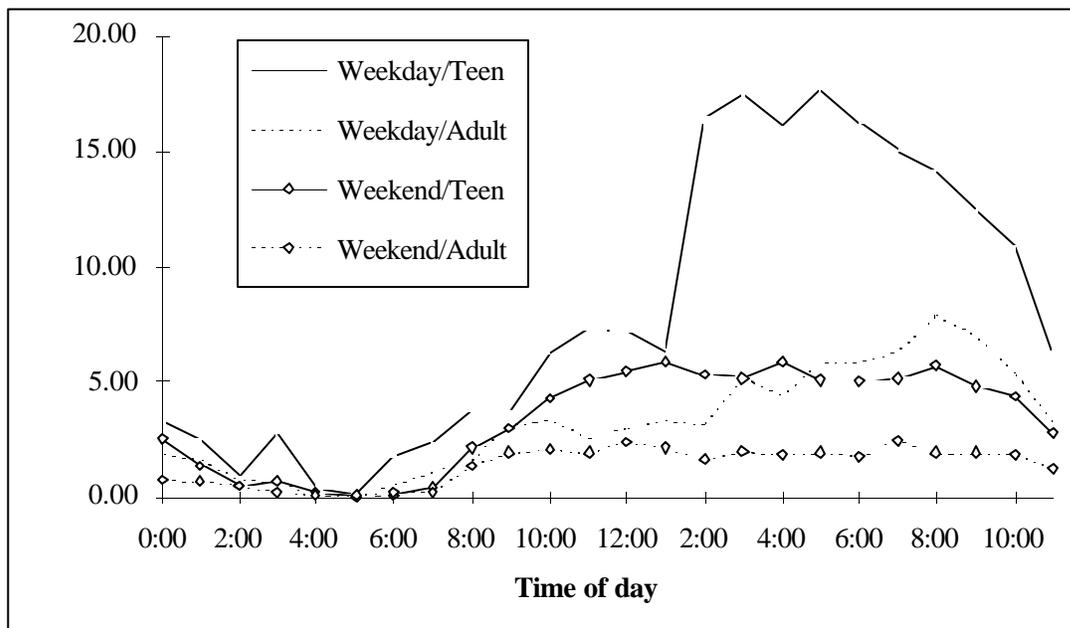


Figure 1. HomeNet computer access over a typical day

As in the statistical data, these routines can be seen to be sensitive to the day of the week. For example, in the last quote above, the father refers to a routine of doing email and short pieces of work on weekday evenings but a longer piece of work at the weekend when there is more time and opportunity. The fact that he chooses to do this task on Saturday mornings rather than at any arbitrary time of the weekend, also reveals an attempt to constrain the amount of time spent on the activity and its impact on family life. Individual routines of this kind are very idiosyncratic and not adequately reflected in the overall trends of Figure 1. Thus although this father works on Saturday morning, other fathers avoid PC use at the weekend (as in the second quote above) or use it to play games and relax (quote below). This variation is not captured in Figure 1 by the steady but lowered use of the Internet by adults on a weekend morning.

Boston 2

F *On Saturday morning or Sunday morning if I come down and make a pot of coffee and I'm waiting for it to perc I might play a fast game of bridge just cos I'm waiting for the coffee pot to perc through*

Most individual routines for PC and Internet use were designed to fit with those of other members of the family. Thus each family was found to have its own complex set of routines for taking turns on the computer. These were not described in terms of a simple schedule of time slots and users, but rather as a system of turn taking rules with some typical outcomes. The following quote captures this attitude exactly, and outlines some characteristic patterns of use in many of the families we spoke to:

Boston 5

I *So when would you use it?*

M Its almost always in the evening after dinner especially in the Summer. We haven't actually used it as much in the Summer 'cos obviously its nice out and we want to be outdoors. But you know through the year we usually notice it's like I said after dinner. I'll come in, the kids will usually use it first because they're anxious to get on it like right after dinner. They want to come in and get on it and then sometimes they'll get to the point where they're all taking turns on their games and I'm anxious to get done whatever it is I have to get done or whatever, but I wait. So I'm usually later on in the evening. Claudio uses it more during the day because he works off shifts so he has the opportunity when no one's around to hop on and do his cheque book or whatever. So we all use it at different times mostly at night, and I use it mostly once the kids have got settled and they're having their baths and getting ready for bed. I'll come in and work on it at that time.

Many family routines varied not only by day of the week but by seasons. School vacations were particularly significant for both parents and children. The relaxation of school schedules and activities meant that PC and Internet access could be spread more evenly throughout a weekday, and the lack of homework liberated more time for children to play PC games! However, the fact that children spend more time at home during vacations, affected parents working from home:

Boston 2

M But see we don't separate necessarily how can I say this we work sometimes at our office sometimes here and we are more productive at home and during the school year we actually work more at home

I Right

M Because during the summer Becky is here a lot and she does not understand the nature of our work and wants to chat so we have to go the office a little bit more so we can get things done. But the office is a hard place for us to work- its very busy very noisy

The extent to which computing routines had become established in family life was revealed by reported reactions to disruptions of various kinds. Going away on vacation or having a computer break down often led to what can only be described as withdrawal symptoms. These symptoms ranged from a heightened sense of appreciation for the PC, to an almost animal-like series of visits to the place where the PC used to be! The addiction to email was so strong in one family that it had led them to seek a public Internet access point on vacation:

Boston 4

M I really enjoy it. I miss it so much where it's broken down I really enjoy it

Pittsburgh 12

MK It's pretty useful, since the computers been in for I guess this little updating and our printer is in here for a repair, I sit in the family room which is adjacent to the living room and I'll be reading the newspaper and watching TV and I'll see the kids keep coming down to the desk where the computer was and then they stop. And they're, it's like if your car is gone and you keep going outside to drive somewhere and you just, they're just stuck. They keep going to this space and there is nothing

there for a few days. And I guess if we never got it back they'd quite doing it, but it's kind of funny watching them go for it and it's not there.

Pittsburgh 10

BK: We went down to North Carolina the outer banks for two weeks, my niece and I we just we couldn't stand it we had to go find a computer...laugh... I mean not to be able to the check email you know especially, I mean the chats well I can handle that, but not to be able to check email it was like I couldn't stand it. So we went, we found a library that had, and we stood in line and waited. Of course, it was a small library, they only had one computer you know...

4.1.2 Developing routines

Routines do not emerge full-blown as soon as a household gets a computer, but develop over time, with personal experience and mutual accommodation among household members. Generally, when an individual performs a behavior repeatedly in similar circumstances, the behavior becomes internalized and automatic. With practice and repetition, the cognitive and motor activities needed to initiate a behavioral sequence and then execute to completion becomes automatic and performed in parallel with other activities, requiring minimal allocation of focal attention (Schneider & Shiffrin, 1977; Ouellette & Wood, 1998). The behavior becomes integrated into a larger chunk size. For example, when a person first uses a home computer, each step in booting it up and starting the program for checking electronic mail must be thought about separately. Aiming a cursor with the mouse or typing the return key after entering a form are conscious actions. With experience, however, this action sequence is encapsulated into the higher-level task of “checking my email” and is performed with minimal attention to the details. Not only is habitual behavior performed in a single, automatic sequence, but the sequence is often set off unthinkingly by environmental events (e.g., the ringing telephone sets off the sequence to answer the phone) or schedule (e.g., finishing dinner may trigger TV viewing). As a result, these routinized or habitual behaviors become highly predictable. In contrast are what might be called “controlled” behaviors, which are directed by intention through deliberate reasoning processes. These controlled behaviors are likely to be performed more slower and are less stable, with more variability from one opportunity to perform it and another.

In summary, when people first get a new technology at home, they slowly develop routines, which ultimately lead to the highly regular patterns of use we’ve just described. We examined this process of routinization by tracking the month-to-month consistency in the times during the day participants in the HomeNet trial used the Internet. We expected to see that this month-to-month consistency in their schedules would increase as they became more experienced in using the Internet.

We first calculated the number of minutes per hour of the day that a participant used the Internet, averaged over a four-week period. Call this vector of 24 averages the participant’s Internet schedule for that period. The similarity between an individual’s Internet schedules across adjacent time periods is the Pearson correlation of these

vectors, with each correlation based on an N of 24 time slots. A high correlation implies that their Internet schedule was similar for two months in a row, while a low correlation implies that one cannot predict when they would use the Internet in one month from their behavior in the preceding month.

We expect that the average month-to-month correlation would be substantial and that they would increase with a participant's experience online. In this research, we define online experience as the cumulative time that an individual has spent on line (i.e., the total number of hours the participant had been online since the beginning of the trial). This metric is correlated with the number of months an individual has subscribed to an Internet service, but weights these months online by the amount the subscriber used the Internet during the month. Thus our measure of experience is behavioral, and does not simply reflect the passage of time.

Figure 2 show the average month-to-month consistency correlations in Internet schedules plotted against log to the base two of cumulative hours online. The analysis uses a mixed linear model (SAS, 2002), to predict the consistency correlation based on based on the participants gender and adult status, the number of months they have had access to the Internet in their household, and their personal cumulative hours using the Internet. Respondents were treated as a random effect in the model, with an autoregressive error structure of period one. The average month-to-month consistency in Internet schedule was moderate, with a mean Pearson product moment correlation of .32. Both the plot and the more formal data analysis show that the month-to-month consistency increased the more participants used the Internet. The coefficient for cumulative hours online means that, on average, as participants increased their time online by a factor of 10, their month-to-month consistency correlation increased by .056. An examination of Figure 1 shows that this increase in consistency with experience had a steeper slope after participants logged 100 hours online.

4.1.3 Ad hoc timing

In addition, to using the computer at regular times, people also reported a more spontaneous or ad hoc use. This was often triggered by the need for a particular piece of information or simply finding the PC unattended when they expected it to be in use.

Typically, these spontaneous sessions were short and sweet:

Boston 2

M Um in the evening we use it as people call in and we need to get into the Database to see what a phone number might be

Boston 10

M10 I'll use it when David will call me and tell me to check on something that's when I usually pull it up or to do something

Pittsburgh 10

DH: No, usually if say like my Dad uses it, he'll use it, whatever he does, sign on, work or whatever, then he'll shut it off. Then later I'll see there's nobody on it and I'll turn it on.

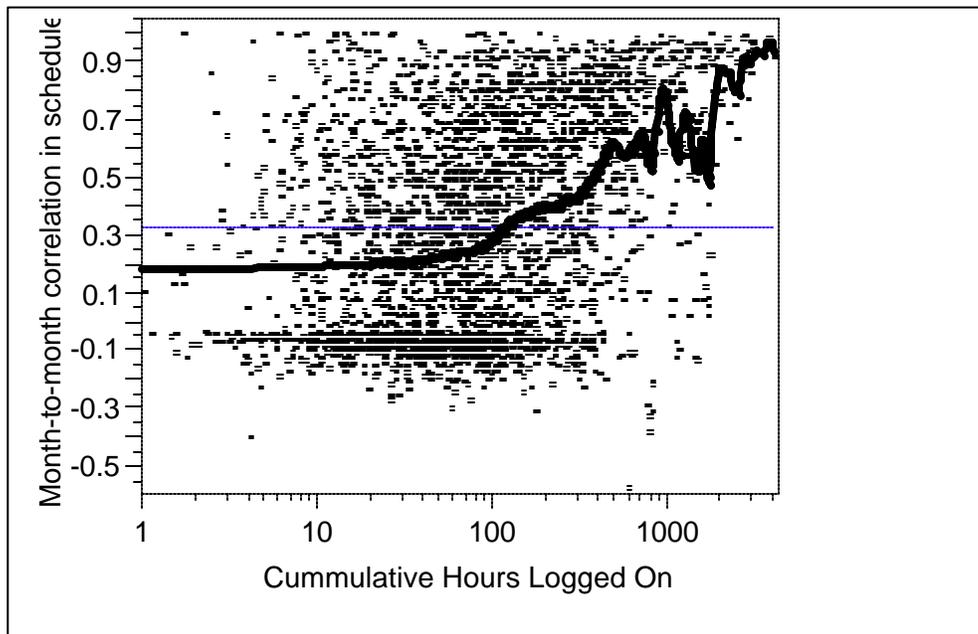


Figure 2: Month-to-month consistency correlation in schedule plotted against commulative hours online (logged). Fixed line is a smoothed, spline fit.

Checking for email was a common ad hoc behaviour. Sometimes this was done during someone else's session by asking them to check the inbox. As in the following quote, seeing or hearing someone logging onto the Internet might be a trigger for this kind of request:

Pittsburgh 4

RK Show me how you would log on to email.

DB All right.

(logging on noises)

SB Whenever anyone does that, he's like "can you check my email?"

DB Yea, whenever I hear that going I'm like, "Hey can you check my email if you're on there?"

4.1.4 Time-saving practices

Because time on the PC was generally a scarce resource in the households we visited, individuals had evolved a variety of time-saving practices within and across sessions.

Within sessions, they would sometimes multi-task to make use of one program in the time taken for another to operate. A typical example was listening to an audio CD while backing up data, or checking email while software downloaded. TV watching was also reportedly done in parallel with PC use. Teenagers seemed to have the greatest propensity to do this, even in tasks that apparently don't need much attention like playing games or doing homework!

Pittsburgh 4

DB It depends what I'm working on. If I'm doing something I really need attention with like if I'm editing resources or something. I want to focus on that or else I can screw up the program. But if I'm working on an English assignment I can type and listen. If I really need to focus on an assignment for school I'll turn it off. But when I play games or something I have the TV on. Or if I'm working over there and I'll have the TV on.

Across a number of sessions, people would organise their tasks according to how much time they had to do them. For example, email processing and web browsing was sometimes done across two sessions, with the first session used to read and filter material and a second longer session used to process and respond to it. Note that printing is referred to in the case of web browsing below, and constitutes another time-saving measure in its own right.

Pittsburgh 10

DH If I do web crawler or yahoo or something, it'll be like, I'll look for say Monty Python then like if it's something I want to go back to I'll leave you know bookmark, maybe. If I think of it. I'd go through here, maybe print it out, or down load it, or you know it never you know consists of spending very much time with it.

These measures reflect a very sophisticated capacity to estimate how much time is needed for different computing activities and to match this with the amount of time likely to be available on the current session. This kind of calculation was described explicitly by a number of interviewees, and is all the more impressive against a backdrop of multiple users competing for a single shared resource:

Boston 3

F Sometimes I'll be on for doing something like this (poster) for 10 or 15 minutes you know to revise it but if I'm doing book keeping which is about once a week I'll be a couple of hours

Boston 7

M For example I have to write a memo to another doctor. I'll probably just do it there (at work). I'll find 45 minutes. But if I want to write a more thoughtful kind of memo I wouldn't have the time there. I would have to take it home and do it.

4.2 Spatial organization of family computing

4.2.1 Choice of home computer location

Where computers were located within the home influence how they were used. Their location in turn is influenced by a number of factors, including the size of the home, the presence of children in the household, whether any household member ran a business from home, and the family's beliefs about the appropriateness of computing technology in various rooms. Figure 3 shows the location of the 108 computers in the Boston and Pittsburgh homes.

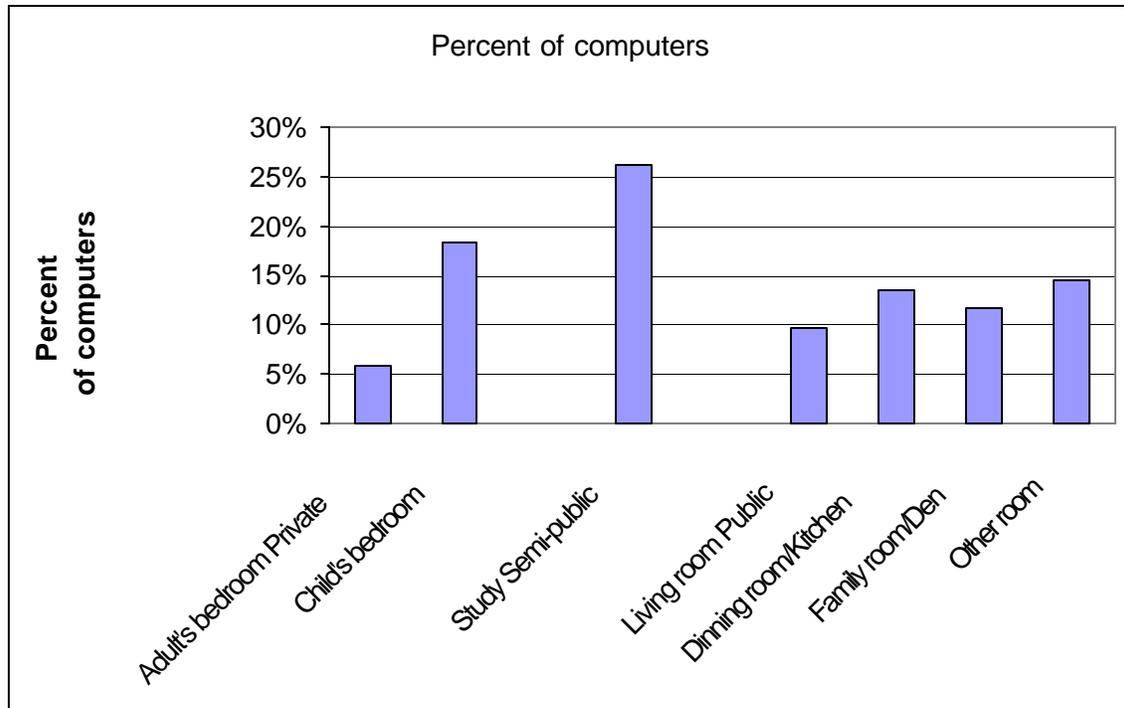


Figure 3. Location of computers within the home (N = 108 computers in Boston & Pittsburgh)

To understand the choice of locations represented in Figure 3, and their effect on home computing we turn now to the interview data. We begin with a review of the problems people associated with different locations, and go on to consider their comments on social interaction around the computer itself.

4.2.2 Location problems

In general, there was a spread of locations chosen for the computer and an ambivalence about the suitability of all of them. There was little agreement within or between families as to where the **best** location for the computer was. Indeed each location tended to be good for some members of the family but bad for others. This was particularly true of locating the primary computer in a private room of the house such as a child or adult's bedroom. If it was in an adult's bedroom, the children couldn't get access to it as much as they wanted and if it was in a child's bedroom, the adults couldn't use it when they the child had gone to bed. The following quote illustrates this dilemma.

Boston 4

M I had it in my bedroom here and after they went to bed I used to go in there and I'd use it. And then I moved it from my room into their room. They[the children] said you had it long enough. You bought it for us

I So did that mean that you couldn't use it again

M No I would just go in their room and use it

I What even when they were asleep

M Oh no I couldn't use it when they were asleep

I So you had to change when you used it
M Right right I have to use it in their room in the day time when they were in school instead of the night time when it was quiet. So I never get the homework done during the day

As a result, only 25 of the 103 (24%) computers in the sample were located in a private space - a parent's or child's bedroom. This placement is surprising, in part, because so many of the families in these sample got their computers for their children. This motivation to get a computer for children is consistent with national data in the United States showing that households with school-aged children are more likely to have a personal computer than households without children (U.S. Department of Commerce, 2002). Families were more likely to place the computer in public spaces like the dining room, kitchen, family room, spare room, or basement (50% of computers) or in a semi-private space, like a study, which had an adult owner, but could be used by all household members (26% of computers)..

However, placing the computer in a completely public room such as a kitchen or family room didn't solve these problems either. Although this made the computer equally accessible to all family members, it did so at the expense of privacy and concentration. This made it difficult to use the computer for tasks like email, finances or word processing that require a degree of peace and quietness:

Boston 4

I OK so where would you do the games?
M Probably in the living room, and typing I would do in my bedroom where its quiet and personal and I cannot be disturbed

Many parents in the sample, however, selected a public place precisely because it denied privacy to their children, as they used the Internet. As we discuss below, by placing the computer in a public place, parents could casually inspect what their children were doing online. As they walked past, they could see what was on the screen, for example, and ask questions about their children's behavior. Some parents used the public location of the computer as a deterrent, believing that their children would be less likely to visit sexually explicit web sites or converse with strangers in chatrooms if their behavior was subject to parental oversight. Conversely, children lobbied to have the computer place in their rooms because of the privacy it afforded them.

Pittsburgh 20

EP Carnegie Museum is a wonderful place, but I wouldn't leave him alone with a map in the middle of it. So its just kind of parental supervision... I mean we're in the same room but its just sort of knowing when he's on... I'd be sitting on the sofa knitting or watching.

One compromise was to locate the computer in a semi-private but shared room, such as an office. This made it more accessible to all the family but capable of private use when necessary. However, even here, there were problems with ownership of the computer falling to the father of the family, and the feel of the computer being too work-oriented. In larger homes, there were also logistical problems with moving the computer too far

away from the hub of family life. If it takes too long to walk to the computer, switch on and connect to the Internet, then a more spontaneous and sporadic use of email or the web is rejected by families:

Boston 11

F You'll see when you go downstairs (office) you're in a different mood you're not relaxed like you are up here (family room)

Boston 11

M I get tired of going downstairs and all of a sudden I think gee I'd better e-mail Lauren in Singapore, so I have to all the way downstairs, and basically I live on this floor because I'm doing the dishes... Its just like people build and they put the washer dryer on the second floor so they don't have to go all the way down to the basement to put the clothes in one machine

Pittsburgh 9

MTR I would e-mail people and say...just pick me up at the airport, you and me, call me on the phone and tell me. Because if you send it e-mail, who knows when I'll be up here to read it again? So, I would e-mail people and tell them to telephone me. Because I wasn't going to hiking up to the third floor to get connected, you know, on the chance that something could be there or not, so that's it. If it was something I needed to know I would send the e-mail and say call me.

All these problems show that the simple choice of where to locate a computer in the home has large effects on family life, both in terms of the way individuals use the computer and also in terms of the way they share their time on it. These problems appear to change rather than diminish as multiple computers enter the home. While sharing becomes less of a problem, control and interaction within the family becomes more difficult. This is illustrated in the next section, which deals directly with the effect of home computing on social interaction within the household. As we shall see, this is not all bad news as both sociofugal (separating) and sociopetal (combining) effects are apparent!

4.2.3 Sociopetal and sociofugal effects of home computing

Just like the placement of chairs around a table, the placement of PCs around a house appears to have consequences for social interaction amongst its users. In general, the PC seems to be a sociable device, somewhat akin to a table or a television in bringing people together around a common activity. This *sociopetal effect* was indicated by the very large number of reports of joint PC use in both sets of interviews. In some cases, the encounter was described as being similar to television for at least one of the parties, who might watch another person's interaction with the PC whilst waiting for their own turn on the machine. This of course provides an opportunity for vicarious learning of interfaces and applications, which can be applied later on. However, even in these cases, the watching may lead into a more active involvement with the interaction, through discussion and direction that goes beyond the television experience:

Boston 5

M Sometimes they're watching me. Sometimes Ewan and Roger will come in if I'm

working on a project whether its on the Internet looking at something in particular they'll watch me, or if they're interested in what I'm doing with work or whatever, or sometimes they'll just be waiting for me to get off. Or they'll sit there, they'll discover something and they'll be like "Mom mom" you know, and I'll come in and I'll sit down and Ewan will sit down and we'll watch Roger or something with this great discovery that he's made, whether its a city he's building or something he's found on the Internet. So we'll just watch. Its a way to interact and do something together which really goes beyond what you can do with the television

The ability to watch or be called over to view someone else's PC session is clearly increased when the PC is sited in the public rooms of the house. However, it also depends on the type of activity being performed on the PC by the primary user, and can happen in the most private of spaces. For example, the quote above applies to the use of a single family computer located in a corner of the parents' bedroom. This is shown in Figure 4 during a session in which the two sons are playing a game 'together'. The figure also illustrates how difficult sharing a computer is, at a close viewing distance with single-user input controls. Compare this to the experience of using a games console with multi-user controls and a TV screen about nine feet away.



Figure 4. The difficulty of joint PC use

A wide variety of local applications were cited in the reports of shared PC use. Games were the most commonly mentioned, and included parents playing with children as well as children playing with siblings or friends. Other applications that seemed to bring people together were creative activities like making movies or cards. Even very personal applications could bring people together when one person was teaching or helping another:

Pittsburgh 4

DB We'd make up jokes like that. And wasn't really cause we wanted to make it a comedy, because well its just fun on the nights we have sleepovers and record stuff

SB It keeps them off the street corner basically (laughter)... I come down 3 o'clock in the morning and a kid, cornstarch in his hair, dancing around in front of here. And my kid is up there with a camera. That's a lot of fun.

Boston 10

F I was the one that taught Carla how to do the invitations

Boston 2

M Carrol and Becky learned how to type by using Mavis Beacon - they learned together

Internet applications were even more effective than local applications in fostering social interaction around the computer. This can be seen statistically from the reports of joint computer use after 9 months in the HomeNet trial. One third of all sessions were reported to be with others, and 75% of these sessions involved Internet use (see Figure 5).

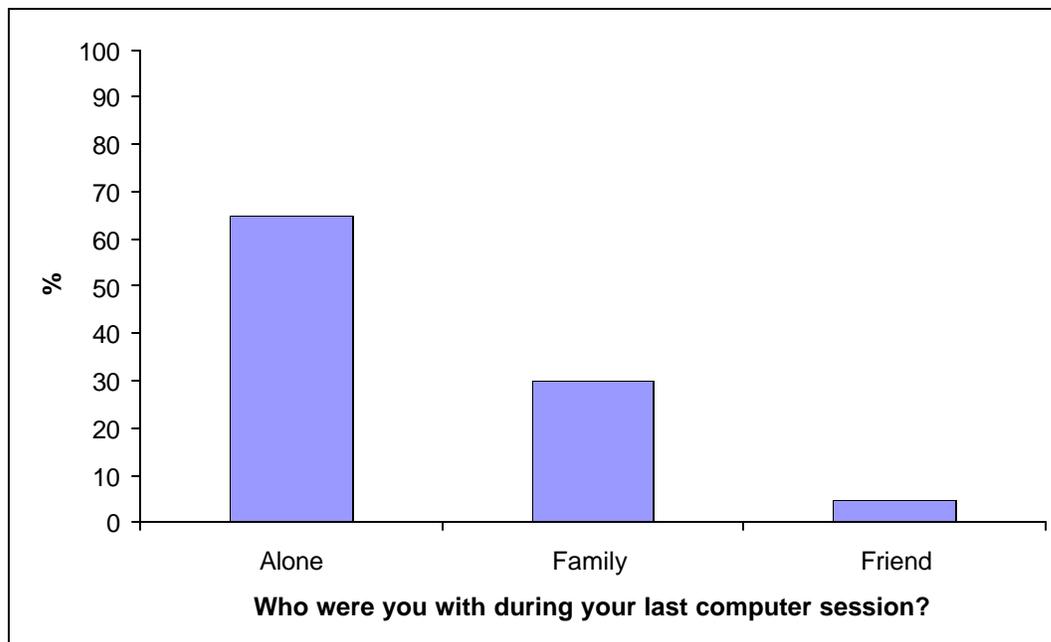


Figure 5. Reports of co-located use of the HomeNet computer

Searching the web together was often mentioned as a joint PC activity. Sometimes this was done as a conscious joint activity from the outset, while at other times people got drawn into doing it together as a result of being called over to see a piece of interesting content. For example, one married couple in the real estate business used to enjoy regularly 'cruising the world' looking at expensive houses together. In another example, a daughter showed her mother how to print out route directions for guests attending a family reunion. Such sessions were generally seen in a positive light, as occasions that enhanced family relationships and time. This can be seen most clearly from the following quote describing the discovery of Santa Claus's homepage:

Pittsburgh 6

SK: How has that affected your relationships with each other?

RC: Well, it was interesting we just happened to find Santa Claus' web page. And it sounds ridiculous, but we spent an hour together as a family. We typed in each others, each ones name, and they give you whether you've been good or bad, and then they say, yeah well, what you've done. And the nine year old she didn't believe in this and then it said, you should be neater, and she went, how did he know!...laugh... It was just a lot of fun. And then they had a quiz, and you got your elf diploma, you print it out and it's signed by Santa Claus. So it was really a good thing for the family, for young kids. We just had a good time with it.

There were fewer reports of joint email or chat sessions on the Internet. Communication appears to be a more personal and private computing activity than information access. Perhaps for this reason, when shared communication behaviour was mentioned it was characterized as a particularly intimate thing to do. This is indicated in the following quote from a daughter who regularly helped her mother compose chat group messages:

Pittsburgh 14

BK And on the chat groups a lot of them know my mother and she sits there and talks through me. You know I type what's she saying 'cos she can't type. So it's actually brought us closer. You know we have more conversations now, because it's going through to somebody else.

Despite the beneficial effects of the PC in bringing family members together, there were serious concerns about more long-term *sociofugal effects* of keeping individual members apart from the family. These concerns were usually expressed by parents in the context of talking about the growing isolation of their children. The following quote is typical of these concerns since it mentions the relatively large amounts of time children and teenagers can spend on computer games when the parents are out of the house or busy with other things. In this example, the presence of the computer appears to affect the family time spent by a son with his parents, and also the playtime spent with a visiting friend:

Boston 7

M Its funny because sometimes I feel like it becomes a solitary thing for Steven up here. He could spend 2 to 3 hours and to me that's like, doing this for 2 to 3 hours is too much and I don't like it. And then his friend Andrew came round today. And I told his mother 'Tell Andrew there's no computer in the house today. Someone was bad and its gone'. Because he's the kind of kid that will come over and

solitarily do something. And then they won't play. That's OK with Steven because he can do something solitary too. But the point of playing is to play together, to do something... To me its like, 'What kind of impact does this have on your kids?'

Parents also recognize the potentially antisocial nature of the ir own computing behavior, particularly when they share their children's passion for games. Again the overall amount of time spent on the computer, in relation to other activities is seen to be a key factor. However, the fact that they can articulate and discuss this concern, shows a level of insight into this effect that the children do not have:

Boston 6

F What do I think of computers?

I Yeah

F They are very useful. They are, um you know, there is this almost like they have this city inside of them

M A world

F And um I can get my work done and be entertained

M They offer a lot but as long as you know when to put the brakes on. Because you could spend your whole life, day after day I mean, I could I always say its a good thing. I don't gamble because I have such a hard time tearing myself away from something like this. ...I get on a game late at night and I probably won't go to bed till 2 in the morning. I mean the idea is that you can get your work done faster and then go enjoy life, but really what happens is you can do so much more that you do so much more - d'you know what I mean?

As a result of these and other concerns, parents try to constrain their own home computing behaviour and that of their children. Exactly how they do this is explained in the next section, together with the attempt by children themselves to reassert their rights to the computer through increased expertise.

4.3 Power, regulation and control

4.3.1 Parental regulation of computer turn taking and Internet access

In Section 4.1 we saw that families develop routine patterns of turn-taking at the computer, as a way of dealing with contention for computer time. What was not so clear from that section was how such patterns come about, and what happens in cases where the routine practices break down with individual violations or shifting demands. We briefly consider these issues here, since they relate to a significant power struggle for computing resources in the home. This is effectively part of a bigger power struggle between parents and children to structure and manage family life itself. It is important to understand this battle, since it lies at the heart of the social context for home computing, and cannot be overcome by simply increasing computing resources and locations in the home.

Contention for computer time is a heated issue in many of the families we visited. Families do not sit down calmly at the beginning of the week and schedule time slots

together. According to our informants, they watch the space in which the computer sits, try to read each other's plans, and fight for a seat:

Boston 4

M We'd get into a fight

Pittsburgh 12

MK They fight over it like they used to fight when we only had one TV

Boston 9

M I've seen people literally pushed off that chair

Boston 5

M I wouldn't say we have a problem with conflict but it does arise just in the manner of seven of us using the same computer

Given this situation, it falls to the parents to arbitrate and ensure that everyone in the family gets a 'fair' amount of time on the machine. Parents do this in different ways. Some parents allocate time limits to stop the dominant children from taking too long. Others enforce sanctions if the children can't agree to sort it out themselves, or negotiate on the basis of who needs it most. In general, school or homework takes priority over recreational uses, and whoever goes to bed first tends to get the earlier time slot:

Boston 5

F When they're playing the games we set time limits so everyone has a turn

Boston 4

M What I do is I say "OK nobody will use the computer. We will decide who needs it and which is more important

I Yeah so it goes on who needs it the most

M Right who needs it the most. If it's to play a game then no. Then if it's to do school work then fine then he gets the priority

Boston 11

F My son gets priority because he goes to bed earlier. She stays up later so she can have it later

In addition to arbitrating between family members for time on the computer, parents also regulate children's overall access to the Internet. Most parents could relate stories of inappropriate content coming up in response to web searches and were wary of leaving children unsupervised on the Internet. Others expressed a general distrust of chat rooms or email. A common metaphor was to liken unsupervised Internet use to leaving young children alone in a public place:

Pittsburgh 20

SP What is it about him having access to it himself that makes you nervous?

EP Well in terms of the World Wide Web I guess you know I wouldn't leave him downtown by himself and say you know here's the number of your bus find your way home. I mean he's smart for his age, he started reading when he was three. But still, he's not so savvy that I'm comfortable turning him loose that way. But with the web it's more... You know the Carnegie Museum is a wonderful place but I wouldn't leave him alone with a map in the middle of it either.

These reservations often led parents to ban Internet use to pre-teen children altogether, or to limit and supervise their access. These attitudes softened for teen use of the Internet, but did not disappear entirely. While teenage children were generally allowed access to the Internet, this was usually according to a strict set of instructions by parents and was subject to monitoring and punishment. In some cases, parents had resorted to a form of spying on their children by reading over their shoulders or logging on under their user name to read personal email messages:

Pittsburgh 14

BJ Freida do you know what she means when she talks about muds?

FW Oh yeah, I've sat and read behind her you know what's been going on and stuff like that. I try to monitor a little bit, because she is you know a minor, and all the things they talk about on the computer. And I'll read over her shoulder and go, what's that mean, what's this?

Boston 3

M ..Every once in a while I'll read one of her e-mails from her rent people and see what's going on

F Yeah I'll do that to but I don't tell her that though

M I think she knows. I don't think she really cares. I don't know if I'd want it to be totally private

F She isn't crazy! She deleted all of the outgoing messages every one of them because she didn't want us to read her outgoing messages.

An additional consideration for some families was the cost of a dial-up Internet connection. Parents would oscillate between trusting their children not to connect for too long, and banning use when that trust is broken. Not surprisingly, this leads to an atmosphere of deception and mistrust:

Pittsburgh 4

DB ...It was funny

RB Until you had a \$115 AOL bill maybe. And we just said that's enough of this.

(general laughter)

RB ...That was it. That got shut off real fast.

Boston 11

F But when he's typing and we come down and we find out he's playing on AOL so we have a yell and a scream session and that's the end of that

In short, a variety of rules and regulations are developed and administered by parents to control their children's access to the computer and the Internet. These rules are designed to ensure a fair distribution of computing resources within the family, based on the age and need of family members. Routine practices emerge from this process insofar as the rules and conditions allow. However, these are always subject to revision and re-negotiation, and can be swept away in the face of an urgent need for the computer or an external family event.

4.3.2 Child control of computer settings and expertise

Despite attempts by parents to constrain their children's computer and Internet use, children have more free time than adults and a more playful and experimental attitude to the technology. This means that children may actually end up spending more time on the computer than their parents, and will try out things for fun rather than to get some task done. For example, many children told us about changes they had made to screen settings, icons and file systems in order to personalize the computer. They also reported downloading software from the Internet, adding bookmarks and addresses and generally performing a variety of system administration tasks. Because most systems we encountered were not carefully partitioned and managed via multiple user names, these changes affected everyone else using the computer and were perceived to be disconcerting or annoying by other siblings and parents:

Pittsburgh 14

BK I have that with my niece, she likes to download pictures. I never know what's going to be on the screen.

Pittsburgh 8

MAR It seems that everytime I have mine on here, I don't know what happens to them. I don't know if you can erase them and that's what my brother does to me, but like I had all my college ones on here, and I think he just erased most of them.

Pittsburgh 19

GH: I think she captured Netscape 3 and we had problems with that. And I questioned whether or not she was taking it off the Internet, whether it would have bugs or anything but she ran a de-bugger program and found one mistake and reloaded.

One effect of this kind of playfulness is that children and teenagers become more competent and knowledgeable about managing the computer than their parents. Teenagers in particular were very adept at using the computer and solving technical problems. This meant that they often became the technical support gurus of the family, and would be consulted by their parents and younger siblings about technical problems and goals (see Kiesler, Zdaniuk, Lundmark & Kraut 2000 for further details of this phenomenon). Both generations acknowledge this role as the following quotes show. Note also that the son referred to in the third quote below has left home, but is still acts as a system consultant to the family!

Pittsburgh 19

JH My brother is like the director of the house.

BJ I see.

JH I'm second in command.

Pittsburgh 19

JH He taught me a little bit and I just found out the rest on my own. I'm basically a trial and error person. I learn a lot of things by myself, I don't like to sit down and listen to people telling me how to do stuff unless I know I have a problem in a certain area, and my Dad just doesn't know. It's tough to explain it to him because he's not used to it at all. Totally different generation.

Pittsburgh 16

RC It's embarrassing because my nine year old granddaughter does better than I do.

Pittsburgh

Father When he comes home... then we usually have a couple of questions for him as to you know, why is this happening and you know. He seems to have all the logical information as to what's going on. He's our source. The house source.

This asymmetry in knowledge about the computer is significant in the context of the power struggle between parents and children for computing time and access. It leads to an unusual social situation in which the normal power relations are partially reversed. Parents have the power to veto or limit access to the machine, but children have the power to modify its setup and operation.

5. Discussion

These findings go some way towards unpacking the social context of home computing, at least for a small sample of American families struggling to accommodate yet another piece of technology into their lives at the end of the millennium. Whereas local PC applications formed the basis of computing activities at the beginning of the 1990's (Venkatesh 1996), Internet services have now added to the functionality and appeal of the PC, providing something for everyone in the households we visited. However, services had **not** taken over from local applications, but rather increased the mix of local and remote software and content used on the same device. Viewed from the user's point of view, the difference between 'local' and 'remote' was irrelevant to the tasks they were carrying out, except where it affected task performance. For example, a decision about whether to use a CD-ROM encyclopedia or an educational website for a piece of homework would probably hinge on factors like the speed of access and the quality of information, rather than on some overall preference for or against the Internet. Furthermore, because the point of access is the same for local and remote information, the social issues of turn-taking and timing, spatial location and control apply equally to both dimensions of computing. This means that in households where the primary Internet access device is a computer, a person's overall Internet experience is part and parcel of their home computer experience, and does not depend on Internet service offerings alone. Indeed as we have seen, it depends as much on how many people have to share the computer, what place they occupy in the household, where the computer is located in the house and whether they are allowed to access Internet services at all!

A convenient way of summarizing these contextual effects is shown in Table 2. This contrasts our findings on the local adoption of the home computer with known findings on the adoption of TV (e.g. Gunter & Svennevig 1987). We have chosen the TV as a point of reference because there are many similarities in the use of the TV and PC, but also significant differences which highlight the PC's distinctive role in family life compared to its more familiar cousin. In order to return to the research questions that motivated our study, we have divided the table and findings by the major contextual factors they relate to. Hence, we step through findings on the temporal and spatial

organization of computer use, and on its relationship to social interaction and control. After reviewing these findings shown in the table, we go on to consider their implications for the design and marketing of computers and other Internet devices in the home.

CONTEXT	TELEVISION	COMPUTER
Timing of use	Prime time Routines stemming from programming schedules Reactive use	Prime time Routines stemming from personal schedules and time sharing patterns Reactive and opportunistic use
Spatial location	Solitary/1 st TV- Public family room 2 nd TV – Private bedroom	Solitary/1 st PC – Semi-public office or private adult bedroom? 2 nd PC – Private child’s bedroom or spare room/ Public kitchen or dinning room or family room?
Social interaction	Conversation Shared presence	Conversation Support Collaboration
Control	Parental arbitration of time and content Based on interest	Parental arbitration of time and content Based on interest, need and cost ‘Child’ maintenance and repair

Table 2. Contextual factors in the adoption of the home computer compared with television

Regarding the timing of PC use we found that it clustered within the same time periods as ‘prime time’ TV use. Hence weekday evenings were the most popular time of the week for using the computer and television, as family members return to the home after school or work and settle down after eating. These findings also indicates where the majority of PC time is coming from, within the existing commitments and behaviours of individuals. It is often taken directly from TV time, as indicated in the large-scale market research and time use studies. However, whereas the scheduling of TV use is driven largely by the programmes on offer, the scheduling of PC use is based on personal schedules and patterns of turn-taking within the family. Both kinds of schedules lead to repetitive and routine behaviours, but these are subject to greater negotiation and revision on the PC where the content is open-ended. This also reflects the fact that PC use is primarily a personal activity, even though it might come to be shared by others along the way. There is therefore a greater sense of ownership of individual ‘sessions’ on the PC than on the TV, with one person allocated overall control. In addition to scheduled time at the TV and PC, family members also engage with them more spontaneously. People may switch on the TV to ‘see what’s on’, or notice a programme that someone else is watching. In the same way, they may see something of interest on the PC over the shoulder of the current user, or get called over to help, or find that they have email waiting to be read. This kind of *reactive use* of each device is supplemented on the PC by a sheer

opportunistic use resulting from finding it free. Children in particular may slip onto the PC in this way, to overcome time sharing constraints before a fixed bedtime.

Table 2 also shows the differences between the spatial location of TV and PC use. In both cases a key factor is the number of devices in the home. When there is only one TV or PC in the household its location is chosen differently from when there are more than one. The location for a solitary TV is often the family room while the location for a solitary PC is often the home office. Subsequent televisions may be placed in more private rooms of the house such as a bedroom. However, the placement of second computers is less predictable from our data, which confounds form factor, age and Internet capabilities, at least within the HomeNet families. All we can say is that second computers turn up in a variety of rooms within the home, which may be private as in a child's bedroom, or public as in a kitchen/diner or family room. A significant factor in the choice of second PC room location is likely to be its status along a *work-play* dimension. Both functions are evident in the use of a solitary PC, but appear to separate somewhat with the introduction of a second PC in the home. Typically the first PC may remain in the office as a work-oriented machine while the second PC becomes more specialized for recreation. In this scenario, the second PC might be located in a more recreational room to match its function. This contrasts with the situation today with the TV, which is almost exclusively used for 'play', wherever it is located and however many sets there are in the house.

The question of whether or not the presence of a computer in the house brings families together or pushes them apart, is addressed in the third row of Table 2. As with the TV, the home PC gives people a common basis for conversation within the family as things come up which match common interests. However, whereas the intensity of interaction around the TV is low, and characterized largely by co-presence in front of the set, the intensity of interaction around the PC appears to be higher. Family members may enter into true collaborations with each other to operate a PC programme or Internet service together. Also, the fact that the PC is difficult and unreliable to use means that family members offer or solicit support from each other in a way not found with the TV. These kind of sociopetal effects of the TV and PC are probably greatest in public rooms of the house where family members are already in close proximity to each other, and with solitary devices whose use is not diluted by the availability of other models.

Finally, we have found that PC and Internet use at home is controlled largely by parents. Control applies to the overall time spent on the computer as well as the kind of content viewed within that time. This appears to be similar to the control exercised by parents over TV use. One difference is that PC use appears to be regulated on the basis of interest, need and cost rather than on interest alone. In addition, the growing expertise of children in operating the computer often puts them in a better position than their parents to control maintenance and repair tasks. Again, this adds an extra level of complexity to the negotiations for PC time and access compared to that for the TV. Thus on every dimension, the PC turns out to be an altogether more complex technology and context for interaction than the TV.

These findings on the social context of home computing have a number of implications for the marketing and design of domestic technology. In the case of the home computer, they suggest that it might be better adapted to a *multi-user* context than it currently is. For example, its propensity to stimulate joint activity and collaboration might be accentuated by providing multi-user controls at a further distance from the screen. Certain creative applications might be targeted for this support, together with general web browsing, both of which were found to foster collaboration between family members. A 'distant' screen mode might also be used to display a range of content in the absence of particular users. This might be done as an extension of screen savers which can already recycle photographs and other items of interest as a background information channel. Another implementation might be to notify users of the arrival of email or other communications, on the screen or monitor casing. Both facilities would cater for the multiple interests of individual family members, and allow them to time their interactions with the machine a little more intelligently. A further enhancement to the multi-user features of the home computer would be to add timers and history logs, to the existing facilities for user settings and Internet content controls. These could be used quite simply to set time durations for PC or Internet sessions, and allow parents to review session activities at mutually acceptable levels of granularity.

The relationship of one computer to another in the home might also be exploited in the way computers are designed and marketed. The fact that primary and secondary computers come to be used in different ways and in different rooms could be influenced by design. One possible split would be to design 'work' and 'play' machines for primary and secondary use in the home. Alternatively, computers might be designed for a combination of work/play uses appropriate to particular rooms - such as a child's bedroom or the kitchen/diner area. Another possibility would be to sell portable machines that can be carried between different rooms for different purposes. In every case, the effect would be to acknowledge and support the complex partitioning of devices, uses, rooms and users that currently goes on in multi-PC homes, rather than ignoring it through the release of standard, standalone computers.

The possibility of building computer and Internet functions into existing home devices like TVs or telephones is also raised by this latter approach. Perhaps families would be better off with a Digital/Interactive TV or an enhanced games machine as their second 'play' PC. Adoption of the PC is already very TV-like as shown in Table 2, and it would be a short step for many families to imagine combining their functionality. Plus the TV, is already designed for the kind of joint viewing and interaction we have just recommended above for multiple users. Unfortunately we cannot really say from our data whether Interactive Television will be a success in the long term, despite slow sales in the short term. Table 2 also suggests that personal schedules may clash with programme schedules on a TV and overload an already well-used entertainment resource with information and communication functions. This is a good place to finish our discussion since it reveals again the complexity of the domestic context for technology design and use. More research is need to understand this relationship better, and to improve the home computing and Internet experience through context-sensitive design.

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REFERENCES

- Aries, P. (1962) *Centuries of childhood*. New York: Knopf.
- Aronsen, S.H. (1977) Bell's electrical toy: What's the use. The sociology of early telephone use. Chapter 1 in I. De Sola Pool (Ed.) *The social impact of the telephone*. Cambridge: MIT Press.
- Bass, W., Green, E. & Esselink, A.K. (1996) *PC time and money*. Cambridge, MA: Forrester Research Inc.
- Baecker, R.M. (1993) (Ed). *Readings in groupware and computer-supported cooperative work*. San Mateo, CA: Morgan Kaufmann.
- Betchel, R.B., Achelpohl, C. & Akers R. (1972) – Correlates between observed behaviours and questionnaire responses on television viewing. In E.A. Rubenstein, G.A. Comstock and J.P. Murray (Eds.) *Television and social behaviour, Volume 4, Television in day-to-day life: Patterns of use*. Washington D.C.: U.S. Government Printing Office.
- Birnbaum, J. (1997). Toward pervasive information systems. *Personal Technologies 1*: 11-12.
- Bower R.T. (1973) *Television and the public*. New York: Holt, Rinehart & Winston.
- Brand, S. (1995) *How buildings learn: What happens after they are built*. New York: Penguin Books.
- Csikszentmihalyi M. & Rochberg-Halton, E. (1981). *The meaning of things: Domestic symbols and the self*. Cambridge University Press.

Ehrenberg , A.S. (1986) *Advertisers or viewers paying?* ADMAP Monograph. London: ADMAP.

Fairclough, G. (1992) Meaningful constructions – spatial and functional analysis of medieval buildings. *Antiquity* 66:348-366.

Friedman, A. (1998) The next home; Expanding housing choice and flexibility. *Sociological Abstracts Supplement* 182, July 1998, 98S34340, p120.

Frohlich D.M., Dray S. & Silverman A. (2001). Breaking up is hard to do: Family perspectives on the future of the home PC. *International Journal of Human-Computer Studies* 54: 701-724.

Goffman, E. (1959) *The presentation of self in everyday life*. Garden City, NY: Doubleday.

Gunter, B. & Svennevig, M. (1987) *Behind and in front of the screen. Television's involvement with family life*. London; John Libby.

Hall, E. (1966) *The hidden dimension*. New York: Premier Books.

Harvey, A.S., Szalazi, A., Elliott, D.H., Stone P.J. & Clark S.M. (1984) *Time budget research: An ISSC workbook in comparative analysis*. Frankfurt/New York: Campus Verlag.

Heath C. (1986) *Body movement and speech in medical interaction*. Cambridge: Cambridge University Press.

Heath, C. & Luff P. (1992) Media space and communicative asymmetries: Preliminary observations of video mediated interaction. *Human Computer Interaction* 7:315-346.

Hediger, H (1955) *Studies of the psychology and behaviour of captive animals in zoos and circuses*. London: Butterworth.

IBA (1987) *Attitudes to broadcasting in 1986*. London: Independent Broadcasting Authority.

Kiesler, S., Zdaniuk, B., Lundmark, V., & Kraut, R. (2000). Troubles with the Internet: The dynamics of help at home. *Human-Computer Interaction* Special Issue, 15(4), 323-351.

Kraut, R., Scherlis, W., Mukhopadhyay, T., Manning, J. & Keisler, S. (1996). HomeNet: A field trial of residential Internet services. *Proceedings of CHI '96*, 284-291. New York: ACM SIG-CHI.

- Lawrence, R.J. (1987) *Housing, dwellings and homes: Design theory research and practice*. Chichester: Wiley.
- Levi-Strauss, C. (1963) *Structural anthropology*. Translated by C. Jacobson & B.G. Schoepf. New York: Basic.
- Lipman, A. (1967) Chairs as territory. *New Society* 9 (No 283): 564-566.
- Luff P., Hindmarsh J. & Heath C. (2000) *Workplace studies: Recovering work practice and informing system design*. Cambridge: Cambridge University Press.
- Lull J. (1980) The social uses of television. *Human Communication Research* 6: 97-209.
- Lull (1982) – How families select television programmes: A mass observational study. *Journal of Broadcasting* 26:801-811.
- Mateas M, Salvador T, Scholtz J & Sorensen D (1996) Engineering ethnography in the home. *Companion Proceedings of CHI '96*: 283-4. ACM Press.
- Nie, N.H. & Ebring L. (2000) *Internet and society: A preliminary report*. Stanford Institute for the Quantitative Study of Society.
- O'Brien, J. & Rodden, T. (1997). Interactive systems in domestic environments. *Proceedings of the Conference on Designing Interactive Systems: Processes, Practices, Methods and Techniques*, 247-259.
- Osmond, H. (1957) Function as the basis of psychiatric ward design. *Mental Hospitals (Architectural Supplement)* 8:23-29.
- Ouellette, J. & Wood, W. (1998). Habit and intention in everyday life: The multiple processes by which past behavior predicts future behavior. *Psychological Bulletin*, 124, 54-74
- The Planning Partnership (1993). Gender differences in telephone use.
- Robinson, J.P. (1988). Time diary evidence about the social psychology of everyday life. In J.E. Mcgrath (Ed.) *The social psychology of time*. Sage.
- Robinson, J.P. & Godbey, G. (1997) *Time for life: The surprising ways Americans use their time*. Pennsylvania: Pennsylvania State University Press.
- Schneider, W., & Shiffrin, R. M. (1977). Controlled and automatic human information processing: I Detection, search, and attention. *Psychological Review*, 84(1), 1-66.

Silverstone R. (1991). *Beneath the bottom line: Households and information and communication technologies in an age of the consumer. PICT Policy Research Paper No. 17.* Brunel University.

Sommer, R. (1959) Studies in personal space. *Sociometry* 22:247-260.

U. S. Department of Commerce (2000). *A Nation Online: How Americans Are Expanding Their Use of the Internet.* Washington, D.C.: U. S. Government Printing Office.

Venkatesh, A. (1996) Computers and other interactive technologies for the home. *Communications of the ACM*, 39 (12), 47-54.

Welman, B. & Tindall, D. (1993) Reach out and touch some bodies: How social networks connect telephone networks. In W. Richards Jnr. & G. Barnett (Eds.) *Progress in communication sciences. Volume 12*:63-93. Norwood, NJ:Ablex.

Wheatley, P. (1971) *The pivot of the four quarters: A preliminary enquiry into the origins and character of the ancient Chinese city.* Edinburgh: Edinburgh University Press.