# Domestic Routines and Design for the Home

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**ABSTRACT**

The domestic environment is predicted by market analysts to be *the* major growth area in computing over the next decade, yet it is a poorly understood domain at the current time of writing. Research is largely confined to the laboratory environment, although it has been recognized that ubiquitous computing will in due course have to resonate with the 'stable and compelling routines of the home'. This paper seeks to inform ubiquitous computing for the home environment by unpacking the notion of domestic routines as coordinational features of domestic life. We focus in particular on the routine nature of communication and use ethnographic study to explicate a discrete organization of coordination whereby household members routinely manage communications coming into and going out of the home. The coordinate ways in which members routinely organize communication are made visible through sequences of practical action, which articulate domestic routines and key properties of communication. These include ecological habitats, activity centres, and coordinate displays at which technology is at the core. These organizational features combine to form a locally produced system of communication and open up the play of possibilities for design, articulating the distinct needs of particular settings and 'prime sites' for the deployment of ubiquitous computing devices.

**Keywords**

Ethnography, domestic environment, routines, organizations of coordination, sequences of action, ecological habitats, activity centres, coordinate displays.

## DESIGN AND THE HOME

The domestic environment is currently receiving a great deal of attention as a place for IT development. The methodological and technical challenges involved in realizing IT systems for the home are significant, requiring researchers to anticipate facilities that are likely to emerge in the home of the future. This agenda has largely been pursued through purpose built 'living laboratories' which enable researchers to explore ways in which inhabitants might experience the home of the future (Brumitt et al. 2000, Kidd et al. 1999, Mozer 1998). These explorations have been complemented by design led 'visions of the future' that seek to convey the potential ways in which new technology might be deployed in domestic settings (Philips Design 2000). The home offers new sets of challenges that move design beyond the current focus on information and knowledge work (Hindus et al. 2001) and exposes us to the demands of new user groups, including the elderly, the disabled, and the mentally impaired (Mynatt 2001, Crabtree et al. 2003a). Despite some recognition of the major challenges facing the development of ubiquitous computing for domestic settings relatively little is known about the domain, however. As Hindus (1999) puts it,

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

Prior emphasis on the world of work means that the designers of IT systems for the home currently have few conceptual and analytical tools at their disposal that are actually rooted in an understanding of domestic life. Furthermore, in turning to approaches that are already familiar to them, it has been suggested that designers run the risk of migrating and operationalizing a set of values that may be inappropriate for

domestic life (Gaver et al. 1999). Gaver (2001) describes the perceived need for new approaches with some clarity:

> There is a danger that as technology moves from the office into our homes it will bring along with it workplace values such as efficiency and productivity at the expense of other possibilities … unless we start to respect the full range of values that make us human, the technologies we build are likely to be dull and uninteresting at best, and dehumanizing at worst.

The need for contextually sensitive approaches is driven, then, by a concern that the methods developed to support design in the workplace may have rationalizing affects (Weber 1930).

The problem here is that such things as 'production' and 'efficiency', which may themselves be construed of in terms of such concepts as 'plans and procedures', 'business processes', and 'workflow' along with a host of other formal analytic concepts that describe the organization of practical action in the workplace in accountable terms of *capital production*, do not apply to the organization of practical action in the home. This is not to say that household members do not have a concern with the production of domestic life or with efficiency in carrying out household activities, early research in the field suggests that they do (Venkatesh 1985). Rather, it is to say that such things as production and efficiency in domestic life cannot be adequately described in formal terms of capital production and the variety of approaches or methods designers have developed to account for that order of practical action, as domestic life is not organized in such terms by household members. The home is not characterized by a *common orientation* to a shared work objective – the production of commodity X or the delivery of service Y. Such an orientation is absent from the home, which is instead characterized by a diverse range of *disparate concerns*, which vary according to household population, age, stage of life, income, gender, sexuality, culture, and the rest. The home and workplace are very different domains and there is no need to carry out an extensive period of research to establish that. As members of society who

inhabit the home we recognize the difference and as designers we know it as a condition of our work. The challenge that faces us not one of understanding that the home and the workplace are different then, but of developing approaches that furnish insights into how and in what ways the home is different in order that we might develop technologies that are *appropriate* to the setting.

Established approaches or methods devised to understand practical action in the workplace and tailor design solutions to the orderliness of capital production are insufficient to meet the challenge. In light of the social and historical development of technology in domestic settings,[1] researchers in the field have suggested that a concern with such phenomena as 'tasks', 'procedures', 'workflow', 'business process', etc., be replaced with a concern for the 'stable and compelling routines of the home' (Edwards and Grinter 2001).

> These routines are subtle, complex, and ill-articulated, if they are articulated at all … Only by grounding our designs in such realities of the home will we have a better chance to … predict the effects of our technologies. (ibid.)

Just what the notion of 'routine' means in the context of the domestic is an open question however, although its situated explication in the workplace has had some considerable impact of the development of CSCW through ethnomethodological studies of 'routine work'. These studies have sensitized design to the skilful character of repetitive activities and the situated arrangements of collaboration through which *workers* accomplish and coordinate routine work (e.g. Suchman 1983, Blomberg et al.

[1] It is worth acknowledging that socially and historically the home has been a rich site of technological development from which many important lessons for the design computer-based artefacts may no doubt be drawn. The literature is vast, detailing the social shaping of housing in general to the design of particular rooms and the furniture and artefacts therein (Crabtree and Hemmings 2001a, 2001b). A comprehensive review is outside the scope of this article, however, even a cursory treatment demanding considerable time and space and we rely on the published work of others instead.

1994, Suchman 1995). Ethnomethodology has respecified the notion of the routine from mere repetition to the formally unrecognized and competent work of incumbents, which the efficacy of organizational plans, processes, procedures, and the rest, demonstrably turn upon (Crabtree 2003a).

The 'routine' is the product of the local and concerted work of parties to it for ethnomethodology and that work articulates accountable features of the home as readily as it does of the workplace (Crabtree 2003b). As Tolmie et al. (2002) put it,

> routines are the very glue of everyday life, encompassing innumerable things that we take for granted such that each ordinary enterprise can be undertaken unhesitatingly. This is especially pertinent in the home where the highly disparate priorities of family members have to be coordinated without the commonality of an orientation to some shared work objective to bind them together. Routines help provide the grounds whereby the business of home life gets done. Routines mean that people can get out the door, feed themselves, put the children to bed, and so on, without eternally having to take pause and invent sequences of action anew or open up their every facet for inspection or challenge or to constantly have to *account* for what they are doing with explanations or rationales.

Just as ethnomethodological studies of routine work have been foundational to the development of CSCW systems for the workplace through the situated explication of routine work, then so too they might inform the development of ubiquitous computing for the home. This may seem paradoxical given what we have said about the adequacy of approaches or methods devised in the workplace. It is important to appreciate, however, that the ethnomethodological notion of 'work' is *not tied* to formal accounts (Garfinkel and Sacks 1970). Work for ethnomethodology is not necessarily a phenomenon to be understood in terms of 'tasks', 'workflow', 'plans and procedures' and the rest. Rather, 'work' means that people must engage in *practical action* if they are to get their day-to-day activities done (Sacks 1992). Work means practical action in its many and varied forms for ethnomethodology and is not restricted to what routinely goes on in the workplace. It is in the sense of practical action that ethnomethodology

might treat the home as a 'place of work', not only in the restricted sense of "women's work" that is the topic of feminist literatures but in the more encompassing sense that the home is a setting of practical action for all its members - practical action that may not simply be reduced to leisure or entertainment either (Morrison et al. 2000). One way in which we might study the 'stable and compelling routines of the home' then, is to explicate the practical action that household members routinely engage in. More specifically, we might explicate the reoccurring *sequences* of practical action which enable household members and observers alike to recognize 'domestic routines'.

This paper explores the home in terms of the work of domestic routines and in details of the sequences of practical action that make those routines visible. As Tolmie et al. (2002) put it,

> There is little empirical understanding of the fundamental nature of domestic routines to date … [and] while some make tentative suggestions for the design of domestic technologies, no means have yet been found for an understanding of domestic routines to impact the design of domestic technologies in a way that is comparable to the impact that the study of routines in the *office* environment has had on fields such as CSCW.

Just as in the workplace, we would maintain that ethnomethodologically-informed ethnography (or ethnography for short) provides no panacea or 'silver bullet' to the wicked problems of design. We would suggest, however, that ethnographic studies of the work of domestic routines make a modest contribution 'impacting' upon or informing the design of technologies for the home.

We articulate this suggestion through ethnographic study of the routine nature of communication in the home, which reveals a discrete organization of coordination whereby household members concert and manage incoming and outgoing communications and order the accomplishment of a diverse array of activities occasioned by such communications. The notion of coordination is central to the interdisciplinary field of CSCW, although as many technical terms employed by

practitioners from different disciplines it assumes various meanings on various occasions (Crabtree et al. 2000). It is employed here to refer to the concerted, collaborative, cooperative or socially organized character of domestic routines. Again, we would make the point that like the ethnomethodological notion of work before it, the notion of coordination in ethnomethodological hands is not tied to the workplace. Evidently, domestic routines are coordinational in character, providing people with the means, as Tolmie et al. (2002) put it for 'getting out the door, feeding themselves, putting the children to bed, and so on'. Previous research into the socially organized character of technology in the home (O'Brien et al. 1999) elaborates the ethnomethodological nature of coordination more precisely:

> Claire: We have the TV on after we've finished breakfast.
>
> Frank: After breakfast, yeah … Claire watches UK Gold.
>
> Claire: Neighbours.
>
> Frank: Yep, she comes in and watches it after she's had her breakfast.
>
> Sarah: I miss it.
>
> Claire: She'll sit down for five minutes while it finishes.
>
> Frank: In fact as soon as it finishes, we get up and put our coats on - we know it's time to go to work!

Technology is intertwined with domestic routines and in the face of the architectural and aesthetic contingencies of place which make up the 'individual' character of the home, our study reveals that the coordinate ways in which members routinely organize communication make visible a locally produced system of communication that consists of ecological habitats, activity centres, and coordinate displays at which technology is at the core. Furthermore, situated explication of the routine work through which this system is produced in different domestic settings opens up the play of possibilities for design (Anderson 1994) and identifies 'prime sites' for the deployment of ubiquitous computing devices in the home (Crabtree et al. 2003c). Below we outline and present

the findings of our study before moving on to consider the design implications of our research.

## STUDYING ROUTINE WORK IN THE HOME

Our studies of routine work in the home were undertaken in May 2001, have been widely reported in the design literature, and are ongoing. They involve 22 family homes distributed across England, 16 of which were participants in a previous study (Morrison et al. 2000) and were recruited by advertising in national papers. The remaining 6 households consisted of family and friends who were interested in our research and agreed to open up their home lives to ethnographic inquiry. Our experiences in recruiting participants and conducting ethnographic inquiries in their homes suggest that it is a misconception to view the home as a particularly difficult domain to investigate through first-hand observation. While the home may be characterized as a 'private' domain, drawing a contrast between 'public' domains beyond the control of householders, the fact remains that many workplaces are encountered as private to *outsiders*, ethnographers and other researchers included. One cannot simply walk up to the workplace and commence study - access is restricted and controlled just as it is to the home. Like many private domains, the home is far from impenetrable however, and securing access is, in our experience, no more difficult than doing so in the workplace. On the contrary, accessing the home is markedly easier as there are fewer 'gatekeepers' to negotiate and the efforts invested in managing organizational politics, particularly concerns with downsizing and automation that (again in our own experience) frequently accompany ethnographic investigations in the workplace, are significantly reduced. Furthermore, and in both cases, it is a condition of ethnographic inquiry wherever it is carried out that the researcher not only gain access to the site, but the *acceptance* of those who inhabit and work at the site (Rouncefield et al. 1997). And that, of course, is an issue that is neither more nor less difficult to address in either domain.

It might be argued that although the home is relatively easy to access, direct observation cannot fail to disrupt the ordinary flow of household activities and, worse, cause people to alter their ordinary behaviour. The Hawthorne Effect (Mayo 1933) is a factor to be reckoned with in the workplace just as much as the home however, and our experiences of studying routine work in both domains suggest that it is not a factor of any great practical significance. Just as in the workplace, people at home have better things to do than impress or worry about the ethnographer, the gates having been opened so to speak and the limits of inquiry established. Instead, we find that people get on with the 'business of daily life' and this of course, as the history and literature of CSCW demonstrates, is just what we find in the workplace when we subject it to ethnographic study. As the home has no special status, as it is no more or less private than the workplace for the practical purposes of ethnographic inquiry, it should come as little surprise to find people going about their daily business too. The extent to which people may 'disregard' ethnographers and get on with the business of daily life in the home is testified to by the nature of our studies. The 16 families that participated in the previous study allowed the placement of video cameras in a number of rooms throughout the home, including the kitchen and the living room at all sites. Cameras were also placed in studies and conservatories where they existed and some families even allowed cameras to be placed in their children's bedrooms for short periods. Up to five miniature, low-light, variable focus, remote cameras and video recorders were installed in each home and up to eight hours of video footage per day, per camera installation, was recorded. Recording equipment was installed in each of the households for a minimum of ten consecutive days per year over two-years. Camera positions and appropriate times for recording were decided following discussions with the families in their homes and with their agreement, and as a result of this collaborative exercise a large corpus of data detailing the routine work of the home was produced.

Examination of the corpus drew our attention to the routine work of communication in particular. From household to household it became visible that a great many of the information resources in the home are implicated in the collaborative production of outgoing communications and consumption of incoming communications. Furthermore, being motivated by the concerns of computer science research, this area of routine work in the home struck us as being highly relevant. Communication has been *the* major area of development in computing, in terms of email and mobile technologies, for example, and early research in the domestic environment suggests that the trend might be expected to continue as design moves into the home (Hindus et al. 2001). While the corpus sensitized us to many of the subtleties of the collaborative character of communication in the home, the fixed location of cameras and temporally partial nature of video recordings limited our understanding of the social organization of this routine work. In August 2002 we undertook a number of highly detailed and focused studies of communication in three different households in order to remedy the situation.[2] These studies ran for one-week each and actively involved the participants. Rather than have an ethnographer 'hang around' the home, we asked our participants to video communications coming into and going out of the home and to keep a log briefly describing where the communications occurred, what they were about, who was involved, and what was done in response to them. This strategy had two distinct benefits. Firstly, it meant that the ethnographers did not have to spend long periods of time waiting around for events of relevance to the research to happen. Over the one-week period of the study, incoming and outgoing communications took up around one and half to two hours of video tape. More time was spent on communication though the

[2] The differences consisted of the following. Household #1 consisted of a professional couple with no children. Household #2 consisted of a family of four, both parents working, two children aged 3 and 5. Household #3 consisted of a family of five, both parents working, with three teenage children.

details were not always recorded, and understandably so, because of a variety of sensitive household matters. Nevertheless, the approach produced a rich corpus of quality data and was highly cost effective. Secondly, enlisting participants as data gatherers provided the opportunity to open up an intimate dialogue with household members. The video and logs became conversational resources, which we used to explore the social organization of communication in the home in collaboration with the parties who actually do and reflexively organize the work. The approach enabled us to involve the experts in communication in our research then, transforming them from docile subjects to active inquirers into the routine work of the home.

#### An Instance of the Routine Work of Domestic Communication

In order to elaborate the findings from our targeted studies we first provide an instance of the routine work of domestic communication, which in this case articulates the collaborative nature of mail handling in the home. Handling mail is a routine activity central to the coordination of domestic affairs. Mail occasions such mundane yet crucial actions as the paying of household bills, attending health checks or school meetings, celebrating birthdays, etc. The following empirical instance explicates the interactional work involved in handling mail, which provides for the coordination of a host of contingent and divergent domestic activities. More specifically, mail handling relies upon the construction of a series of organizational sites where mail is displayed to promote awareness and coordination (Crabtree et al. 2003d).

Mail is typically collected from some central point, whether that point is located at the front door, in the grounds outside a house, or from a post box located elsewhere in an apartment block. Mail may be collected by any household member - in some homes the same person might do the job all the time, whereas in others it simply depends on who gets up first or who is home first. The point to note here is that the collection of mail by household members is not coordinated through the nomination of a 'collector'

but through the public availability of a shared and known in common collection point and, contingently, on the visibility of mail. Any household or group member can collect the mail (not anyone can open it, however).

Figure 1. The porch: a shared and known in common collection point

Having collected the mail, it must be sorted (even one single piece of mail requires sorting). The person acting as collector has certain taken for granted rights and expectations attached to their position. It is assumed by members that persons acting as collectors who are also 'householders' (i.e. persons who are responsible for the running of the household) have the right to open mail concerning the maintenance of the home (e.g. bills) and formal matters concerning junior household members (e.g. letters from school concerning children). The opening of mail is not necessarily ordered by recipient name on an envelope, then, but by entitlement to open mail. The point here is that there is often a visibility to mail that displays and so announces its practical character: what it is about, who it is from, and who may thus be an appropriate recipient and so be entitled to open it. This is often conveyed by a logo, organizational stamp, postmark, or the printing of the sender's name on the outside of the envelope (see Figure 2, for example). The visibility of the practical character of mail allows the collector to make judgements as to the relevance of mail to the home and to household members. It is in this respect

that members come to categorize certain mail as 'junk', to do so at-a-glance, and to respond to the categorisation by throwing the designated mail away. Junk mail is not always so easily spotted however, as categorisation is a matter of judgement rather than given in advance. Consequently, the collector may open mail and browse through it to establish its relevancy status.


Figure 2. Displaying and announcing the practical character of mail: the phone bill arrives

Mail that is deemed relevant to other household members is organized in a variety of recipient designed ways. The person who opens mail may decide that it is also of relevance to other household members. The relevance of mail to other household members is ordered through particular assemblages of display, with each assemblage articulating particular relevancy statuses. Mail which a recipient deems to be of relevance to others in general is displayed in a public location, again shared and known in common, where it is plainly visible (see Figure 3, for example).

Figure 3. Placing mail of relevance to others in general

The precise location for such displays varies from household to household as the construction of displays is contingent upon the particular material arrangements of domestic space. Common places include mantelpieces, bureaus, or tables, but other places may be used as the contingent arrangements of domestic space allow. Mail that is deemed to be of relevance to a particular household member is often displayed in a different location that is relevant to the member in question. Typical sites for displaying mail of relevance to particular others include the person's place at the kitchen table (as in Figure 4), the place he or she usually sits in the living room, and such mail may even be placed outside a bedroom door. The recipient designed and accountable character of mail 'displays' enable members to see at-a-glance that mail has arrived that requires their attention and action.

Figure 4. Displaying mail of relevance to a particular household member

Opened mail that has been viewed is also displayed according to its relevance to practical action. Greetings cards and the like may find themselves displayed on the mantelpiece (as in Figure 5), windowsill or some other visible location where they both

‘decorate’ the home and their visibility reminds recipient’s of a social obligation to be fulfilled (to reply to the sender, for example, and say ‘thankyou’).

Figure 5. Displaying greetings cards, etc.

The display of more mundane mail that has been opened and viewed is ordered by the temporal flow of sorting work and the ordering of mail into discrete groupings that reflect the actions required at-a-glance. Again, the construction of these displays is contingent upon the material arrangements of domestic space. Mail for external use, such as they payment of bills, is placed in a location that reflects the need for external action: e.g. on a desk in the hallway, at the front of the kitchen table, or next to a bag that is routinely taken along when a person leaves the house. Mail for internal use is displayed in an alternate location: e.g. on top of the stereo, on top of the bureau, or at the back of the kitchen table. While particular locations vary from home to home, this latter arrangement is effectively a ‘pending pile’. It may contain mail for external use if it is not of immediate relevance.

Figure 6. Display for external use Figure 7. Display for internal use

When sorting through the pending pile it may also transpire that particular items are no longer relevant and so they may be trashed. Opened mail may accrue in the pending pile until it is felt that some further action should be taken. Further action may lead to the display or movement of mail to other discrete sites that are tied to the projected relevance of mail. Accordingly, mail may be displayed on a noticeboard (which may be nothing more than a designated space on a wall).

Figure 8. Placing mail of short-term relevance

Noticeboards are used as a place to display mail of short-term relevance: things like invoices, concert tickets, appointment cards and invitations, and longer-term information that is frequently consulted, such as school term dates, restaurant menus, etc. Mail of longer-term relevance, such as mortgage statements, legal paperwork, financial affairs, etc., is filed away in dedicated location organized for storage and retrieval: e.g. in a bureau, drawer, or filing cabinet.

The instance described above is 1 of 35 gathered from the Household #1 study and the organization of mail handling it elaborates was found in each of the other homes in our targeted studies, whose details we have amended description of the instance with

where relevant. That organization observably and reportably consists of an *ecological network of displays* (Crabtree et al. 2003e) constructed by household members to 'mark out' or make visible what point a job-to-do has reached (Harper et al. 2000) and to coordinate the actions occasioned by the arrival of mail. Recognition of the ecological organization of communication takes us beyond existing insights into the spatial distribution of technology around the home (O'Brien et al. 1999) to consider the constitutive organizational features or key properties that distribution consists of. In the following section we consider 'what more' the other 34 instances from the Household #1 study show of the ecological character of routine work implicated in domestic communication.

## THE ECOLOGICAL CHARACTER OF ROUTINE WORK

We present the findings to emerge from examination of the corpus of instances in terms of a representational format. The format consolidates the individual instances and enables us to move beyond a mere 'corpus of exhibits' (Bittner 1973) or collection of fragments to develop an understanding of the social organization of communication in the home as a coherent whole (Crabtree 2003b) and to do so in a manner that delineates critical features of the design situation. The format is not an *a priori* format, something developed before or outside analysis of the instances, but was developed through close and careful inspection of each instance for its constituent features. Specifically, the activities it observably consists of, the locations where those activities occur, the information resources or media involved in the action, and the pathways those media travel along through the ecology of the home. These features were first mapped onto a representation of the domestic environment in which each instance occurred, as shown in Figure 9 for example.

**Handling Mail**

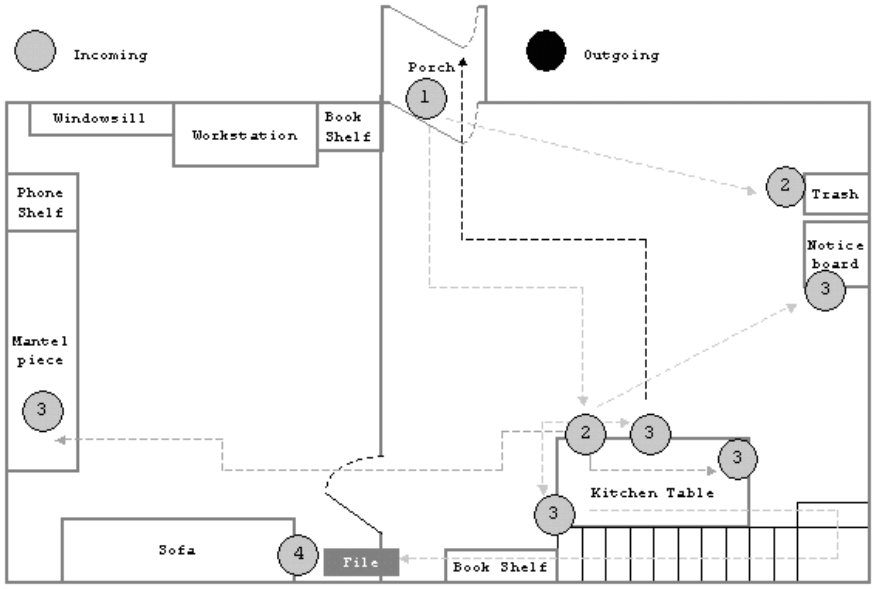


Figure 9. Ecological distribution of mail in the home

By tracing the ecological distribution of communication in this way the instances make it visible and instruct us that a key feature of the social organization of communication in the home is a members' concern with the practical management of *traffic* in and through the domestic space.

> **traffic** n. & v. **4** dealings or communication between people etc. **5** the messages, signals, etc., transmitted through a communications system. *The Concise Oxford Dictionary*

The phenomenon becomes more apparent when we consolidate the corpus of instances. Figure 10 represents the traffic coming into and going out of Household #1 over the period of study.

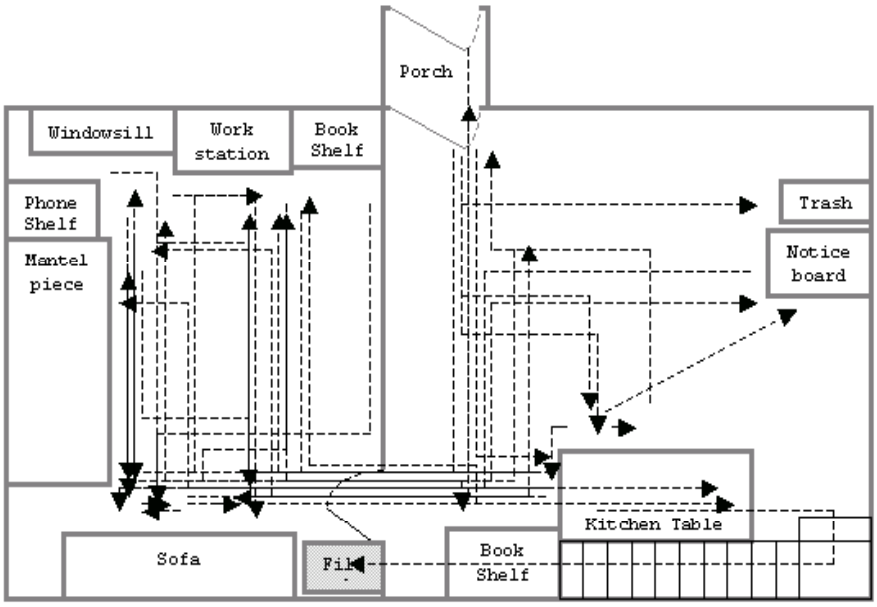


Figure 10. Ecological distribution of traffic over a one-week period

While this representation makes the phenomenon of traffic plainly visible, the 'systematic' ways in which traffic is socially organized remain to be explicated and it is towards identifying key properties of that organization that we now turn.

#### Places of Communication

We identify key properties of the system of communication at work in the home by consolidating the representations of each instance to develop a view of the home as a coherent whole. What emerge are the visible and manifold relations of place to the social organization of communication. Specifically, these manifold relations consist of the following:

- *Ecological Habitats:* places where communication media live and where residents go in order to locate particular resources.
- *Activity Centres:* places where media are actively produced and consumed and where information is transformed.
- *Coordinate Displays:* places where media are displayed and made available to residents to coordinate their activities.

We explicate each of these key properties in turn to elaborate the social organization of communication in the domestic environment and to make that organization available to design reasoning and inspection in other residential settings.

*Ecological Habitats*

When we examine the individual of instances for their organizational features it is grossly observable that the various media implicated in communication live in particular places where they are to-hand. Household members do not have to search for the mail, or the computer, or the telephone and address book, etc., because they *situate* communication media in particular places from where they may be readily retrieved or accessed as and when they are needed. This, of course, is not to say that communication media do not stray, that members do not lose things. Indeed, such occurrences demonstrate the rule as it were and may be accounted for by invoking the ordinary notion of 'misplacing' things. The home is an orderly and ordered environment where communication media are situated and live in particular places so that they may be readily located. More formally, we might call these places 'ecological habitats'. The term draws analytic attention to the physical surroundings within which communication media reside. Ecological habitats are readily available to observation. They are in plain view and require no special methods to see. They are elaborated in local detail in terms of fine-grained categorical and physical distinctions of space and place that household members ordinarily make to describe the constituent features of their homes: tables, desks, settees, mantelpieces, chairs, bureaus, windowsills, etc. These fine-grained distinctions make up or are constituent features of gross categorical and physical distinctions of space and place, such as kitchens, living rooms, bedrooms, etc., which in turn make up the home as a whole. When we move beyond the individual instance and consolidate the corpus we can see the range of ecological habitats 'at work' across the environment.

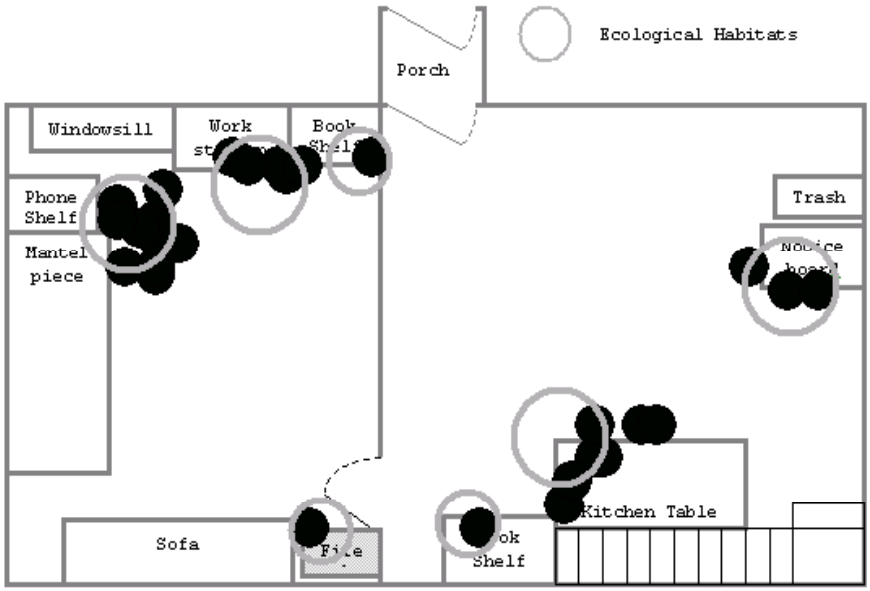


Figure 11. Ecological habitats in the Household #1 study

In the case of the Household # 1 study we can see, for example, that the phone shelf, the workstation, the bookshelves, the kitchen table, the noticeboard, and the filing cabinet are all ecological habitats where the media implicated in communication reside. Each of these habitats was illuminated or made visible by a single instance and through the use of particular media, which the single instance elaborates in detail. What the individual instances do not show – until they are consolidated – is the 'make up' of the environment as a coherent whole. Consolidation makes an unnoticed social organizational feature of communication in the home plain to see then: namely, that traffic is socially organized through members' local arrangement of domestic space into discrete ecological habitats where communication media reside.

*Activity Centres*

The places where communication media live (ecological habitats) are not necessarily the same places where communication media are used and our observations highlight this. The mail handling instance shows, for example, how incoming items of relevance to a particular household member are placed at locations relevant to them, locations at which the item is read, discussed and in other ways used before being placed elsewhere according to the kind of response that is required. We call the places where communication media are used 'activity centres' insofar as the consolidation of the

instances shows us that there are certain places in the home where communication media are recurrently employed. Consolidation reveals the following activity centres in the Household #1 study.

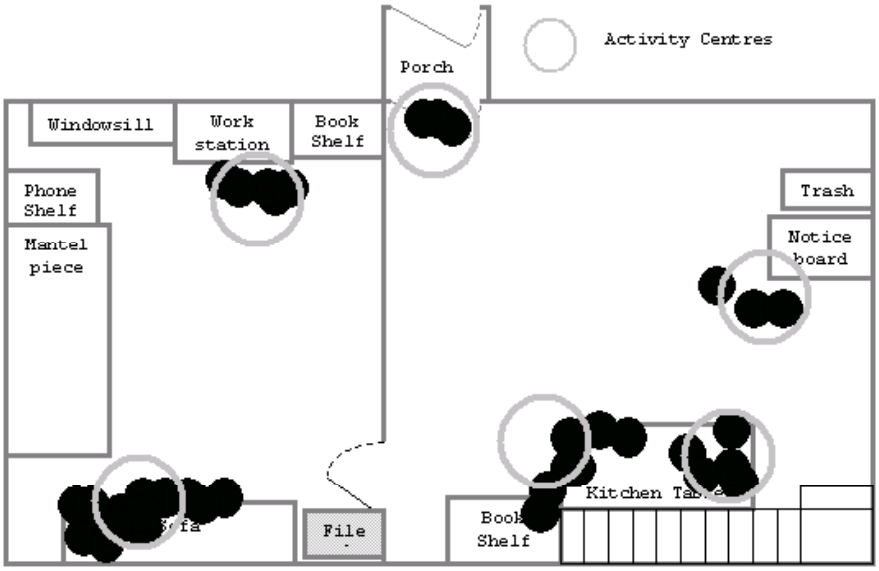


Figure 12. Activity centres in the Household #1 study

Although functionally distinct, some activity centres clearly overlap with ecological habitats (see Figure 11 for comparison). In Household #1, the workstation, noticeboard, and kitchen table are at different times employed by members to perform different functions. For example, the kitchen table is at one time a habitat for keeping mail pending further action while at other times it is a centre for collecting and reading mail, or for conducting phone calls, or for compiling shopping lists, etc. The noticeboard is at one time a habitat for information of short-term relevance (appointment cards, concert tickets, school term dates, etc.) and at another a centre where the information situated there becomes a resource in social interaction, furnishing times, dates, schedules, etc. Similarly, the workstation is at one time a habitat where documents are kept and displayed as reminders of ongoing jobs of work and at another a centre where emails are received and sent. The overlap of activity centres and ecological habitats is of direct relevance to design for reasons that will be articulated in due course.

*Coordinate Displays*

The mail handling instance makes it plainly visible that household members routinely construct displays from out of the flow of communication media to coordinate action. On receiving mail of relevance to household members in general the item is placed at a specific location – at the front corner of the kitchen table in the Household #1 study, for example. Or again, an opened letter that requires some immediate action – such as a bill – is placed at the front of the table where it is clearly visible. No words or discussion is needed to articulate the meaning of such actions as household members can see at-a-glance that mail has arrived that requires attention by the very act of its visible placement and display. The important point about such sites of display is the rationale and function of their construction. The display of mail triggers practical action such as the timely paying of household bills, renewing vehicle tax or household insurance, for example, *not that the person who opens the mail is necessarily the one who takes action*, however. In other words, the construction of displays at certain sites through the placing of mail and other media implicated in communication provides for the coordination of practical action between household members. Figure 13 shows the coordinate displays constructed by the members of Household #1 when the instances are consolidated. As is the case with ecological habitats and activity centres, the sites at which displays are constructed to coordinate the actions of household members overlap. Just as some places may at one time serve as activity centres and at others as ecological habitats, then so too they may also serve as sites for the construction of coordinate displays.

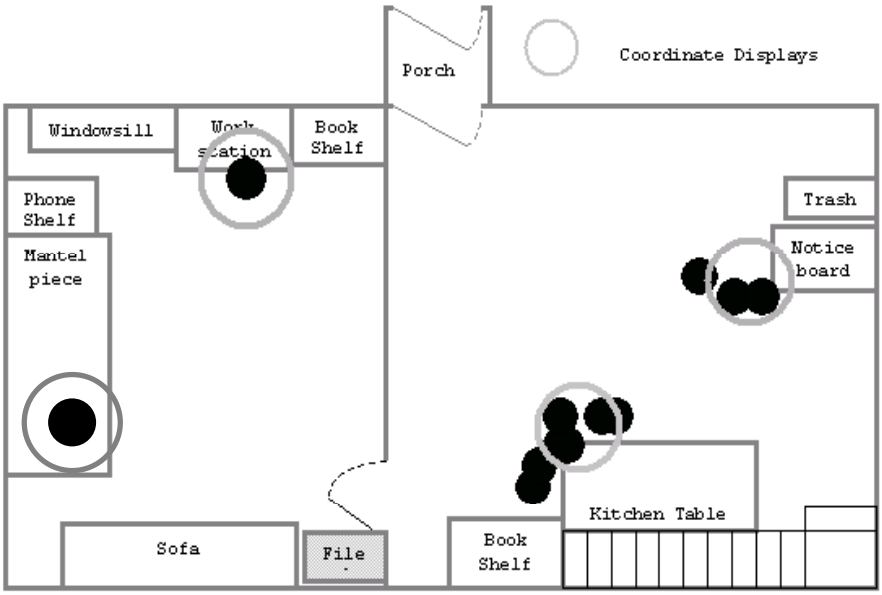


Figure 13. Coordinate Displays (Workstation, Kitchen Table and Noticeboard)

In the Household #1 study, or example, the noticeboard is at one time a place where information of short-term relevance is kept to-hand, at another a place where that information is employed as a resource in communication (coordinating family visits through consulting school term dates, for example), and at another time a place where the information placed there displays and so provides for the timely coordination of social activities (such as taking the children to a party, attending a dentist's appointment, or paying an invoice at the end of the month). Just what places overlap and serve multiple functions will depend on the architectural and aesthetic contingencies of the particular residential environment under study.

#### The Ecological Distribution of Communication

The various places outlined above assume coherence through the distribution of communication around the ecology of the home. The key feature providing for this coherence is that of discrete and recurrent 'sequences of action'. Sequences of action consist of the reoccurring courses of practical action and technology/media use that link the various ecological habitats, activity centres and coordinate displays together in any single instance. Sequences of action elaborate the social organization of particular forms of communication in particular domestic settings. For example, on getting up in a

morning, someone might collect, open and read mail at-the-kitchen-table over breakfast, placing items to be dealt with later on the bureau-in-the-living-room and bills to paid on-the-trolley-in-the-hall. Sequences of action articulate the spatial and temporal distribution of information around the home and draw attention to the particular ecological habitats, activity centres and coordinate displays implicated in particular forms of communication in particular settings. In reoccurring details of the workings of a locally produced system of communication sequences of action convey to designers the everyday routines of the home. These routines are known to inhabitants and are used as a resource for managing their collaborative activities such that outstanding-jobs-to-be-done are placed within an appropriate routine. Thus, and for example, the packed lunch is left on the kitchen table where correspondence is opened and read in the morning, or beside the porch where household members may place various media to be taken to work. In the following section we consider the design implications to emerge from our consideration of the social organization of communication in the home.

## ROUTINE WORK AND DESIGN FOR THE DOMESTIC

Although the ecological distribution of communication implies and indeed consists of the flow of information around the home, our studies are not concerned to support the design of workflow systems however they are construed. Rather, we are interested in the interactional dynamics that routinely shape the domestic environment.

> Between the dazzle of a new building and its eventual corpse … [lies the] unappreciated, undocumented, awkward-seeming time when it was alive to evolution … those are the best years, the time when the building can engage us at our own level of complexity. How do those years work, actually? (Brand 1994)

While we would not be so bold as to suggest that our studies provide anything like an exhaustive answer to such a complex question, we would suggest that they shed some light on the matter and in a way that is of relevance to design, highlighting “how

inhabitants continually reconfigure domestic spaces and the technologies within them to meet particular demands" (Rodden and Benford 2003). Close examination of a corpus of empirical instances has enabled us to identify a core set of socially organized features or constitutive elements of a locally produced system of communication in the home. Explication of this socially organized system, and the ways in which inhabitants manage traffic through discrete and routine sequence of action that link various functional locations in the home together, highlights key properties of communication that may be oriented to by designers to find a place for ubiquitous computing in a wide variety of residential settings.

Obviously everyone's house is different - a broad set of architectural and aesthetic contingencies are involved in the layout of the home. Nevertheless, members of the architectural community have already highlighted ways in which people configure and reconfigure the spaces they occupy. For example, work on patterns presents common arrangements (Alexander 1979), while work on the evolution of buildings highlights the underlying dynamics of change in the home (Brand 1994). To complement these insights, the key properties that we have identified – which may be treated as sensitizing concepts for the purposes of design - convey the ways in which different ecological features of the home are exploited by members to manage and coordinate their activities. The point is not that every home will have a kitchen table and that bills are kept there in order that they can be found and acted on appropriately. Indeed, many homes may not have a kitchen table or may not even have a separate kitchen at all, especially in non-Western cultures. Nevertheless, we would suggest that each home will have *its own* ecological habitats, activity centres and coordinate displays that are constructed, arranged and linked together by household members in the course of carrying out the sequences of action whereby they routinely produce, manage and consume communications. Culture – whether understood in terms of nationality, age,

gender, identity, etc., is manifest in the routine character of communication in the home and the role of particular locations or places implicated in such action. In other words, 'culture' is not something separate from communication, something that stands behind it and shapes it as it were, but visibly implicated and manifest in its ecological organization. Accordingly, we suggest that there is a need for designers to be aware of the ecological character of communication and to chart the various places 'at work' in communication in order that ubiquitous computing might resonate with and so fit into domestic life in a wide variety of different settings. Below we consider how the key properties identified in our studies may be used to drive the design and deployment of ubiquitous computing for the home.

#### Situating Ubiquitous Computing in the Home

Considerations of the nature of the domestic space and the relationship and placement of technology therein is already of major concern to ubiquitous computing. Researchers have suggested that design will be required to develop a wide range of media spaces to support domestic communication (Hindus et al. 2001). Others have explored the integration of sensing technologies and digital services within the domestic space (Brummit et al. 2000, Kidd et al. 1999). We seek to provide conceptual and analytic tools for the research community that are emergent from the social reality of everyday life in the home and will help guide the placement of ubiquitous computing to meet the routine day-to-day needs of inhabitants. The need to integrate media spaces and digital services with the architectural and aesthetic fabric of buildings has already been emphasized by the notion of 'roomware' (Streitz et al.1998). Roomware consists of such components as the *DynaWall* (an interactive electronic wall), *CommChairs* (mobile and networked chairs with integrated interactive devices), and the *InteracTable* (an interactive table). The relationship of new and emerging technology to the arrangement of domestic space has also been explored through the use of Pattern

Languages (Alexander 1979) and seen the emergence of *comZONES* (Junestrand et al. 2000). As with roomware, this use of patterns is predicated on the integration of the digital into new, purpose-built environments. Consequently, it is not at all clear how existing approaches support the 'fitting' of technology into pre-existing environments, which make up the largest sector of the housing stock and potential market for domestic technologies. As Edwards and Grinter (2001) put it,

> while new homes may eventually be purpose-built for smart applications, existing homes are not designed as such. Perhaps homeowners may decide to 'upgrade' their homes to support these new technologies. But it seems more likely that new technologies will be brought piecemeal into the home; unlike the 'lab houses' that serve as experiments in domestic technology today these homes are not custom designed from the start to accommodate and integrate these technologies.

The sensitizing concepts we have articulated may assist designers and help them to address this problem by engendering an orientation to the various socially organized ways in which particular locations are routinely employed, and so 'situate design in the home' by elaborating the various places in particular environments that provide candidate locations for future technologies.

### *Prime Sites for Technology*

One of the most obvious uses of our sensitizing concepts is to highlight 'prime sites' for ubiquitous computing in domestic settings. Our approach makes visible the socially organized ways in which a host of technologies are ordinarily employed. This in turn supports the identification of the ecological habitats, activity centres and coordinate displays associated with a particular setting and so provides a resource with which to frame design. It has already been noted, for example, that some ecological habitats, activity centres and coordinate displays overlap, as can be seen in Figure 14. Places of overlap might be considered as 'prime sites' for design as they identify locations that inhabitants habitually exploit to conduct and accomplish communication. The overlaps draw attention to commonly used locations that household members return to, time and

time again, as matter of routine, in order to manage communication within the home and, consequently, they identify places that offer good candidate locations for placing ubiquitous computing in particular settings. Their explication allows designers to reflect upon the nature of overlaps within particular environments, contrasting the ways in which digital functionality is currently concentrated at the desk in the living room in the Household #1 study, for example, with the openness and flexibility of the noticeboard and the kitchen table to open up the play of possibilities for design.

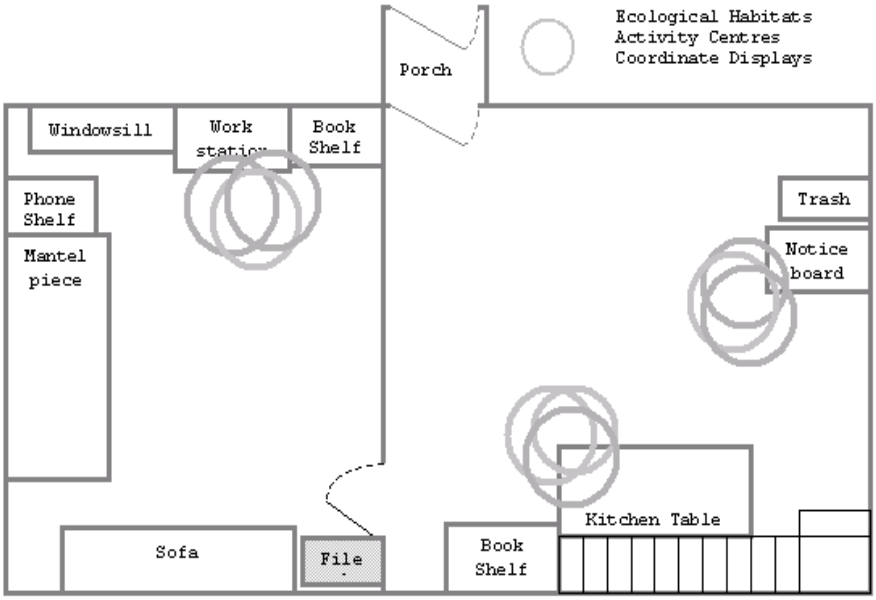


Figure 14. What place might ubiquitous computing find in the home?

If we were to consider extending digital functionality across Household #1 through the implementation of a *DynaWall* and *InteracTable*, for example, then the points of overlap elaborated through consolidation of ecological habitats, activity centres and coordinate displays suggests that this would be best achieved by placing those technologies in the kitchen to create a network of digital services and surfaces manifest in locations that are habitually exploited in this household.

### *The Convergence of Media*

Our studies also highlight the diverse collection of media that are used by inhabitants in carrying out the routine work of communication. In designing systems to fit into domestic settings we often need to consider the different forms of media that new

technology will have to find a place alongside. Our studies suggest that rather than displacing existing media in the home, new technologies are used alongside a variety of different media that are employed across a range of different sites. The diversity of media involved in the household study reported here and the places where they are manipulated is reflected in Figure 15. Essentially, this representation draws attention to the various sort of media that coalesce at particular places and allows designers to pose questions as to whether or not they seek to supplement, augment or replace existing media. As an emergent product of a corpus of instances gathered from a setting, this representation also supports the making of design decisions with some definite insight into the ways in which new technology might, *pace* Edwards and Grinter (2001), effect or impact upon the current organization of domestic routines.

More generally, this particular representation makes it perspicuous that paper-based media are well integrated into the home environment. Paper-based media can 'find a home' in any ecological habitat and coordinate display (they can be put in drawers, left on surfaces and pinned to walls). The means of creating and modifying them can be easily used in any activity centre (you can write and draw in activity centres throughout the home). Digital media, by way of contrast, are less comfortably integrated. Some, such as email, Internet and hyperlinks don't easily spread beyond the workstation, which is still required to produce, manage and consume them. To break this dependence, inhabitants often transform digital media to paper by printing them out. They also leave paper pointers to digital media, writing notes to remind others to read an email from a friend, for example. The mobility of devices may impact upon this. Telephone media are more widely spread throughout the home, for example.

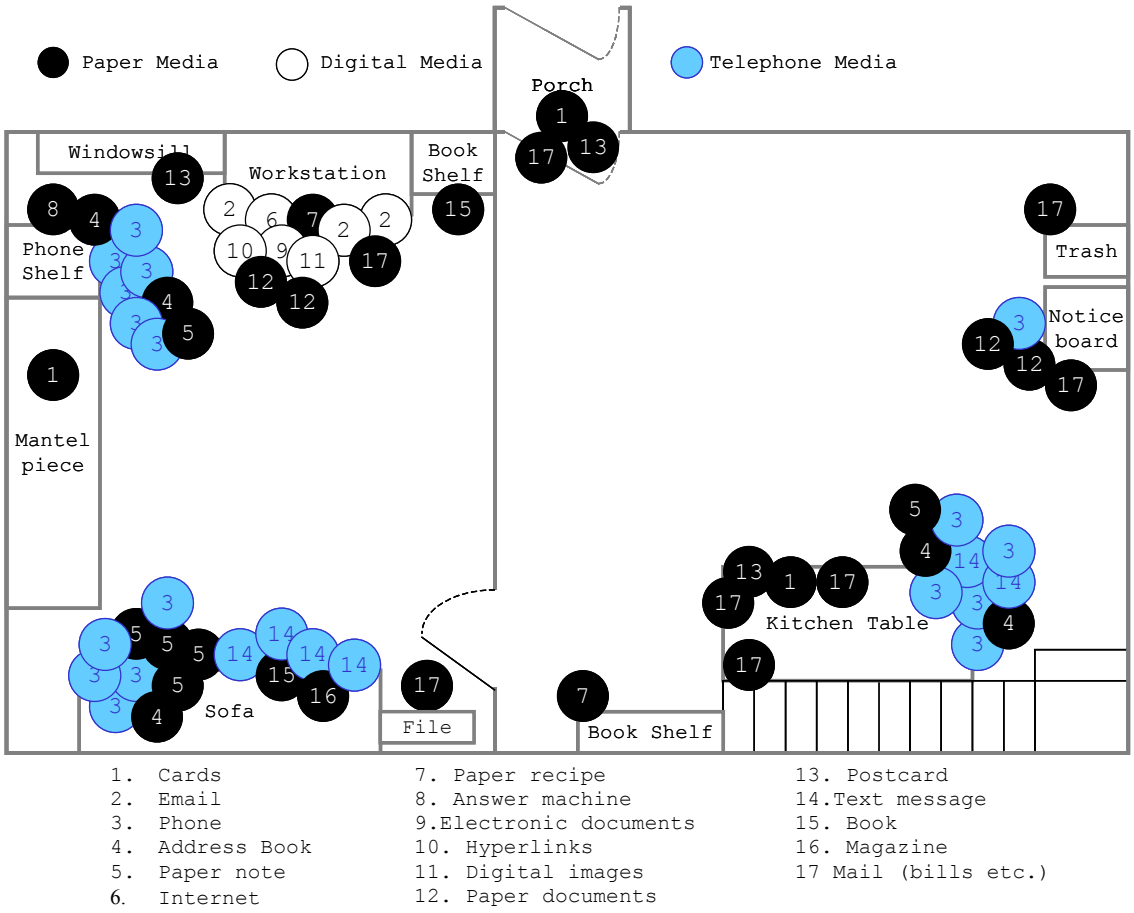


Figure 15. Media Usage across Ecological Habitats, Activity Centres, and Coordinate Displays

However, and as the representation makes visible, such mobile media still tend to cluster around but a few locations where they coalesce with other media (such as address books and paper notes), which suggests the need to *link* ubiquitous computing with other media at these places.

### *Building on Communication Places*

In addition to raising a set of pertinent questions regarding the places where new and future technologies might be situated to meet the day-to-day needs of particular households, our research has provided a set of concepts that can be matched to existing and emergent research agendas. The three main features of places of communication provide a conceptual guide for more targeted investigation that combines more focused studies with different forms of technological development. Essentially, in just the same way that concepts associated with the workplace (plans and procedures, business processes, workflow, etc.) allowed researchers to develop research agendas within HCI

and CSCW, then our concepts may be used to motivate and illuminate research questions in ubiquitous computing. Below we provide brief illustrative examples of research issues to emerge in our own work from each of the different features of place.

*Ecological Habitats* are places where communication media reside. They are places where users return to find the resources needed to deal with communication. As we have seen in our studies, digital media currently tend to be closely connected with digital devices. In contrast, paper finds its way to a greater variety of places and uses in the home. What might it mean to make the digital more prominent throughout the home? How might the presence of various media - particularly non-digital media - be represented in ecological habitats to allow them to be digitally available? How might we manage issues of security and privacy when ecological habitats are made digitally available? These and a host of other issues, including the digital evolution of ecological habitats, represent interesting areas of future study.

*Activity Centres* are places where media are manipulated, consumed and transformed. These places provide a key set of research issues regarding the augmentation of existing media used at them and beg the question as to what new forms of device may be developed for activity centres? Might we use electronic displays to augment electronic noticeboards or calendars, for example? How may a system represent the work that goes on in activity centres to household members in order to support the management of activities within the home? How may a system make activity centres available at a distance, particularly from outside the home? How may a system exploit knowledge of the work carried at activity centres and support access and privacy? Are sensing technologies a solution and do activity centres provide a guide to place video cameras and to guide video recognition to identify media uses and interactions that occur there?

*Coordinate Displays* are places where communications media are made available to others in the domestic setting in order to support the coordination of activities. Primary

research issues surrounding coordinate displays focus on recognizing the events to be coordinated, and the various media implicated in coordination, to consider how these are best propagated throughout the household. It might also be important to consider how can we augment coordinate displays to make the information displayed available outside of the domestic setting? If so, the representation of information and associated issues regarding the management of distributed collaborative access and control are important matters here and present significant challenges to the design of new technologies that seek to merge the digital with the physical fabric of the home.

*Exploiting Sequences of Action*

As a final reflection we wish to briefly consider the sequences of action that elaborate and link ecological habitats, coordinate displays and activity centres together. These sequences are the means by which communication is handled and they articulate the local system of communication at work in a setting. Designing technology to support sequences of action raises a number of questions, many of which arise from the limited penetration of digital media. Essentially digital media need to be more flexible in terms of how individual items are moved to and from ecological habitats, manipulated in different ways at activity centres, and placed to be seen by others at coordinate displays. Sequences of action raise distinct design questions regarding how devices may be used to support the distribution of objects and information around the home. For example, how might we assign email to various locations as with paper mail? Or again, how might personal devices be used to coordinate actions within sequences of action, enabling individuals to see and pick up email when it has been left in a public place for them? Sequences of action are not only topics for design, as it were, but also raise questions as to how they may be used as a resource within applications to support the overall management of communication in the home. This is a different order of question that shifts the focus from one concerned with the use of technology to one concerned

with supporting the activities involved in sequences of action. Accordingly we might ask how can we exploit representations of sequences of action to make information available to others when it is most relevant? For example, might a system exploit the sequence of action associated with the principle bill payer to best *place* a reminder to pay a bill as he or she leaves for work? Or again, how might we exploit representations of sequences of action to monitor coordinate actions across the household, providing notification that a bill payment has been made by associating the payment with a prior sequence of action? These and the other questions articulated above open up a host of complex research issues. They may be explored in a range of different settings and further elaborated by other researchers through continued ethnographic study and the application of our sensitizing concepts to the empirical materials gathered (Crabtree et al. 2003c).

## ADDRESSING A NEW CHALLENGE FOR DESIGN

This paper has argued for the need for new conceptual and analytic tools to inform the development of ubiquitous computing as design moves out of the workplace and into the home. Researchers in the field have suggested that design might be usefully informed by attending to the stable and compelling routines of the home, although it is not clear what the notion of 'routine' means in this context. We have undertaken a range of ethnographic studies to unpack the notion and its relevance to design, examining the routine work of communication in particular. Our studies show that communication relies on a discrete organization of coordination, which consists of ecological networks of displays constructed by household members to track jobs-to-be-done and to coordinate relevant actions. Further examination of a corpus of instances reveal key properties of the ecological organization of communication in the home. These properties may be treated as sensitizing concepts orienting designers to a locally produced system of communication in the home. They sensitize design to the

importance of the ecology of the domestic space and distributed arrangements of collaboration to communication, drawing particular attention to ecological habitats, activity centres, and coordinate displays. These locations are articulated and linked together by reoccurring sequences of action and highlight 'prime sites' for situating ubiquitous computing in the home. They also raise a set of design questions informing the development of existing and emerging research agendas. The constitutive elements of the local system of communication at work in the home may be identified and explicated in other domestic settings by other researchers by conducting short periods of ethnographic fieldwork to gather a corpus of instances. The constituent features of each instance – specifically, the activities an instance observably consists of, the locations where those activities occur, the information resources or media involved in the action, and the pathways those media travel along through the ecology of the home - may then be mapped to elaborate the sequences of action implicated in the use of domestic media. Following that, the instances may be consolidated to identify the key properties of the system - ecological habitats, activity centres, and coordinate displays – and to locate design in the routine, socially organized, concerted, collaborative or cooperative work of the home.

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