

Making the Home Network at Home: Digital Housekeeping

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Abstract. This paper exploits ethnographic findings to build on and elaborate Grinter et al's 2005 study of "the work to make the home network work". We focus particularly on the work involved in setting up and maintaining home networks, which we characterize as 'digital housekeeping'. Our studies reveal that it is through digital housekeeping that the home network is 'made at home' or made into an unremarkable and routine feature of domestic life. The orderly ways in which digital housekeeping 'gets done' elaborate a distinct 'social machinery' that highlights some important implications for the continued development of network technologies for the home. These include a requirement that designers take existing infrastructure into account and pay considerable attention to how future technologies may be incorporated into existing routines. The preoccupation of household members with making the home network transparent and accountable so that it is available to practical reasoning suggests designers should also consider the development of dedicated management interfaces to support digital housekeeping.

Introduction

Interest in the home as a site of technological research and development has burgeoned over recent years. Much of this is focused upon 'living laboratories' (Edwards & Grinter 2001). However, in a paper entitled *The Work to Make the Home Network Work*, Grinter et al. (2005) draw attention to the increasing presence of distributed computing in *ordinary* homes via the home network. This real world focus complements earlier efforts in CSCW to understand and inform the development of new agendas in distributed computing (e.g., Bowers 1994, Bowers et

al. 1995, Button & Sharrock 1997). Similarly seeking to inform IT research as to the real world character of technology in homes, Grinter et al. present an ethnographic study that explores the work involved in making the home network work. The study reveals the complexity of the home network as it is manifest 'on the ground' and elaborates the work involved in incorporating the home network into the domestic routine; including practically managing network complexity, handling tensions that emerge between individual and communal needs, and meeting the demands of administration and troubleshooting.

Grinter et al.'s observations about network complexity complement concerns of other researchers in the field. Shehan and Edwards (2007) have sought to unpack the infrastructural origins of network complexity and associated problems. They explore different ways in which new approaches to infrastructure might help and note the current lack of tools supporting management of the home network. Others have also taken up the issue of complexity, focusing on mismatches between professional and ordinary user expectations (Bly et al. 2006), congruence and divergence between professionals and ordinary users (Brush 2006), and on improving understanding of how users ordinarily orient to complexity (Chetty and Grinter 2006). These investigations have been complemented by conceptual and technical work which is concerned to improve the coherence and visibility of the home network (Elmore et al. 2007, Lemhachheche 2006, Newman 2006, Shehan et al. 2006, Yang and Edwards 2006).

Whilst matters of complexity are not outside of our remit, we concentrate here upon elaborating the ways in which the management of the home network is becoming *an integral part of the larger management of the household*. Thus our focus is upon what is practically involved in leveraging the technology into everyday life such that it becomes an unremarkable feature of the household's domestic routines (Tolmie et al. 2002, Crabtree & Rodden 2004). This achievement relies on what might be described as 'digital housekeeping'. Here we seek to unpack some of the ways in which that achievement is organized across households so as to provide for 'making the technology at home' (Sacks 1992a) in the face of the endlessly variable social arrangements and activities that make up the 'routine' within any home. Domestic routines are not fixed but change from home to home and over time within any home. It is as if they were built on shifting sand and yet somehow household members can and do weave the home network into their daily lives. We want to understand something of what that 'somehow' consists as a socially organized accomplishment that extends beyond the particularities of the routines at work in any particular home.

We would start by drawing a contrast between digital housekeeping and traditional social science accounts of housekeeping, which emphasize the role of gender divisions to the accomplishment of housework in general (see Blythe and Monk 2002, Bell et al. 2005, Wyche et al. 2006). It is not that we dispute that gender can play an important role in the development of computing for the home.

Clearly it does (see, for example, Taylor and Swan 2005). Rather, and as our invocation of Sacks suggests, we prefer to suspend the broad concerns with gender that occupy mainstream social scientists, and instead seek to inspect the particular demands of digital housekeeping from the perspective of *household members* - particularly from the point of view of how members themselves see, understand and reason about the relationship between technology and the home in the course of situating it within their ongoing domestic affairs.

What we find when we do this is that members exhibit a number of preoccupations that revolve around setting the home network up and ongoing maintenance. These include locating the technology in the physical fabric of the home, maintaining the wider order of the home environment, and planning and preparing for change. They also include ongoing housekeeping, recurrent housekeeping, managing access and security, managing digital media, and restoring order when order breaks down. The concerns that members exhibit across different households in their practical efforts to make the home network at home draw attention to the importance of marrying technology development to existing infrastructure in the home (Rodden & Benford 2003) and put flesh on the bones of what Grinter et al. could be talking about when they say, “tools that provide views of the network oriented around the services the network provides - rather than the devices that comprise it - might greatly aid householders in working together on family solutions to not just media sharing problems, but also the set-up and administration of the devices and infrastructure itself.”

Setting and Method

The findings on which this paper is based are drawn from 3 households in the UK. They are part of a longer term and ongoing course of research that seeks to explore the potential for, and inform the development of, new technologies in the home. The current studies focus on homes where the occupants have installed or are in the process of installing home networks. They involve:

- *House A*, which consists of two adults, 44 and 30 years old, both computing professionals, living in a large two-bedroom apartment.
- *House B*, a family consisting of 2 adults, 38 and 36 years old, and 3 children, 9, 7 and 15 months, living in a semi-detached house. One of the adults is a computing professional, all other members of the household have very limited technical experience.
- *House C*, a family consisting of 2 adults, both 43 years old, and 2 children, 12 and 9, also living in a semi-detached house. Once again one of the adults is a computing professional but all of the others in the household have no specialized experience of technology.

Whilst there is at least one member in each household involved in computing in some way, these homes cannot be said to constitute “advanced technology set ups” as in Grinter et al’s study. In fact, all of the computing professionals in-

volved expressed reluctance to get involved in computing activities at home as it already occupied their working days. Indeed, it quickly became apparent that having someone technical in the house does not make the home subject to rapid technology adoption. There are numerous other everyday household concerns that hold sway and any technical undertaking is *accountable to these*. Thus the building of home networks in these and other households seems indicative of an altogether different phenomenon. Broadband connections amount to over 70% of all Internet connections in the UK and this is accompanied by an increasingly widespread uptake of wireless technologies in the home. Home networks are no longer ‘geek’ experiments, they are an ordinary solution to burgeoning technological complexity. The participants in our study have, like others across the country and farther afield, installed home networks because it makes sense for them to do so in order to manage a host of technologies that are increasingly pervasive in character. Theirs are home networks *for* the home, not for professional curiosity.

The households were studied through direct ethnographic observation (Crabtree 2003). The study itself is ongoing but the reflections offered here are derived from monthly site visits and interviews conducted during the first 4 months of study. In keeping with the ethnomethodological approach that we adopt towards analyzing ethnographic fieldwork, we focus on what we can learn by inspecting particular ‘instances’ (Sacks 1984) in which members display the real world, real time competences and practices where they organize their interactions with computers (Button 1992). These ‘embodied displays’ (Dourish 2001) exhibit patterns of conduct that extend beyond the individuals involved (Garfinkel 2001). Think, for example, of the patterns of conduct made manifest by yourself as you walk down the road, buy goods in shop, and drive home, and how what you do is organized in very much the same ways as those around you who are engaged in the same activities. There is an ‘incarnate’ orderliness to human activity that we, as fellow members of the ordinary society, naturally observe and regulate (*ibid.*).

The fieldwork vignettes presented here should not, in that case, be read as being solely about the particulars of each observed instance. A whole range of *orderly concerns* that cut across households are manifest in the vignettes. They exhibit the kinds of reasoning that make ‘homes’ and ‘households’ recognizable for what they are. They are populated by such issues as where do you put the technology? Where do you plug things in? How do you organize your seating around it? What do you ask of your children with regards to its use? Working out answers to these and other routine problems of order in the home is of course subject to the local, the contingent, the endlessly variable and changeable. Thus, the particular physical characteristics of the home, the particular technological arrangements installed, the particular members that occupy the home, the particularities of the activities being undertaken, etc., all shape the ways in which household members actually come to make the technology at home in any particular setting. Nevertheless, the orderliness, or social organization, or ‘machinery’ as

Sacks called it, exhibited and displayed by members within particular instances is of much broader purchase and relevance. That purchase and relevance is located in the *broad recognizability of a set of mundane arrangements and activities* within which members find the resources to weave the home network into their everyday lives (Sacks 1992b).

The suggestion, then, is that despite local variation in their accomplishment, a particular assemblage or family of practices cuts across homes and that ‘making the home network at home’ relies on them. We treat this family of practices, or social machinery, in terms of ‘digital housekeeping’, a notion that is intended to denote that making the home network at home is not only about managing networks - it is also about managing the whole gamut of digital resources tied to it and rapidly populating the home environment. Furthermore, it is about *doing that* not as experts but as ordinary people who have to manage their digital resources as a part of their everyday lives. Most of what we speak of here does not trade on any profound computing expertise then. Rather it is a mixture of ordinary reasoning about what it takes to run a home and what it takes to use a computer, a digital camera, and a collection of other increasingly pervasive technologies within a local nexus of quotidian concerns. Our goal here is to begin to uncover the ordinary social machinery whereby household members make their digital resources available as resources within the broader organization of the home and accessible across a wide range of domestic activities. Key to this achievement is the *setting up* and configuring of digital resources so that they can be managed as part of the routine organization of the home, and the *ongoing housekeeping* of digital resources which provides for the maintenance and adaptation of the home network over time to meet the household’s changing needs. Below we explicate important features of these primary constituents of the social machinery in turn.

Setting Up Digital Resources in the Home

When digital resources enter the home they cannot just be positioned in any way within the household and its routines. Their entry into the home is not only managed for the here-and-now by household members but for the *future* as well and this is an integral part of how people reason about them when setting them up. Furthermore, it is clear that there are features of the work of setting up that get oriented to as ‘chores’ to be done as part of the larger round of housekeeping in the home. Where technologies are placed, how this placement is achieved, how these fit with the everyday order of the household, and how this change is prepared for and planned play a key role in making the home network at home.

Locating Technology in the Home

One of the most important ways in which people provide for the future management of digital resources in the home relates to how they *physically position* technology. A number of constraints impact where we can place digital equipment in our homes, of which power supply is the most evident. Additionally, certain items of equipment may have to be placed within reach of where data/telecom lines enter the home and, when wireless devices are being used, there may be constraints upon where one can get a good signal.

However, there is much more to placement than just technological constraints. For a start people routinely reason about the things or ‘stuff’ (Rodden and Benford 2003) in their homes in ecological or topological ways (Crabtree and Rodden 2004). They therefore position things in such a way that the connections between things and the activities they engage in is transparent to household members. Thus, the placement of digital stuff is framed by established routines in the home and concerned with maintaining an appropriate relationship to those routines. For example, places where people used to do written work (e.g., the kitchen table) become places where they also sit to do writing on their laptops. Even when technology opens up completely new possibilities, it continues to be located for its availability to the routine. The positioning of things in the home, *including digital resources*, is therefore intimately bound up with household routine and how it may be reasoned about to support everyday household practice. In the following vignette we can see how such consideration of other household concerns can come to influence the positioning of technology.

House B

Ethnographer: Why did you put the hub on the windowsill? Was that necessary because of lengths of wires?

Householder: I could have used an active extension cable, but I'd already anticipated that I might have multiple USB things plugged in over there so I put the hub in straight off - and the windowsill is sort of at least slightly out of the way and it's already got a pile of rubbish on it ...

Here, then, we can see how things may get positioned so that their ‘untidy’ aspect will be hidden by the presence of existing physical disorder. Simultaneously, by being ‘out of the way’ the routine concern with child safety in this home – they have a young toddler – were solved. Thus we can see how the installation of digital resources can intersect with and become a part of other physical housekeeping issues. Where this is the case the reasoning applied is always in terms of being *accountable to the broader issues in the household*, not the other way round, and the practices of installation *reflect* the logic of those concerns.

The following example reveals that the existence of even a wireless home network does not simply write anew the possibilities for how new technology gets incorporated into practice:

House C

I have discovered that my favourite seat for viewing the television, which is on the other side of the house from the PC, is just on the edge of network range, so I do tend to go through some

shenanigans of sitting in the right position in the seat to be able to put my laptop on the coffee table and trust the intermittent connection if I want to do something like read my mail while I'm watching telly or whatever. You sometimes have to reorient yourself a bit to get back the signal.

In each of the households involved in our study, it can be seen how the set up of home networks is shot through with a set of larger concerns regarding how best to organize digital resources to facilitate not just personal use, but their routine use within broader household activities. Matters such as 'tidiness', 'child safety', 'room usage', 'positioning of furniture', 'décor', 'where the power and phone lines are', and so on, are critically implicated in the way the technology gets set up and installed, and likewise, the positioning of technology becomes implicated in how such things are reasoned about in the home.

Maintaining Order in the Home

The actual work of installing technology can be hugely disruptive to the household routine. It may involve the movement of furniture, the turning off of things like televisions, the trailing of wires across floors so that whole rooms are out of bounds, and, of course, one of the members of the household is physically unavailable for other activities at that time. Consequently one finds that the work of installation gets organized around what else is happening in the household to try and minimize the impact of these things.

House A

I'm going to be moving a new media PC in next. I'm going to do it next weekend when Rachel isn't here because I know how disruptive it's going to be. I'm going to have to turn stuff on and off - the TV for instance - and I know I'm going to have to move stuff around the living room and all this has a knock on effect: I'm going to put the box in a targeted space - the TV has a cupboard with a slot in it but there are DVDs in the slot at the moment - there's just not enough storage in the house for all the DVDs -and then I'm also going to have to unplug lots of stuff.

Planning and Preparing for Change

The above comments about how the digital housekeepers we observed strive to maintain order as they install technology are indicative of how important it becomes to undertake certain projects, especially larger-scale ones like installing or extending home networks, in several stages. This involves knowing in advance that the work can be accomplished within a certain amount of time and that, at the end of it, everything can be restored to good order until the next time.

In view of the need to mesh installation with other household routines, those who engage in setting up home networks can devote considerable attention to thinking them through in advance. The critical problem here is figuring out how to get a fit between a new technological arrangement and a well-established and fine-tuned body of practice to which the household is already oriented. In this situation inhabitants may overtly devote effort to making the technology at home. Questions like where things are going to be stored, how people are going to get

access to them, where people are going to be able to access them from, what people will and won't need to be able to see, how they are going to be able to shift stuff around, how things are going to get linked up together and synchronized, and so on, all come to matter enormously, not as technical matters, but as matters of moment that can clearly impact upon any household member and their routine. Consequently, those setting up the network not only draw upon a range of online resources as Grinter et al. note, but also construct representations of their networks to address the issues that confront their efforts to make the home network at home. One householder's solution to being able to think these kinds of things through is shown below:

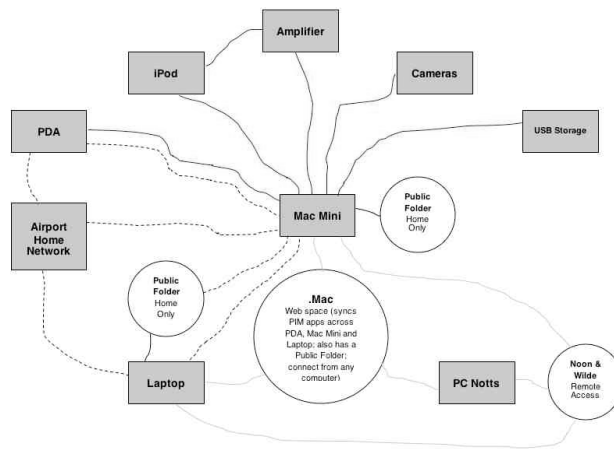


Figure 3. Making the home network transparent and reason-able.

Resources such as these make technological configuration of the home network visible and available to practical reasoning. As Grinter et al. note,

“without the ability to understand the whole network, troubleshooting the network - let alone installing or modifying the network - becomes virtually impossible.”

It would seem, then, that developing representations that enable household members to reason about the configuration of the home network at the level of device and service is an important feature of making the technology at home. A question that arises out of this, however, relates to how this might extend to service providers who are invited into the home to assemble and configure the home network (Verjee 2006). If the current work of configuration is oriented to a *local understanding* of how things are arranged and managed in any particular household, how will an external ‘digital plumber’ be able to anticipate or support this body of local reasoning? A part of the answer lies in developing representations that articulate the lines between digital plumbing and digital housekeeping. Either way, there is a serious need for the design community to make the home network much more transparent and available to practical reasoning by professional digital plumbers and DIY householders alike.

When the technology has been positioned, set up and installed, and everything is back in place, the orientation of household members shifts to living and engag-

ing with the network as part of daily practice. Here the concern is not just with embedding particular devices in ongoing routines but about arriving at a point where managing the ensemble of devices can *become routine*. A major issue here is whether or not the technology is *stable* so that effort only needs to be devoted to keeping it that way rather than having to continually rebuild and reorganize. To that end those who set things up also seek to reassure themselves that such stability is present before adding any further layers of complexity.

House A

I've not got everything plugged in yet. Now one of the reasons for this - again a bit of natural caution - is, I want to see if the media PC collapses before adding more.

With the stability of the network established the practical concerns for digital housekeeping shift to maintaining the ensemble in the broader context of the household's everyday routines. We now turn our attention to that *ongoing* work.

The Ongoing Housekeeping of Digital Resources

As digital resources become more stable features of the home they require a different kind of housekeeping effort. Now it is a matter of keeping them in good order. From our studies it is clear that there are two principle ways in which household members reason about this ongoing housekeeping. Firstly there are predictable kinds of *necessary and recurrent housekeeping tasks* that are viewed as a part of having digital resources. Then there are *occasional housekeeping tasks* that arise as either a part of things breaking in some way or the kind of entropy that infects computational networks generally. The latter are 'one-offs' and it is hard to know when the need to undertake them might arise.

Recurrent Housekeeping as a Part of Domestic Routine

Some of the tasks that have to be undertaken as part of digital housekeeping in home environments are relatively invisible in work environments. Thus in most medium and large-scale enterprises the backing up of materials stored on the individual parts of the work network is the responsibility of dedicated support staff. The users of particular workstations or laptops connected to the network therefore have their materials backed up without any special effort on their part. The same is also likely to be the case for various upgrades and security patches. One can similarly schedule for automated back-ups and upgrades in home networks. However, we found that the work of setting that up and maintaining it was falling to *particular* members of the household who have to attend to the broader rhythms of the household when undertaking and scheduling such work.

The setting up of such systematic handling of routine digital housekeeping is either itself a job on an as-yet-to-be-realised 'to do' list, recalled as a requirement in the context of other household planning activities, or else wholly unreflected

upon until things go wrong. Thus, backing up and upgrading are matters a) occasioned by other circumstances that arise, or b) are scheduled to be handled manually with some suitable periodicity. What does it take, then, for such tasks to be undertaken and what kinds of concerns are oriented to by the digital housekeeper? The following remarks reveal the extent to which, even for those members of the household who have considerable expertise with computers, and even where existing resources should make backing up relatively painless, it still turns upon the ways in which maintenance is *occasioned* within the household.

House C

I try not to leave anything I would cry about if it got trashed on the home machine. My partner's different, I think it's mostly her main machine. I, at various points, have shown her how to back stuff up onto various different media but I think it's always been enough of a pain that I'm damn sure she doesn't do it. I think she emails stuff to herself - she certainly does that - and occasionally I will say, "you need to back stuff up" when it occurs to me because I know she hasn't, and occasionally I do it for her but not regularly.

Occasionally upgrades are more to do with hardware, but once again these are an occasioned part of the wider concerns and routines of the household, rather than planned and structured as part of the ongoing business of 'keeping the system up to date' that one may encounter in larger enterprises. Upgrades could be prompted by any number of different household concerns such as someone who previously worked elsewhere beginning work at home; school work; more children reaching an age where they are playing games or going online; not to mention the increasing use of a growing number of linked leisure and entertainment resources (photos, music, films, chat, etc.). In the following case there are just too many people all trying to use the same desktop PC, with all of the attendant arguments about memory, applications, times of use, security, etc.

House C

At the moment, already under the pressure of our single PC ... I have retreated to working with my laptop, which means a wireless network. So... we've done the basics but now we're still under more pressure for that PC so now it looks like we'll introduce a second PC and that has to run right across the house and I'll connect that up. So the network's growing at the moment.

In the above excerpt we can see how it might be that more and more people are seeing the sense in setting up wireless facilities and constructing some kind of home network. Whatever the local reasons that occasion this, when it happens it involves a whole new set of housekeeping concerns that are of broader relevance.

Managing Access and Security

As computing facilities become more widespread throughout the home and are used in a wider variety of ways the range of routine concerns that manifest themselves can become quite daunting, involving things like password management, setting up and updating individual user accounts and profiles, and installing firewalls and virus checkers. One may also need to engage with more sophisticated interests such as the synchronization of resources such as file stores and calen-

dars. However, all of this is as much an occasioned part of the evolution of the household as anything else, as is made clear by the following householder.

House C

The real maintenance is on the PC. That's because of ... different uses it's put to and the number of programs that are coming and going from it - particularly going. Initially it was worse because the previous PC - we didn't even bother with separate accounts because the kids were young ... and we didn't feel like we needed them and it just felt like more hassle for them to have to do that, but obviously, you know, as people have started to mess more and more with the configurations and do more different things, we did then introduce a system of accounts.

While many of these housekeeping issues prove to be one-off enterprises that only occasionally require further intervention, other features may require more regular consideration. In Household C the presence of children requires the management of NetNanny, for example, to ensure the children are not browsing anything unsavoury on the Internet. Yet here the actual management of it is not in any sense formulaic, but rather nuanced to each situation as it arises:

House C

As the kids got more into the Internet we kind of thought "yeah, we're not entirely sure what they're going to find, what they're going to browse" so we thought we'd install NetNanny. It's hard to be systematic about which sites you want to block and which ones you don't. It does take active control. So basically you've got a couple of options: you could go into the sites that NetNanny recommends by default, but it turns out that doesn't satisfy the kids. There are some things they want to look at that we are happy for them to look at that aren't on the list, so you can then either maintain the list of allowed and blocked sites yourself but you'd have to update that fairly regularly with a fair bit of discussion about each one or you end up saying "never mind all that, we'll log you in as 'grown up' mode". For us updating the list doesn't happen because it feels like just a bit too much hassle to do it. So when they log on, NetNanny will be set to kid mode and then if they want to look at something else they'll come to me and there'll be a bit of whingeing and they'll say "we hate Net Nanny, wurr-wurr-wurr" and then we'll decide whether to unblock it temporarily. The problem is we almost certainly won't remember to turn it back on for the remainder of that session and obviously we don't sit with them while they browse.

Managing Digital Media

A growing phenomena that runs to the heart of digital activity in domestic settings is the creation of blogs and community software such as Flickr. In many cases these may be personal resources with only limited interest in terms of how to maintain things for the rest of the household. However, the management of these things is indicative of an area of regular digital housekeeping that is rapidly becoming a chore. It is increasingly hard to find a home where there is not at least one digital camera and often there are several. Households are therefore increasingly confronted with multiple members of the household generating and then wanting to store, manipulate, and share digital photos. Downloading these photos, locating them in the right places, sorting them, sifting them, rotating some, deleting others, improving yet others, adjusting format, size and compression for different uses, often over and over across several directories, not to mention issues like naming and categorizing the photos so that they can be recovered easily from household repositories, can all add up to a significant amount of work. One of the

households we have been looking at has adopted the practice of placing their photographs on a website for access by remote family members. This practice has evolved so that one of the household's members can make available to her mother, who lives in another country, photographs of the various places she has been recently. This practice is reciprocated by her mother. They are then able to phone one another and talk through the photographs. However, for the digital housekeeper in this situation the work involved is really quite substantial (Kirk et al. 2006), as the following account indicates.

House A

To start with I have to connect my camera with a USB to the laptop. The photos are then all collected into a single folder. However, whilst getting the images to the laptop is easy ... we can't then both look and discuss them because the laptop is too small for us to be able to view the photos together. The only screen we have that is big enough is on the PC in the office. But there's only space in the office for one chair. We have to review them because ... only about one in ten is interesting. I used to thin things on the camera but lately I've got into the habit of just dumping everything to the laptop. We can't display the raw material on the website so we have this painful thing to go through ... reviewing with only one chair in the office. We did the latest batch over two consecutive weekends. Once I know what we're keeping I have software that runs through the photos and creates a set of web pages including thumbnails and a navigation bar. So it's created in a folder as a website and this is then copied to our web-server. So, in order for it to happen at all I have to move files to a number of different locations which is tedious.

Restoring Order when Things Breakdown

In our study we found that many of the kinds of tasks that may get talked about as 'digital housekeeping' are the things that arise as a consequence of some kind of breakdown. Similarly, situations arise where the degree of disorder has become so great that it is harder to account for continuing to tolerate it than it is for getting on and fixing it. The latter kind of tasks can be motivated by things like problems with space, either in terms of machine memory or desktop 'real estate'. Ensuing work usually revolves around clearing out what one might call digital clutter. This can involve things like deleting shortcuts from desktops, getting rid of replicated or unwanted files including digital photos and music, moving larger files to other locations, or uninstalling software. Locating what can be deleted or moved in these circumstances can involve a great deal of work. Trawling through directories to compare them, sometimes even printing them, can be a significant part of the labour here, especially if there are multiple directories and multiple accounts on the same machine. Much of it is 'work of the eye', spotting things like the same size and date of creation, or the telltale tilde sign before the name of a temporary file. Furthermore, in the home situation resources open to disposal involve the application of local knowledge where reasoning is very much bound up with being a household member. The following is a case in point:

House C

Running out of disc space is a classic problem with games eating up huge amounts of memory. Particularly freebie games that are a nightmare that come with cereal packets, but the kids want to try them out. Eventually when everything's really falling over you have to go in and uninstall,

and you have to work out what to uninstall. I try and maintain a view as to what I think they are using at the moment. I think I have a sense of what are hot games right now. That may be wrong, but I think I have enough sense about their playing habits. So I know that right now we bought them Sims Two recently and everyone is playing Sims Two. So I know that uninstalling Sims Two would cause a riot. But I know that The Jolly Postman they probably haven't played for three or four years or mentioned. I imagine no one would notice if that slipped away.

The responsibility for the digital housekeeper in these circumstances can be onerous and installing and uninstalling resources can become a matter of identifying *accountably appropriate* courses of action. It is not just that one has not seen someone using something for a while. The apparent non-use provides for an account that is appropriate under the circumstances. When confronted with having to remove something an accountably appropriate course of reasoning is to remove what no one seems to use. Other criteria, such as 'this one is huge' and 'I don't think it's very good' might be applicable, may also be used. However, this would not provide an account that is attendant to the *communal* interests in the home. There is, of course, software available that can produce data regarding relative use of different applications. However, an application may be used only rarely but actually considered by some member of the household to be critical to what they do. Furthermore, if only one member of the household plays some particular game and others are played more often the preference of that person will become hidden in the statistics of use. Here such software is not enough. Arbitration falls instead to what is known of the habits of the household. Knowledge of this order is not often available to those outside of the local cohort.

An important thing to understand about things like running out of disc space, machines suddenly 'hanging', the appearance and settings being in need of re-configuration, etc., is that the priority attached to restoring order, and the accountability of the digital housekeeper for dealing with it 'now', is completely different to those attached to more routine tasks. In this case, the problem has to be resolved here-and-now and may extend beyond the home itself:

House C

Games in particular mess with screen resolution so that's one of the most common and frustrating ones and no one else in the family really knows how to re-set those things. Quite often it happens in the middle of a game when the kids are really into it. They will complain - not really about the resolution, but about things hanging. I certainly find it a problem for myself if I sit down to use the computer and find it. So then I have to grumble a bit and re-set it.

My wife who uses it for her PhD work, she's definitely going to get on to me - "hey, the machine's broken, I don't know what's going on" - and then if I'm at work we have this whole protracted distant negotiation about stuff.

It might, of course, seem that handling of breakdowns is a relatively rare occurrence. However, as the range of digital resources in the home increases the likelihood of *something* causing trouble increases as well. In the case of one of the households we have studied the level of commitment here easily extends to several hours a week. As one household member put it to us,

House C

Of course you sit down with a problem that looks like it ought to be five minutes and it can take you anywhere between five minutes and an hour depending on what it is.

Digital Housekeeping: The Social Machinery

If one concentrates on the particulars of the vignettes provided above, it may appear that the actual tasks involved in digital housekeeping are relatively trivial and that the small number of households involved in the study tell us little about the scope of the issue. Numbers, however, having nothing to do with the matter. Nor are we suggesting that digital housekeeping is restricted to the particular things we have presented and discussed here. Instead these particulars offer concrete occasions with which we might witness a much larger phenomenon at work: a ubiquitous phenomenon that is invariably manifest *in the small details* of making the home network at home; in small details which vary from home to home depending upon the technology installed; in small details that depend upon the routines at work in any particular home; and in small details which testify to the efficacy of members' methods for embedding the home network in their everyday lives. It is very much the case that what is a big issue for household members insofar as all must confront and address it, is nevertheless *reduced to an ongoing series of small, routine tasks*. This is what makes it manageable. This is what the incorporation of the home network into everyday life turns upon. Much like doing the washing up, emptying the bins, washing clothes, etc., it may seem trivial yet like such mundane activities it is critical to the domestic enterprise.

Digital housekeeping is done for the communal good of the household by certain individuals and is beginning to be recognized by household members as a contribution to the overall management of the domestic environment.

House C

One of the things that has now happened is that maintaining the PC is seen as a household chore rather than "messaging about on the computer".

While one might be tempted to think of idealized versions of the organization of the home that could support routine management of the home network through things like task lists, alarms, stickies, etc., it is clear from our investigations that **occasioning** is everything. Few people use generic resources to prompt this kind of housekeeping activities. The use of such artefacts is itself occasioned - e.g., putting a post-it on the computer monitor saying 'back-up' after realising it hasn't been done for a while. This is because shared computing resources in households need to be *collaboratively negotiated* and reasoned about *in relation to ongoing routines* in the home. By ongoing routines we speak of those activities undertaken in the home without pause for special comment or account, recognizable by all in the household as unremarkable because they are the things 'we usually do' being done in the ways 'we usually do them' (Tolmie et al., 2002).

Many routine activities in the home are given priority: access to the bathroom before going to work, children's bedtime, and so on. However, housekeeping is notably oriented to as an activity of a *different order*. Forlizzi and DiSalvo (2006) found exactly this in their investigation of the use of domestic robots:

“Most families engaged in primarily opportunistic cleaning, engaging in cleaning activities when time in their weekly schedule permitted. Many set a deadline of the weekend, noting that as long as cleaning tasks got done by Friday, it did not matter when they were done ...”

Indeed, to say something like “I need to get the kitchen cleaned before I get the kids to bed” could be unusual on many occasions. Digital housekeeping is the same in this respect. How could those responsible for it negotiate its priority above the other business of the home? Instead, it becomes something that will *fit in, around and with* other routines. The different routine activities visible in the homes we have been studying are too numerous to mention and their contingent and variable nature makes it pointless to do so. So it is not just that the home network is woven into a specific enumerable set of routines but that in the face of endless variety the home network is made at home by being made answerable to whatever passes as the routine in any particular home. The *accountability* of the technology to household routines simply cannot be underestimated.

The orientation to digital housekeeping as something that is *for* the household and something that needs to *fit with* the household is manifest in a number of ways that go beyond the small details of the particular instances we have considered here. There is a social machinery at work in making the home network at home – an orderliness to the enterprise that rises above the particularities of particular network configurations. Whatever the technology and whatever the activity involved in installing and maintaining it, it is always *somehow* accountable to ‘just how we do things here’. Just what that ‘somehow’ might amount to is something we have opened up to examination above.

So, to sum up what we have uncovered so far about that machinery and its operation, we can see that household members order their relationship to the home network in the following ways:

- The components of the home network are placed both physically and socially in such ways as to *accommodate* existing infrastructure and established routines, such as the current placement of the television or the doing of work at the dining room table. The work of accommodation involves consideration of where things are done now and how things are done now such that the building of the network will not involve radically reinventing those placements and patterns of doing.
- The components of the home network are positioned so as to *reflect* abiding practical concerns in the home, such as keeping the technology out of view, attending to child safety, only making mess where mess already exists, etc. It is the placement of technology in such a way that, when inquired into, the

accounts can pay testimony to these concerns that provides an exhibition of this kind of reflection in action.

- The work involved in setting up and adapting the home network is *accountable* to existing routines in the home, such that it will not unduly disrupt other courses of action central to domestic life. Thus we saw digital housekeepers actively accounting for how they ordered the work of installation around things like who would be in the household when and what other responsibilities they had to attend to.

Once introduced into the home, digital technologies are maintained in such ways that they resonate with existing routines in the home. Again, organizationally this means that household members order their relationship to the home network in the following ways:

- Ongoing digital housekeeping is characterized by recurrent and occasional housekeeping tasks that are *fitted in and around* other household routines as occasion permits or demands.
- All digital housekeeping tasks are conducted under the practical orientation of *appropriate priority*, which is to say that they ‘get done’ as and when time permits or demands and in such a way that their doing is manifestly accountable to other household routines. Thus, and for example, breaking off in the middle of washing up to sort out a machine that is hanging in the course of the kids doing their homework requires no special account. The account is manifest in the circumstance. Breaking off in the middle of doing the washing up to do a back-up or sort the digital photos is something different and others in the house may justifiably demand an explanation.
- Digital housekeeping tasks rely on *local understandings* of the configuration of the home network and what actions need to be carried out to maintain it. Thus deleting the Sims or only putting the family photos on your own desktop could be a source of future trouble. Yet, for an outsider, the currency of the Sims or just what might constitute a ‘family’ as opposed to a ‘personal’ photo cannot be guaranteed to be self-evident.

In these ways the home network becomes embedded in the social and physical fabric of the home. If some are dissatisfied with the unsystematic character of the social machinery at work, it needs to be remembered that the home is not the workplace. It is not subject to the order of action and control that inhabits paid labour. It exhibits a much looser organization that revolves around the daily articulation and coordination of domestic routines rather than procedures, processes, or workflows (Crabtree and Rodden 2004). Furthermore, the orderly ways in which the home network is made at home and embedded in domestic life raise serious challenges for the continued development of the home network.

Implications for Design

Making the home network at home is not simply a matter of installing and using the technology. It relies upon digital housekeeping. Through digital housekeeping household members weave digital resources into the larger constellation of routines that make up the social organization of the home, thereby keeping the home network in tune with the household's ongoing and evolving needs. The highly contingent, particular, and local character of digital housekeeping is underpinned by a social machinery that is of broader purchase to design. In outline, we think two main issues present themselves, issues that have been of longstanding concern within the design and CSCW communities:

- The need to develop the home network with *legacy* in mind.
- The need to provide for the *transparency* of the home network.

Legacy issues have been of concern in the design of workplace systems (e.g., Rouncefield et al. 2000). In the home they are less about developing technology with respect to previous computational systems and more about developing technology with existing infrastructure in mind. Looking back to how digital resources are set up in the home it can be seen that when introducing new technology household members exhibit an abiding preoccupation with legacy issues. These are couched in terms such as will the technology fit into the existing infrastructure? How will it fit? Where will it fit? These and more are key issues to the adoption and use of new technology in the home and are of some consequence to design. To be specific, it is not simply a case of providing for the 'piecemeal' entry of new technology into the home (Edwards and Grinter 2001), but also of ensuring that new technology is compatible with existing infrastructure such that household members might accommodate it within the physical and social fabric of the home.

While it will no doubt take a great deal of work to work out how legacy issues are to be addressed, the need to provide for the transparency of the home network is perhaps rather more tangible and available to design. Just as household members have an abiding interest in fitting technology into existing infrastructure and routines so too they have an abiding concern with the accountability of the home network. This is evident across set up, in planning and preparation for example, and ongoing housekeeping where household members draw on a host of resources to make network activity visible and available to practical reasoning. Indeed, it is by making the home network transparent and available to account that household members come to embed it in their domestic routines.

The design challenge here is not one that revolves around scheduling routine tasks but of making the home network *inspectable*. From the few particulars we have considered here it can already be seen that this will not only consist of representing the various devices constitutive of the home network, but also the serv-

ices, user accounts, applications, and traffic that inhabit the home network in use. The challenge, then, is one of designing representations that make the day-to-day life of the home network *as articulated in user interactions with it* visible and available as a resource for supporting set up, maintenance, and change. Doing this will involve developing dedicated *management interfaces* that represent the network as a whole and in the details of its constituent parts, processes, and the transactions between its constitutive elements at a level that is intelligible to the ordinary household member. This intelligibility will turn upon being able to reason in the same way that one might reason about the interfaces one encounters on a daily basis if one is not a part of the computing profession. Clearly not all interfaces are of this order and we have already mentioned work that has begun to explore how to improve matters in this direction (e.g., Newman, 2006, Shehan et al. 2006, Yang and Edwards 2006). The efforts of household members to make the home network transparent and accountable, and the development of management interfaces that support this, articulates and elaborates what Grinter et al. allude to in talking about “developing tools” to support the work that makes the home network work. Indeed, the work of digital housekeeping that provides for transparency and accountability, and the development of systems support, are key ingredients in making the technology at home.

Conclusion

We have sought to build upon and extend the work of Grinter et al. (2005) on the work to make the home network work. We have focused particularly on the work involved in setting up and maintaining home networks, which we characterize as ‘digital housekeeping’. Our ethnographic studies have revealed that it is through digital housekeeping that the home network is made into an unremarkable feature of the domestic routine. In examining digital housekeeping we have been concerned to move beyond the particulars of the work in participating households and identify a ‘social machinery’ that provides for the broad incorporation of the home network into domestic life. This machinery articulates the orderly ways in which household members set up, maintain and change the home network to meet their ongoing needs. This has some major implications for the continued development of network technologies for the home. It demands that serious attention be paid to legacy issues in terms of how technologies are designed to fit into the home environment. This requires that designers take existing infrastructure in the home into account and pay considerable attention to how future technologies may be incorporated into existing routines. Additionally, the concern household members exhibit with making the home network ordinarily available to practical reasoning suggests a need for resources such as dedicated management interfaces to support digital housekeeping.

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References

- Bell, G., Blythe, M. & Sengers, P. (2005) "Making by making strange: Defamiliarization and the design of domestic technologies", in *ACM Transactions on Computer-Human Interaction (TOCHI)*, vol. 12 (2), pp. 149–173.
- Brush, A.J. (2006) "IT@Home: Often Best Left to Professionals" *Position paper for the CHI 2006 Workshop on IT@Home*, April 23, 2006, Montreal, Canada
- Bly, S., Rosario, B., Schilit, B., Saint-Hilaire, Y. & McDonald, D. (2006) 'Broken expectations in the digital home', in *Proceedings of the 2006 Conference on Human Factors in Computing Systems (CHI)*, Montreal, Canada, April 2006, pp. 568-573, Montreal: ACM
- Blythe, M. & Monk, A. (2002) "Notes towards an ethnography of domestic technology", in *Proceedings of the ACM Conference on Designing Interactive Systems (DIS) 2002*, London, 2002, pp. 277-281, London: ACM.
- Bowers, J. (1994) "The work to make a network work", in *Proceedings of the ACM Conference on Computer Supported Cooperative Work (CSCW) 1994*, pp. 287-298, Chapel Hill: ACM.
- Bowers, J. Button, G., & Sharrock, W. (1995) "Workflow from within and without", in *Proceedings of the European Conference on Computer Supported Cooperative Work (ECSCW) 1995*, pp 309-324, Stockholm: Kluwer.
- Button, G. (ed.) (1992) *Technology in Working Order*, London: Routledge
- Button, G. & Sharrock, W. (1997) "The production of order and the order of production", *Proceedings of the European Conference on Computer Supported Cooperative Work (ECSCW) 1997*, pp. 1-16, Lancaster: Kluwer.
- Chetty, M. & Grinter, R. (2006) "Making connections", *Position paper for the CHI 2006 Workshop on IT@Home*, April 23, 2006, Montreal, Canada
- Crabtree, A. (2003) *Designing Collaborative Systems*, Springer.
- Crabtree, A. & Rodden. T. (2004) "Domestic routines and design for the home", *The Journal of Computer Supported Cooperative Work (JCSCW)*, vol. 13, pp. 191-200.
- Dourish, P. (2001) *Where the Action Is*, Cambridge, MA: MIT Press.
- Edwards, K. & Grinter, R. (2001) "At home with ubiquitous computing" in *Proceedings of the International Conference on Ubiquitous Computing (UbiComp) 2001*, pp. 256-272, Atlanta: Springer.
- Elmore, B., Subbarao, I. & Hamilton, S. (2007) "Designing software for consumers to easily set up a secure home network", in *Proceedings of the 2007 Conference on Human Factors in Computing Systems (CHI)*, San Jose, April 2007, pp. 1735-1740, San Jose: ACM
- Forlizzi, J. & DiSalvo, C. (2006) "Service robots in the domestic environment", in *Proceedings of the 1st Annual Conference on Human-Robot Interaction (HRI), Utah, USA. 2-4 March 2006*, pp. 258-265, Salt Lake City: ACM.
- Garfinkel, H. (2001) *Ethnomethodology's Program* (ed. Rawls, A.), Lanham MD: Rowman and Littlefield.

- Grinter, R. E., Edwards, W. K., Newman, M., and Ducheneaut, N. (2005) "The work to make the home network work", *Proceedings of the European Conference on Computer Supported Cooperative Work (ECSCW) 1995*, pp. 469-488, Paris: Springer.
- Kirk, D., Sellen, A., Rother, C., & Wood, K. (2006) "Collecting and editing photos: Understanding photowork", in *Proceedings of the 2006 Conference on Human Factors in Computing Systems (CHI)*, Montreal, Canada, April 2006, pp. 761-770, Montreal: ACM.
- Lemhachheche, R. (2006) "Inowiss", *Position paper for the CHI 2006 Workshop on IT@Home*, April 23, 2006, Montreal, Canada
- Newman, M. (2006) "Now we're cooking", *Position paper for the CHI 2006 Workshop on IT@Home*, April 23, 2006, Montreal, Canada
- Rodden, T. & Benford, S. (2003) "The evolution of buildings and implications for the design of ubiquitous domestic environments", in *Proceedings of the 2003 Conference on Human Factors in Computing Systems (CHI)*, Fort Lauderdale, April 2003, pp. 9-16, Ft. Lauderdale: ACM.
- Rouncefield, M., Rodden, T., Sommerville, I. and Randall, D. (2000) "Remembrance of designs past", *Systems Engineering for Business Process Change* (ed. Henderson, P.), Springer.
- Sacks, H. (1984) "Notes on methodology", *Structures of Social Action* (eds. Maxwell, J. and Heritage, J.), pp. 21-27, Cambridge: Cambridge University Press.
- Sacks, H. (1992a) "A single instance of a phone-call opening", *Lectures on Conversation* (ed. Jefferson, G.), Lecture 3, Spring 1972, pp. 542-553, London: Blackwell.
- Sacks, H. (1992b) "On sampling and subjectivity", *Lectures on Conversation* (ed. Jefferson, G.), Lecture 33, Spring 1966, pp. 483-488, London: Blackwell.
- Shehan, E., & Edwards, K. (2006) "Pinning the tail on the networked donkey", *Position paper for the CHI 2006 Workshop on IT@Home*, April 23, 2006, Montreal, Canada
- Shehan, E. & Edwards, K. (2007) "Home networking and HCI" *Proceedings of the 2007 Conference on Human Factors in Computing Systems (CHI)*, San Jose, April 2007, pp. 547-556, San Jose: ACM.
- Taylor, A. & Swan, L. (2005) "Artful systems in the home", *Proceedings of the 2005 Conference on Human Factors in Computing Systems (CHI)*, Portland, April 2005, pp. 641-650, Portland: ACM.
- Tolmie, P., Pycock, J., Diggins, T., MacLean A, and Karsenty, A (2002) 'Unremarkable Computing', in *Proceedings of the 2002 Conference on Human Factors in Computing Systems (CHI)*, Minneapolis, Minnesota, April 2002, pp. 399-406, Minneapolis: ACM
- Verjee, N. (2006) "DSG shops to offer 'Tech Guys'", *The Times Online*, 5th September, 2006.
- Wyche, S., Sengers, P. & Grinter, R.E. (2006) "Historical analysis", *Proceedings of the International Conference on Ubiquitous Computing (UbiComp) 2001*, pp 35-51, Newport Beach: Springer.
- Yang, J. & Edwards, K., (2006) "ICEbox", *Position paper for the CHI 2006 Workshop on IT@Home*, April 23, 2006, Montreal, Canada