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ORIGINAL ARTICLE

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The fuzzy felt ethnography—understanding the programming patterns of domestic appliances

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Abstract In this paper, we discuss domestic appliance use based on an ethnographic study of nine households. Specifically, we look at which domestic appliances users choose to "program", and break them into two categories for analysis; those that allow users to program actions for the future and those that allow for macro creation to make repeated tasks easier. We also look at domestic programming habits based on gender.

Keywords Ethnography · Domestic appliances · Programming · Gender

1 Introduction

At work, if our appliances run amok, we can retreat into the sanctuary of our homes. But if we encounter technological problems at home as well, where can we go for respite? Imagine you arrive home to find that the VCR failed to record your favorite show; or you awake in the morning to find that neither the bread-maker nor the coffeepot started working on time, leaving you deprived of both caffeine and breakfast—assuming, that is, that your alarm clock woke you up in the first place.

As the above scenarios illustrate, programming can be problematic, yet it is increasingly a part of even non-programmers' daily life. Programming permits us to initiate appliances' actions in the future or to create macros to make repeated tasks easier. But, at the same time, the introduction of programming to domestic technologies brings with it new possibilities for failure and frustration. As microprocessors are added to stereos, washing machines and even toasters, the programming challenges facing domestic technology users are becoming increasingly complex. When domestic technology goes awry, it is often more invasive than office technology; not only do we expect our homes to provide a haven of calm and security, but breakdowns in domestic technology can actually prevent us from meeting our basic needs.

In this paper, we discuss our attempts to examine how a range of households cope with the complexity of technology in their homes. We have taken a broad-spectrum approach, rather than focusing specifically on VCRs [8, 22], TVs [16], set-top boxes [19] or home PCs [14]. We interviewed nine households of professional people, with the aim of understanding their usage patterns of "electric and electronic technology". We chose this middle-aged, relatively prosperous, settled and well-educated sample because they are a significant target market for high-end programmable domestic technologies, and were likely to have reasonable numbers of programmable devices in their homes[1].

We cataloged their appliances and learned which ones household members had learned to program. We asked further questions to discover which appliances allowed setting up either "ahead of time" or "to make repeated tasks easier", and how easy or difficult our participants considered these tasks to be. We aimed to find out about both the beliefs of individual users on domestic programming, and about the relationship between domestic technology and the *domestic economy* of the household; in other words, the ways in which "utility-maximizing individuals can benefit... by means of gains in trade through specialization, the sharing of 'public goods' (such as housing) and economies of scale" [23]. We hoped that this dual approach would lead to insights for the design of programmable domestic appliances.

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[1] Two of the authors have previously worked in the consumer electronic industry where this demographic is found to be typical for the "early adopter" market.

2 Abstraction, domestic programming and the domestic economy

Before the advent of the microprocessor, all electrical appliances had the key usability advantages of *direct manipulation*. With direct manipulation interfaces, every action a user takes has some small incremental effect; users can immediately see the result of each action; they can assess whether this was the desired result; and they can modify or reverse that result if they want. If you grab a drawer full of files and place them in the trash can, your action is both unambiguous and reversible; if you change your mind, you can fish the files out and put them back. In the computer world, a single innocuous command might have massive unseen consequences that could never be reversed (for instance, the command to delete all files in Unix: "rm *"). This illustrates how direct manipulation can be safer than using abstract commands. The disadvantage of direct manipulation is that you have to make a lot of little actions, and you have to be there to monitor the results. After a while, people start to wonder whether they could specify a whole lot of repetitive actions at the same time or, perhaps, initiate an action which could happen some time in the future, without them having to be around. However, introducing this sort of functionality to a device fundamentally changes the way users interact with it because it is not possible to directly manipulate a future situation or set of situations. Therefore, when we specify a set or a series of future actions, we have to *abstract* over them, using some kind of *notation* (for instance, the menu screen of a VCR or the formula commands in Excel).

The problem with abstraction for the user is that it quite often takes more work than just waiting around to do things manually. Thus, the user has to calculate a trade-off between the probable effort involved in creating the abstraction and that involved in doing the same task by direct manipulation. To make this calculation, the user has to ask questions like: how long will it take me to learn to use this notation? Can I specify the effect I want? What is the risk that it will not work for some subtle reason, perhaps with horrible consequences? In earlier work, one of us (Blackwell [2]) created a cognitive model that simulates a user deciding to either program or not to program appliances. The model has been used by Peyton Jones et al. [20] to design end-user enhancements to products like Microsoft Excel. However, this model emphasizes the behavior of a single user working alone.

In the real world, users also have the option of trading programming expertise and other work with each other. So, for instance, a household may have only one member who has learned to program the VCR—and they may trade this off against other chores with other household members. We wanted to investigate this possibility in relation to the domestic economy as a whole, hence our use of an ethnographic approach, to complement our earlier research.

While many domestic ethnographies have made their way into the literature [16, 17, 19], none of them have discussed programming appliances in the home. Mateas et al. [17] looked at the role of the PC within "a spatial, temporal and social model of the home," and observed that the home PC is often in a world apart, despite being located in a corner of a public space [17]. O'Brien et al. looked at a range of appliances and how they affected the social organization of the household; for instance, how appliance use affects morning rituals. They claimed that technology is often a means by which a well-run household is judged; for instance, their informants believed that good parents monitor what children watch on TV [19]. The study by Logan et al [16] followed purchasers of new TVs for 10 weeks after purchase, through questionnaires, interviews, logging and photographs, with a focus on mean household viewing times, button-pressing and menu access. They also looked at cultural and social issues surrounding television viewing, and, in particular, at whether men and women engaged in different ways of viewing television. In general, men in the study were more interested than women in acquiring larger television screens, and in "owning and operating the latest, greatest technologies" [16].

A great deal of research into "smart homes" might be viewed as oriented toward this type of technophile. The Microsoft EasyLiving project [4], the Aware Home at Georgia Tech [12], the House_n project at MIT [10], the Orange-At-Home project at the University of Surrey [9] and the AutoHAN project in Cambridge [3] all aspire to be the home of the future, in which networked environments and sophisticated controls are integrated into the fabric of the home. These ambitious research projects are anticipated in the domestic market by existing "hobbyist" infrastructure, such as the X10 standard for home automation, which already provides extensive programmability and interaction between home appliances. However, these home-of-the-future projects are separated from the context of family life. Usability studies tend towards a "one night stand" with expensive and fragile technology, rather than long term residence in which social consequences can be studied. One exception to this is the Smart Home and Usability Living project at the Tampere University of Technology in Finland, which is notable for its ethnographic approach [13]. We have, therefore, proceeded by studying the social context for existing appliances that anticipate the greater degree of programmability that will be found in future smart homes.

There is a long history of domestic appliance research in the sociology literature [6, 15, 23], which reveals that gender is a key factor in the organization of the domestic economy, including appliance purchase and use. Webley et al. [23] recently commented that "although more and more women have been spending increasing amounts of time in paid work, their domestic responsibilities have not been adjusted accordingly." They backed this claim with evidence from the 1992 British Social Attitudes Survey, which showed that, in 75% of the households,

women were responsible for domestic tasks [11] and from the study by Antonides and van Raaij [1] showing that, in a range of European countries, women spend double the time that men spend on housework.

Livingstone [15] has outlined a number of key differences in how men and women discuss domestic technologies. In her ethnographic study, women talked more concretely about the significance of domestic technology in their lives. They spoke of controlling situations and minimizing domestic chaos. For men, on the other hand, control was more of a means to express expertise. Men "tended to emphasize that technologies are 'purely functional,'" and discussed them in terms of features.

> Women are also concerned with the utility of objects... Their concern is how the object allows them to function in their everyday lives... They tend to refer outwards to domestic practices when justifying object use rather than pointing out its inherent properties, its modern features or its price tag. [15, p. 120].

Cockburn [6] has argued that appliances are predominantly designed by men, and that "contemporary western femininity has involved the construction of identities organized around technological incompetence." The large imbalance between the numbers of male and female professional programmers [5] might be taken to bear out Cockburn's point. We wondered whether a similarly significant gender difference would be visible in household organization of domestic appliance programming; would domestic programming, like professional programming, be an activity dominated by men, or would women's greater responsibility for housework mean that they would do the majority of domestic programming tasks as well?

Although we were focusing primarily on the way *households* dealt with domestic programming tasks, we were also interested in the perceptions and preferences of *individuals*. Here, our principal goal was to understand whether the perceived ease and frequency of programming differed across what we see as the two major subsets of domestic programming tasks—programming to do something at a set time in the future and programming to make repeated tasks easier. Overall, with respect to both the household and individual aspects of the data, we were looking for meaningful patterns in how and why people chose to program appliances that could inform future appliance design.

3 Method

3.1 Participants

We interviewed nine professional households representing a variety of household structures; three single-person households (two women and one man), three households of younger, childless couples, one family with children and two couples whose children had left home ("empty-nesters"). The age range of the participants (not including the children) was 29–60 years, with a mean age 40.6 years. Our participant households were recruited via our colleagues and acquaintances, and all lived in or around Cambridge (UK). Potential participants were screened by telephone interview to gather demographic data on the household construction. All participants were non-programmers and non-computer scientists. The adult participants' professions were: financial analyst, three administrators, music teacher, two academic historians, retired secretary, retired accountant, operations manager for a cereals manufacturer, food technologist, teacher of English as a foreign language, concert hall manager, occupational therapist, company prosecutor for a railway company. We were limited to households with a maximum of two adults because it was not feasible for us to conduct more than two individual interviews with adult household members in a single evening session. We aimed to gather broad descriptive data rather than statistically significant data. Dinner was used as an incentive to participate. Participants were recruited by requesting assistance from colleagues and acquaintances.

3.2 Provocative data collection

In his article *Cultural Probes*, Gaver et al. [7] makes a strong case for information-gathering methods that are provocative. He used postcards, cameras and maps as information-gathering tools to promote rich ethnographic understanding of elders in their community. He makes the case as follows:

> Using official-looking questionnaires or formal meetings seemed likely to cast us in the role of doctors, diagnosing user problems and prescribing technological cures... Trying to establish roles as provocateurs, we shaped the probes as interventions that would affect the elders while eliciting informative responses from them.

We wanted to establish this sort of rich dialog with our participants, and considered Mateas et al.'s [17] felt board as a source of inspiration. Mateas et al. [17] used their felt board to model daily home life. He and his colleagues asked participants to walk through a typical day using a felt board and felt shapes to represent the rooms, people, artifacts and activities in the home. Mateas et al. [17] assert that "the visual and tactile engagement of the board facilitates the recall and keeps the conversation grounded."

3.3 Our felt board

We adapted Mateas et al.'s [17] felt board (Fig. 1) as our primary data-gathering tool to help us understand the *programming* of domestic technology.

We designed icons to represent appliances commonly found in British homes. A subset of the icons is shown in Fig. 2. We wanted to ensure that our icons were easily recognizable, so we performed a mini-usability study

Fig. 1 Felt board

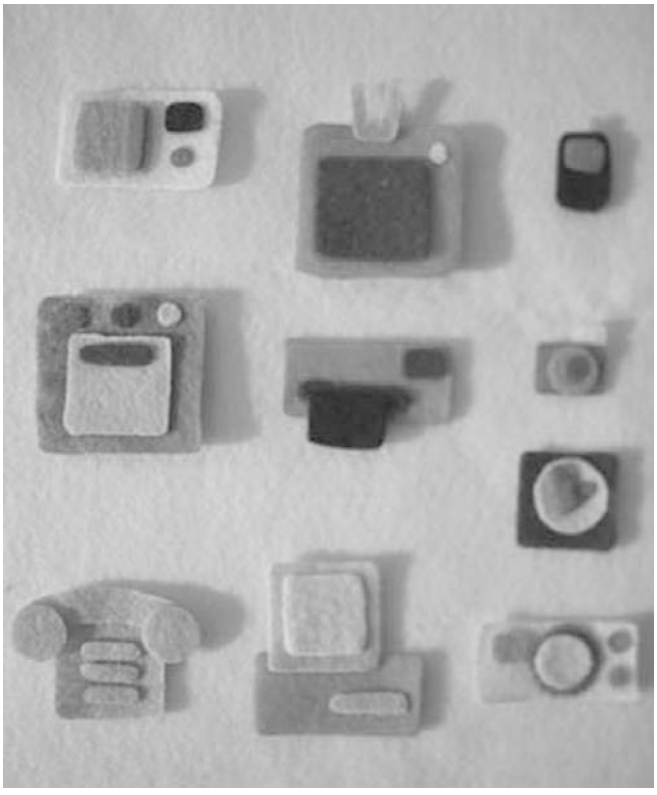

Fig. 2 Felt icons. Clockwise from *top left*: microwave, TV, mobile phone, camera, alarm clock, heating control, PC, phone, stove and VCR in *center*

using Nielsen's method for designing on screen icons [18]. Five participants were given individual icons drawn at random to identify in a freeform fashion. Participants were then asked to match icons with labels, which allowed them to use a process of elimination. We iterated on the icon design until we achieved approximately 75% freeform recognition rate, with the matching rate being nearly 100%. We were content with this number, as we found it very difficult to design, for example, a universally recognizable fuzzy felt "security system." During the main ethnographic study, all icons were introduced to the participant and referred to by name and pointing gesture. If participants had any questions, they were reminded what the icon depicted.

The board itself consisted of four sections. The first listed seven categories of rooms: bed, bath, living, kitchen, storage, roving and office (Fig. 3). These were categorical constructs rather than corresponding to physical rooms. Thus, "bed" would correspond to all bedroom appliances, "office" might not be a physical room at all but a corner of the living room reserved for work, "living" could refer to dining areas, formal and informal entertaining spaces, but always contained the primary television viewing area. "Roving" referred to appliances like mobiles, PDAs, and cameras that moved around the house. Felt icons representing appliances could be placed into these categories on the felt board.

Once appliance icons had been identified and placed on the room category board, they could then be sorted into our two programming categories (labeled "repeats easy" and "ahead of time" on the board) by the participant[2]. Participants were first asked to move icons for appliances, which could be used to make repeated tasks easier onto the "repeats easy" section of the board. We asked whether they had, in fact, used the "repeats easy" features of these appliances. If they hadn't, they placed the corresponding icon on "never"; otherwise, they were asked to describe in what way the device made their life easier, and how often they engaged in this programming task and to place the corresponding icon on a scale ranging from "once" to "lots" (Fig. 4).

They were then asked to choose the icons for appliances that permitted programming of actions "ahead of time"[3]. We asked about the frequency with which they conducted these programming tasks, e.g. daily, weekly on fixed days, weekly at random intervals, seasonally, rarely or never programmed. Participants were asked to classify their habits by placing the appliance icon on the corresponding section of the board, and discuss how and when they typically used the appliance.

[2]At no point was the word "programming" used in the experimenter's script.

[3]Some appliances were identified by participants as having both "repeats easy" and "ahead of time" functions. When a participant wanted to discuss an appliance with "ahead of time" functions that had already been placed on the "repeats easy" section, they simply moved the icon from one section of the board to the other, after the board had been photographed with their selected "repeats easy" icons.

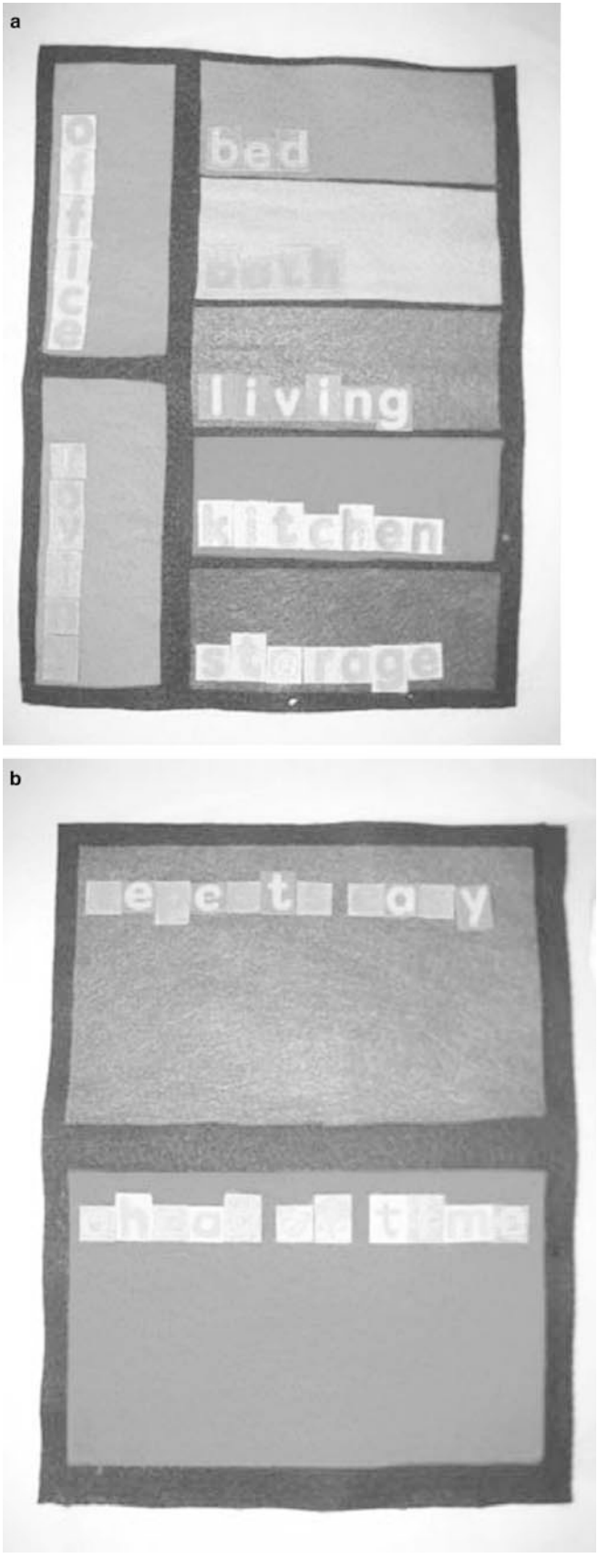

Fig. 3a, b Felt board details: room category board (**a**), sorting board (**b**)

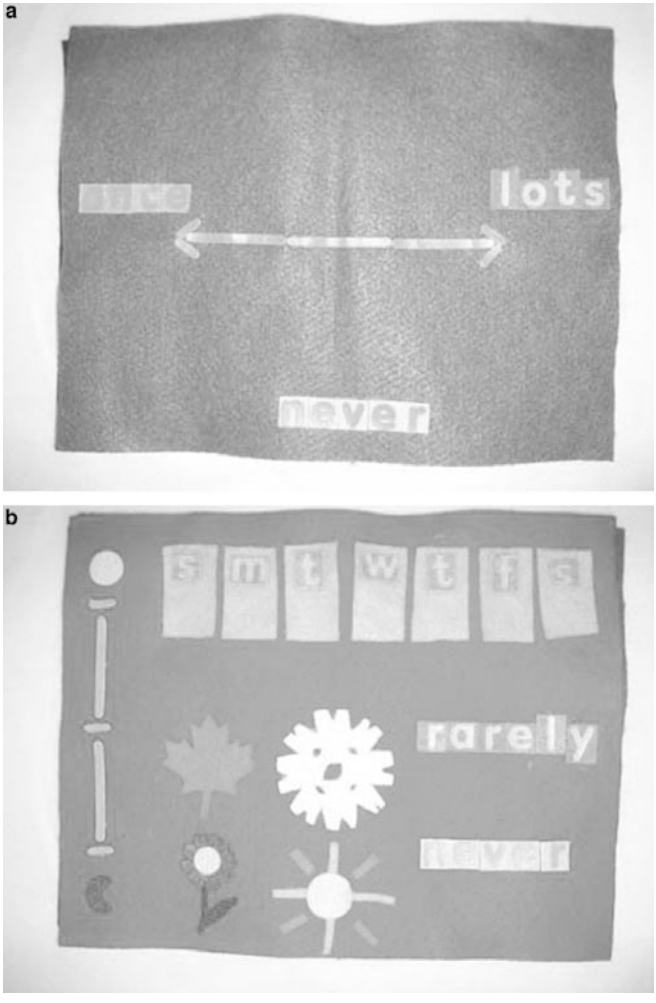

Fig. 4a, b Felt board details: ''repeats easy'' board (**a**), ''ahead of time'' board (**b**)

3.4 Procedure

Our study took place in the evening so the entire household could be at home. There was one experimenter for each adult member of the household. We brought dinner and used it as an opportunity to build rapport and to get background information. This approach has been used successfully by the HomeNet project [14] and by Mateas et al. [17]. Following dinner, we asked for a tour of the appliances in the home. After dinner, the experimenters paired up with the adult householders and had a session with the felt board. This was followed by a post-test questionnaire, which asked for a selection of common appliances:

- How frequently the appliance was used
- How easy or difficult it was to learn
- An estimate of over what duration and for how long learning occurred
- What people, services or documentation were used to facilitate learning

Participants were then debriefed and allowed to ask questions to the experimenter.

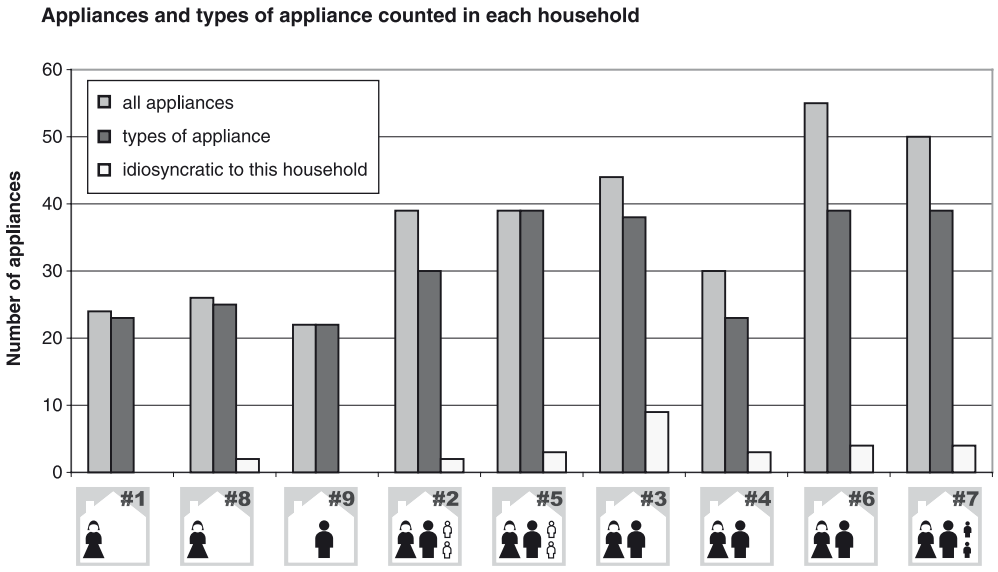

Fig. 5 Appliances and appliance types by household

4 Results

4.1 Overall

The numbers of appliances per household ranged from 22 in a single male's home to 55 in the home of a couple who had just moved in together[4]. The mean number of actual appliances per household was 34.2, and the mean number of appliance types (e.g. "toaster," "kettle," "VCR") per household was 29.4 (see Fig. 5)[5].

4.2 "Ahead of time" compared to "repeats easy" appliances

Overall, we observed that there were more "ahead of time" appliances, both in terms of the number of appliances programmed (100 "ahead of time" appliances compared to 64 "repeats easy" appliances) and the number of appliance types (20 types of "ahead of time" appliances compared to 13 types of "repeats easy" appliances). Tables 1 and 2 show the range and mean number of appliances and appliance types by household for appliances that were believed to be programmable and then for those that were actually programmed.

For each appliance that was actually programmed, we asked a question about how easy or difficult it was to

Table 1 Range and means for numbers of potentially programmable appliances by household

	Number of appliances/household		Number of appliance types/household	
	Range	Mean	Range	Mean
Ahead of time	4–15	7.3	4–10	5.9
Repeats easy	1–11	4.8	1–5	3.2
Total	6–24	11.9	6–10	8.7

Table 2 Range and means for numbers of actually programmable appliances by household

	Number of appliances/household		Number of appliance types/household	
	Range	Mean	Range	Mean
Ahead of time	1–8	4.7	1–6	3.9
Repeats easy	0–5	2.5	0–4	2
Total	3–12	7.3	3–8	5.9

[4]We describe our data in terms of households, appliance types and individual participants. Because of the fairly small number of individuals and households involved in the study, we have simply aimed to describe our findings, rather than to treat our sample as representative of any larger population. Thus, we do not assume that, for instance, the behavior of men and women in our sample necessarily generalize to any particular larger population of households. Therefore, we have not performed any statistical tests. We have given means and ranges where these are an effective way of summarizing our data, but we do not assume that our data is normally distributed.

[5]Although we recorded all the electrical and electronic appliances that our participants mentioned, we have excluded some appliances from our count of number of appliances per household. Appliances, which might be considered as part of the fixtures and fittings of the house, were not always mentioned, and so, were not always recorded consistently. For this reason, our count excluded power showers, extractor fans and heating systems. We also omitted power tools, garden tools and car appliances, because not all participants were comfortable with showing us the garage, and not being in the same room introduced variability in recalling appliances. However, where participants revealed useful information about programming these appliances, we have included that data in the discussion below. We counted fridge/freezers, washer/dryers, TVs with integrated VCRs, PCs with peripherals including printers and multi-part stereos each as one item. We included appliances that were unique to only one household but also reported these idiosyncratic appliances separately.

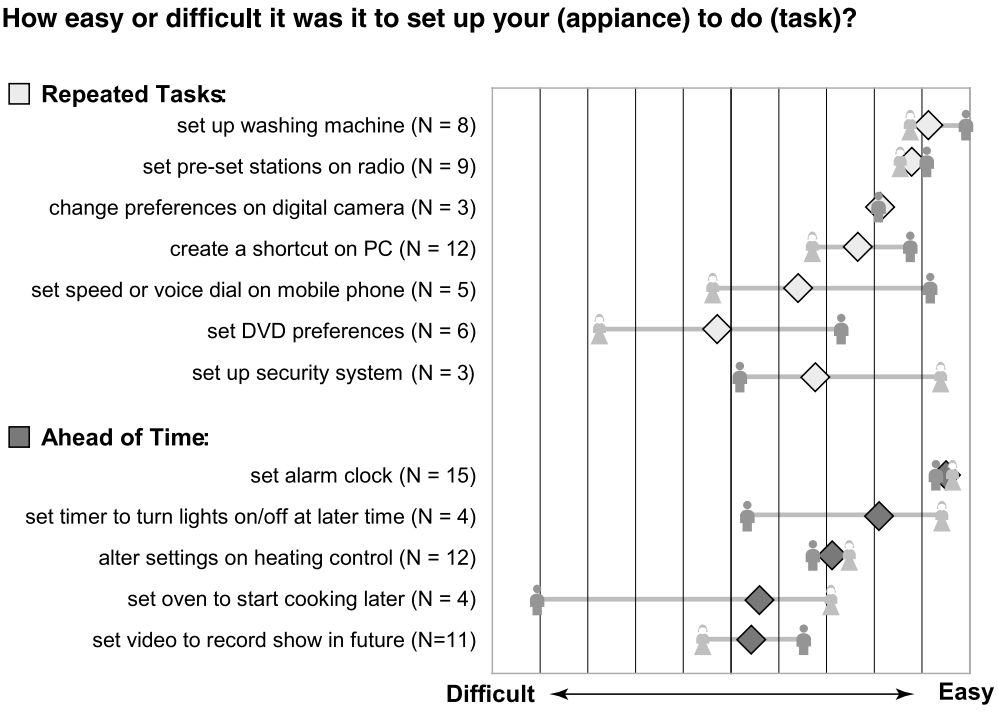

Fig. 6 How easy or difficult was it to set up your (appliance) to do (task)?

use for a specific task, for instance scheduling a recording on a VCR (Fig. 6). Participants chose a degree of difficulty on an unmarked 10-cm line, with 0 cm being "difficult" and 10 cm being "easy." The perceived ease ratings of the specified tasks were roughly the same across the "ahead of time" questions (mean rating 7.6/10, where 0 = difficult and 10 = easy) and "repeated tasks" questions (mean rating 7.4/10).

Figure 7 shows the numbers of appliances believed to be programmable by household, and then breaks them down by programming category ("ahead of time" or "repeats easy"). Figures 7, 8 and 9 do not necessarily represent the appliances that were actually programmed, but only those that were believed to have programmable features.

Figure 9 shows the number of appliances believed to have the capacity for programming, either for "setting up ahead of time" or to "make repeated tasks easier"[6].

4.3 "Repeats easy" appliances

For all the "repeats easy" appliances present in at least three households, we looked at how frequently they were programmed (Fig. 10) and how many of them were present in our sample (Fig. 11).

[6]Although we did not include hot-water heaters or heating controls in our count of numbers of appliances per household because of their anomalous status as fixtures and fittings, we were still interested in their programmable features. Again, although we excluded car appliances from our appliance count because of variability in how they were recorded, where participants discussed programmable features, for instance of car radios, their responses were of interest. We have, therefore, included these items in some of our graphs and discussion.

4.4 "Ahead of time" appliances

For all the "ahead of time" appliances present in at least three households, we looked at the intervals in which they were programmed (Fig. 12) and how many of them were present in our sample (Fig. 13).

4.5 Demographics

4.5.1 Gender

For each appliance that was named as programmable, we looked at how many of our 15 participants (seven men, eight women) reported actually programming this type of appliance (Fig. 14). For "ahead of time" appliances, slightly more women reported programming activities, while for "repeats easy" appliances, slightly more men reported programming.

Figure 6 looked at the ease of use of appliances. Note that all the appliances that women rated as easier than men are "ahead of time", except for the security system, while all the appliances that men rated easier than women are "repeats easy", except for the video recorder. This is congruent with the data in Fig. 14, which showed that, on the whole, women actually had slightly more practice with "ahead of time" appliances and men had more practice with "repeats easy." Another way of looking at this difference between men's and women's preferred appliances is in terms of domestic control vs. entertainment: the appliances that women thought were easier to program all permit domestic control, whereas men were more comfortable

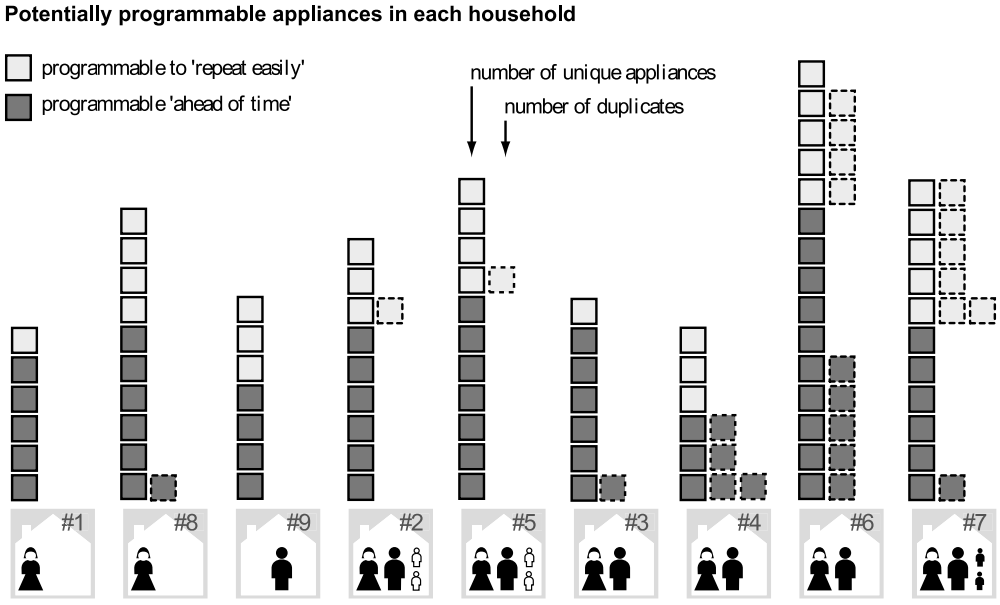

Fig. 7 Potentially programmable appliances by household, including duplicates

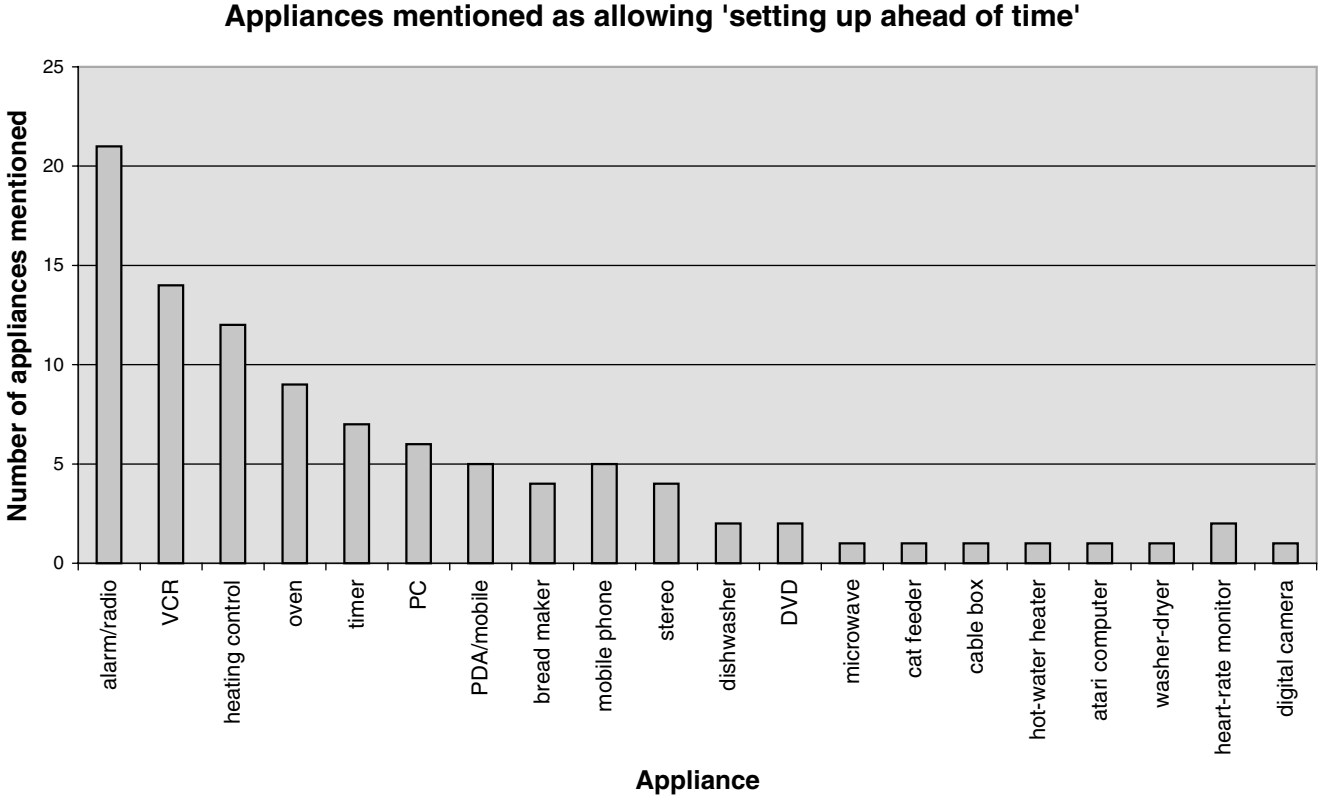

Fig. 8 Appliances mentioned as allowing "setting up ahead of time"

with mobile phones, PCs, etc. The only exception to this classificatory rule was that men regarded washing machines (definitely a domestic control device) as easier to set up than women did.

For household #2–7, we compared the numbers of appliances that were listed as potentially programmable by the man and the woman in each household. As Table 3 shows, for household #2–5, there were only minor differences between the numbers of programmable appliances reported by male and female partners. In household #6 and 7, the men both reported a

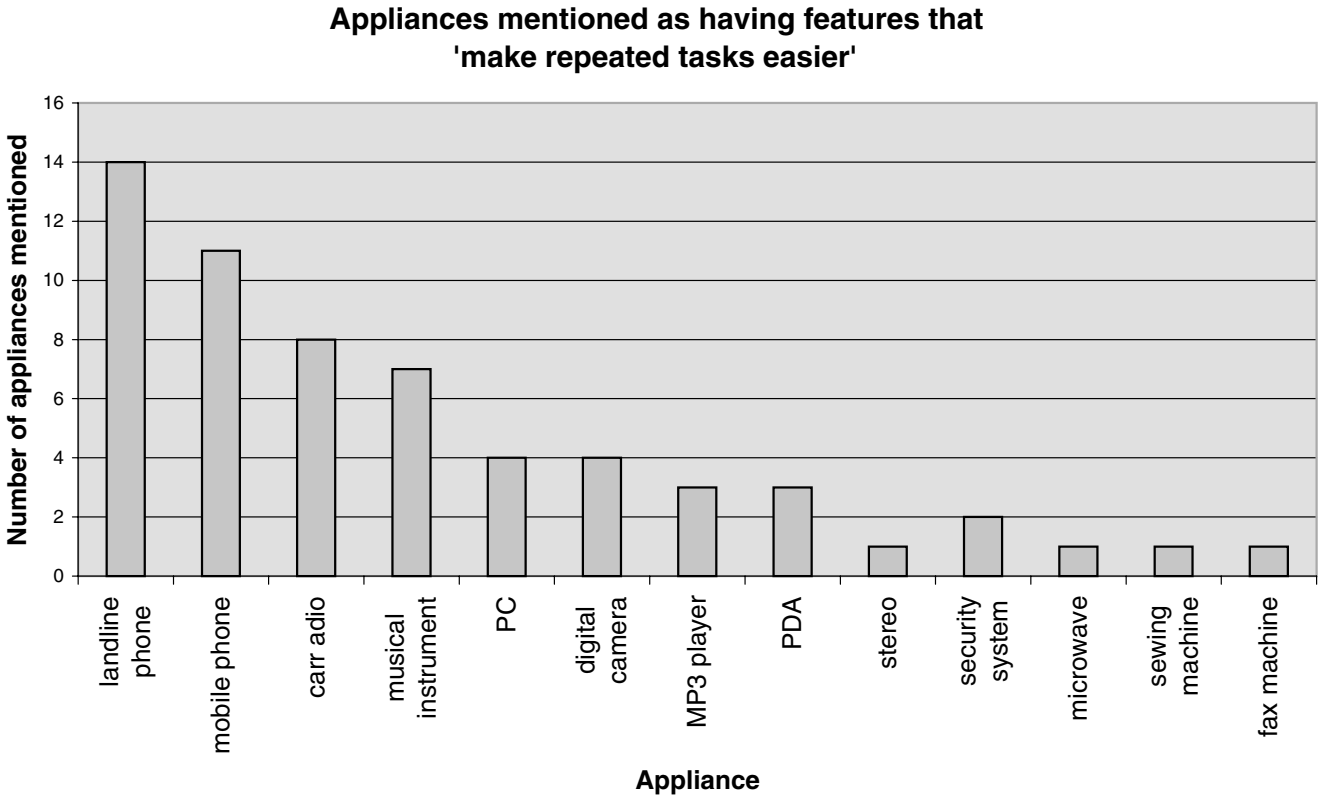

Fig. 9 Appliances mentioned as having features that ''make repeated tasks easier''

much larger number of programmable appliances than the women[7].

Household members typically did not actually program all their appliances in all the ways that they believed were possible.

We looked at the number of programmable appliances in the home vs. the number of actually programmed appliances. Women reported 21 appliances, which they believed to be programmable but did not actually program, whereas men reported 27. However, the gender difference appears to be attributable to the large numbers of appliances reported by the men in households #6 and 7. If we omit data from these two households, we find that the total for women drops to 11 and for men to 10 (Table 4).

Livingstone's work [15] noted a difference in how men and women generally discuss domestic technology, with women wanting to minimize domestic chaos and men being more feature-oriented. While, generally, we found much to support this claim, we noted one key exception from a conversation over dinner. A young married couple had recently purchased a new iron. In this household, the wife claimed her husband was the resident technical expert. Both parties did at least some of the ironing. The husband wanted the simplest iron available, without steam or other special functions. The wife had initially followed her husband's wishes and bought a very simple non-steam iron, but it had an aluminum plate rather than a steel one. She said it was of low quality, and gave a scratchy feeling when running over the clothes. The wife decided that this wasn't tolerable, returned it and tried to find a higher quality but simple model. She didn't succeed, lost patience and bought a top-of-the-range steam iron instead, which her husband has tolerated, although it was not his preferred type of iron. Here, we do see a reversal in Livingstone's [15] gender roles, but we are discussing a very traditional appliance of the ''female'' sphere.

[7]These two households were the ones with the largest numbers of appliances reported overall (household #6 reported 55 appliances and household #7 reported 50). It appears that the discrepancy between the numbers of programmable appliances reported by these two men and their partners was at least partly due to the fact that the men in both households each reported a larger number of appliances than their partners in total. In household #6, the male participant reported three stereos, which the female participant did not report, and also mentioned the separate tumble dryer, while the female participant only reported the washing machine. In household #7, the male participant mentioned a video camera, a DVD player, an extra fridge–freezer and two mobile phones, which his partner failed to report. These differences do not cover the whole of the discrepancy between the numbers of potentially programmable appliances reported by the male and female partners in these two households. We did have the impression that these two men were particularly enthusiastic about technology, while their partners were less so. It seems likely that these men both reported more appliances *and* remembered more programmable features of the appliances they reported than their partners because of their greater interest in technology.

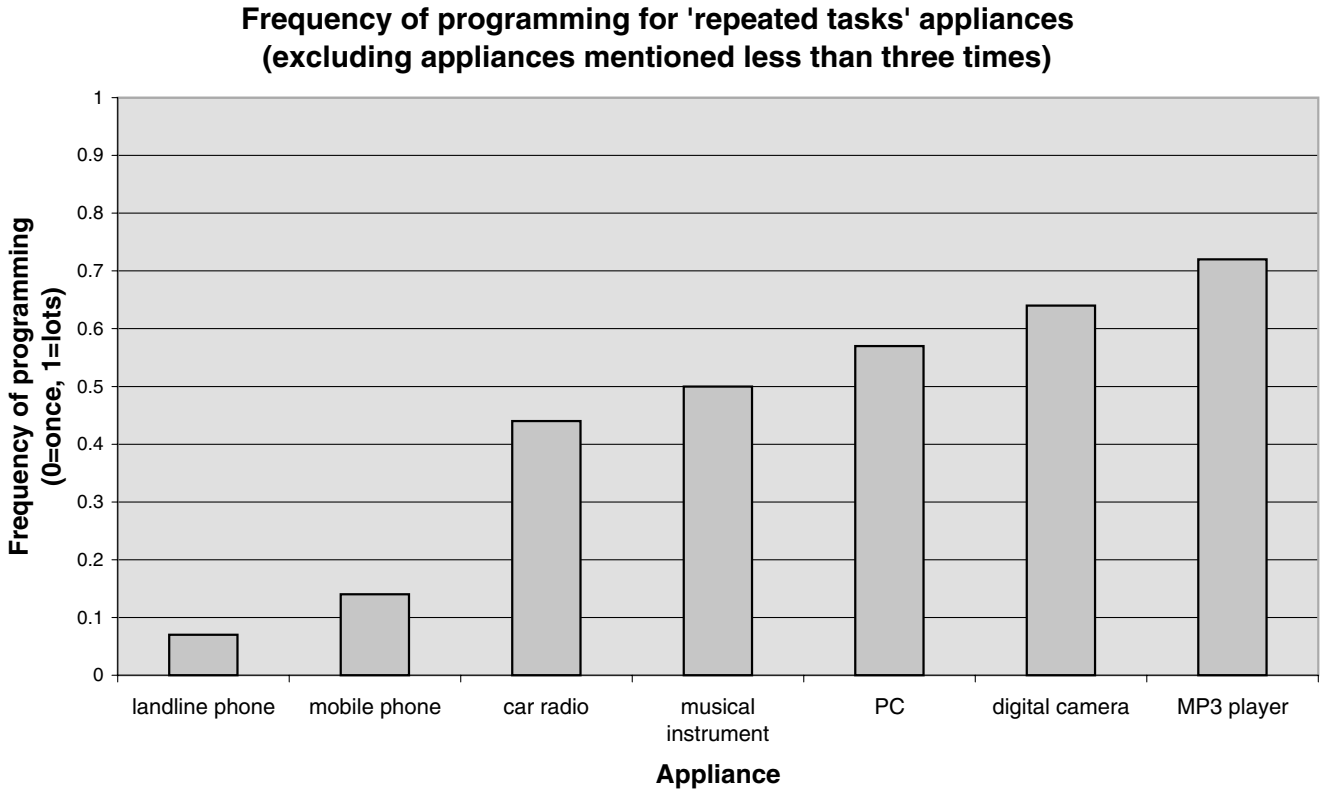

Fig. 10 Frequency of programming for "repeated tasks" appliances

4.5.2 Technology household

Seven households referred to individuals outside of the household for technical assistance or sharing of appliances; we have called this their *technology household*. Two households (including one single household) did not refer to anyone else. Only household #2 mentioned three outside parties (Table 5).

In some cases, appliances had been borrowed from other households, for example a VCR and a video camera. Household #2 (empty-nesters) often asked their adult sons for technical expertise, and the sons had provided crib sheets on how to use their DVD and their digital timers. The single woman householder in household #1 had recently divorced her husband, but they remained on good terms, and she had asked him to help her select the AV system for her new home.

4.6 Comparing ovens to VCRs

We noticed that the tasks of programming a VCR and an oven are cognitively very similar, and are both examples of "ahead of time" programming (Table 6). Since, according to urban myth, VCRs are very difficult to program, we considered it worthwhile to look in greater depth at these two structurally similar tasks, and at our participants' impressions and experiences of them.

Seven households had a VCR. All households with a VCR programmed it. All nine households had an oven. Only four of these ovens had been successfully programmed. We asked if the users thought their oven was programmable, but we did not check the ovens themselves to see if they were. All ovens that were successfully programmed were programmed by women, with the one unsuccessful oven-programming attempt being done by a man. Seven out of seven women whose household owned a VCRs programmed them, versus four out of five men (Table 7).

So, on the whole, it seems neither our male nor female participants had been discouraged from programming their VCRs by any difficulties with usability. They were somewhat more wary about using their oven timers, perhaps because of the greater risks associated with a negative outcome. However, where this programmable feature was considered necessary to the smooth running of the household, users (in this case, mostly women) braved the difficulties and learned how to make it work.

4.7 Idiosyncratic appliance use

We saw a wide range of appliances that were unique to only one household: an electric tuner for a harp, 11 appliances for a recording studio, two CD discmans, a mini-disc player, a cassette walkman, a cassette player, two MP3 players, an electronic weighing scale, an ice

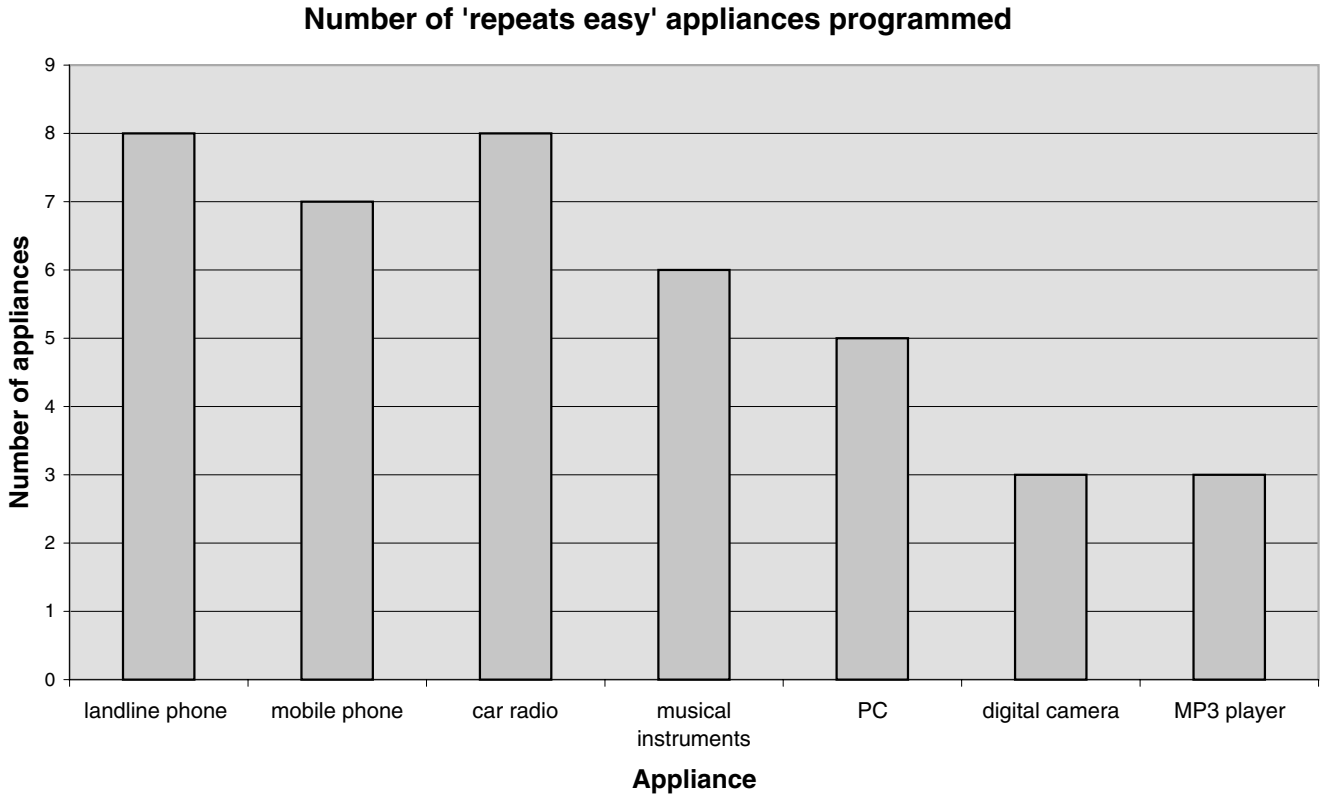

Fig. 11 Number of "repeats easy" appliances programmed

cream maker, a popcorn machine, an electric carving knife, a coffee grinder, an electric typewriter, an automatic cat feeder, a trouser press, a bug zapper, an ultraviolet lamp for checking forged checks, a rice cooker and a car battery charger. Some of our participants described particularly idiosyncratic appliance use: one man, who was a historian, scanned books and papers (or assigned the scanning task to his PhD student) and then converted them to audio, so he could listen to them while gardening or cycling. Another man had a suite of 1980s audio equipment given to him by his father-in-law and a close friend. This shows the variability and uniqueness of individual households' appliance use.

4.8 Future work

Our work was broad in that it focused on the household's entire suite of appliances. We see this body of data as providing important background and context for further, more detailed studies on the use of individual appliances. Following our observations about VCR programming and oven programming, our immediate research plans will focus on exploring further how users tackle the task of programming appliances to record televisions. In particular, we are planning both lab-based and home-based studies to determine whether personal video recorders like TiVo or Sky+ really can solve the usability problems found in programming videos.

We have already commented on the limited number and variety of households in the current study. Further ethnographic research to extend our findings would, ideally, include younger and more transient households, as well as more families. In particular, we feel a separate study is merited on the appliance use of families building on the excellent work of Plaisant et al.'s CHI 2002 workshop on "Technologies for families" [21]. At the same time, survey data might be best suited to determine the statistical significance of these findings across broader populations. We believe that a mixture of ethnographic research, lab-based studies and surveying is likely to provide the richest and most design-relevant model of programming in the domestic environment.

5 Conclusion

Our impetus for this study was an exploration of Blackwell's [2] attention investment theory of programming behavior in a household context. We had three questions in mind. Firstly, is there a difference in difficulty between abstracting over time and abstracting to simplify repeated tasks? Secondly, how do individual technology users share work with other members of their domestic economy? Thirdly, does our data have any implications for the design of programmable appliances? We will address each of these questions in turn.

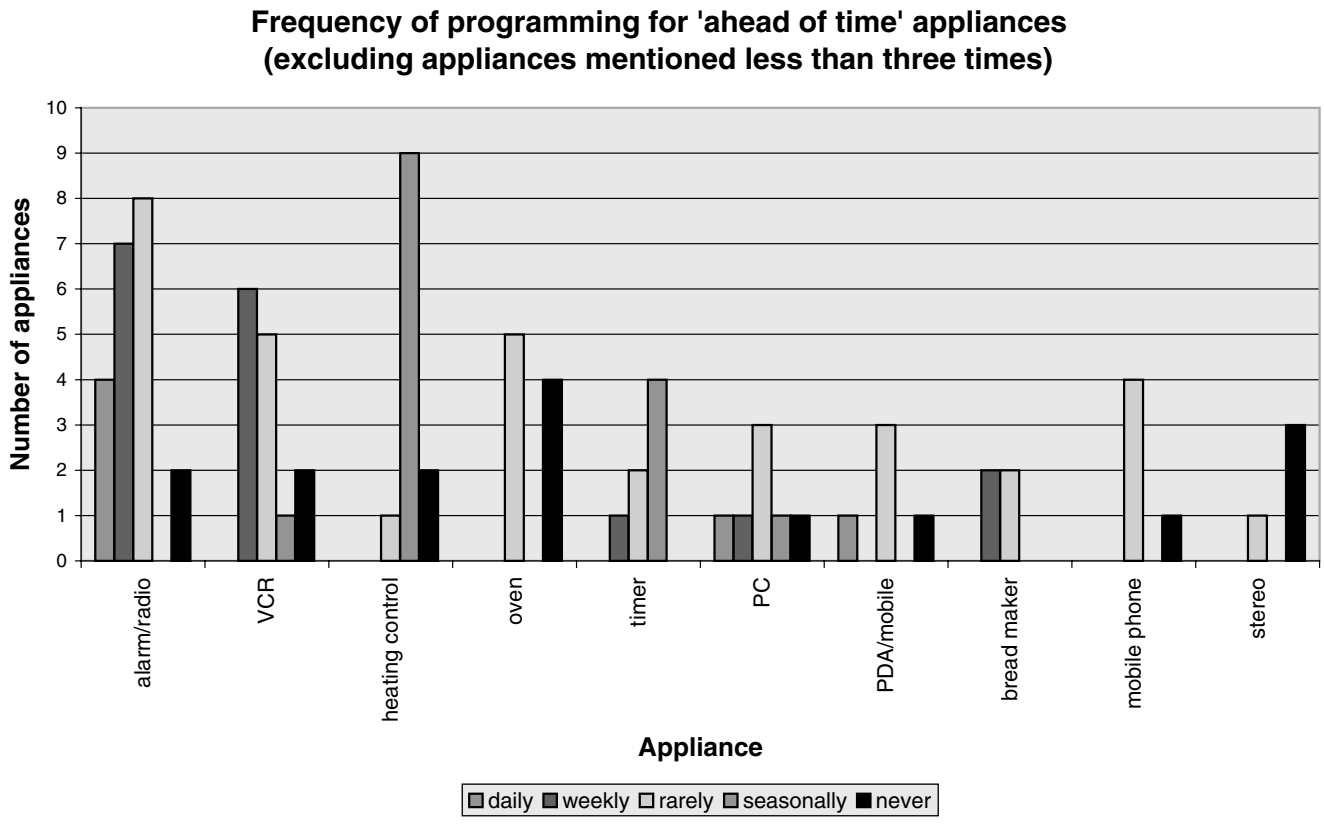

Fig. 12 Frequency of programming for "ahead of time" appliances

In total, we counted more "ahead of time" appliances (100) than "repeats easy" appliances (64). However, we found that appliances programmed to do tasks ahead of time and those that make repeated tasks easier were of similar difficulty. We expected to see gender differences in domestic programming on the basis of sociological evidence, but we were unsure of which way they would fall: surveys [1, 11] have found that women still do the majority of domestic work, but the computer science literature [5] confirms the reality that the majority of programmers are men, so the implications for domestic programming were unclear.

We looked at the numbers of appliances in the household that members of each gender thought were programmable, and we saw no gender differences. We also looked at the number of each appliance type programmed by members of each gender, and saw no large differences, although there was a slight trend towards women doing more "ahead of time" programming and men doing more "repeats easy" programming. We did see distinct gender differences in the types of appliances users considered easier to program. Almost all of the tasks with appliances that women found to be easier than men were appliances that permitted programming of actions ahead of time. The appliances men ranked easier were mostly those that permitted configuration for repeated tasks. The exceptions were the video recorder, which men ranked easier, and the security system, which women ranked easier. An alternative way of looking at this data, in line with the distinctions made by Livingstone in her study of general appliance use [15], and which, perhaps, takes into better account of these anomalies, is that men found programming AV equipment like videos, DVD and car radios easier, whereas women were more comfortable with programming devices that permitted them domestic control: alarms, ovens, heaters, bread-makers, security systems etc.

There are at least two possible interpretations of these results. In theory, it is possible that women are inherently better at temporal abstractions, and that this encouraged the women we studied to take on responsibility for household management. Alternatively, perhaps the organization of the domestic economy encouraged the women in our study to develop expertise in "ahead of time" appliances as a result of their responsibility for household management.

The data on oven timers and VCRs may offer the best suggestion of the underlying factors. Both are "ahead of time" tasks, and they require very similar cognitive processes while programming, but we saw significant gender differences in terms of which were found easier. Women found ovens easier to program than men (7.1/10 for women, 1/10 for the one man who responded, with 10 = easiest), whereas men found VCRs easier (6.6/10 for men, 4.5/10 for women, with 10 = easiest). Given that these tasks have similar cognitive complexity and

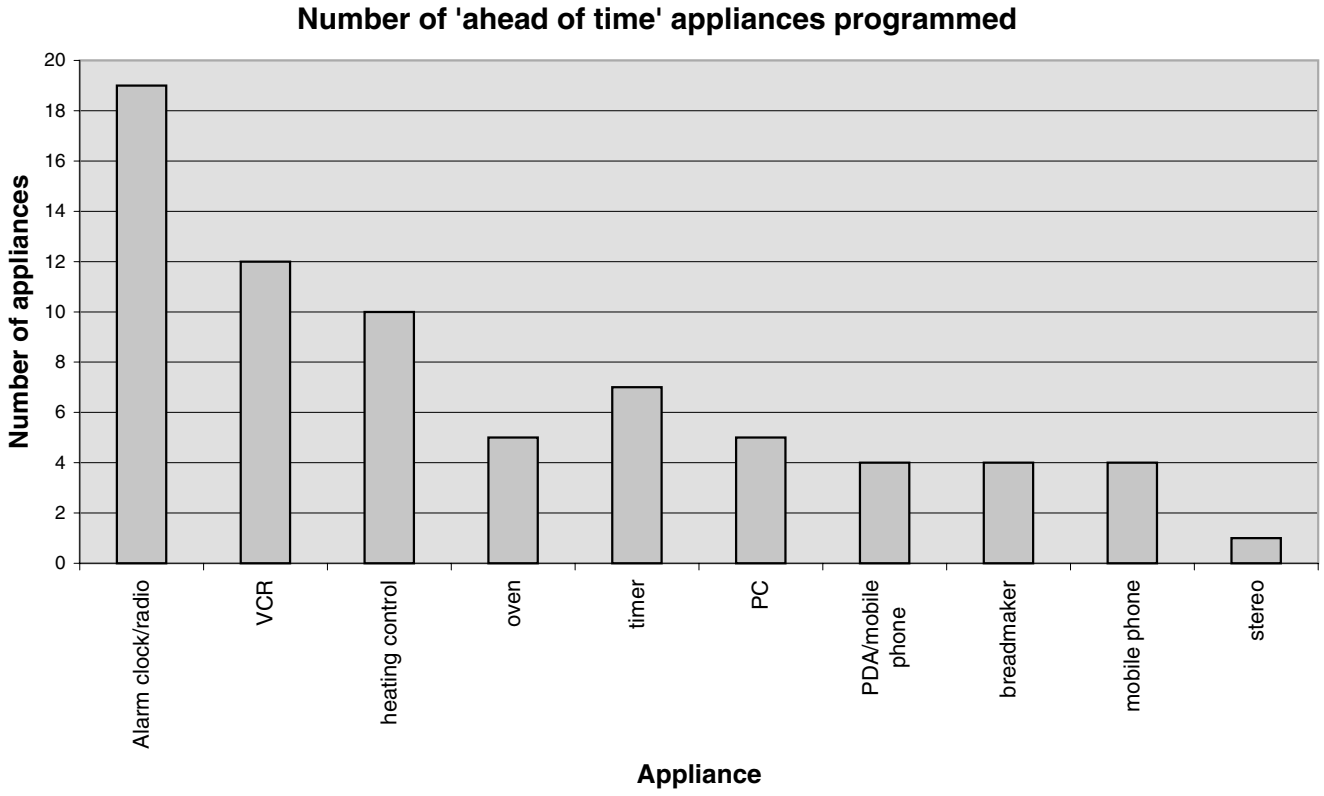

Fig. 13 Number of "ahead of time" appliances actually programmed

structure, and that the men's scores for VCRs were so similar to women's scores for ovens, perhaps it is social roles that drive who programs what, rather than any inherent cognitive differences between men and women.

We believe further research is required to disambiguate these two models. However, even in its present form, the data suggest programming patterns for appliances of different types, and these patterns have implications for design. As we showed, appliances with very different outcomes, like oven timers and VCRs, can require very similar cognitive processes while programming, and yet, their frequency of use was very different. This suggests that designers can learn from both successful and unsuccessful designs from other appliance categories, as well as from the domestic context in which the appliance has to operate.

Our discussions about ovens uncovered stories about fear of setting the house alight, and of embarrassed dinner parties where the main course was charred by a failed attempt to program the oven. These stories explained the hesitance to program ovens. The exceptions were our female empty-nesters, who had both used the feature often when their children were still at home, as a way of providing regular meals for the family while juggling other activities. However, they have both stopped using the feature now that their children have left home.

These findings suggest that, even where programmable features are difficult and risky to use, users will persevere in the face of adversity if they have a real need for the feature. However, where there is no real need for programming, users will not bother. Thus, while programmable features may be included in items like ovens and bread-makers because they are considered selling points, these features may not, in practice, enhance the usability of the appliances. If such features are considered desirable, or are essential (as is the case with VCRs), perhaps designers should focus on reducing the chances of failure, and/or the associated risks.

Our nine households had over 250 separate appliances, ranging from programmable cat-feeders to bread-makers. Some appliances were truly ubiquitous and were programmed by the majority of users, including alarm clocks (14/15 users programmed this appliance) and VCRs (11/12 users who owned a VCR programmed it). Other appliances, despite their ubiquity, were not always programmed; for instance, central heating timers. Our ethnographic approach helped us to understand why these sorts of differences occurred: alarms and VCRs must be set if an action is to be performed while the user is asleep or away, but, with heaters, it is often easier to say you want heat now than to predict your heating needs.

Our felt board technique allowed us to elicit rich contextual data, which is vital to understanding why users go about making the calculations into whether to "invest" their time in learning or using a program-

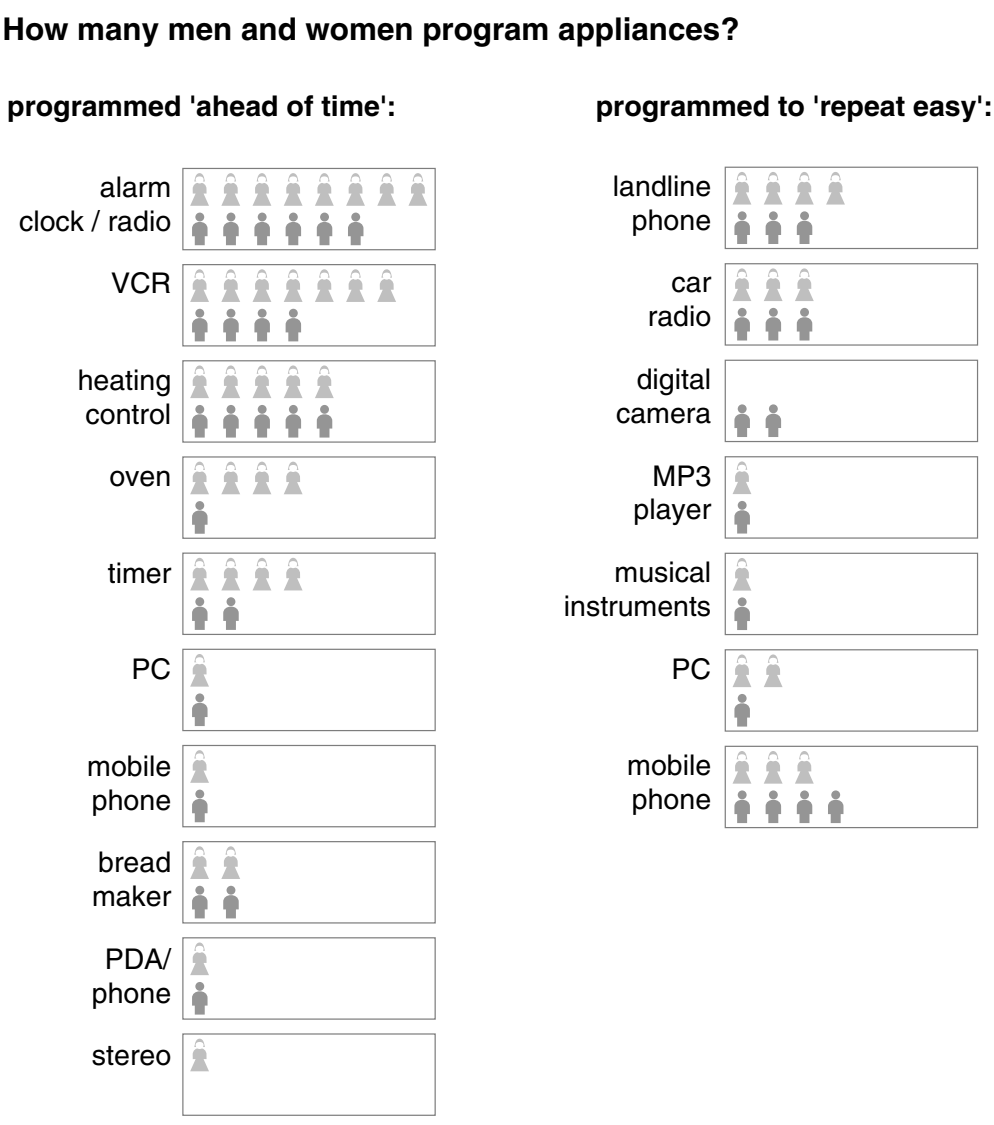

Fig. 14 Number of men and women who programmed "ahead of time" appliances

Table 3 Numbers of potentially programmable and actually programmed appliances reported by male and female members of couple households

Household number	Number of reported potentially programmable appliances			Number of appliances actually programmed		
	Male	Female	Difference score	Male	Female	Difference score
2	8	8	0	5	6	−1
3	10	8	+2	9	5	+4
4	7	10	−3	7	10	−3
5	12	11	+1	8	7	+1
6	24	12	+12	12	5	+7
7	18	11	+7	9	8	+1

mable feature. Programming decisions are not made in isolation, but, instead, are made based on their potential effect on the domestic economy as a whole. The notion of domestic economy, our discoveries of programming roles in the home and the social context of appliance use all have important implications for designing the home-of-the-future to suit the everyday needs of the groups of people that live within them.

Table 4 Appliances believed to be programmable and actually programmed, by participant

Household number	Gender (age) of participant	Number of potentially programmable appliances reported	Number of appliances actually programmed	Difference between number reported and number programmed
1	F (30)	6	4	2
2	M (58)	8	5	3
	F (60)	8	6	2
3	M (29)	10	9	1
	F (30)	8	5	3
4	M (59)	7	7	0
	F (57)	10	10	0
5	M (30)	12	8	2
	F (35)	11	7	3
6	M (37)	24	12	12
	F (30)	12	5	7
7	M (47)	18	9	9
	F (42)	11	8	3
8	F (44)	12	11	1
9	M (32)	7	3	4

Table 5 Household demographics and their "technology households"

Household number	Household members	Number in "technology household"
1	Single F (age 30)	1 (ex-partner)
2	M (58) and F (60) (empty-nest)	3 (two adult sons, one colleague)
3	M (29) and F (30) (no children)	2 (father and friend)
4	M (59) and F (57) (empty-nest)	1 (daughter)
5	M (30) and F (35) (no children)	2 (one PhD student, one friend)
6	M (37) and F (30) (no children)	2 (M's parents)
7	M (47) and F (42) (three sons, aged 9, 11 and 11)	0
8	Single F (44)	1 (niece and sometime lodger)
9	Single M (32)	0

Table 6 Comparing oven and VCR programming tasks

	Oven	VCR
Information source	Recipe	Schedule of programs
Time	Start to cook	Start to record
Duration	Cook time	Program length
Source of variability	Recipe	Schedule change
Potential calibration problem	Oven temperature	VCR clock
Consequence	No dinner; family hungry	No TV tonight; can often record later

Table 7 Comparing ovens and VCRs for difficulty, frequency of use, tasks and period to learn

	Oven timer	VCR
Difficulty rating (10 = easy)	5.6/10 for beginning to cook at a specified time ($n = 4$)	5.4/10 for recording shows ($n = 11$)
Frequency	Five rarely Four never	Six weekly Five rarely One seasonally Two never
Tasks	Three used timer to start to cook One tried to use timer to start to cook but failed One uses alarm Four never used this feature	11 record Two did not record shows One was uncertain if they had ever recorded a show
How many times did it take you to learn? (w/o instructions)	3/4 who program claimed they had never learned how to do it without instructions 1/4 said it took two times to do it without instructions, over 5 min. She said she does the task monthly	Mean of 2.7 times to learn how to do task without instructions ($n = 8$) (Range = 0–6 learning attempts) Three had never learned how to do the task

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