The Domestic Economy: a Broader Unit of Analysis for End User Programming

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ABSTRACT
Domestic ubicomp applications often assume individual users will program and configure their technology in isolation, decoupled from complex domestic environments in which they are situated. To investigate this assumption, we conducted a two week study of VCR use by eight families. Each household member old enough to write completed a diary, interviews were conducted before and after, and information on demographics and appliance ownership was collected. Our key finding supports the notion of the domestic economy and the trading of programming expertise. We use the Attention Investment paradigm, and discuss how the model fits with multi-user programming situations. We discuss the importance of the parent v/s child roles in VCR use, as well as, the tension between direct manipulation (e.g. pressing record) and programming ahead of time. We propose that future work on end user programming must focus on the household as a domestic system rather than on the individual.

AUTHOR KEYWORDS
Diary Study, VCRs, Attention Investment, Domestic Appliances, Programming, Families, Children

ACM CLASSIFICATION KEYWORDS
H.1.2 [Models and Principles]: User/Machine Systems—Human Information Processing, H.5.3 [Information interfaces and presentation (e.g., HCI)]: Group and Organizational Interfaces – CSCW

INTRODUCTION
Ubiquitous computing is complex and being increasingly developed for domestic environments. The programmability of appliances is central to domestic ubicomp. We are interested in looking at existing household appliance practices, because members of larger households come to rely on one another to meet daily needs. Technology expertise is one such possible area of specialization and trading. Skills like VCR programming may be learned by only one member of the household, and might be traded off against chores with other household members. Using the broader definition of programming as advocated by Blackwell[2] we focused on its social situatedness in a domestic environment.

Attention Investment is a cognitive model that simulates a single user's programming decisions [1]. In this context of VCRs, we define 'programming' as scheduling a recording ahead of time, but not simply pressing record. The model generates decisions about whether to engage in programming activity or to perform the same task by direct manipulation, by comparing projected effort and risk for each. Because users' expertise at programming tasks varies, and the importance and timescale of their goals also vary, the model generates different decisions for different users, or for the same user under different external constraints.

In this study, we gathered data on individual programming decisions in the home, with the purpose of investigating how well the Attention Investment model maps onto TV recording behaviour in practice. However, as households are systems of individuals that have come to rely on one another for domestic programming among other things, we could not focus solely on the single user or on a single task when trying to understand patterns of domestic appliance use. Therefore we recruited whole households, to enable us to look at individual programming decisions within the context of a domestic ecology of effort, roles and skills.

We chose to look at families' use of TV recording appliances (VCR, DVD-r, Sky+ and TiVo). TV recording appliances are of interest for three reasons. Firstly, TV recording technology in the form of the VCR has been widely used in the home since the mid-1980s, so it is now integrated into the life of most households in Europe and North America. Secondly, TV recording appliances offer users a clear choice between recording using direct manipulation (i.e. pressing a button to record what is currently on) or setting up recordings ahead of time, i.e. programming. Thus this type of technology is a good test case for the accuracy and usefulness of the Attention Investment model for describing domestic programming decisions. Thirdly, according to contemporary folklore, VCRs are a particularly difficult and frustrating domestic appliance to use – in spite of the fact that the VCR is by now a mature technology and is more or less ubiquitous. We were therefore interested in building on previous work [7,10] in investigating whether this common perception is an accurate reflection of video use in the home.

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We chose to look at families with children after conducting an informal survey (sample size = 50) to find out how often respondents used their VCR or other TV recording technology. According to our UK sample (recruited via colleagues and acquaintances), single people and couples without children used their VCRs very rarely. The one demographic group we sampled who reported using TV recording technology regularly and recently were parents with children still living at home. For these reasons we choose to focus on families with children for our study.

RELATED WORK

Technology is often a means by which a well-run household is judged; for instance, O'Brien's informants believed that good parents monitor what children watch on TV [8]. One way of monitoring television is allowing children to watch commercial-free videotapes of appropriate age-related content. The adoption curve of the VCR was far steeper than that of the household PC, facilitating its now near ubiquity[11]. Both Venkatesh and Mateas point out the PC often exists in a separate space from the rest of domestic activity [11,6]; whereas the VCR is in the thick of things. These two factors in combination made the VCR a good vehicle for investigating domestic programming. The existing work on VCR programming focuses on cognitive models of individual users' VCR programming [2] rather than the larger household ecology. Work by Mateas, Logan and O'Brien looked at PCs, new televisions and household appliances respectively within the ecology of the household [6, 3, 8], but this work did not focus on the programmability of appliances. Kiesler looked at the household ecology and saw that often one household member takes the role of technology manager[4]. Plaisant et al stress the need to understand distributed, multigenerational families when designing technologies [9]; we feel this holds especially with programmable technologies. Venkatesh argues it is the relationship between the social and technological space that shapes usage patterns of technology in the home; thus we wanted to look at the household ecology surrounding programming.

METHOD

Our 8 participant households were in or around Cambridge (UK). Potential participants were screened to ensure they were VCR-owning families with at least one child. None of our households had DVD-r or PVRs, like TiVo. The age range of the 16 adult participants was from 25 to 63 years, mean age 42.8 years. These households included 15 children, 8 girls and 7 boys, ranging in age from 18 months to 17 years. All participants were non-programmers, and non-computer scientists. Households came from a range of backgrounds- employment ranged from cleaners to lecturers. Three households had children under the age of six (#1, 4, 8), three had older children (#3, 6, 7) and two families had older teens (#2, 5). We aimed to gather broad descriptive data rather than statistically significant data.

PROCEDURE

Households were asked to participate in two 45-minute interviews, at the beginning and end of a two week period during which we asked them to complete a diary listing all of their recording appliance use, including start, stop, show name, and whether they were watching, manually recording or programmatically recording. On days they did not use the VCR, subjects were asked to record why. Our study took place in the evening with the intent that the entire household could be at home. We requested all household members to be present at the sessions. In reality the adults actively participated in the study, and were always present. Younger children usually participated in the early stages of the interview when we asked what they did with their VCR or DVD player, but would often lose interest and go back to playing midway through the session. The four teenagers (14-17) were a challenge: while we tried to include them in the study as much as possible, only one teen completed both interviews (#7). Two were absent for both interviews, but completed diaries (#5), and one completed a diary and one interview only (#1). The younger children were eager to 'be helpful', and completed diaries with their parents' assistance.

During the first session we collected demographic information, information on what recording appliances the household owned, and which members of the household used appliances for what purpose. We also collected information on history of the appliances, including how they were obtained, how long each was owned, and previous ownership of appliances of the same type. Finally, we gave members of the household an opportunity to relate key memories of each appliance's use. We also explained how to complete the diary itself. During the second session we reviewed and discussed the diary, as well as any video-related problems or interesting situations encountered during the course of the study.

RESULTS

Trading Programming Expertise

We looked at the number of shows recorded versus those viewed in each household. Perhaps unsurprisingly, we found that viewed episodes outnumbered recorded episodes in all but one household (#5). During our two week study, VCR use for all households was 106 viewing episodes, 44 manual recordings and 9 pre-recordings. Four out of 8 households made no pre-recordings. Three households (#4, #7 and #8) made no recordings at all during the fortnight of the study. The other five households made 3-27 manual recordings and 0-6 pre-recordings. For instance, 15 of the 27 manual recordings in household #5 were by a teenage girl who was in the middle of exams at school, and wanted to catch up on her favourite soaps when she had completed her work. There were significantly more manual recordings (44) than pre-recordings(9) suggesting a preference for manual recording.

Table 1. Summary of VCR viewing and recording activities

	Viewing Episodes	Viewing Errors	Manual Recording	Manual Errors	Pre-set Recording	Pre-set Errors
total	106	1	44	1	9	1
range	4- 23	0- 1	0-27	0 -1	0- 6	0-1

Our data did not show many errors occurring with VCR use, but they do provide examples of potential risks to be factored into Attention Investment decisions. Our data revealed only one of each type of error; viewing, manual recording and pre-recording. The viewing error occurred because a visitor did not know how to use the AV function on the TV. The manual recording error occurred when a user forgot to press 'record' and missed 10 minutes. The pre-recording error in household #6 occurred when a babysitter unwittingly reset the VCR; the daughter unsuccessfully tried to fix it, so Mom had to sort it out. We observed that VCR problems often occurred because of intervention by people other than the 'expert user'; which may suggest that in households that do a lot of recording, contention and confusion between different users may be significant issues.

This small number of errors suggests that our households had settled into a pattern of VCR use that they understood and with which they could cope; however, it does not mean that all household members were equally competent and willing to attempt VCR recording. Instead, we saw responsibility for TV recording falling on individuals who had mastered VCR programming, which to some extent, they were able to trade in exchange for cooperation from other household members. We also saw that when other people besides the household 'expert' tried to use the VCR, confusion could result.

Household #6 illustrates this particularly clearly. The VCR was mostly used by the mother and son aged 9. Mom was a fan of *Casualty*, which shows on Saturday evenings, when the family was often out. The soccer matches the son was interested in often did not finish until after his bedtime. Therefore Mom and son both had typical 'soap and sport' motivation for pre-recording TV programmes; in fact 6 of the 9 pre-recordings we gathered data about came from this household. Dad and daughter both used the VCR very little, and in a distinctly different way, manually recording. Only Mom knew how to use the pre-record function, but as the family pointed out, the numbers had worn off the VCR remote, and it would have been difficult for anyone else to learn. Mom was responsible for ensuring that *Casualty*, important soccer matches, and a show each for her husband and her daughter were recorded. In the case of the daughter, Mom did this favour explicitly in exchange for the daughter hurrying to get ready for school.

While data from 8 households can only be suggestive, it is interesting that mothers were responsible for 24 recordings while fathers made 11 recordings. We observed women using VCRs as a child management tool. This is consistent with our work and that of others which indicate that women tend to take on the role of household manager [12].

Parents and Children

We were struck with how poorly designed VCRs are for operation by households with children. We watched a 2 year old boy operate the VCR by kicking an ejected tape to start it playing automatically. Most of the VCRs in our sample were stored at floor level, as this is how most TV carts are designed. Unfortunately, as four of our households reported, this permits children to 'post' objects into the VCR's tape slot, which resembles a mailbox. Objects placed into the VCR included crayons, cereal box toys, jigsaw pieces and a 'jam butty' (jelly sandwich). One informant mentioned that in her sister's household the VCR was used as a piggy bank. We find it amazing that a mature technology intended for the domestic environment possesses such fundamental problems. Yet, as one parent pointed out, VCRs require substantially less dexterity than a DVD player; consequently our youngest DVD user was 8. Older adults reported similar difficulties, and described crawling down to reach VCRs near the floor and finding it hard to read in dark cabinets (#2). This underlines Plaisant's point, that we must design domestic technology for the intergenerational family.

The ability to program the VCR allows the programmer to take on the role of media provider for other individual family members. This can cut across the parent/child power dynamic, or complement it. The 15 year old son in Household #2 explicitly cited the "power" it gave him over his dad as the reason he learned to program the VCR. He could threaten not to record something unless conditions were met. They missed an episode of *NYPD Blue* due to confusion over who was supposed to adjust the VCR clock during British Summer Time. The father was supposed to adjust all of the clocks, and the son assumed this included the VCR clock. The father said he was very "sanguine" about missing *NYPD Blue*. The interview clarified it was a mistake, but the way programming ability cut across the power dynamic impacted the conflict resolution process. Even in this household we saw time-shifting (recording for later, by scheduling it or pressing record) occur to permit parental monitoring. Actually, this type of "good parenting" was commonplace in households #2, 3, 6 & 8, which is consistent with O'Brien's findings. Households with younger children (#1&4) accomplished the same effect, because children must ask for help to start – or in the case of our resourceful 2 year-old – change a cassette.

The household rhythm, the pattern of when the household does what, was often echoed by VCR recording and watching. Rainy days and vacations resulted in more VCR usage. A parent in household #1 remarked guiltily that the duration of the tape represented a predictable unit of time where a parent could engage in something else, or it can be

a way to help a working dad control the kids (#4). Most households with younger children had explicit routines surrounding children watching (#1) or not watching (#3) TV in the morning, after school (#8) or before bed (#1,6,7). TV in the evening represented "adult time" in one household's words. Programmability permits time-shifting which impacts household rhythms.

DISCUSSION

Our families' relationship to technology was more complex than individuals programming in isolation for themselves. They formed a *domestic economy*, trading expertise for mutual benefit. As Webley puts it, "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" [12]. Even when we see the emergence of a technology "czar" within the household, they are providing for other household members' needs, impacting the whole household's technology usage. In domestic ubicomp, programming becomes a household responsibility, like loading the dishwasher and taking out the trash.

Our data broadly supports the Attention Investment model, i.e. that individual programming behaviour occurs when it is strongly motivated and is considered to be relatively low risk (because of the programmer's expertise). We saw that users primarily favoured direct manipulation either by watching TV live (N=106) or pressing record (N=44), but occasionally circumstances did motivate a user to schedule recordings (N=9). Social issues within the domestic economy, such as screening TV shows suitable for children or time-shifting so TV does not conflict with household activities provide motivation to program, and therefore contribute to the risk/benefit calculation. However, we have also seen that households seem to benefit from a division of programming labour. This specialization and trading of expertise needs to be included in an Attention Investment model for programming behaviour in its social context. Therefore we propose an extension to Attention Investment for domestic programming. It must work with the household as an operational unit, taking into account the risk for the household as a whole, and trade it off against effort for all possible programmers. In this way Attention Investment can be effectively extended to domestic settings, and we wish to continue to verify this model

CONCLUSION

Households engage in programming decisions through a complex process of programming specialization, informal calculations of risks, benefits and effort for the household. Attention Investment can be extended to work with the whole domestic economy as a broader unit of analysis for end user programming. Still these cost/benefit calculations of risk depend in part on social factors surrounding technology use – including roles, power balance and household rhythms. The programming needs of distributed, multigenerational families are highly situated – social and technological space shapes the programming patterns of technology in the home. As we move increasingly towards the vision of a highly-programmable smart home we must accommodate the complexity of the household ecology. To do so we must focus not on the individual, but on the household.

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