Family Accounts:
A new paradigm for user accounts within the home environment

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ABSTRACT

In this paper we present Family Accounts, a new user account model for shared home computers. We conducted a study with sixteen families, eight who used individual profiles at home, and eight who shared a single profile. Our results demonstrate that Family Accounts is a good compromise between a single shared profile and individual profiles for each family member. In particular, we observed that because Family Accounts allowed individuals to switch profiles without forcing them to interrupt their tasks, family members tended to switch to their own profiles only when a task required some degree of privacy or personalization.

Author Keywords

Home computers, user account models, personalization, ubiquitous computing, access control, and file sharing.

ACM Classification Keywords

H5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous, H.1.2 User/Machine Systems, D.4.6 Security and Protection

INTRODUCTION

Individual user profiles on multiuser computer systems are typically segregated such that most documents and settings are kept private from other users, but sharing between profiles may occur if users take special actions. This user account model evolved out of a desire for privacy and security. In an environment, such as the workplace, where the user does not personally own the computer or when the computer may be shared with strangers or adversaries, this account model makes sense. However, it is not clear how useful this model is to users of shared family computers, where privacy and security requirements may be less stringent and the computer is usually shared with trusted individuals. In addition, different social norms exist in the home than in the workplace. Previous research performed by Brush and Inkpen suggests that families who use individual profiles have trouble sharing files with other family members. At the same time, families who share a single profile cannot personalize settings and have trouble keeping sensitive material private [3].

In this paper we build on Brush and Inkpen's work by implementing a new account model for users of shared home computers that provides easier sharing at the expense of privacy. We analyzed a survey of 1,712 households to determine how shared family computers are being used. Based on these results and prior research in this area, we constructed a new user account model. The Family Accounts model takes the opposite approach of the previous model: documents and settings are shared with other users by default, but individuals can personalize settings and make certain folders and documents private by using a personal profile. If a user does not require any privacy or personalization (e.g. she needs to perform a quick ad-hoc task), she can use a shared family profile. Family Accounts also does not force users to close applications or otherwise suspend their current tasks to switch profiles.

In the spring of 2008 we performed a laboratory study to test whether our new model appealed to families who share home computers. We were particularly interested in what sorts of features family members wanted to personalize, whether they would use their personal profiles, whether they would use a shared family profile or someone else's profile, and how these decisions may change based on context. We found that our model is intuitive without any substantial training, privacy and personalization needs are task-dependent, and that our model may provide a tenable compromise between sharing and personalization (dichotomous concepts in the old model) for both users of shared accounts and individual profiles. We also saw that users make decisions about privacy and personalization in the middle of a task, and not immediately when sitting down at the computer. Family Accounts allowed them to change profiles when they wanted to without having to repeat their task, unlike previous account models.

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BACKGROUND

Related Work

Controlling access to multiuser systems is a difficult problem for system designers, administrators, and users alike. In a 2003 study, Good and Krekelberg found that many users of peer-to-peer file sharing networks were inadvertently sharing their entire hard drives because of poorly designed access control interfaces [6]. Later in 2003, a minor political scandal was caused when a system administrator working for the U.S. Senate incorrectly set file permissions on a file server shared by members of the Committee on the Judiciary. The poor interface for setting file permissions was thought to be the main cause of the incident [14]. In response to these problems, Maxion and Reeder discovered that by simply changing the file permissions user interface in Windows, users made significantly fewer errors when they attempted to restrict file access [11]. However, much of the work in this area has focused on changing the interface rather than addressing the underlying models.

Zurko and Simon introduced the concept of "user-centered security" in an attempt to overcome conflicts between usability and security. They advanced the idea that designers of user-facing security mechanisms should conduct usability testing, develop user-friendly models, and consider the needs of the user foremost [16]. It is clear that models for access control have come a long way since their original goal of preventing one user from harming another [2, 4, 9, 12]. However, it is not clear that any of these models are appropriate for the domestic environment.

Adams and Sasse have pointed out that many usability problems still exist in security mechanisms because applications that are developed for the work environment have transitioned to the home environment without the designers reevaluating the needs of the users [1]. This is far from surprising as software companies primarily derive profit from business customers. Additionally, up until the past decade, research on collaborative work has primarily focused on software usage in the workplace [2].

Failure to understand the context in which a system may be used is also a problem for security designers. Singh et al. conducted a study of 108 individuals in Australia and found that many couples, indigenous people, and disabled people tend to share banking credentials. The reasons for disclosing one's credentials ranged from trust to survival. The authors conclude that "security design that does not take this social and cultural context into account is inherently flawed [13]."

According to a March 2007 survey of 2,200 U.S. adults, over 67% have access to a computer at home [7]. As domestic computer adoption increases, the range of uses for computers has increased as well. In the 1980s, home computers were used 70% of the time for work, and 87% of the users were male. Venkatesh found that in the 1990s, domestic computer use had expanded such that all family members used the computer for a plethora of different tasks [15]. In 1996, the HomeNet project gave computers to 48 families. Initially participants thought that the utility of the computer would be limited to work-related tasks, be it job-related, schoolwork, or housework. However, the researchers found that "chit-chat quickly became the dominant use of the Internet, and especially so for teenagers [8]."

Kraut and Frohlich published a follow-up study in 2003 wherein they discovered the dichotomy between individual usage at regular intervals and ad-hoc usage for short information-seeking tasks. They also examined the role of the computer's location within the home and found that the location was largely influenced by demographic factors, and in turn the computer's location influenced how it was used. Seventy-six percent of the computers were located in public or semi-public spaces, such as kitchens, living rooms, and offices, and tended to promote social interactions among family members. Computers in private spaces tended to be used in solitude. However, the type of applications being used also played a role in whether the computer was used for social interactions among family members. For example, email was deemed private and generally was not used while others were around [5]. This may be generalizable as Lutters and Heckle found that in a hospital environment, clinicians were highly protective of others being able to view their email on single sign-on systems [10]. Frohlich and Kraut also reported that most of the families in their study used a single profile, and would get annoyed when one user (usually a child) personalized the computer by changing settings or installing new applications [5].

In the spring of 2007, Brush and Inkpen conducted a study on how fifteen families shared technologies within the home. They identified two models for sharing technology: the appliance model, where every user shares the same environment and settings; and the profile model, where users can customize settings unique to their profiles after identifying themselves. Eight of the fifteen families had their computers configured to use profiles for the individual family members, while the other seven families used a single shared profile on their computers. Of the eight families who had multiple profiles configured, three families never used the profiles and choose instead to share a single profile while one family used multiple profiles on one computer and shared a single profile on two other computers. Those who used multiple profiles did so because they wanted a greater degree of individual personalization, but at the same time there were complaints about how difficult it was to share files between users and the amount of time it could take to switch profiles. Those who shared a single profile did so because they felt it was more convenient and they did not care about privacy. However, users of shared profiles expressed disappointment that they could not personalize the computers to the degree that they would have liked, and that certain applications

contained incorrect settings (e.g. the web browsers stored cookies for other users) [3]. Thus, there is evidence that current user account models are not well suited for the domestic environment. Instead, we believe users need a new account model that supports personalization, intuitive file sharing between family members, and the ability to change profiles quickly.

Survey Analysis

In 2007, Microsoft conducted a survey of 1,712 U.S. households who used Windows on home computers. The goal of this survey was to determine how computers were being used in the home, whether they were single-user or shared, and how they were shared. Respondents described the members of their household, how many computers were in the household, and how the computers were shared. The median age range of respondents was 36-45 years and 82% were male. Because of the male bias, the results are only generalizable regarding the statements of fact about the households and not respondents' opinions.

The data collected represents 6,016 computers in 1,712 households. However, we were only interested in how shared computers were being used. We excluded all non-shared and corporate-owned computers, since corporate-owned computers are likely to be configured to follow corporate policies (rather than the user's preferences). This resulted in data representing 2,750 shared computers, with 771 laptops and 1,979 desktops, in 1,627 households. Each household had a median of three (μ=2.88, σ=1.01) individuals who used a home computer, corresponding to a median of two (μ=1.71, σ=0.82) shared computers per household. Thus, over 95% of the households that we surveyed had at least one shared computer and over 45% of the computers were shared.

We found that of the 2,750 shared computers, 34% had a single shared profile, 28% had individual profiles for every user, and 38% used some combination of these (mixed). We examined whether the desire to keep certain files from other users had anything to do with why people tended to choose one sharing mode over another. We performed a chi-square test across the three different sharing modes with regard to whether each computer stored private files and found significant differences ($p<0.0005$, $\chi^2=396.31$). That is, computers on which users always used multiple profiles were more likely to store private files (see Figure 1). It is likely that people share a single profile when they do not care who accesses their files.

We were curious if computer location had any correlation with personalization. We coded the responses in terms of public and private locations. In the case of laptops, participants listed all the locations where their laptops were used. Living rooms, dining rooms, dens, and kitchens were coded as public locations, whereas bedrooms, bathrooms, and private offices were considered private areas. This coding was designed to match the dichotomy used by Brush and Inkpen in their 2007 study [3]. We found no

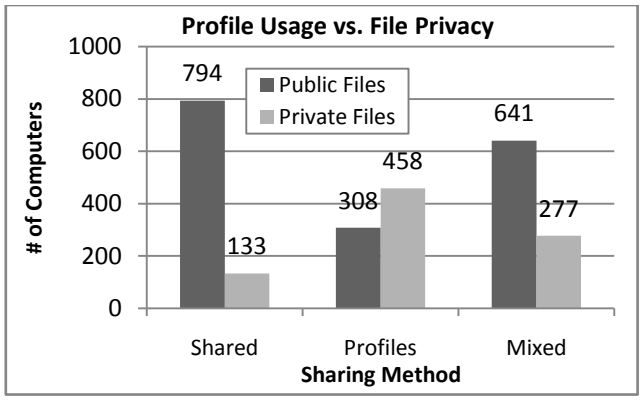

Figure 1: Whether the computer contained private files for each sharing type (shared profile, separate profiles, or mixed).

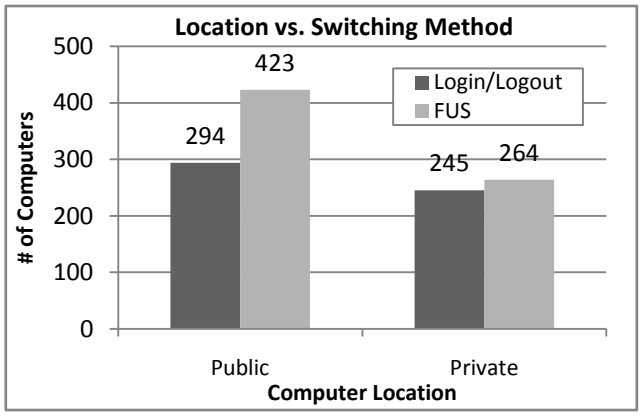

Figure 2: Correlation between user account switching method and location of the computers within the home.

statistically significant evidence to correlate the type of multi-user usage with whether the computer was in a public or private space. However, we found that significantly more computers located in public areas used Fast User Switching (FUS) than login/logout ($p<0.013$, $\chi^2=6.14$). This can be seen in Figure 2, which shows the breakdown of the 539 shared computers that used login/logout and the 687 computers that used FUS.

We believe that the computers in public areas were more likely to use FUS because these computers were more likely to be used for ad-hoc tasks. This is corroborated by Kraut and Frohlich's work, and motivates a user account model that facilitates both quick ad-hoc tasks (e.g. web browsing) and longer personal tasks (e.g. email and word processing) [5].

THE FAMILY ACCOUNTS SYSTEM

In the spring of 2008 we created a new user account model intended for users of shared family computers. The current file sharing model used by many desktop computers can be thought of as hierarchical: a user's personal directories are at the top of the hierarchy, and directories used for sharing with other users are underneath. Files and settings are private by default, but can be shared if specific actions are taken. In the Family Accounts model, shared files and resources are at the top of the hierarchy and personal folders are at the bottom. Files and settings are shared by

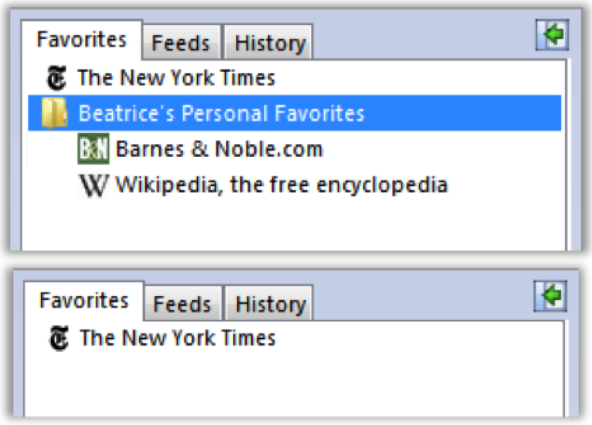

Figure 3: The Internet Explorer favorites when using Beatrice's profile (above) and then when using the shared family profile (below). Notice that the shared favorites appear in both profiles, but the personal favorites only appear in Beatrice's profile.

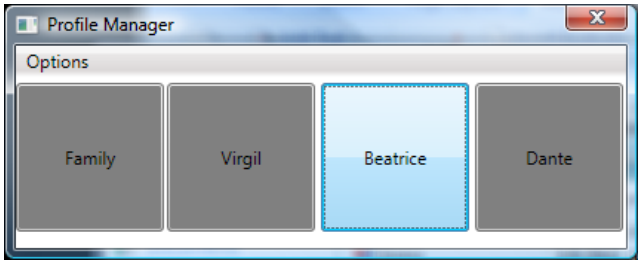

Figure 4: A screenshot of the Profile Manager application which participants used to switch between profiles.

default, but can be made private if a user takes additional actions. The Family Accounts model also includes a "family profile" which is not intended to be personalized for any single user. This profile does not contain any personal directories; when using the family profile, users can only access shared documents and settings. We created the family profile to see if families need (or desire) a profile that is not tailored to a particular family member.

Our Family Accounts prototype was implemented under Windows XP, and allowed users to switch between personal profiles and a family profile. When users switched to their profiles, personal folders appeared on the desktop and inside the "Family Documents," "Family Music," "Family Pictures" folders, and within Internet Explorer's Favorites folder (see Figure 3). Desktop background images could also be customized in each profile. Users switched between profiles by selecting a tile from the "Profile Manager" (see Figure 4). When using their personal profiles, users could choose between saving files to the shared folders, or to their personal folders within these folders.

User accounts in the prototype were implemented under a single Windows XP account. Configuration meta-data for each user's account were stored in a database. Switching accounts in our prototype was performed by swapping registry keys and setting/unsetting the hidden bits on personal folders for the current and previous users. Unlike login/logout or FUS, switching accounts with Family Accounts takes about a second since there is not a separate process spaces for each user. Likewise, all open applications remain open, but settings change to match those of the new user. Instantly switching accounts with Family Accounts comes at the expense of privacy: while the web browser's bookmarks and homepage will reflect those of the current user, it will remain at the last website that the previous user was viewing. Since our implementation was only meant to test the underlying model, a deployable version would likely need tighter security controls.

METHODOLOGY

Participants

We recruited 38 individuals from sixteen families in the Seattle area (the sixteen families had 64 total members, but only 38 participated in our study). Since the goal of Family Accounts was to find a compromise between sharing a single profile and using individual profiles for each family member, we recruited eight families that used a shared profile at home, and eight that used individual profiles. Fifteen participants were female and twenty-three were male. The average age was 36.7 (σ=17.97). As our focus was on examining the Family Accounts model and not quantifying the performance of a specific implementation, we performed a laboratory study rather than a large scale field study.

Study Design

When the families arrived at our laboratory, we first asked them how many shared computers they use at home. For every shared computer, we asked how many people use it, how often they use it, what sorts of tasks they perform on it, and whether they use profiles or a single shared profile. We seated the participants in a laboratory decorated to resemble a living room and provided them with food.

Upon completing the group interview, we told participants that we would be "looking at a different way of sharing a home computer." We gave a brief demonstration of Family Accounts, and then the family agreed on settings for the family profile. They customized the desktop wallpaper, Internet Explorer's (IE's) starting page, and several IE favorites.

The family moved to a conference room to complete questionnaires about their individual computer usage. The questionnaires contained questions about the features they personalize at home, how often they change settings, and the methods they use for sharing some documents while keeping others private. While participants worked on the questionnaires, we asked participants to return to the living room individually to create and customize personal profiles.

To create their personal profiles, participants used the "Profile Manager" (see Figure 4). This involved choosing a username (usually their first name) and a tile color. They then customized these profiles by first changing the desktop background image. If they did not choose new images, their profiles would use the shared family desktop image as a default. We then asked participants to launch IE and set a new starting page if they did not wish to use the same one as the family profile. Next, we introduced them to their personal favorites folders within IE, and we encouraged them to add one or two websites to their personal favorites. We emphasized that these favorites would only appear when they were using their personal profiles. Finally, participants performed an exercise where they used IE to save one image from a website to their personal pictures folder and then one image to the shared family pictures folder. This was done to illustrate that files can be saved as either personal or shared when using a personal profile.[1]

After participants created their profiles, they performed a series of eight tasks individually. We grouped the tasks into sessions of two, such that each participant performed two tasks, and then the next participant performed the same two tasks. Once every participant had completed the session, the next session began. All tasks were performed individually, and participants completed each session in the same order. Participants who were not completing tasks stayed in the conference room with another researcher and completed the questionnaires. Participants who finished early were given additional questionnaires as part of an unrelated study. At the conclusion of all the tasks, participants completed individual exit surveys and were given compensation.

Our main research question was whether Family Accounts offered a good compromise between a single shared profile and individual profiles. We also wanted to explore whether participants would switch to their personal profiles within Family Accounts based on the type of task being performed. We hypothesized that the family profile might be used to perform various ad-hoc tasks (e.g. looking something up online). We also hypothesized that users would likely switch to their profiles when a task required some degree of personalization or privacy. For instance, users may use the computer in a profile other than their own if the task does not require any personalization, and the computer was already in that profile when they approached it. We tested these hypotheses by creating two within-group conditions.

[1] Every family except for the first two families performed this exercise. We added this exercise amid concerns that participants might think they needed to be in the shared family profile to access the shared documents. However, we found no reason to believe that these first two families behaved any differently than the other fourteen.

Session	Task	Description	Mode
1	1	Check email	Personal
	2	Save shared photos	Public
2	3	Find shared photos	Public
	4	Send email	Personal
3	5	Save private file	Personal
	6	Save shared photos	Public
4	7	Find shared photos	Public
	8	Send email	Personal

Table 1: This table depicts all of the within-group conditions and tasks for the study. The "Mode" column indicates whether the task was personal (i.e. conducive to personalization) or public (i.e. conducive to sharing).

The first within-group condition was the type of task to be performed: half the tasks that participants performed could be made easier by switching to their personal profiles (tasks 1, 4, 5, and 8), while half the tasks could be performed just as easily while using the family profile (or someone else's profile; tasks 2, 3, 6, and 7). Each session of two tasks was constructed such that one task did not require any personalization—we considered these "public" tasks—while the other task could be made easier by using participants' personal profiles—the "personal" tasks. The former involved viewing and saving shared files, while the latter involved using email and saving personal files. We considered sending and receiving email to be a more personal task because previous research has found that users have privacy concerns when using email on shared computers [5, 10]. All of the tasks can be seen in Table 1.

The second within-group condition was the profile that the system was in when the participant approached the computer: either the family profile or the profile of the last family member to use it. The goal was to examine whether the type of task influenced which profile participants used, whether there was a need for the shared family profile, and whether participants would use someone else's profile. The experimenter controlled this condition by manually switching profiles before each participant began a session.[2] The tasks and sessions were designed such that each of the within-group conditions was counterbalanced.

Tasks

In the first task, participants checked their email with IE and encountered a message from the experimenter explaining the scenario for the study and the next task: the family is planning a trip to Paris, and participants must now find photos of three landmarks and save them to a location where the rest of the family can find them (task 2). A printout was also provided to all participants in case they did not receive this email (e.g. incorrect email address, spam filters, etc.).

[2] This was done before participants entered the room, such that they had no idea this was a controlled condition.

In the second session, participants found pictures that other family members had saved and chose their four favorites (task 3). Next, they emailed their selections to the other family members (task 4). In the third session, participants used Notepad to create an itinerary; we instructed them to "save it such that none of the other family members can view it" because it contained a surprise dinner (task 5). Next, participants used IE to share photos and pricing information for two hotels with the rest of the family (task 6). Participants accomplished this by saving pictures and a text document. Finally, in the fourth session participants reviewed the photos that the other family members had saved (task 7), and then emailed the rest of the family their top hotel choices (task 8).

ANALYSIS

In this section we review how the participating families previously used their computers at home, we examine how during the study their profile usage changed based on the type of task being performed, how the starting state influenced whether they switched profiles, and whether their behaviors differed based on whether they used a single shared profile or multiple profiles at home. Finally, we discuss the overall reactions to the Family Accounts system.

Home Computer Usage

Table 2 provides descriptive data on the families' home computer usage. The families had a median of three computers in the home and four family members who used a computer daily. Multiple family members shared 68% of the computers in the home, and we found a significant correlation between the total number of computers and the number of those that were shared ($p<0.001$, $r=0.738$). Thus, as new computers are added to the household, they are likely to be shared among multiple family members. This corroborates previous research which found that home computer usage patterns are different from television usage patterns, since additional televisions are usually used individually and in private [5].

By design, eight of our recruited families used a single profile at home and eight used multiple profiles. However, data collected in the interview and through the individual questionnaires suggests this distinction is blurrier than it appears, as Brush and Inkpen also found [3]. Five of the eight "single profile" families had one or more computers configured to use multiple profiles, however all of the family members ended up using a single profile most of the time. They indicated that it was often not worth the effort to switch profiles each time they used the computer. One person noted, "We can't find a huge reason to change accounts…all the programs are the same." A member of a different family noted that he does not like his programs to close when someone logs him out, so he allows everyone else to use his profile: "[the] only thing I leave up is my corporate email…I assume that they won't touch it…if I close it, it doesn't respond well." Another family who used password-protected profiles mentioned that everyone except the mother had forgotten their passwords, so they relied on her to remain logged in. Only one study participant claimed to never use someone else's profile, while seven of nineteen (37%) claimed to use someone else's profile at least weekly. A majority of the participants in the multiple profiles group mentioned that they use other family members' profiles for quick tasks due to convenience, if the computer is already logged in. Two families indicated they tend to use other family members' profiles for quick tasks, but prefer the personalization that comes with their individual profiles; "if I was just checking the weather I'd leave it, otherwise I'd go to my own," and "if I need to do something real quick I will just use it…but I like my desktop [and] my bookmarks."

Family	Total (Kids)	Daily Users	Computers (Shared)	Used Daily	Sharing Method
1	4 (2)	2	4 (3)	2	Multiple
2	4 (2)	4	4 (3)	3	Multiple
3	5 (3)	3	4 (3)	3	Shared
4	4 (2)	2	2 (1)	1	Multiple
5	5 (2)	4	3 (2)	2	Multiple
6	4 (2)	4	4 (3)	3	Shared
7	3 (1)	3	2 (2)	2	Shared
8	3 (1)	2	2 (1)	1	Multiple
9	4 (2)	4	2 (1)	1	Shared
10	2 (1)	1	8 (3)	1	Shared
11	3 (1)	2	3 (2)	2	Multiple
12	5 (2)	3	5 (3)	3	Multiple
13	4 (3)	2	2 (2)	2	Shared
14	4 (2)	4	4 (3)	3	Shared
15	5 (3)	5	3 (3)	2	Shared
16	5 (3)	2	1 (1)	1	Multiple
Total	64 (32)	47	53 (36)	32	

Table 2: Details of home computer use for the 16 families. The second column depicts the total people in each household. The third column depicts the number of household members who used at least one shared computer daily. The fourth column depicts the total number of computers in each household, and how many of those were shared. The fifth column depicts the number of shared computers which were used daily, while the sixth column indicates whether each family shared a single profile or used multiple individual profiles.

Regardless of how the families shared computers at home, most participants indicated that they enjoyed personalizing their home computers. Sixteen (84% of 19) participants who used multiple profiles set desktop background images compared to seven (37% of 19) of the participants who shared a single profile ($\chi^2=8.922$, $p<0.003$). Twenty-five (66% of 38) claimed to use bookmarks at least weekly.

Participants answered several questions concerning personalization using a 5-point Likert scale. We compared the answers to an expected value of 3 using a t-test (i.e. a value of 3 indicates no preference). We found that users of multiple profiles and users of a single shared profile only differed significantly from the expected value in a few areas. First, users of a single shared profile want to keep certain things private but have difficulty doing so without

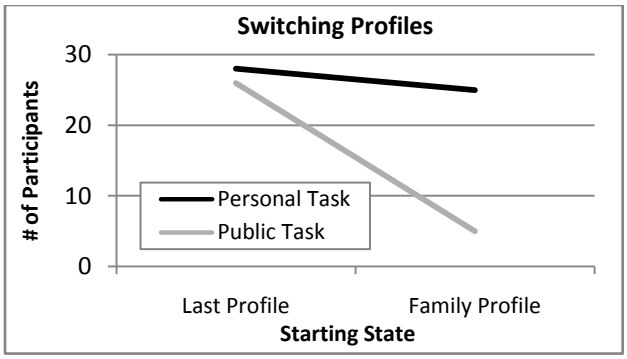

Figure 5: The number of participants who switched profiles based on starting state and task type.

Session	Task	Own Profile	Last Profile	Family Profile
1	1.Check Email	19 (50%)	9 (24%)	10 (26%)
	2. Save Shared Pictures	22 (58%)	5 (13%)	11 (29%)
2	3. Find Shared Pictures	4 (11%)	5 (13%)	29 (76%)
	4. Send Email	21 (55%)	3 (8%)	14 (37%)
3	5.Save Private File	34 (89%)	1 (3%)	3 (8%)
	6.Save Shared Files	25 (66%)	1 (3%)	12 (31%)
4	7. Find Shared Files	7 (18%)	8 (21%)	23 (61%)
	8. Send Email	18 (47%)	5 (13%)	15 (39%)
Total		150 (49%)	37 (12%)	117 (38%)

Table 3: The profile that each participant used to complete each task.

setting up multiple profiles. Likewise, users of multiple profiles have files they would like to share with other family members, but find this difficult. Additionally, families that use multiple profiles do not see the need to switch profiles if they are performing tasks that do not require it. These are exactly the problems we hoped to address with Family Accounts.

Tasks & Profiles

We found that both the starting state (i.e. the last user's profile or shared family profile) and the type of task (i.e. personal vs. public) significantly influenced whether participants chose to switch profiles ($F_{1,36}$=20.82, p<.001 and $F_{1,36}$=24.34, p<.001, respectively for a repeated measures ANOVA).[3] We also found a significant interaction effect between starting state and task type ($F_{1,36}$=11.35, p<.01). Figure 5 shows the number of participants who switched profiles (in tasks 1, 3, 5, and 7) depending on the starting state and the type of task. Table 3 depicts the profiles that participants used to complete each task.

Public Tasks

We considered tasks 2, 3, 6, and 7 to be "public" tasks because they involved saving pictures or documents to shared folders and then viewing the files saved by other family members. These tasks were also designed to make use of the "Family Documents" and "Family Pictures" folders that appeared on the desktop. We instructed participants to save files to a "location accessible to the rest of the family."

Overall we found that 26 of the participants (68% of 38) were able to consistently save and locate shared files. It should also be noted that none of the participants who incorrectly saved files did so on more than one task. Upon performing Fisher's exact test, we found that participants made significantly more errors when saving shared files than when locating shared files (p<0.031). One explanation for this is that since more participants used the family profile to locate shared files, they were less likely to use their personal directories simply because they could not view their personal directories from the family profile. Another more likely explanation for this is that participants had an easier time of navigating to the shared folders using the desktop icons as opposed to navigating to the shared folders from within the "save file" dialog.

We wanted to examine whether participants were more likely to switch profiles to perform public tasks, and to which profiles they would most likely switch. We found that participants were significantly more likely to use the family profile to complete public tasks 3 and 7 (task 3: χ^2=54.000, p<0.0005; task 7: χ^2=27.000, p<0.0005). We believe that this is because these tasks were at the beginning of the sessions, and therefore were not directly preceded by personal tasks.

For task 6, significantly more users ended up using their own profiles which is not surprising given that task 6 immediately followed a personal task. After performing a Wilcoxon signed-ranks test, we discovered that significantly more participants switched profiles when starting task 3 than when starting tasks 2 or 6 (p<0.005, Z=-2.837; p<0.046, Z=-2.000), and significantly more participants switched profiles when starting task 7 than task 2 (p<0.001, Z=-3.317). We did not observe a statistically significant difference between the number of participants

[3] This analysis only looked at the first tasks in each session since we did not control for starting state during the second tasks.

who switched profiles between tasks 3 and 7 (i.e. the public tasks performed at the start of the session) nor between tasks 2 and 6 (i.e. the public tasks performed at the end of the session). When a public task was preceded by a personal task, participants were more likely to simply continue using whichever profile they used for the personal task. What we did not expect was that so many participants would switch to the family profile when the public task was at the beginning of the session; we expected most participants to simply use the computer as they found it, since they indicated they normally did this at home. It is likely that because the Family Accounts system—specifically the family profile—was new to them, they made a concerted effort to use it. It is possible that this behavior may change given long term exposure to the system.

Personal Tasks

The other half of the tasks that participants performed were more personal in nature. These tasks, using email or saving personal documents, either took advantage of the user's personal settings or personal folders. These settings and folders were not accessible using the other family members' profiles or the shared family profile. While the tasks could still be completed from any other profile, they were designed to be easier to complete from the participants' own profiles. Thus, we considered tasks 1, 4, 5, and 8 to be "personal" tasks. Roughly 50% of participants switched from the starting state to their own profile when performing these tasks. We observed that participants switched to their own profiles significantly more often for personal tasks than for public tasks ($p<0.0001$ for Fisher's exact test).

In task 5, participants were asked to save a draft itinerary to a location where "none of the other family members can view it." This prompted 34 participants to switch to their personal profiles. We found that this differed significantly from the null hypothesis—that only users in the multiple profiles group (19 of the 38) would switch to their own profiles and the other nineteen would use the computer in its starting state—($\chi^2=23.895$, $p<0.0005$); participants understood to switch profiles and that it would be easiest to use their personal folders to save the files. Everyone who switched profiles managed to save their itineraries to their personal documents folder. Interestingly, fourteen of these participants were cued to switching profiles once they began to save their files and could not locate their personal directories using the "save file" dialog box. We believe that this is one of the biggest benefits of the Family Accounts system: users can switch to their personal profiles at the exact moment that they need them without having to close all of their existing applications and reopen them after switching profiles. Family Accounts gives the most benefit to users when they transition from a task that does not require personalization to a task that does.

We found that when performing a public task, participants were more likely to switch profiles if the public task was at the beginning of the session. This was not the case when performing personal tasks. We noticed that significantly more participants switched profiles at the start of task 5 (the first task of the session), but we did not notice a significant difference between the other personal tasks. We believe that the need for personalization/privacy was much stronger for saving personal files (task 5), than sending or receiving email.

We were interested in measuring the personal nature of email in tasks 1, 4, and 8. We were curious how many participants would log out of their email (either by clicking the "logout" button or closing the window) after they were done using it. We found that all but six participants (84% of 38) logged out of their email at least once during the study. However, on a task-by-task basis, we found that this behavior was very inconsistent, and found no correlation between whether participants said they normally logged out of email and whether they did so in the laboratory. In the first task, 25 of the participants logged out, while significantly fewer logged out during task 4 ($p<0.012$, $Z=-2.524$; Wilcoxon's signed-ranks test). Yet in task 8, 26 logged out of their email. Even examining the number who logged out after each of these tasks, we still could not find a significant correlation between them telling us they normally log out of their email and actually doing so in the laboratory.

We observed different behaviors when the participants first sat down at the computer to perform a personal task. When performing tasks 1 and 5, the starting conditions had no observable effect with regard to switching profiles. That is, when performing personal tasks, participants who found the computer in the last user's profile were just as likely to switch to their own profile as participants who found the computer in the family profile. The role of the starting state needs to be examined closer because it may have had more nuanced effects.

Starting State

We examined whether the state in which the participants found the computer (i.e. the family profile or the profile of the last family member) influenced whether they chose to use it in that profile or switch to a different profile. Using Fisher's exact test, we found that participants who first sat down at the computer and found it in the profile of the last user were significantly more likely to switch profiles when performing a public task (task 3: $p<0.0005$; task 7: $p<0.019$). Task 3 involved participants finding pictures of landmarks in Paris that the other family members had saved. A total of fifteen participants (75%) switched from the last participants' profiles to complete this task, whereas only two participants switched from the family profile (11%). Task 7 involved participants finding pictures of hotels in Paris that other family members had saved, and we discovered similar results: eleven participants switched from the last participants' profiles (61%), compared to only four who switched from the family profile (20%).

We could not find a correlation between starting state and the public tasks that were preceded by personal tasks (i.e. tasks 2 and 6). Significantly more participants switched from the last participants' profiles during task 2 ($p<0.001$), while participants in both starting conditions were equally likely to switch profiles during task 6. It is possible that this can be attributed to the Hawthorne effect: towards the beginning of the study (i.e. task 2), participants wanted to please the experimenter by using their own profile to complete the tasks. Perhaps after an hour or two into the study, during task 6, participants were no longer thinking about this, and their actions better reflected natural behavior.

Single vs. Multiple Profiles

Overall we observed a few significant differences between the families who shared a single profile and those who used multiple profiles. The most interesting finding was that families who used multiple profiles at home used the last user's profile more frequently during each task than the single profile families. This difference was only statistically significant for tasks 3 and 8, where five participants in the multiple profiles group used the previous user's profile compared to no participants in the single profile group ($p<0.0463$; Fisher's exact test). However, when examined across all tasks this difference was highly significant ($p<0.0003$), since the multiple profiles participants used the last user's profile a total of 29 times, whereas the single profile users did this only 8 times. Since the majority of the participants in the multiple profiles group said that they regularly used another family member's profile if the computer happens to be in that state, they may be habituated to ignoring which profile the computer is in. Whereas the single profile participants were not accustomed to using different profiles, they were more aware of the state of the system and used it accordingly.

Overall Opinions

Participants completed written questionnaires about their opinions of Family Accounts after completing all of the tasks. We used a t-test to analyze participants' answers on a 5-point Likert scale (comparing to an expected value of 3) and found that families from both conditions significantly preferred the Family Accounts system to what they previously used at home ($\mu=3.7$, $p<0.0005$). We believe this is an important finding because participants who shared a single profile said that Family Accounts would make it easier to keep certain files private ($\mu=3.7$, $p<0.028$), while both groups said that Family Accounts would make it easier to share files ($\mu=4.3$, $p<0.0005$). Both groups also responded positively to the family profile ($\mu=4.2$, $p<0.0005$), yet at the same time neither group believed they would use the family profile for most tasks.

In the free-form response section, eight users of multiple profiles (42% of 19) said they liked Family Accounts because it allowed them to switch profiles without waiting. Seven users of multiple profiles (37% of 19) said they liked the ability to easily share files. Seven participants in the single shared profile group (37% of 19) said that Family Accounts was much easier to use than what they do at home, while six participants (32% of19) said that they liked Family Accounts because of the personalization and privacy features.

Finally, we asked participants what they disliked about Family Accounts. We found that a significant number of participants in the multiple profiles group wished they could personalize more features ($\mu=3.58$, $p<0.023$).We also found that three users in each group explicitly mentioned security as the biggest problem with Family Accounts. This was not surprising since authentication was not required to switch profiles. We probed participants further by asking if they would have preferred to use passwords to switch profiles, and found that 25 participants agreed (66% of 38), but we did not see a significant difference between the two groups (five participants in the multiple profiles group did not want passwords, compared to eight in the single profile group). This is especially curious since less than a quarter of our participants used individual passwords at home.

CONCLUDING REMARKS

We believe that Family Accounts is a more appropriate user account model for shared computers within the home because it offers a compromise between shared and individual profiles. Participants who used a single shared profile at home liked Family Accounts because it gave them privacy and allowed them to personalize the computer. At the same time, participants who used multiple profiles at home found that it was easier to share files with Family Accounts. Both groups liked Family Accounts because it gave them the ability to sit down and use the computer without having to decide up front whether they needed to switch to their own profiles. Because switching profiles does not cause applications to close and it happens in less than a second, users can switch profiles only when they require personalization or privacy. However, we also believe that there are a lot of questions that need to be addressed in future work.

Many participants used the computer in whichever profile they found it or they switched to the family profile when the task did not require personalization or privacy. It is possible that the family profile will best serve users as a default profile to which the system switches after it has been idle. Ten of our participants mentioned that this would be something in which they would be interested, however a controlled study is likely needed in order to determine if they would find this valuable.

One family mentioned that they use a fingerprint scanner to switch profiles on their main shared computer. They do this not for security, but because it is much faster than typing a password each time. If they did not do this, they said it is likely that everyone would simply use the profile of the last person or they would get rid of profiles altogether. We believe this illustrates the need for quick user identification within the home. We asked three of the other families

whether they would like the computer to automatically recognize them when they sat down in the future (e.g. using a camera, fingerprint reader, etc.), and two of the three responded positively. None of them mentioned privacy concerns, but we would expect that privacy would become a focus if such systems were widely deployed.

Finally, a long-term field study of Family Accounts is needed to determine the subtler nuances between our study conditions. We observed that families who are accustomed to using a single shared profile at home were more likely to switch profiles in the laboratory. We believe this is because switching profiles was new to them and they were excited to use their personal profiles. On the other hand, those who were accustomed to personal profiles usually switched to their profiles only when needed. These differences will likely become less pronounced if families are accustomed to using Family Accounts over a longer period of time.

Overall we found that our participants liked using Family Accounts. Most importantly, we believe that Family Accounts is a better model for computers in the home environment because it allows for easy file sharing, while at the same time making it easy to keep certain files private, and allowing individual users to personalize shared computers.

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REFERENCES

1. Adams, Anne and Sasse, M. Angela. Users are not the enemy: Why Users Compromise Computer Security Mechanisms and How to Take Remedial Measures. *Communications of the ACM*, 42(12). New York, NY, USA: ACM (1999), pp. 41-46.
2. Baecker, Ronald M. *Readings in GroupWare and Computer-Supported Cooperative Work: Assisting Human-Human Collaboration.* San Francisco, CA, USA: Morgan Kaufmann Publishers Inc. (1994).
3. Brush, A. J. Bernheim and Inkpen, Kori M. Yours, Mine and Ours? Sharing and Use of Technology in Domestic Environments. *UbiComp 2007: Ubiquitous Computing*. [ed.] John Krumm. Berlin: Springer-Verlag (2007), pp. 109-126.
4. Dewan, Prasun and Shen, Honghai. Controlling Access in Multiuser Interfaces. *ACM Transactions on Computer-Human Interaction (ToCHI)*, 5(1). New York, NY, USA: ACM (1998), pp. 34-62.
5. Frohlich, D. M. and Kraut, R. The Social Context of Home Computing. *Inside the Smart Home.* [ed.] R. Harper. London: Springer-Verlag (2003), pp. 127-162.
6. Good, N. S. and Krekelberg, A. Usability and Privacy: A Study of Kazaa P2P File-Sharing. In *Proceedings of the ACM Conference on Human Factors in Computing Systems (CHI 2003)*. New York, NY, USA: ACM Press (2003), pp. 137-144.
7. Horrigan, John B. and Smith, Aaron. *Home Broadband Adoption 2007.* Pew Internet & American Life Project, 2007. http://www.pewinternet.org/PPF/r/217/report_display.asp (Accessed: March 21, 2008).
8. Kraut, Robert, Scherlis, William, Mukhopadhyay, Tridas, Manning, Jane, and Kiesler, Sara. HomeNet: A Field Trial of Residential Internet Services. *CHI '96: Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*. New York, NY, USA: ACM (1996), pp. 284-291.
9. Lampson, Butler W. Protection. *ACM SIGOPS Operating Systems Review*. New York, NY, USA: ACM (January, 1974), pp. 18-24.
10. Lutters, Rosa R. and Heckle, Wayne G. Privacy Implications for Single Sign-on Authentication In a Hospital Environment. *Symposium On Usable Privacy and Security (SOUPS)*. New York, NY, USA: ACM (2007), pp. 173-174.
11. Maxion, Roy A. and Reeder, Robert W. Improving User-Interface Dependability through Mitigation of Human Error. *International Journal of Human-Computer Studies*, 62(1). Amsterdam, The Netherlands: Elsevier Science Publishing (2005), pp. 25-50.
12. Sandhu, Ravi, Ranganathan, Kumar and Zhang, Xinwen. Secure Information Sharing Enabled by Trusted Computing and PEI Models. *ASIACCS '06: Proceedings of the first ACM Symposium on Information, Computer and Communications Security*. New York, NY, USA: ACM (2006).
13. Singh, Supriya, Cabraal, Anuja, Demosthenous, Catherine, Astbrink, Gunela, and Furlong, Michael. Password Sharing: Implications for security design based on social practice. In *Proceedings of the ACM Conference on Human Factors in Computing Systems (CHI 2007)*. New York, NY, USA: ACM Press (2007), pp. 895-904.
14. U.S. Senate Sergeant at Arms. *Report on the investigation into improper access to the Senate Judiciary Committee's computer system.* United States Senate Committee on the Judiciary, March 4, 2004. http://judiciary.senate.gov/testimony.cfm?id=1085&wit_id=2514 (Accessed: March 21, 2008).
15. Venkatesh, Alladi. Computer and Other Interactive Technologies for the Home.*Communications of the ACM*, 39(12). New York, NY, USA: ACM (December 1996), pp. 47-54.
16. Zurko, Mary Ellen and Simon, Richard T. User-Centered Security. In *Proceedings of the 1996 Workshop on New Security Paradigms*. New York, NY, USA: ACM (1996), pp. 27-33.