Shared Family Calendars:
Promoting Symmetry and Accessibility

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ABSTRACT
We describe the design and use of a system facilitating the sharing of calendar information between remotely located family members. Users can choose to enter information into a computerized calendar or to write by hand on digital paper calendars. All of the information is automatically shared among everyone in the distributed family.

KEYWORDS
Home, Calendar, digital paper, elderly, universal usability, family technology, privacy.

1. INTRODUCTION

There is increased interest in the development of new technologies for the home and for families. Previous research revealed the importance of respecting privacy, not creating new obligations, and offering multiple modes of communication. This project focused on facilitating coordination and awareness between distributed family members by the sharing of calendar information. In particular, it addresses the needs of older adults for simple modes of interaction and promotes a symmetrical open exchange of information between family members. Our experience leads us to believe that sharing of calendar information provides a useful window into the day-to-day activities of remote family members. Grown children can see if their parents' activity level is normal or not and grandparents greatly appreciate the heightened sense of awareness of their children and grandchildren's daily lives. While we acknowledge that no single tool will suit the needs of every family, we believe that the prototypes we have developed can lead to successful products that would serve the needs of distributed families wishing to remain in touch.

This paper first describes the context and motivation for the design of shared family calendars, and then reviews previous work on shared calendars and on technologies for sharing information between families. A prototype for shared family calendars using digital paper is described and results of a field study of the use of the prototype in three households are presented. We conclude with suggestions for improvements and possible future directions.

2. CONTEXT AND MOTIVATION

Our work is part of the interLiving project, a 3 year, European Union-funded project where we work with distributed, multi-generational families as design partners to create new technologies. Using

cultural and design probes, interviews and workshops, the interLiving project identified coordination and awareness as important needs of families. In parallel, a web survey confirmed the need for coordination between the many calendars users maintain. Finally, we studied the needs of one extended family in more detail and they helped us design and test the prototype.

2.1 The interLiving project

The interLiving project recruited 3 families in Sweden, 3 in France, and 1 in the U.S. Each family has multiple households and generations. We began with an ethnographic approach, interviewing the families in their homes to learn about their needs for and attitudes toward technology. Next, we appropriated the idea of cultural probes (Gaver and Pacenti, 1999) from design researchers, giving the families tools such as disposable cameras, diaries, and Post-It notes to gather information about their daily lives and communication habits. As cultural probes, these artifacts were meant to provide researchers with insight about the families and to inspire new design ideas.

After gathering information about the families and having them become more comfortable with the project, our goal was to help them become our partners in the design of new technologies. Participatory design with families had not been tried before, so another goal was to learn, sometimes on the fly, how to adapt existing techniques and invent new ones that would work with multi-generational families. We conducted workshops with individual households, entire families, and multiple families using low-tech prototyping exercises to get the families comfortable with the idea of designing things. We discovered that family dynamics plays an important role in these workshops, and we learned that occasionally separating families by gender or age was effective in allowing everyone's voice to be heard.

One of our key challenges was to develop new participatory design strategies in which family members could actively participate in the design of new technology. We did not expect the family members to become designers, but we did want them to be active in the design process. To achieve this goal, we introduced the concept of a 'technology probe' (Hutchinson et al. 2003), which combines the social science goal of collecting data about the use of the technology in a real-world setting, the engineering goal of field testing the technology, and the design goal of inspiring users (and designers) to think of new kinds of technology.

Our version of technology probes involved installing a technology into the families' homes and watching them use it over a period of time. We instrumented our technology probes to capture two types of data: the use of the probe itself and the relationships within the family. We developed and installed two technology probes: the MessageProbe and the VideoProbe. Each was designed to gather data about a family's communication patterns while inspiring them to think about new ways of communicating.

The MessageProbe was a simple application that enabled members of a distributed family to communicate using digital Post-It notes. It functioned synchronously, with two or more family members writing from different locations at the same time, or asynchronously, with family members checking it periodically for new messages. The probes were connected only to a small set of family members, removing the need for complicated setup and remembering names or addresses. There was no need to use the mouse or keyboard – just a writable LCD tablet and pen (Fig. 1). The MessageProbe was deployed in the three households of our U.S. family design partners and in two households of our Swedish family design. In the U.S, the probes were used mostly to write notes updating status, news, feelings, and coordination. The probe helped reveal that coordination between the households was an important issue. In contrast to the U.S. family, the Swedish messages were more playful, used mostly by two sisters to write fun notes to each other.

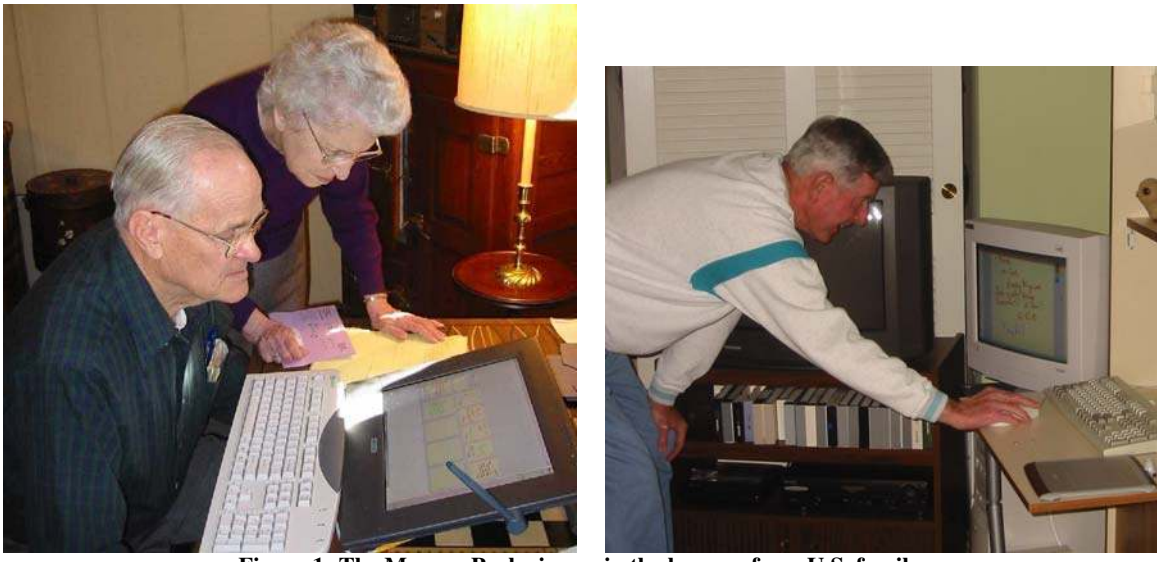


Figure 1: The MessageProbe in use in the homes of our U.S. family

The VideoProbe provided a simple method of sharing impromptu images among family members living in different households. We used a video camera that takes a snapshot when the image it captures becomes steady for approximately three seconds. The images were collected, stored, and made available to anyone else in the network. Family members could browse the images with a remote control. Images faded over time and eventually disappeared, to encourage families to create new ones. The VideoProbe was deployed in four households of two of our French family design partners – two sisters from one family and two brothers from another family. Like the MessageProbe, the families used it in a playful way, to send funny pictures, and for communication and coordination purposes - e.g. taking a picture of a hand-written message.

The probes were successful as concrete applications that the families could use as a point of comparison for how their needs as co-located and distributed family members were or were not being met by current technologies. One of the most prominent needs we identified among these families across all cultures and ages, through our interviews, workshops and the technology probe deployments, was coordinating between and within households.

Families need to coordinate everything from who picks children up from school and where to meet after work, to scheduling surprise parties or vacations. The dizzying array of technologies available to families to accomplish these tasks, from cell phones and PDAs to Internet calendars, seems only to have added to the existing confusion of paper calendars, Post-It notes, and answering machines. Frequently, problems arise because the necessary information isn't available in the right place or at the right time – a PDA isn't synchronized with the home calendar and someone misses an appointment, the soccer schedule is at home when the coordinating parent is at work, or the cell phone of the person that is picking someone up is turned off or out of power.

To explore these issues more thoroughly, we held more workshops with our family design partners to brainstorm about coordination needs. Across all three cultures, we saw a common desire for better ways of keeping track of the multiple people and events going on between and within the various family households (Figs. 2, 3 and 4). Whether it was a display of multiple people's calendars embedded in the refrigerator or a small piece of jewelry that pinched or blew air as a reminder or message, our design partners were full of creative and practical ideas for improving family coordination. We saw a continuum of devices, from unobtrusive things to support lightweight awareness, all the way to full-blown calendaring solutions accessible from cell phones, PDAs, refrigerators, and watches. People's

needs were located along this continuum depending on the closeness of their relationships and their practical needs for coordination. Relying on someone to pick up your children might require close coordination, while letting your significant other know you are thinking about them might just require a small bit of awareness.

Figure 3: Augmented awareness prototypes designed during the family workshops: a bracelet that shines (left) and a phone that blows air (right) to indicates that another family member may think of you or alert you a something.

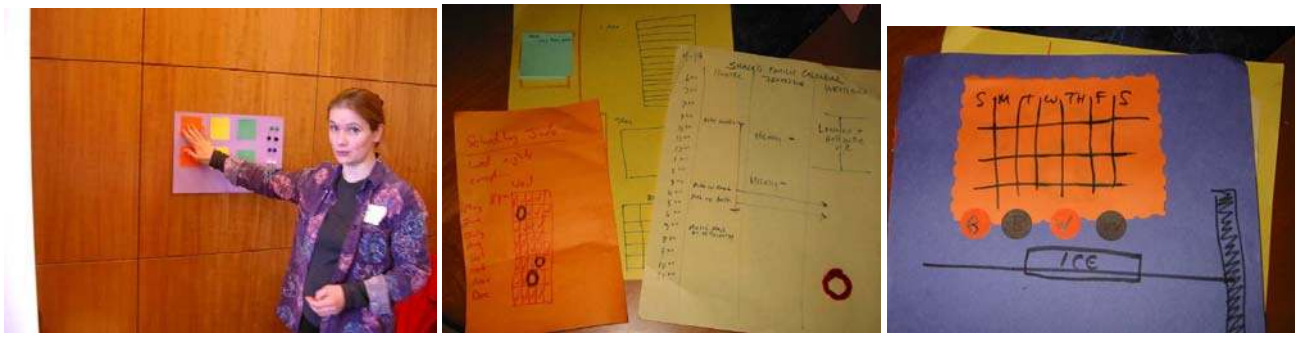


Figure 4: Shared calendar prototypes designed during the family workshops: for the wall (left), or the refrigerator (middle and right)

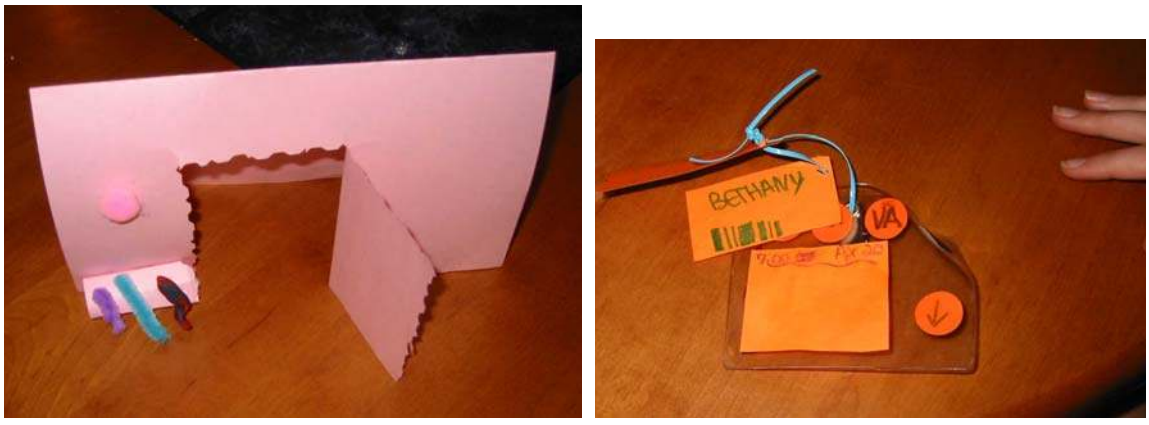


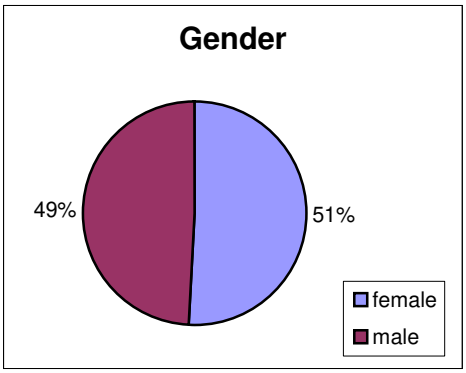
Figure 5: Other opportunities for sharing just-in-time information: a door messenger prototype allows family members to record audio messages saying where they are going as they leave the house (left), mobile devices for children send discrete updates about whereabouts (right).

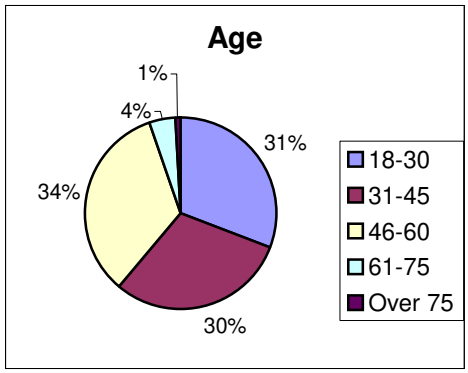
2.2 Web survey

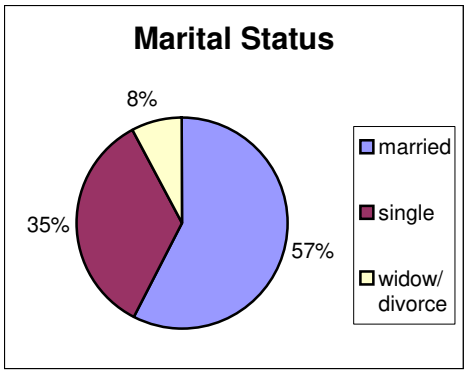
The early paper prototypes designed during the family workshops were helpful in eliciting ideas about how and why existing calendaring events might be shared electronically, and how they might be used for coordination activities like arranging rides for children. To augment our findings, we designed a survey (Hutchinson et al., 2002), available at https://www.cs.umd.edu/users/hilary/survey/survey.htm) to gather more information about not only how people currently do their calendaring (what they record, who they share with, etc.) but also how they handle uncertain or fuzzy calendar information. We sent it to our friends, family members, and colleagues with a request for them to forward it on to their friends and colleagues. We realized that this "chain mail" approach would probably yield responses from a population biased towards people demographically similar to ourselves – upper middle class and technologically savvy – but we knew that this would be the initial target audience for our application.

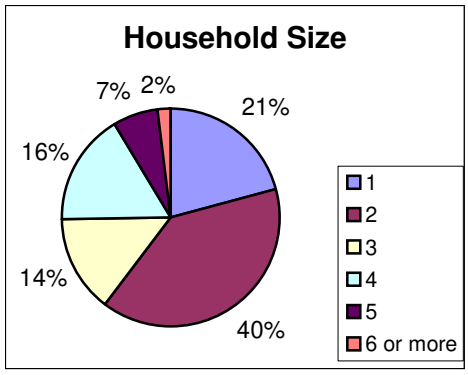
Over a period of about 2 months (end of July to beginning of September, 2002), we received over 400 responses to the survey. We don't really know what percentage of recipients this represents because of the chain-mail format of the survey, but consider this response to be quite good. We are aware that some of our results may be biased because individuals from the same family responded to the survey. Their individual calendaring habits, preferences, and problems are distinct, but their family calendaring issues (e.g. who maintains the family calendar) are probably similar. Many of our respondents likely came from the HCI community as the mailing went out to our large lab mailing list. Still, we gathered much valuable information.

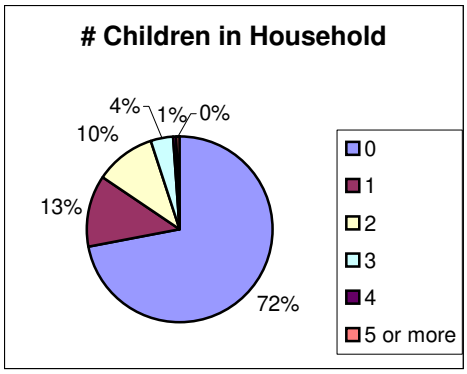
Demographics: Out of 401 respondents, we had near parity between men and women (49% vs. 51%). By age, we had about 30% each between 18 and 30, 31 and 45, and 46 and 60, but only 5% over 60. Fortunately, we have some of family design partners are grandparents, so we do have representation of the needs of this demographic. More than half of the respondents (57%) were married, while about a third (35%) were single, and the remainder widowed or divorced. 60% of the respondents lived in households with more than one person, but only 28% had children living with them. We would have liked to have had more respondents with children, since we believe that they add numerous scheduling issues due to their many activities, and their need for adult supervision and transportation. However, our family design partners include children, so we do cover this demographic that way. Finally, as expected, the bulk of respondents (70%) use a computer at least 30 hours a week.

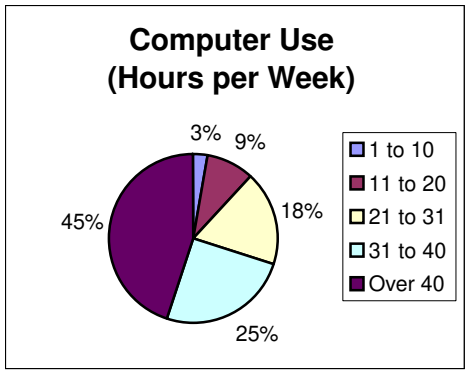






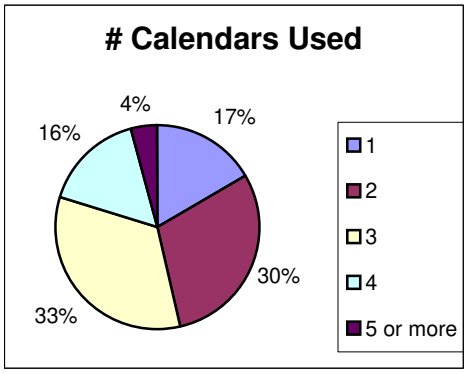


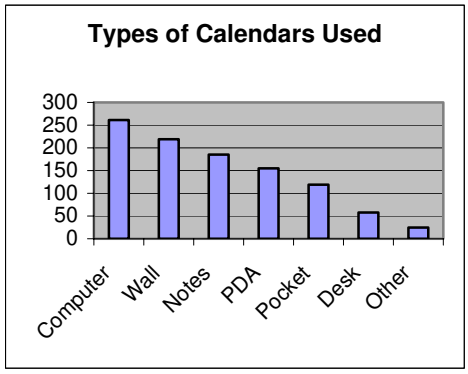


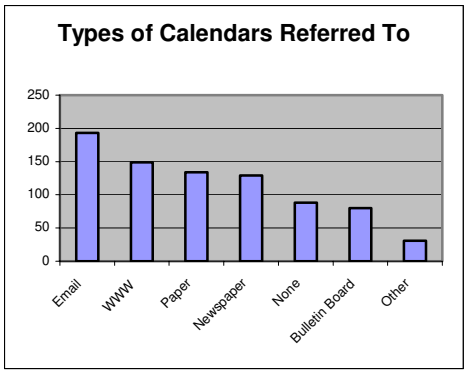


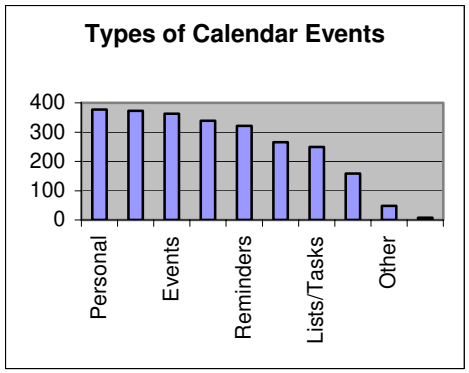
Calendar Usage

Only 17% of respondents use just one calendar to record information. Given the heavy percentage of computer users, it is not surprising that many people use computers and PDAs for recording and gathering information, but paper-based calendars are also heavily utilized. Personal and work appointments and events are the most recorded items.

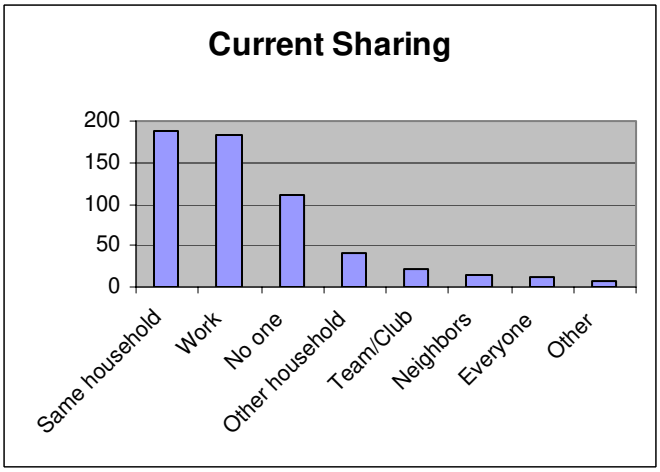


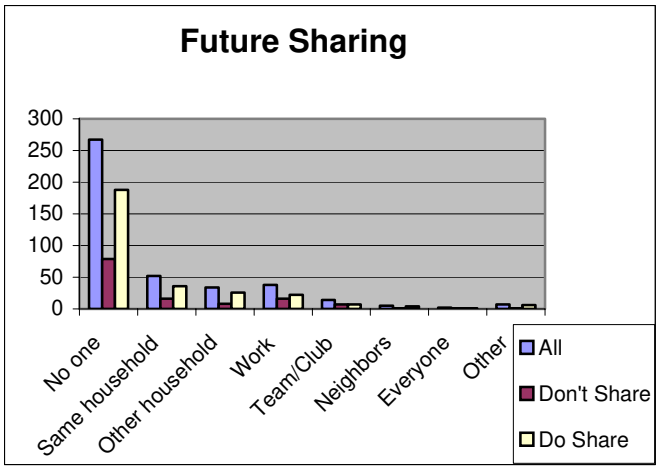






Calendar Sharing: The majority of calendar sharing takes place between people in the same household, or with work colleagues. These are also the people that respondents most wanted to share with in the future.





Calendar Problems: The following were the most common problems cited (at least 20 people mentioned them), in order from most to least frequent:

- Too many calendars to maintain, synchronize, and/or duplicate information on
- Unable to access from a different location
- Paper or electronic spaces too small to write in
- Compatibility issues with other software

Uncertain Events: The following were the most common ways of handling uncertain or tentative events (at least 50 people mentioned them), in order from most to least frequent:

- To do lists/notes/Post-It notes
- Make item visually distinct, using a question mark, pencil, or different color/font
- Guess day/time and manually or automatically move as necessary

At least 20 people also mentioned the following:

- Don't record it
- Record it somewhere else on the calendar, like a margin, evening, or Sunday
- Mark it with a tentative, free, or low priority label
- Set a reminder or alarm

Synchronization and Duplication: Out of 318 people who answered the question, only 53 reported they explicitly do not synchronize or duplicate information between calendars.

Maintenance of Family Calendar Information: Of the 270 people with at least 2 members in their household who answered this question:

- 119 have a single person who mostly maintains the family calendar information
- 151 have more than one person do this
- More than 90% of the "single maintainers" were women

3. THE CASE OF OUR FAMILY DESIGN PARTNER

The U.S. family worked more closely with us on this prototype while other families worked with our European partners on other prototypes. The U.S. family had already worked on the MessageProbe with us so we first present that family and then summarize the results of the MessageProbe testing relevant to the shared calendar prototype design. Next we summarize the interviews conducted in the family regarding their calendaring habits and their feedback to early paper prototypes of the shared calendars.

3.1 The family

The family consists of three households. The junior family consists of two parents and two children between the age of 10 and 13. Both parents work and the children have a very busy schedule of school and non-school activities including early morning swim practice, music lessons, theater or dance practice, rehearsals and concerts, interspersed with occasional school-related events such as fund-raising or test preparation, as well as medical appointments and social activities. The parents also organize car-pooling to school and volunteer to help in many of their children activities.

The two sets of grandparents constitute the other two households. Both live close to the junior family. They are in regular contact by telephone with their children (almost daily) and visit often. The paternal grandparents lived about 10 minutes away from the junior family but moved during the project to be within walking distance of their son's house. They had never used or owned a computer until we

installed the MessageProbe in their house. With time they became more comfortable with the computer and bought their own (with the help of their son). Even though she was the most reluctant to use the computer and participate in this experiment at its beginning, the main user is the grandmother. She enjoys playing solitaire and can use the basic functions of AOL email to communicate with friends. The grandfather uses the Internet to check the stock market every day. However, using the computer remains a formidable challenge that can not be sustained without regular assistance from family members or friends. They can perform a few simple tasks using "recipes" provided by others, but any unexpected behavior of the computer results in great confusion, sometimes a request for help, but usually abandonment. The computer is appreciated when working properly but rapidly ignored when something goes wrong.

The maternal grandparents live about 15 minutes away from their daughter's house. They have had their own computer for many years. The grandfather is fairly comfortable with computer technology, having used them regularly for work before retirement. He is a regular email user, and can comfortably help us "debug" problems over the phone when they occur. He has a strong - but often well founded- skepticism about computer technology and its reliability. The grandmother has not shown too much interest in using the computer herself, but has been supportive of the experiment and mostly an indirect user of the information provided by the computer.

3.2 Lessons learned from the family during the early use of the MessageProbe

The family used the MessageProbe for a few weeks during an earlier phase of the interLiving project. Three relevant results came from this experience: 1) the desire to have more awareness between remote households, 2) the desire to improve the coordinating of events such as arranging childcare arrangements or choosing a time to visit, and 3) the desire to have more reliable hardware and software. The first issue confirmed that the CSCW literature advocating the support of remote awareness in workplace groupware applications carries over to families as well. Despite the fact that the MessageProbe interface was designed to be used both asynchronously and synchronously, users in all the households wrote a number of notes wondering if another party was "there" to chat, and used the board to play synchronous games like tic-tac-toe or connect the dots (Fig. 5).

This need for awareness carried over to the second issue of trying to coordinate between the different households. Our family partners tried to use the board to coordinate meetings and pickups for childcare. They found this task difficult because often the requestor wasn't sure of the other party's schedule and if they would even see the note in time. We realized that remote schedule access would be helpful to address this problem. Knowing what others were doing at the time you needed them to pick up a child might save you the trouble of writing a message, and knowing what they were doing at the time you wrote the message would be helpful in deciding if they would even see the message before you needed their help.

The most obvious lesson from that experiment was the need for more reliable technology. We provided the households with high-speed Internet access, but it frequently didn't work for various reasons. The Internet service sometimes failed and the MessageProbe software or the server at Maryland supporting it sometimes crashed. When the software crashed, the less technology-savvy households often had to rely on the more savvy relatives to help them, adding an extra burden to these relatives. In another case, a family went away and when they came back, had forgotten how to use the interface. This result really drove home the already-reported-on need to make technologies for the home more attractive, easy to use, and fault-tolerant than the ugly, often complicated and crash-prone technology we tolerate at work. The families all agreed that the software was fun to play with, but they couldn't rely on it for any kind of important communications – if a child needed to be picked up from school, they would use the phone.

Since they could use it for unimportant communication, this family didn't show much interest in continuing to use the probe.

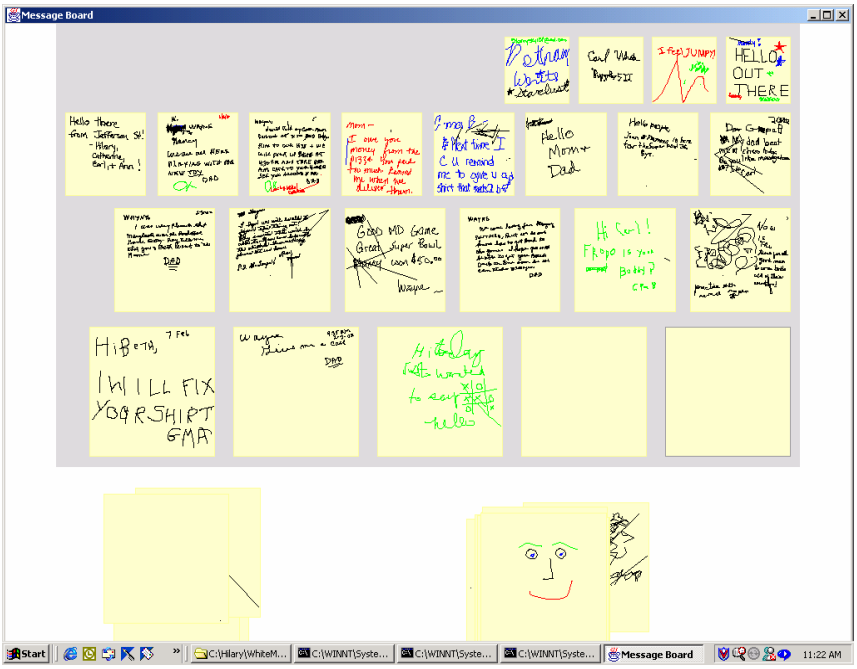


Fig. 5: Example of messages written on the message board by the family.

3.3 Interviews about calendar information

After we took the decision to pursue the design of shared calendars as our next step, we conducted a new round of interviews in the three households aimed at understanding how calendar information was kept and communicated between family members. After the first interviews we sketched paper mockups (Fig. 6) of a shared calendar and collected feedback and suggestions from the families.

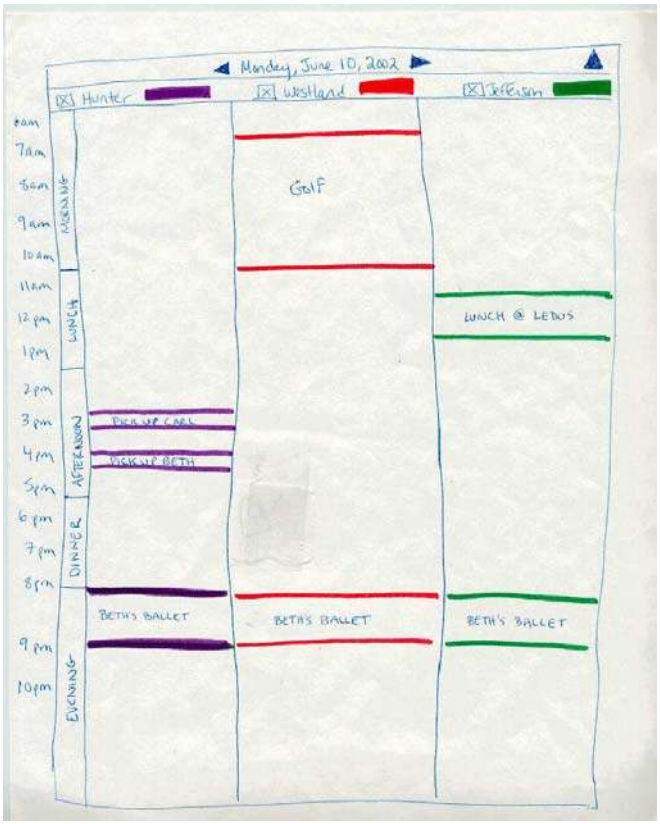


Fig. 6: Early paper mockup showing the three shared calendars for the three household, populated with realistic examples, used to collect early feedback on our planned prototype.

The busy calendar of the junior family is managed using a computer setup in the most used room in the house: the large kitchen where most meals are taken (Fig. 7). For more than a year before we started working with them, the junior family has been using Microsoft Outlook calendar program to record appointments and set reminders for the family. The parents usually enter events in the calendar but all four members of the family know how to consult the calendar, which they do several times a day. They are pretty happy with the system, but don't have a way of checking or managing the calendar when they are outside of the house. For this household, a shared electronic calendar would thus be an easy transition, but they would also benefit from some portable devices.

In looking at the paper prototype, they thought it would be nice to be able to put events on someone else's calendar, so long as it was clear whom they were coming from and it didn't imply any kind of commitment on the recipient's part. They liked the idea of keeping the grandparents in the loop with what was going on in their house, especially since grandparents can sometimes be a bit forgetful. We discussed the different ways you could use the calendar: to enter traditional precisely timed events (e.g. dentist at 9am") or for fuzzy events (e.g. "shopping today"), reminders, tasks/to-do lists, and notifications. We discussed how most of those things could be done in Outlook, but not always very easily. For example in Outlook, tasks are separated from calendar entries, and fuzzy times are hard to show. Notifiers (e.g. I've gone to the gym) could be done with separate electronic "sticky" notes but all those things are complex to specify and are not well integrated. All agreed that it would be too difficult to use for most of the grandparents.

We discussed the issue of data input because keyboards (or the tablet used with the MessageProbe) were hard for the grandparents to use. Voice annotations seemed like a great idea for notifications and sharing requests. If you wanted to put an event on someone else's calendar, you could drag it over to their column and then add a voice annotation that they could play. Or, if you were going out to do errands and

wanted others to know where you were, you could just leave a voice annotation at the time you left. The audio quality would have to be quite good though. Interestingly, they have a microwave where you can record voice messages but no one uses it. So, we may to investigate if this feature would be useful.

Fig 7: The Junior family's daughter using the computer in a corner of the large kitchen. On that computer the Outlook calendar is updated and checked several times a day.

The two sets of grandparents rely entirely on paper for their calendar information. The paternal grandparents use a pocket calendar, maintained and used daily by the grandfather who meticulously records appointments but also keeps detailed diary information such as stock values or time spent on particular tasks (Fig. 8). The grandmother relies on the calendar kept by her husband, but also keeps a separate personal list of birthdays and other special regular events.

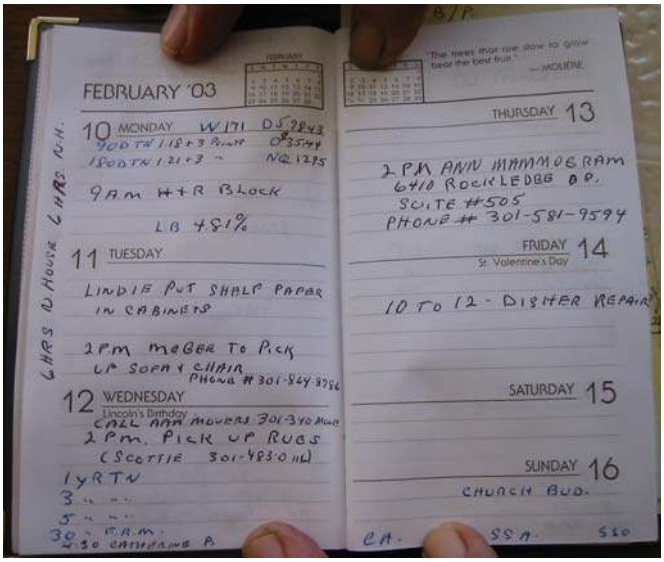


Fig. 8: The meticulously kept pocket calendar-diary of one of the grandfathers. A few appointments are recorded, plus several diary entries such a stock prices or hours worked on particular tasks.

The maternal grandparents have a much simpler, more ad-hoc way of handling calendaring. The grandmother handles most of it – important appointments or events (e.g. doctor's appointments) that come in paper format are put on the refrigerator as notes. To keep track of birthdays, she writes them on

3x5 note cards so they don't have to be entered into a calendar every year. A lot of their appointments are regular events (e.g. golf and haircuts) so they don't bother to write them down. A monthly wall calendar is used to record a very small number of special events. Occasionally messages are left on the coffee machine as special reminders (e.g. I'll go for lunch with Tom today after golf).

Our interviews of our family partners confirmed that even closely knit families who stay in touch through regular visits and phone conversations still have difficulties remembering the dates of each others' activities (e.g. Tell me again, when are you going on that trip to New York? Are the children still taking music lessons? Is school out for Veterans Day and do you need help from us that day?)

The grandparents know that their children and grandchildren's lives are very busy, so they clearly indicated that having access to their schedules would be nice. In looking at the early paper prototypes (Fig. 6) the idea of using voice for some features (e.g. I'm going to the store) came up. They wanted the calendar to flash or beep for reminders and messages. They liked the idea that if their children wanted to have them pick up one of the kids, they could drag that item from the children's calendar over to a grandparent calendar, and it would flash or beep until they saw it. They could accept the responsibility by clicking on it, or say no by dragging it back to their son's calendar. Given that they don't make much effort in their current calendaring, a simple, easily accessible interface was important. Writing on the refrigerator or paper was OK; typing appointments into a computer was not.

4 RELATED WORK

Coordination

Beginning with its first organized conference in 1986, the field of computer-supported cooperative design (CSCW) has produced a broad body of literature about how to design software (often called groupware) to support the work of groups of both collocated and distributed people (Ellis, C., Gibbs, S., & Rein, G., 1991; Grudin, J., 1994; Olson, G. & Olson, J., 1997.) There has been a great deal of research in the area of coordination technology, particularly group calendaring, but it is focused almost exclusively on the workplace (Beard, D. & Palanlappan, M., 1990; Palen, L., 1999; Bullen, C. & Bennett, J., 1990; Kelley, J. & Chapanis, A., 1982; Kincaid, C. & DuPont, P.; 1985; Mueller, E., 2000, Mynatt, E. & Tullio, J., 2001) In the area of information visualization, there has been some interesting work in improving the interfaces of electronic calendars through fisheye views and animated zooming, for example the Perspective Wall (Robertson et al. 1993) or Datelens (Bederson et al., 2003). However, none of this previous work has addressed the unique needs of home use and in particular distributed families.

Shared information between homes and families

The HomeNet study at Carnegie Mellon (Kraut et al. 2002) indicates that computers and the Internet can contribute to coordination problems by isolating people from family and friends and increasing their daily stress levels. However, the study also suggests that when used for communication, computers and the Internet can play a positive role in keeping people connected – email, instant messaging, and family web sites are just a few of the ways the Internet helps keep people in touch. Thus, the jury is still out among many families about the value of computer technology in their daily lives. A huge diversity of ages, abilities, interests, motivations, and technologies must be accommodated. People are much more concerned about the aesthetics of technology artifacts in their home than at work (Westerlund and Lindkvist 2002) and their values may influence their use of technology (Voida and Mynatt, 2002). Finally, the line between home and work, and thus the technology needed to support both, is becoming ever more blurred, with dual income families and telecommuting now commonplace. Previous research with families revealed the importance of respecting privacy, not creating new obligations, and offering multiple modes of communication (Hindus et al. 2001). Checking on elderly relatives has been addressed with technologies such as the digital family portrait (Mynatt et al. 2001) that provides ambient

information abstracted from sensor data collected in the home of the elderly parents. Others have looked at using distorted sound from the remote home to monitor activity (Marmasse and Schmandt, 2003).

Digital paper and pen

A number of researchers have recognized the benefits of digital paper, and rather than looking for ways to replace paper in the workplace or at home, they have instead explored ways to enhance it so that users can continue to rely on it. Mackay et al. (1999) summed up the reasons nicely, noting that physically, paper is lightweight, flexible, adaptable, and disposable. People can continually invent new uses for it on the fly, and manipulating and writing on paper can help aid memory. Socially, sharing it can provide peripheral awareness of other people's activities. This is especially relevant in shared calendaring, where the placement of a Post-It note or the recognition of someone else's handwriting can convey important meaning. Researchers have tried a number of techniques for augmenting paper to imbue it with some of the benefits of computerized information, such as storage, recall, editing, and linking to related media. Some solutions involved using video cameras to read information from and project information onto paper using optical character recognition (Johnson et al, 1993; Wellner, 1993). Other applications were enhanced with the use of barcodes to identify specific pieces of paper (Ishii and Ulmer, 1997; Lange et al., 1998; Nelson et al., 1999) or a similar marking called a DataGlyph invented at Xerox PARC using cameras or scanners (Grasso et al. 2000; Heiner et al. 1999; Johnson et al, 1993; Moran et al., 1999).

Recently, computer vision techniques have advanced enough to allow researchers to identify even individual Post-It notes without any special markings (Klemmer, 2001). The advent of small, inexpensive radio frequency ID (RFID) tags has lead other researchers to explore embedding them in books, documents, and business cards (Back et al. 2001; Want etal. 1999]. Others have used special graphics tablets overlaid with paper to record both real and digital ink (McGee et al. 2002; Stifelman, 1996; Seiko SmartPad). Despite the ability of these technologies to enhance paper with useful features, many require expensive and/or awkward to use tools such as high resolution video cameras or special scanners or tablets. The switching cost to invest in and adapt normal modes of operation in order to use them is high.

Most recently, researchers have succeeded in embedding tiny cameras in pens to record handwritten text [Dymetman and Copperman, 1998; Nabeshima, et al. 1995; Anoto technology; Seiko InkLink), scan typed text (Arai et al. 1997, C-Pen), or react to invisible ink embedded in the page (Paper++). These technologies show more promise for deployment in the home – they do not require investment in large or complicated equipment or reconfiguring of the home environment to accommodate them. Among the most promising technologies supporting the recognition of handwritten text is a pen and paper system created by Anoto (www.anoto.com) and sold by LogiTech (www.logitech.com). Anoto's technology works by printing a tiny pattern of uniquely spaced dots on any regular paper. A camera in the pen records the coordinates of the pen tip on any such page and sends them (e.g. via Bluetooth or USB) to a computer, PDA, or cell phone to reconstruct the handwriting. The advantage of the Anoto system compared to competitors (e.g. Seiko's InkLink) is that it really does only involve pen and paper. The pen is special, but any paper will work once it has the pattern printed on it, either by one of Anoto's many commercial paper company partners (e.g. 3M), or by developers.

Some paper calendar companies have already agreed to produce their products on Anoto-patterned paper (e.g. Mead At-A-Glance and Franklin Covey). Anoto has already built software to allow appointments created in these paper calendars to be routed directly to either Microsoft Outlook or Lotus Notes calendars. A software development kit allows developers to provide access to other programs. For users who currently have to manually synchronize either their own or others' paper and electronic calendars,

this automatic linking could provide huge time savings, as well as avoid the all too common forgotten or improperly copied appointment.

However, the current support for calendaring with Anoto assumes and requires the same workplace interface imposed by the computer-based calendars they synchronize with. In the paper appointment book we received with the Anoto demo kit, users must not just simply write their appointment at the desired time, but draw a line next to it indicating the duration. There is no way to integrate input from less time-specific weekly or monthly calendars, or even less uncertain data from Post-It notes that you might want to affiliate with a specific day or week or just use as a reminder or fun note. Anoto has built support for digital Post-Its, but they are not integrated with calendaring. Worse, in Microsoft Outlook, there is no support for handwritten input, so the appointment shows up in typewritten text as "Pen Appointment" and users must open the appointment to actually view the handwritten information. Supporting the most common computer based calendaring programs is clearly necessary to integrate paper and electronic calendars, but this sort of hacking to display the output is limiting and awkward.

5 SHARED CALENDAR PROTOTYPE

Some recent research projects that address family awareness have done so with surveillance systems where the older adults are monitored by their children (Mynatt et al. 2001; Marmasse and Schmandt, 2003). This may be appropriate in some situations but we believe that more benefits could be gleaned from a symmetrical open exchange of information. Sharing of calendar information could provide a useful window into the day to day activities of remote family members. Grown children could see if their parents' activity level is normal or not (e.g. one Grandpa is mowing the lawn and going to the movies with Bob as usual, while the other has not seen anyone for a while and does not have any if his usual doctor's appointment scheduled). On the other hand, Grandma could see that her granddaughter is taking flute lessons again every Tuesday and that the next concert will be on October 15th. For those reasons and after collecting positive feedback from the family about this design principle we decided to provide entirely symmetric access to the calendars.

A common hurdle for the use of technology in extended families is the resistance many older users have to use computers as well as pointing devices. Off-the-shelf calendar software is available but designed mostly for business users and overwhelming for older adults who are very hesitant about using computers at all. Pointing devices such as the mouse can be difficult to master and intimidating. Even the pen and tablet we used for the MessageProbe were found clumsy to use and discouraged use. Our approach to address this problem was to: 1) provide alternative modes of data entry and 2) layer the calendar graphical user interface to provide a simple interface as well as more advanced ones, with a mechanism for the families to specify – or request to us - what interface they would use. To allow the grandparents to enter data in the simplest way possible we investigated the use of a digital pen and digital paper.

Other researchers have recognized the important affordances of paper in many domains and sought to augment it with electronic information using cameras, tags, and special tablets (Johnson, et al. 1993; Wellner, 1993; Stifelman, 1996; Mackay and Fayard, 1999; Klemmer et al. 2001; Guimbretiere, 2003). We see digital paper as a Trojan horse to introduce the grandparents to the shared calendars – and maybe computers in general – but our hypothesis and goal is that some users will gently make the switch to the keyboard based interfaces that will give them access to more features, while others will prefer the simpler interface which limit the number of features.

Description of the interface

The basic principle of the shared family calendar interface that we built is to tile multiple calendars next to each other and synchronize their navigation (Fig. 9). A click on a day enlarges the day on all calendars and makes it more readable (Fig 10). Everyone can see all the calendars on their computer

screen, but each household has the ability to hide the calendars they do not want to see to make more room for the others. For example, grandparents will most likely choose to see their own calendar and the one(s) of their children, but not the calendar of the other grandparents (Fig. 11). In the simple mode of the interface, only a week view is available and all calendars are coordinated and can be navigated at once with the mouse and the keyboard. The next and previous arrow keys select and enlarge the next or previous day, the up or down arrows switch to the previous or next week, and the escape keys un-enlarge the currently selected day to make all days of similar size. Users can also select the size of the characters. Bigger characters are more readable, but may lead to multi line labels and some of the text of events to disappear until the day is selected and enlarged. At the top left of the screen a home icon allows users to return to the current week with the current day highlighted. The interface was built by extending DateLens (Bederson et al., in press) and takes advantage of its animated transitions.

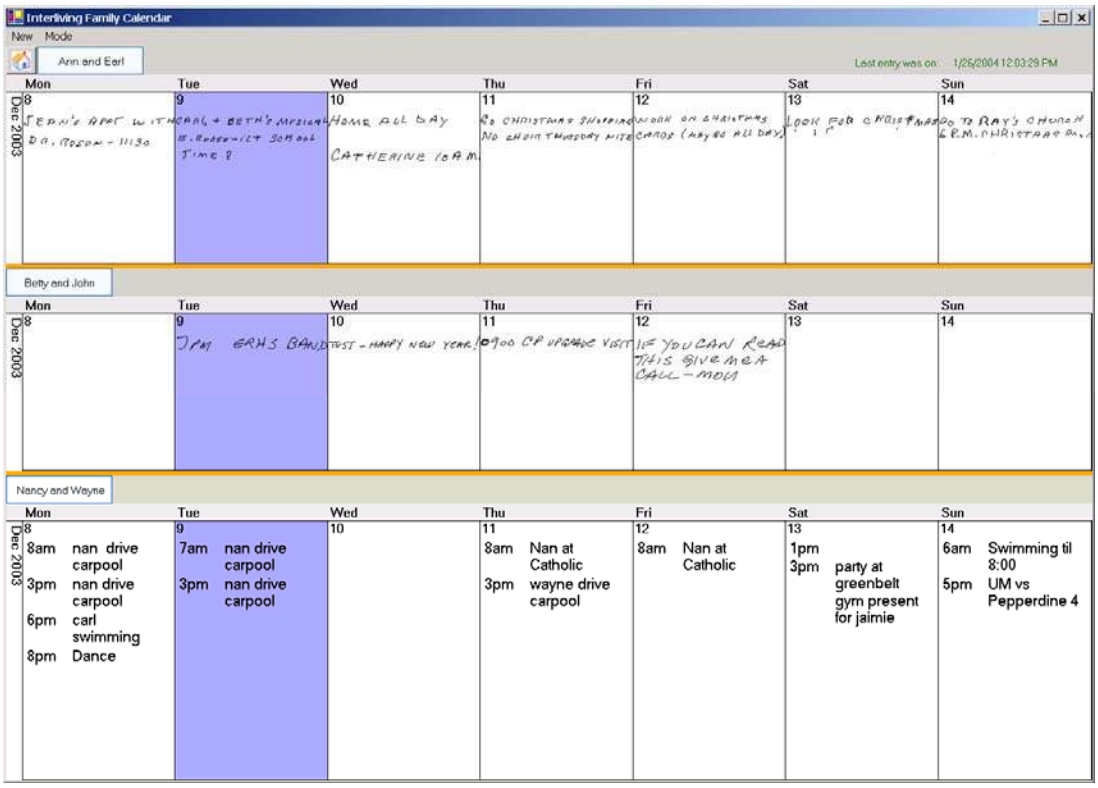


Fig 9: The basic interface shows a week view of the 3 calendars side by side. The information on the top two calendars was handwritten by the grandparents. The information in the lower calendar was entered with Microsoft Outlook by the junior family.

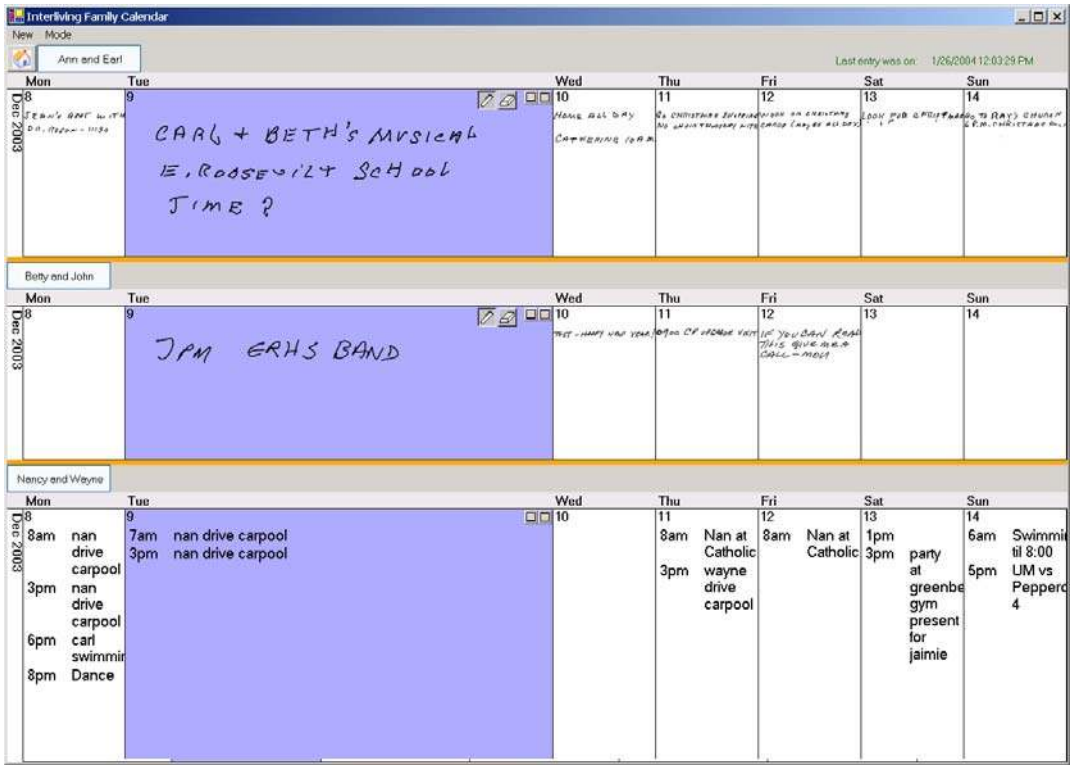
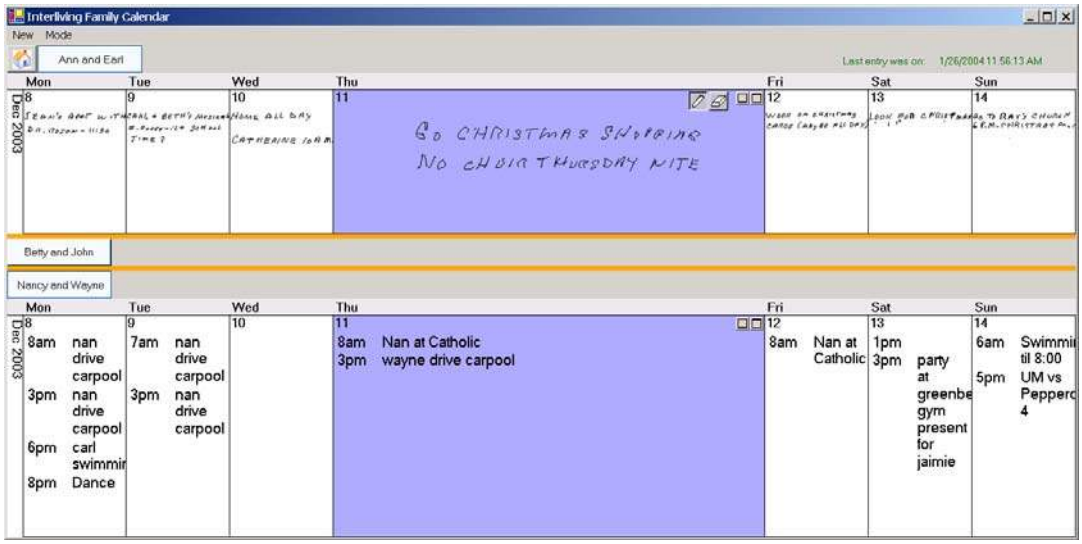


Fig 10: Clicking on a day enlarge the day to improve readability.



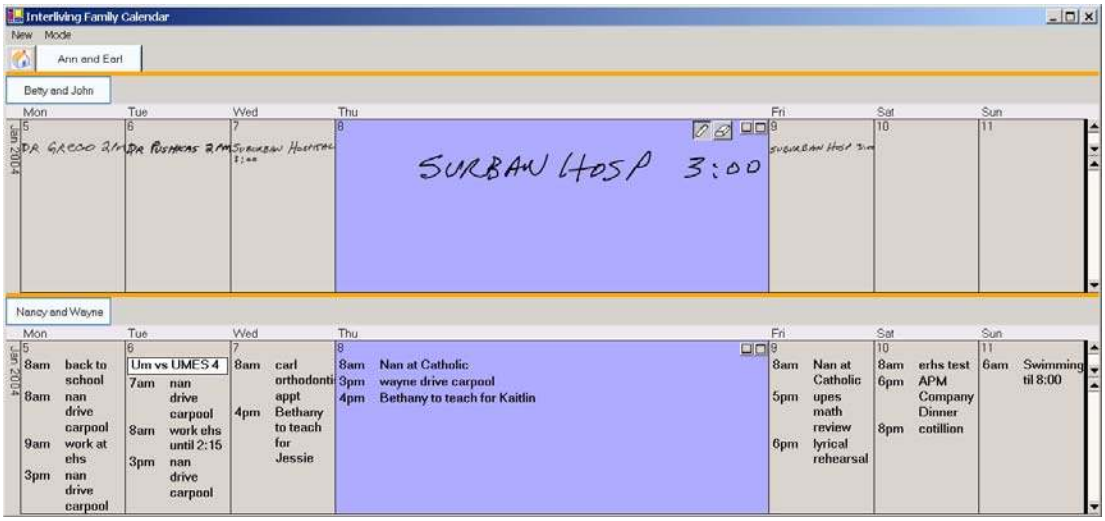


Fig. 11 a and b: The grand parents chose to see only their calendar and the one of their children.

The methods of data entry can vary. The simplest method which was used for the grandparents is to write on calendar printed on digital paper using a digital pen (Fig. 12). When the pen is placed in its cradle the information is transferred to the computer and appears on the corresponding day.

Fig 12: The grandparents write on their small pocket calendar printed on digital paper (left) and replace the pen on the cradle to transfer the information to the computer (right).

Advanced users (for example the junior family) can use Microsoft Outlook to enter all the calendar information. That allows them to specify the start and end time of an event, edit their descriptions, or delete or move events. They can set reminders, enter repetitive events all at once and specify their periodicity, make events private, and enter as many events as needed for any particular day. The interface for those numerous functions seems fairly simple for users with computer experience but is overwhelming for users with limited computer knowledge. It requires users to memorize long series of actions for navigating menus, typing, setting widgets and dragging icons or scrollbars, which are very difficult for novice older adult users.

The data entered with the digital paper calendar appears exactly as it appears on paper, rescaled as needed to fit the screen space. The data entered with Outlook appears as text that can be laid out to fit the screen space.

Implementation

The calendar was implemented as a special version of Datelens (Bederson et al. 2003) (Fig. 13). It uses a layered architecture that automates Microsoft Outlook in the background, while providing a custom view to the families. This approach enables us to create our own visualizations tailored for novice users by using any desirable features already built into Outlook, while filtering out the more complicated features. In particular it allows us to use a standard Microsoft Exchange server running at the University of Maryland to coordinate and synchronize all the calendars in the distributed households. A single Exchange server mail account was created for the family, and three calendar folders were created for that user (a standard capability of Outlook). The calendar information for each household is stored in a different calendar folder, and the three calendars are synchronized periodically on the network.

Our shared calendar interface software reads the three Outlook calendars and presents the information on a single screen. The paper and pen data input interface uses Logitech digital pens with Anoto technology. We printed the calendar ourselves on commercially available pads of digital paper with Anoto patterns. This allowed us to create calendars of the size and layout we wanted to fit the needs of our families. When users write on the calendar and replace the pen on the cradle, the Anoto software generates an XML document to describe the strokes on the paper. All the ink written on a given page of Anoto paper is saved in a single XML file. For our software to know which portion of the XML file corresponds to each day of the calendar, we print the calendar double-sided on consecutive pages and pass the Anoto page number of the 1st day as an attribute to our calendar software. We parse that XML document and using the Tablet PC Software Development Kit, we convert it to a set of ink objects (one per day of the calendar, i.e. per rectangular portion of a page) that are saved as individual attachments to appointments in the Microsoft Outlook. Our shared family calendar software renders all the ink objects in the calendar displays. It also listens for updates in the Outlook calendar folders which occur either when local users enter new information, or remote users have entered new data and Outlook has synchronized the three calendars.

We chose not to use optical character recognition to convert the handwritten information because it would force the families to write more deliberately, and we want to preserve the benefit of unconstrained handwriting. Because of the choice of using a small pocket paper calendar, there was no room for laying out the hours of the day as found on day-by-day calendars or large weekly calendars. Users of the paper calendars can choose to write a begin time for an event, or not.

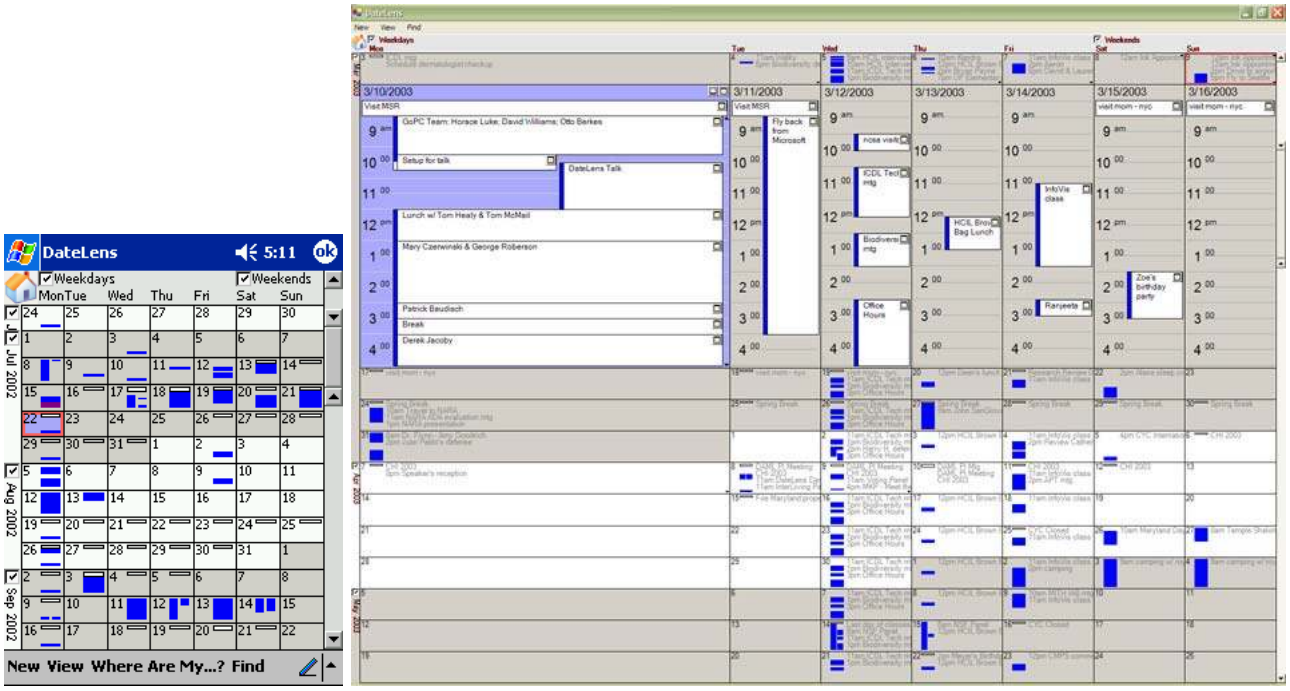


Fig. 13: DateLens was designed for small mobile devices (left) but can also be used as the desktop application. It uses fisheye views, multiple views and visual data summaries to assist users navigate the calendar.

We hypothesized that advanced users – i.e. the junior family adults – might also want to use the full DateLens interface to have access to scrollable monthly and yearly views, or search and filter on the three calendars, or decouple the calendars to view and compare different weeks in different calendars, at the price of increased complexity. Therefore, options were added to allow users to access such functionality within the shared calendar interface if they chose to. In this more advanced mode the three calendars are decoupled, allowing the individual scrolling of calendars. Moving a sliders' range thumbs also allows users to change the number of weeks seen in each calendar, from one to 3 or 4 for a monthly view. Windows are resizable and individual home icons allow users to return to home for each individual calendar. Users can also enter events using the keyboard and mouse using menus and a form fill-in similar to Outlook's new event interface.

FIELD STUDY OF THE SHARED CALENDARS

Deployment in the families - Dealing with scheduling delays and technical difficulties

The prototype was installed in the three households and is still in use. Deployment was significantly more difficult than we anticipated, particularly in dealing with aspects relating to networking. There were general networking problems which were compounded by the requirements of our University network as described later. The deployment in the families started in early September but we were able to collect usage data only at the end of October. This surprising delay was due to a combination of scheduling problems and technical difficulties.

Even though our own schedule was fairly flexible and the families live close to campus, scheduling visits for interviews or to install software or debug problems sometimes took weeks to schedule. The junior family is very busy even during evenings and weekends, and special events such as holidays or trips constrained our visits as well. For the grandparents there was either no problem setting

appointments for the next day or we had to wait several weeks. Travel, moving, illness or illness of close friends sometimes created unexpected long delays. It is unrealistic to believe that older adults are always available and ready to deal with the complexity of interviews, computer installation, training and operation.

Despite the fact that we use fairly standard technology, we had many technical problems, most of them unrelated to the software we had written ourselves. One important constraint was that we had to use the computers of the families (as opposed to new hardware that could be set up in the lab), and therefore we needed to minimize disruptions to their current setup. Grandparents were happy to have us come and upgrade their new computer with more memory or new software, but changes were not acceptable to the junior family, which relies so much on the computer that they dread the idea of having us modify anything in their computer. Of course we had to make some changes but this created a great deal of anxiety for the family, and for us as we feared erasing precious calendar information while we were setting up the synchronization with the network server or upgrading to a newer version of Office to allow such synchronization. We also struggled with using different versions of Windows and Office. The three computers had three different configurations. The options and setting we had to set for Outlook were accessed through different menu hierarchies and often used different names. When something went wrong debugging could not always be done immediately. We consistently underestimated the amount of time require to install software and even updates.

We often had to schedule additional visits to finish installing or setting up software, which could again delay installation for a week or so. The final details were difficult to arrange as we could not be in all three houses and in the lab at once to correct problems. One example of this problem occurred after we installed the junior family version, and proceeded to install the software on one of the grandparent computers. The installation went well, ink could be written on the paper calendar, the Outlook synchronization seemed to work properly, and we could see the junior family calendar from the grandparents' house. We left and started celebrating but the next day we had a report of ink calendar events being duplicated at random in the calendar and of duplicated events appearing in the junior calendar exactly one day off. After some extreme puzzlement and a few days of investigation it turned out that the grandparent's computer had a different daylight saving option which had no effect locally but affected synchronization. The anxiety ran high as we had to clear the junior calendar by hand of all the duplicate events and clean and reset the paper calendar XML files in all three households. Fortunately no permanent damage was done and after about two months of setup time we were ready to really start the field study.

Even today some problems remain: Appropriate University security policies require a Virtual Private Network (VPN) to be setup before connecting to the Microsoft Exchange server. But our families have been experiencing consistent problems with keeping that connection alive. We tried to train the families to recognize that the VPN was down and to restart it, but this was not effective. Finally, we created a small program to monitor the status of the VPN and restart it automatically. Bugs within Outlook have also created minor problems that still remain. For example, events sometimes get duplicated when the calendar information is accessed by an outside program (it appears as if the event had been modified and the two variants are kept, see Fig. 10 for examples of duplicated events).

Overall results

After two months of use, the main finding of the field test is that grandparents have strongly indicated an appreciation of being able to see the schedule of their children and grandchildren. Both sets of grandparents report checking the calendar at least once a day. They have entered data on the paper calendar on a semi-regular basis, when the connection and software have been functional. They regularly apologized to us for not having that many things to include in the calendar. The junior family

on the other hand has been so plagued with technical problems that they have not used the shared calendar very often. They did continue to use Outlook regularly as before, and the mere synchronization of the calendars allows their parents to review up-to-date calendar information. The junior family repeatedly indicated that their limited use was due to the technical challenges and not lack of interest. Because the junior family is currently checking the grandparent's calendar very seldomly, the grandparent's motivation to enter information in their calendar is limited. The maternal grandparents never had any difficulty using the pen or the calendar, but clearly indicated that they were not motivated to enter data if their daughter was not going to look at it. In two cases he even entered illogical entries in his calendar to see if that would be noticed by the others. Despite limited use, both sets of grandparents spontaneously requested new paper calendars when the first one expired, without us asking them if they were interested in continuing this experiment.

The pen and paper calendar was easy to explain and quickly learned. "How much simpler could it be?" said one of the grandfathers. The only problem encountered with the pen was that it had to be returned to the cradle the proper way and not upside down. There was a problem on the first day but never again after that. The pen never ran out of batteries, mostly because it was usually kept in its cradle. It was found unnecessary to carry it around since the data was not transferred until the pen was returned.

Training was always an important part of the visits to the paternal grandparents. During the initial visits we were struck by the strong interest of the grandparents in seeing the schedules of their children. While we were presenting information about how to use the interface, they were barely paying attention to us and our explanations but instead carefully studying the calendar and discussing together some of the implications of what they had found (e.g. "We should move the birthday dinner earlier because there is a music lesson later that day"). This interest was made clear at every visit when we had to restart the computer or software because something had been disconnected. We also spend a fair amount of our time discussing how to use Microsoft Word and how to turn off features such as the automatic spell checker, or how to eliminate the annoying popup ads that appear when browsing the internet.

After a month and a half of use, the paternal grandmother requested the ability to enter appointments directly into the calendar by typing. She explained that while the pen-based interface was simple, she felt that her handwriting didn't look nice enough on the screen. She used to type on a typewriter so typing was not a problem and she wanted her text to look as nice as the text entered by her children (Fig. 14). We switched her software to be in the "intermediate" mode that allowed her to enter appointments directly. The interface proposed is similar to Outlook, but simpler (Fig 15). Nevertheless it is still difficult for her to enter events with the keyboard and we worked together with her to prepare a set of written directions to help her remember what to do. This feature has not been used much and we suspect that it is too complex to be used in its current form. This request indicates that digital paper may be a powerful tool to introduce older adults to computers, but that once they feel more comfortable, they may be ready to switch to more conventional modes of interaction. While we were explaining how to enter text with the keyboard to his wife, the grandfather indicated that he still much preferred to use the paper calendar and had no intention of using the keyboard.

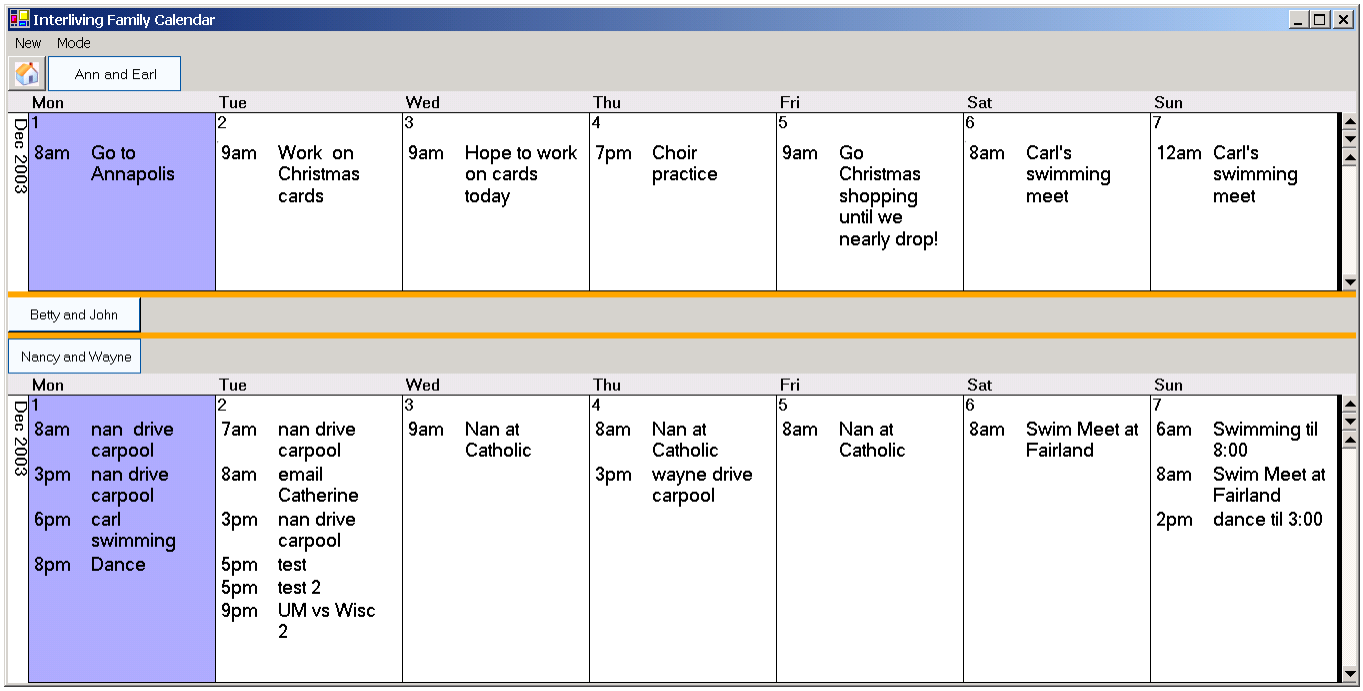


Fig. 14: One of the grandmothers found typed text nicer looking that the handwriting. Other grandparents preferred the simplicity of the paper calendar.

Fig. 15: To type the event description users need to use a more advanced version, which has a NEW button to create new events. Editing and deleting events can also become more challenging.

Incremental changes made to the interface

Through the course of our experiment, we have gone through several iterations of the software. The changes have been driven by comments from the families using the application.

The initial improvements were made to improve the readability of the text and ink. The grandparents said that they could not easily read the text of the events, and complained that the text was often clipped while there was plenty of space to display it (Fig 16). The day names (Monday, Tuesday etc.) were also hard to read. We added an option for setting the font size of the text, and displayed the event as a simple list instead of trying to place the event at a fixed position corresponding to the time of the event. This also reduced the need for scrolling when events occurred early or late (in fact it eliminated it entirely during the testing).

To increase the readability of the ink we first tried to set a limit to the rescaling of the ink, which lead to clipping of some of the data. This was found misleading as some information was simply never noticed, and it was decided that it was better to be able to see the whole content than to clip it, even if this meant

that the ink would appear smaller on the display. On the other hand, it was found acceptable to pan the ink on the available display space to see it better. For example, if all the text for a day was handwritten at the bottom right of a rectangle on paper, it would still appear zoomed in as much as possible to fit the area of the display corresponding to that day, making it more readable.

As we tested the usability of the interface, we also removed more DateLens features that were not needed for the family calendar. For example, the Weekend and Weekdays buttons were removed (all days were found equally important), the scroll bars were removed (the weekly calendar was found sufficient and the arrow keys fine to navigate), and the calendars were labeled with users names instead of generic labels such as "Calendar 2".

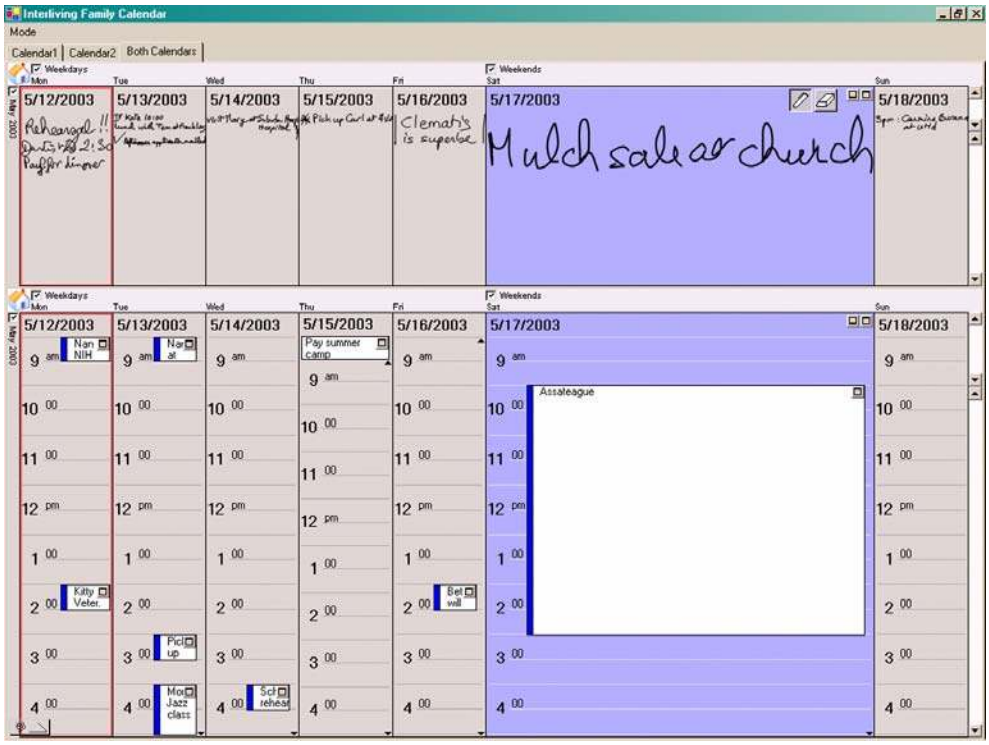


Fig. 16: An early version of the interface with unnecessary controls, event descriptions displayed in too small a font and often clipped.

A concern for the junior family was the issue of privacy. Even though this would rarely be necessary it was deemed important to provide a mechanism to "hide" certain events when needed. This could easily be addressed by the privacy feature of Outlook. When necessary, events can be made private when entering them using Outlook, and the shared family calendar simply ignores them. This has only been used for one event during our field study. Grandparents could make appointments private by simply writing with an ordinary pen instead of the digital pen (this has not been used during the test).

CONCLUSIONS

Our interviews demonstrated that even closely knit families that stay in touch through regular visits and phone conversations still have difficulties remembering the dates of each others' activities. Our investigation suggests that users who maintain home calendars will glean valuable information from peeking at each other's calendar, and that the heightened sense of awareness of current and planned activities might actually increase the amount of communication ("So, what did the doctor tell you?" or

"When you go on that overnight business next week, check the Van Gogh exhibit"), and potentially facilitate coordination. We observed a clear increased awareness of the junior family's activities by the grandparents. Technical problems and the overwhelmingly busy lives of the junior family limited their use of the shared calendar but their impressions were positive. We observed that different family members used the calendar in different ways. For example, one grandfather diligently recorded many events, while one grandmother never really touched the computer but regularly went to simply look at the screen. We also confirmed that the digital pen and paper was an effective way to create easy-to-learn, non-threatening technology for older adults. All three household chose to continue the testing for a few more months. We hope that as use increases, the families will also start using the shared calendar to plan tasks that require coordinating the schedules of multiple people.

ACKNOWLEDGMENTS

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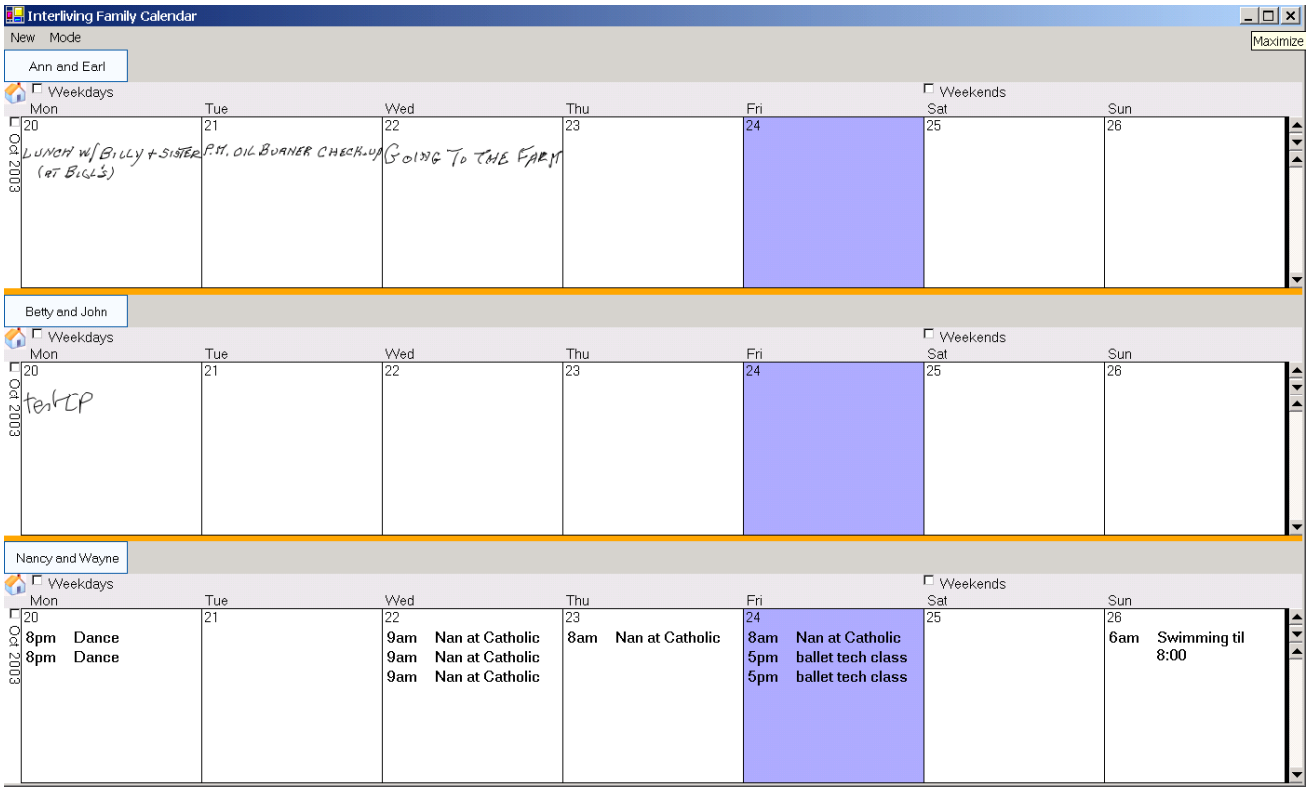
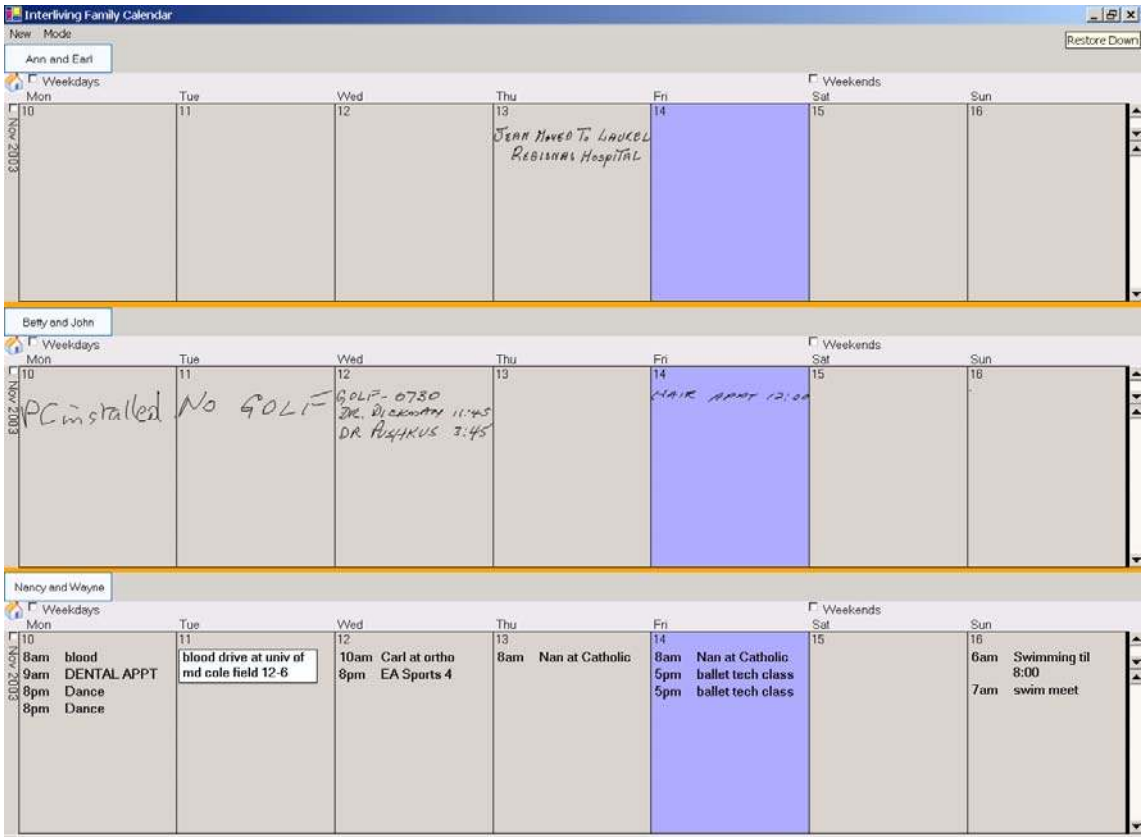
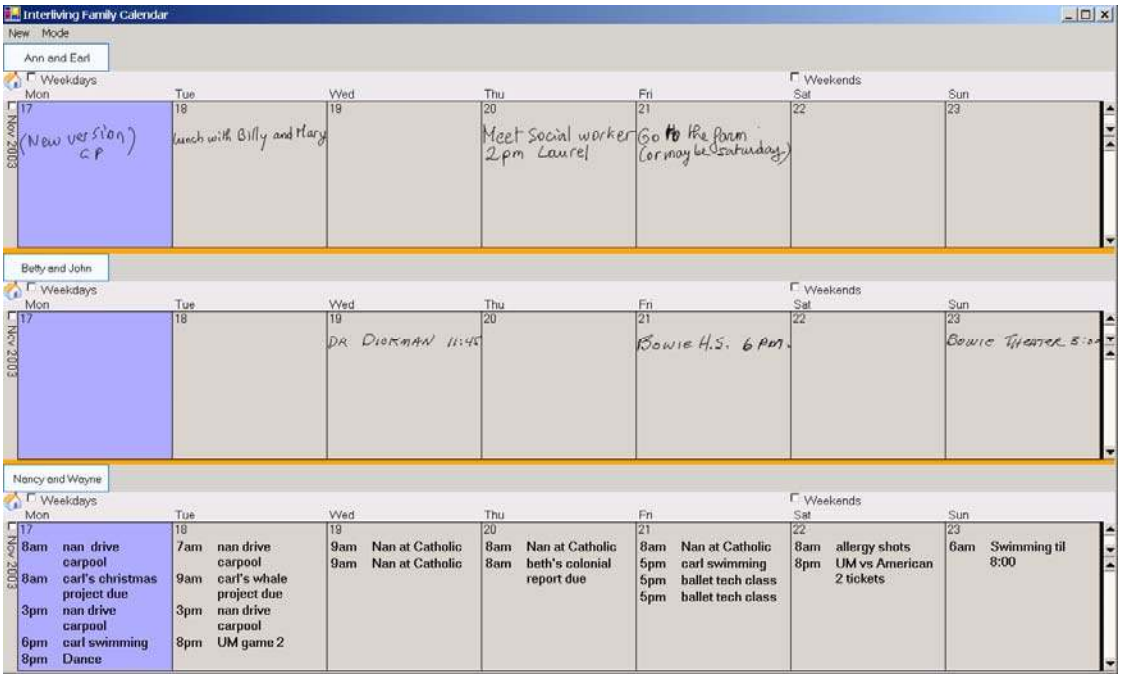
Appendix A: Additional screen prints at different stages of the field test.



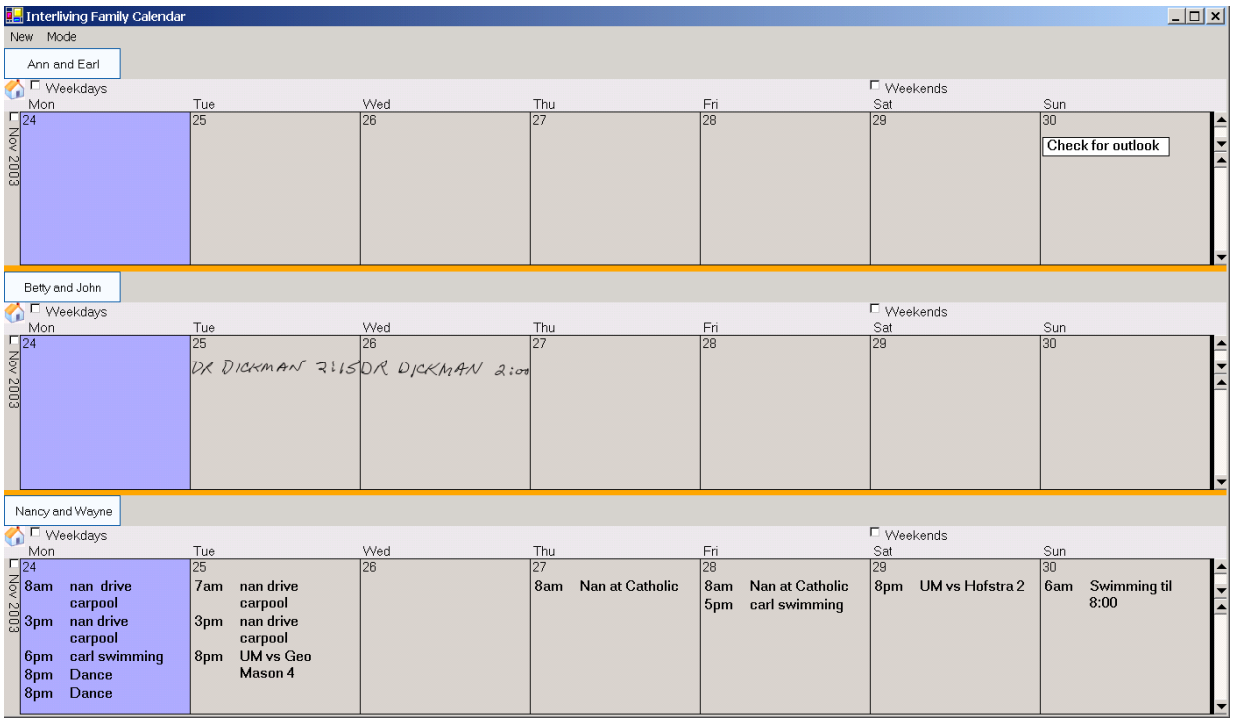
The 1st week of the study, running only in two households. Some events became duplicated later on.



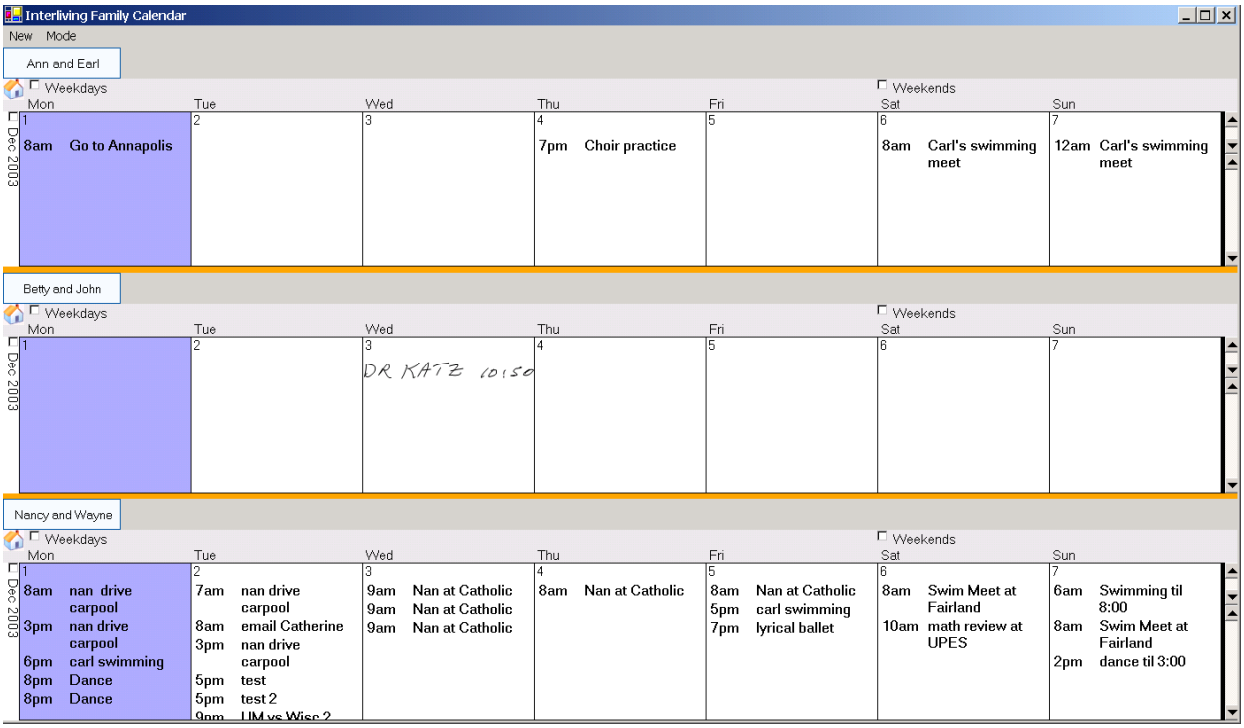
Third week. The third household joins in.
A close friend is ill and the paternal grandparents become mostly unavailable.

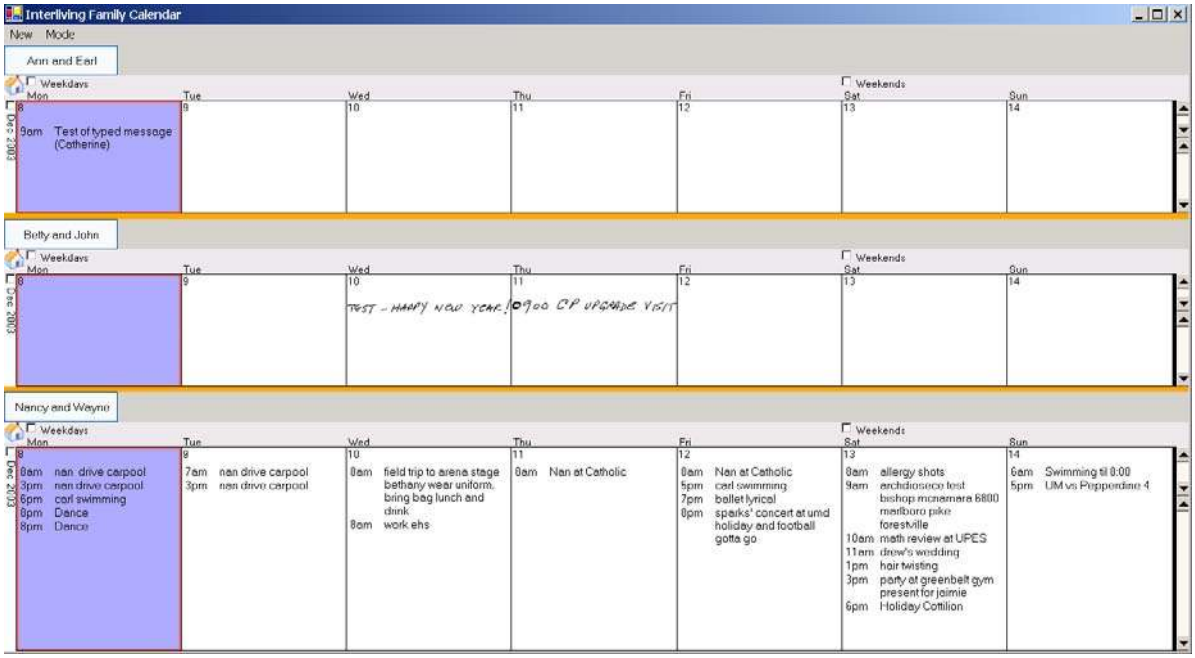


Fourth week

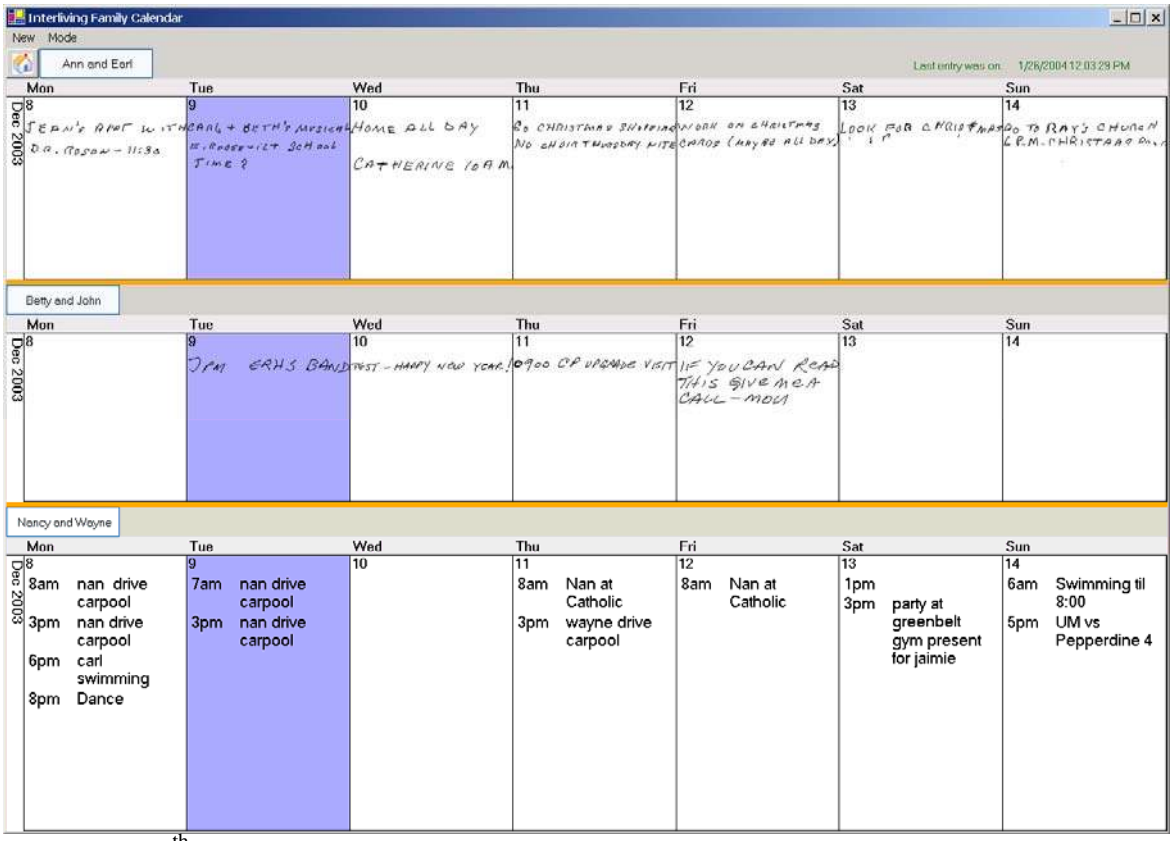


Start of Fifth week





Start of 6th week (see next Figure for later view of that week)



Same week 6th, more handwriting but some of the junior family events have been removed. This is the final week included in the paper calendars. Grandparents requested new calendars.