Designing an Interactive Message Board as a Technology Probe for Family Communication

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ABSTRACT
In this paper, we describe the design issues and technical implementation of an interactive Family Message Board. The Family Message Board enables members of a distributed family to communicate with one another both synchronously and asynchronously via simple, pen-based, digital notes. Each household running this Java-based software can view, create, and manipulate notes in a zoomable space. The Family Message Board will be used as a "technology probe" to help us understand the communication needs of distributed families, and to help us design new devices to meet those needs.

Keywords
Technology for families, CSCW, shared communication, remote awareness, zooming user interfaces, ZUIs, disappearing computer, cooperative design, participatory design, technology probes.

INTRODUCTION
Today's families are more geographically distributed than ever. Children attend schools far away from their parents; grandparents may live in a different country than grandchildren. Letters, email, instant messages, and telephone conversations can help keep remote family members up to date on major family events, but the patterns of everyday life are often missed. In addition, these communication techniques are all either strictly synchronous or asynchronous, and each suffers from some bothersome complications.

Letters and email are asynchronous activities that don't provide any remote awareness to the participating parties about one another. Letters are addressed to only one household and require a trip to the mailbox or post office. Email requires computer and internet competence, time wasted dialing up and logging in, and isolation from collocated family members. Both also assume that participants are able to read and write.

Instant messaging and phone conversations are synchronous activities, requiring both parties to be present to communicate at the same time, and are not persistent – once you log off or hang up, there is no record of the interaction. Like email, instant messaging requires computer knowledge and literacy, and can lead to wasted time and isolation. Phone conversations can be expensive and are limited in the number of participants.

Figure 1: Family Message Board

In an effort to address these problems, the InterLiving Project, a part of the European Union-funded Disappearing Computer Initiative [7], is attempting to develop embedded technologies to improve and simplify communication, collaboration, and creativity among distributed families. We are working with multi-generational families in Sweden and Paris as design partners, using traditional ethnographic study and participatory design methods in addition to what we have termed "technology probes" to explore the communication needs and desires of distributed families.

One of these technology probes is the Family Message Board, a software program designed to be used with a digital writing surface and display where family members can write or draw notes to each other, much like paper sticky notes (see Figure 1). Local and remote family members can have boards in multiple locations (e.g. home, work, school), and all are networked together so that all the messages posted show up on all the message boards in real time. As a technology probe, the Family Message Board was designed to be adaptable to a variety of uses and scenarios so that family members could experiment and

discover the most valuable ones (see Technology Probes below).

The message board can function synchronously, with two or more family members communicating at the same time, or asynchronously, with family members checking their boards periodically for new messages. This second function allows family members to see messages that may be totally unrelated to them (e.g. "Pick up milk after work"), but help give a sense of daily events. The boards are connected only to a small set of family members, removing the need for complicated setup and remembering names, addresses, or buddy lists. There is no mouse or keyboard – just a pen - and literacy is not required. Finally, the message board hardware can be embedded in social areas of the home such as a family room or kitchen, and can be made portable via wireless technology.

RELATED WORK

The Family Message Board design encompasses work from a variety of fields, which we describe below. The technology is heavily influenced by shared whiteboard projects in CSCW and commercial communication software such as instant messaging. As a device for families, our work builds on growing research into technology for the home. In an effort to keep remote family members connected in a meaningful way, we were influenced by research in remote awareness. Our user-interface design is based on past experience with zoomable user interfaces. Finally, our desire to involve our users in the design process comes from experience in participatory design and lead to the concept of technology probes.

The idea of a networked, digital writing surface has a long history in the CSCW literature through numerous implementations of shared whiteboard technologies. From early work such as Wang's Freestyle and Xerox's Tivoli projects to more recent applications including Flatland and Rekimoto's Pick-and Drop, these whiteboards have provided innovative features for synchronized, networked communication in the workplace [39,30,27,32].

The shared whiteboard idea quickly gravitated from dedicated devices to standard PC desktops and from synchronous activity to asynchronous messaging via virtual notes. Lotus' TeleNotes application was among the first projects to recognize the need for shared, asynchronous workplace communication by supporting virtual desktop sticky notes [40]. Greenberg's Notification Collage is a more recent example that supports more advanced communication by allowing colleagues to post pictures and converse via live video in addition to posting notes to one another [14].

In the commercial arena, virtual note applications are ubiquitous in the PC and PDA markets. TurboNote+ is a shareware program that allows Windows PC users to create onscreen sticky notes that can be delivered over the Internet via IP or via email [35]. Electric Pocket has developed an application called BugMe! Messenger that allows users of Palm OS-equipped PDAs to exchange handwritten, text, and graphic notes to other PDA's or via email [6].

In the home, asynchronous communication via notes and more popular email soon gave way to synchronous communication via instant messaging (IM) and chat applications such as AOL's Instant Messenger and Internet Relay Chat (IRQ) [1,29]. Recently, both research and commercial efforts have been made to identify and exploit additional remote awareness information available during IM and chat sessions.

Nardi et al. have identified a number of uses for IM in the workplace that fall outside of traditional communication, including negotiation of availability and sustaining social connections [28]. Researchers at Fujitsu are experimenting with augmenting IM on cell phones to include icons indicating emotions and text memos [25]. Yahoo's Messenger IM service has recently integrated Webcam functionality to allow users to see each other via live video [42]. In the chat arena, traditional text-based applications have been augmented with avatars equipped with a selection of gestures and expressions [22] and abstract shapes that convey information about a user's activity graphically [37].

Our Family Message Board borrows features from all of these previous projects and products, but the combination results in a unique application: first, it is meant for home use by a fixed set of users; second, it is meant to be used with an embedded or portable writable tablet display; third, it can be used both synchronously and asynchronously; fourth, it is meant to support remote awareness; fifth, it makes use of a persistent, graphical, zoomable user interface; and finally, it is a technology probe whose design is being guided by the families using it.

This first difference is perhaps the most significant. Designing technology for the home is far different than for the workplace. People have goals other than improving productivity or efficiency when using technology in the home. For instance, the HomeNet study at Carnegie Mellon found that interpersonal communication (e.g. email) is more popular than information or entertainment applications [20]. Home users are also likely to be less tolerant of ugly, utilitarian designs and hardware or software failures. Finally, they are far more diverse, in every sense of the word, than the target audiences of many technology products [33] – people of all ages, interests, and abilities are potential users.

Despite these differences, households and designers of household technologies continue to treat home technologies such as the PC as work-related devices. The social spaces in the home where family members spend most of their time interacting with one another (e.g. kitchen, den) are separated from work spaces (e.g. "home offices") where PC's are kept [23,36]. Thus, technologies such as email and instant messaging that home users appear to want to use to stay in touch with remote friends and family can have the unwanted side-effect of keeping these users isolated from

their collocated family members, perhaps even causing declines in psychological and social well-being [21].

To avoid this problem of isolation, technologies can be embedded in more social areas of the home, or made lightweight and portable so they can be carried and shared where people wish to use them. As part of the Disappearing Computer Initiative, the InterLiving project seeks to develop technologies that do exactly this. The evidence for home users' desiring such technologies is compelling. In a recent study by MediaOne Labs, home users given portable, wireless, Internet-enabled tablets cited portability and the ability to multi-task as the nicest features of the tablet as compared to a PC [24].

Interval Research's Casablanca project used ethnographic field studies and consumer testing of design concepts to gauge home users' interest in new technologies for the home [15]. One of these devices, a prototype simulation of a ScanBoard, provided similar functionality to the Family Message Board. Users could post messages using a writable LCD screen networked to other family members, as well as scan in photos, drawings, and other paper artifacts to be digitized and shared. Users appreciated the ability to keep in touch with or monitor family members in a fun, low-cost, simple way, and specifically liked the ability to share via scanning and to communicate in more expressive ways.

The Casablanca project also revealed that in addition to the more obvious goals of simple, low-cost devices to use to keep in touch, users wanted devices that respected privacy, did not create new obligations, and offered multiple communication modes. The Family Message Board addresses all of these criteria with its communication mechanisms. Note posting can be done synchronously, like IM or chat, or asynchronously, like email. Privacy is ensured because only known family members are connected to the network and there is no monitoring aspect. There is no obligation to reply immediately or at all to a message.

In addition to supporting both synchronous and asynchronous communication, we were also interested in providing remote awareness for family members separated by distance, making frequent face-to-face meetings impossible. Work in this area, such as the Xerox PARC's Media Space project, and the Portholes, Peepholes, and Thunderwire applications, has focused on helping remote colleagues work together and maintain informal connections using video, audio, and icons to create virtual media spaces [5,8,13,16].

In later work, the AROMA project sought to find more abstract representations for mapping remote activities into local displays [31]. IBM's Babble software augmented a traditional chat interface with "social proxies" – small digital dots that moved in and out of a circle to indicate participation in a conversation [10]. Recently, research in this area has spread to the home and is becoming especially popular as the baby boom generation ages. For example, Mynatt's Digital Family Portrait was designed to help adult children check in on aging parents in an unobtrusive manner via active icons on a picture frame [26]. Likewise, the persistent, real-time updating of colorful notes and drawings on the Family Message Board provides a sense of presence to remote family members.

Another difference between our Family Message Board and many other communication technologies is its persistent, graphical, zoomable organization of messages. This user interface design grew out of a number of years of experience in our lab with designing zooming user interfaces (ZUI's). Unlike most chat and IM applications, which are text-based and transient, we used the Jazz toolkit (see Technical Implementation below) to help users arrange and navigate graphical messages written with a digital pen in a large zoomable space [3].

A recent study by Bederson and Boltman indicates that the animated transitions between viewpoints in this sort of zoomable environment improves users' abililities to reconstruct information spaces [2]. The Family Message Board aims to help users organize and find their messages by allowing them to arrange their messages in a persistent space. Users can zoom in and out of the space and drag notes in and out of a default grid arrangement to design their space of notes in a meaningful way.

TECHNOLOGY PROBES

The final differences between the Family Message Board and many other communication devices involve its use as a technology probe with our family design partners. The idea of partnering with users has a long history in the HCI community, with methodologies including contextual design [41], cooperative design [4], and participatory design [12] all allowing adult users to work with technologists. More recently, Druin has extended this partnership to include children through the method of cooperative inquiry [9]. We extended this idea to work with distributed, multigenerational families, which we believe will result in new methodologies as well.

The idea of a technology probe was motivated by Gaver's work with cultural probes – maps, postcards, disposable cameras, and other materials "designed to provoke inspirational responses from elderly people in diverse communities" [11]. These probes were distributed to a group of elderly people, who returned them over the course of a month filled with informal information about their lives and cultures. We extended this idea to use technologies, rather than physical objects, to gain an understanding of communication needs, rather than cultural norms.

The Family Message Board is one such technology probe that we plan to deploy in families homes. Like the cultural probes, it was designed to inspire creativity and encourage them to think about how they like to communicate. Families can use it synchronously and asynchronously, draw or write in multiple colors, and develop conventions to arrange notes however they like. We will gather this

information via log files, interviews, written correspondence, and other methods and use the feedback to inform designs for future communication devices.

DESIGN ISSUES

Our main goal in designing the Family Message Board was to keep it as simple, adaptable, and open-ended as possible. As a technology probe, the design needed to allow families to find innovative and unexpected uses for it without being encumbered by restrictive functionality. Once the families had discovered the best uses for it, we could then alter the existing design, hardware, and software, or perhaps even start over and build something totally different, to create what they really wanted.

We decided to build a message board based around virtual notes because of the universal popularity of paper sticky notes for informal family communications and reminders. We would lose the very nice feature of being able to stick notes on anything anywhere in the house, but gain an unlimited supply of notes and the ability to share them remotely with others. As much as possible, we wanted to simulate the experience of writing real paper notes, moving away from standard desktop computing and towards a single, small, embedded, portable, device that users could view and write on with a digital pen.

This design goal was reinforced by results from the MediaOne web tablet study, which showed that users found small, portable keyboards and handwriting recognition were difficult to use with the tablet [24]. The Family Message Board only takes free-form input from a single pen. We also chose to stay away from added features like voice or video annotations, as supported in the Notification Collage [14], or the ability to scan in real paper, as supported in the Scanboard [15], for two reasons. First, we didn't want to complicate the device or introduce features that might threaten families' perceptions of privacy. Second, as a technology probe, we wanted the message board to encourage families to suggest such features on their own if they really wanted them.

The interface design for the Family Message Board proved to be the most interesting design issue. With the potential for multiple remote family members to be viewing, manipulating, and writing on their devices simultaneously, there were a number of usability and synchronization issues to consider. Not only is the message space shared by family members at multiple locations, but multiple family members at the same location share a single message creation and viewing device. As a result, there is really no sense of individual ownership in the space.

Thus, we chose to implement a bullitin board-like interface rather than one involving mailboxes or separate visual areas for notes to or from individual users, topics, or devices. Control of the notes in the message space is shared by all users. Anyone can write on, move, or delete any note in the space, regardless of who created it. When a note is created, a margin near the top of the note is stamped with the name of the device that created it (chosen by each family location when the device is installed) and the date and time it was created. This information is used to give a sense of remote awareness and timing when the board is used asynchronously.

New notes are immediately sent to all the devices in the family and are displayed in the same location on all devices. By default, new notes are arranged according to their creation time in a grid demarcated by a yellow border. New notes appear in the lower right corner of the grid and older notes are scaled to progressively smaller sizes and pushed to higher rows in the grid. Notes can be emphasized by tapping an "!" icon in the top left corner of the note with the pen, causing it to become slightly larger and changing the background color of the top margin. Notes are deleted by tapping an "X" icon in the top right corner of the note. All actions except for drawing are delayed on remote devices until the device is idle for 10 seconds to prevent remote actions from interfering with someone interacting with a device locally.

We did not want to force any kind of organization of notes on users, but needed some way of arranging them initially and of managing the space required to display a large number of notes. We chose to arrange them in a grid according to their time of creation because it is the only known note feature. Any one of the multiple family members that share a device can create a note, and any other family member, locally or remotely, can later modify it.

Organization and personalization of notes beyond the default placement is entirely up to users. Notes can be dragged out of the message grid anywhere in the message space. Notes can also be dragged back into the grid, where they resume their place in the time-based order. The background color of a note's top margin changes color as it is moved in and out of the grid. As notes are added or removed from the grid, the grid reorganizes itself to fill up empty space. This design choice means that spatial consistency is lost as notes are moved in and out of the grid, perhaps making notes harder to find in the grid.

However, we believe that spatial consistency will be achieved by users removing notes from the grid to organize the notes themselves. Without the automatic reorganization, the grid would rapidly become a huge waste of space filled with holes. Thus, the design does not preclude the idea of organizing notes by topic, creator, ink color, whatever; rather it leaves this decision up to the users collectively.

This design also allows for some interesting, and perhaps unexpected interactions, which add to users' sense of remote awareness. Two users can draw on the same note at the same time or one user could delete a note that someone is in the middle of writing. There is also no erase functionality – users simply add to existing notes, create new ones, and delete old ones. Like paper sticky notes, crossing out errors or simply starting over is less effort than finding an eraser.

The only things that aren't shared collectively by local and remote users are the toolbar controls fixed to the top of the message space in each device. Although the arrangement of the notes in space is the same for all devices, each device controls its ability to create new notes and its selection of pen color for writing and drawing. This allows multiple users to interact with the message space at the same time. Buttons are available for creating new notes and selecting one of four pen colors.

In addition, each note controls its own selection of notes to interact with and its own view of the message space. This allows users at each remote location to control their own view of the notes for browsing. Only one note at a time in each device's view of the space can be selected. This note is the only note that a local user can draw on, emphasize, move, or delete. Tapping a note with the pen makes it the active note and animates it into a full screen view via zooming the current view of the message space.

Six navigation buttons enable local users to view the message space in various ways, independently of remote users. Left and right arrow buttons navigate through notes in the order they were created. Tapping the left arrow button animates the view to the note that was created before the currently selected note, if any. Tapping the right arrow button animates to the note created after the currently selected note, if any. These arrows are disabled if there is no currently selected note or no note before or after the currently selected note.

Zoom in and out arrow buttons animate the camera view to focus on more or less of the message space. If a note in the local device is selected, the view zooms around this note. Otherwise, the view zooms around the center of the entire message space. A "Show Recent" button zooms the view so that only the two most recent rows of messages in the grid are visible. A "Show All" button zooms the view so that all the messages in the space fit in the device window and unselects the currently selected note, if any.

TECHNICAL IMPLEMENTATION

The Family Message Board software was built using Java 2 and three Java-based toolkits: the University of Maryland's Jazz, Sun's Java Shared Data Toolkit 2.0 (JSDT), and Interbind's XIO, all available for download on the web [19,18,17]. The Message Board hardware requirements include a writable LCD display, such as Sony's Slimtop [34] or Wacom's PL Series [38] pen tablets, and a Windows-based PC. The software will also work with a regular graphics tablet, such as a Wacom Graphire, and a regular monitor.

We used the Jazz toolkit for the spatial arrangement of messages in the Family Message Board. Jazz provides a two-dimensional scene graph structure for organizing graphical objects in a large, zoomable canvas. Objects are viewable and zoomable through a virtual camera and can be translated, rotated, and scaled. Messages in the Family Message Board are arranged on the canvas in a grid as they are created, with older messages shifted and scaled to less prominent grid positions. Individual messages and areas of the grid can be zoomed in or out, and messages can be dragged out of the grid and placed in arbitrary locations on the canvas.

We used JSDT to support communication between multiple Family Message Boards scattered among the various households of a distributed family. JSDT provides support for collaborative, networked applications by supporting full-duplex, multicast communication. Multiple clients can join and leave communication sessions in order to exchange and share information. Each instance of the Family Message Board is a client that joins a well-known session established by a central server, who is also a client in the session. A separate JSDT registry process keeps track of all the clients in the session.

Each time a client creates or modifies a message, JSDT sends information about this message to all other clients and the server using a reliable, TCP-based communication channel. When a client receives this message information, it creates or updates its local copy of the message and updates its display to reflect the change. When the server receives this message information, it stores it locally so that new clients who join the session later can request the current messages in the system. The receipt of new or modified message information is synchronized at each client so that only one is processed at a time in the event that multiple remote devices are active.

Finally, we used Interbind's XIO to provide robustness in the event of a server failure. XIO is a Java package that can be used to read and write Java objects to and from XML files. Users create templates describing the objects in a class that they want written out to an XML file. XIO uses the template, a serialization manager, and the class's JavaBeans setter and getter methods for these objects to create the file when writing and to recreate the objects from the file when reading. The server for the Family Message Board uses XIO to write out information to an XML file about each message in the session whenever it receives an update. If the server crashes, all of the message information can be retrieved from the XML file to recreate the message space.

FUTURE WORK

With the design and implementation of the Family Message Board complete, our next step is to deploy it in the homes of our family partners to be used as technology probes. Using feedback from their comments, suggestions, and system log files, as well as feedback from other technology probes in the InterLiving project, we will gain a better understanding of their communication needs. With this information, we can work with them to design new communication technologies that address these needs better.

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