

“LINC-ing” the Family: The Participatory Design of an Inkable Family Calendar

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ABSTRACT

Families must continually organize, plan, and stay aware of the activities of their households in order to coordinate everyday life. Despite having organization schemes, many people still feel overwhelmed when it comes to family coordination. To help overcome this, we present our research efforts on LINC: an inkable family calendar designed for the kitchen. LINC was developed using a participatory design process involving interviews, paper prototyping, and a formative evaluation. Our work outlines key implications for digital family calendars and family coordination systems in general. We found that coordination is not typically done through the family calendar; rather, the family calendar is a tool that provides family members with an awareness of activities and changes that in turn enables coordination. Thus, digital family calendars should provide tools that enable families to use their own coordination routines which leverage the social affordances prominent in existing paper calendars.

Keywords

Calendars, families, home, coordination, awareness

ACM Classification Keywords

H.5.3 Group and Organization Interfaces - Computer supported cooperative work

INTRODUCTION

Everyday family life involves a myriad of mundane activities. For example, recurring soccer games, piano lessons, doctor’s appointments, work schedules, relatives’ visits, family outings, and much more. These events must all be scheduled and coordinated between family members and then re-scheduled if things do not go as planned or conflicts arise. As a result, family life often requires a complex routine for awareness and coordination to manage the everyday activities that constitute personal and family life [1,11,20]. This notion of family coordination extends beyond the home to also encompass activities while mobile or at work [1,3]. For example, it involves scheduling appointments while at the doctor’s office or checking the

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family calendar at work for evening events. Despite families using various organization schemes, family coordination still remains an everyday problem for many people [17].

Paper calendars are one tool used by families to help stay organized: they are easy to use, easily shared, mobile, personalizable, and create an instant archive of family activities [2]. Yet the downside is paper calendars are not available outside the home and can be hard to synchronize if multiple calendars are used [2]. The alternative is a digital calendar, which brings with it the power of technology: information access anywhere, the ability to easily change and edit events, and easy synchronization between calendars. Technology already plays a role in family calendaring in the form of email, digital work calendars, and mobile devices [1], yet most technologies do not adequately address the coordination problems faced by families because they are not designed specifically to address domestic coordination needs.

It is clear that family calendaring is part of a vast and intertwined coordination system. Yet the family calendar in the home is one of the core pieces of this system. If a digital coordination system is to be adopted by families, the in-home family calendar must be designed to easily fit within existing domestic routines. Given this, we focus specifically on the family calendar in the home in an effort to better understand how to design a digital home calendar that could then be part of a larger family coordination system.

We present the participatory design of LINC—an inkable family calendar for the home—where our goal is to unite the flexibility of paper calendars with the ability to turn calendaring information digital, allowing it to then be used as part of an integrated family calendaring system. We outline a series of design principles based on related work and then show how we have used and extended them through our participatory design process, which included interviews with mothers, paper prototype sessions, and a formative evaluation of a digital version of LINC. We conclude by discussing the key implications we have uncovered for the design of family coordination systems.

DESIGN PRINCIPLES FOR FAMILY CALENDARS

Our initial ideas surrounding family calendar designs were largely influenced by design implications that we found in

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the related literature. We present these here as high-level design principles and in subsequent sections show how our design supports and extends them.

1. **A family calendar should be designed as a simple awareness appliance.** Naturally, all designs should be simple, but this is especially true for the design of home technologies. Through ethnographic studies, Beech et al. [1] found that people have little time to learn how to use new systems when at home and Edwards and Grinter [6] point out that current home appliances are largely successful because they are both simple and reliable. One way to overcome complexity is to design *information appliances*: devices designed to perform a specific task or function [12]. Neustaedter et al. [11] argue that families are often not at the computer and that *awareness appliances* that can be spread throughout the home are needed as tools for family coordination rather than applications designed for a desktop PC. *In the case of digital calendars, we feel this means that a family calendar should be just that, a family calendar. Moreover, its visual layout and user interaction should be simple.*

2. **A family calendar must be flexible in order to support a variety of domestic routines.** Taylor and Swan [20] examine mothers' work in the home and introduce the notion of "organizing systems," which capture, integrate, arrange, and convey information through the use of artifacts such as calendars, to-do lists, and paper notes. They suggest that digital systems for the home must allow combining heterogeneous devices, support flexible systems of organization, and integrate with established organization systems. Dourish's theory of embodied interaction also describes how a design's usage should be decided by the user and not the system [5]. Similarly, Neustaedter et al. [11] discuss that family awareness tools should not be designed to replace existing routines; rather, they should augment them and create new opportunities for coordination schemes. *In the case of digital calendars, we feel this means providing tools through which people are able to employ their own routines rather than restricting them. It also points out that a digital family calendar should be part of a larger system of coordination tools.*

3. **A family calendar should provide tools for coordination.** Neustaedter et al. [11] found that family members use a daily awareness of their cohabitants' activities to coordinate schedules. This awareness is gathered using face-to-face interaction or technologies like the phone, email, or instant messaging, which highlights the role that communication systems play in family coordination. From their fieldwork, Crabtree et al. [4] found that family coordination is about negotiating schedules rather than predicting event attendance and making others aware of who is going to be at an event. They suggest that family calendars should support *negotiation protocols* that provide families with the ability to negotiate schedules through the calendar. *For a digital family calendar, we feel*

this means presenting family members with an at-a-glance awareness of daily activities and coordination tools built into the calendar.

4. **A family calendar should support contextual locations.** Crabtree et al. [3] and Elliot et al. [7] show that people already have well-established routines for the placement of communication media throughout the home. Technology should be designed to be placed in these locations or moved between them. Work on situated displays for the office by O'Hara et al. [13] highlights the idea that placing displays in a particular location brings added value for users. Crabtree et al. [4] show that family calendars are typically in high-traffic areas of the home and argue that digital family calendars must maintain this physical presence in the home, yet be accessible from anywhere at anytime including outside of the home. Location-based designs should naturally allow social acts to remain noticeable, which Harper et al. [9] points out is a current strength of paper-based systems that allow people to share, broadcast, and notice change. *In the case of digital calendars, we feel this means that a family calendar should be designed for easy placement within a variety of locations in the home, likely those of frequent communal activities.*

Several commercial family calendars have been developed (e.g. 8,14), yet they are designed specifically for the web. In contrast, our goal was to understand how to design for domestic locations. Plaisant et al.'s [16] shared family calendar focuses on sharing between multiple families, rather than our focus on intra-family coordination.

These principles provide guidelines for the design of a family calendar. Our contribution is to show how we have put them into practice in our own design and, more importantly, how we have extended them with new implications for the design of digital family calendars that were not found in the related work. In the next section, we describe our method for building on these principles.

PARTICIPATORY DESIGN METHOD

We recruited twenty mothers with at least one child over three years of age to participate in our design process. We chose mothers as prior research has shown women are the primary schedulers for households [1,10,20] and that family scheduling is more difficult with children [1], though naturally calendaring challenges will vary amongst households depending on other factors as well. Otherwise, we sought a diverse group that varied in age, family composition and employment. One caveat of our user selection is that we did not include other family members that comprise the secondary users of family calendars. While we can learn from all family members, with a limited number of users we felt that the primary scheduler could provide us with the best overall picture of the family's coordination processes.

As it turned out, all but one of our participants said they were the primary scheduler within their family while the

remaining participant shared the role with her husband. Eleven participants were aged 31-45 and the remaining nine were aged 46-60. All but two participants were currently married. Our participants were fairly diverse in the number and age of their children. Six participants did not currently work outside of the home and the remaining fourteen had a variety of jobs (e.g., realty, law, art, teaching), working a range of hours from less than 20 to over 40 per week.

Our participatory design process began with the iterative design of several low fidelity prototypes [18]. After reaching what we felt was a reasonable design, we had ten participants partake in individual paper prototyping design sessions. During these sessions, we interviewed each participant about her family's current calendar usage and then had her perform a series of coordination and awareness tasks with the paper prototype calendar. Tasks included locating a particular family member, adding events to the calendar, moving events, and looking for conflicts. The calendar was preloaded with a sample family's events and the participant was described a family scenario where she played the role of the mother. One of the researchers acted as the computer by updating screens as needed. Each session was videotaped and notes were taken by the researchers to record suggested interface changes and other observations. The session concluded with a discussion of the prototype and any recommended changes.

Next, using the feedback we gained from the design sessions and interviews, we iterated on our low fidelity prototypes and created a digital medium fidelity design. This digital version was prototyped as a location-based information appliance using a Motion Computing Tablet PC (12" display) in landscape mode. We then had the remaining ten participants partake in a formative evaluation of our digital prototype where the goal was to inform the redesign of the prototype. This study used the same methodology as the first study except that the participant interacted with the digital version of our calendar.

CURRENT CALENDAR USAGE

All twenty of our participants took part in an interview about their family's current coordination routines at the beginning of each study. To ground our interviews, we asked participants to bring in their primary family calendar or printouts of a current time period if it was digital along with any additional items they may be using for family coordination (three forgot, in this case we still discussed their calendar). We begin by outlining one participant family's coordination routines and then use this to highlight the major findings from our interviews.

Kayla's Family Calendar

Kayla and Larry are married with a nine-year old son, Ian (names have been changed). Kayla works around 25 hours a week as a teacher and also volunteers with the school drama program. Larry works over 40 hours per week as a finance director. At the heart of the family's coordination routine is the school district calendar (Figure 1, left), which is normally kept on the wall next to the kitchen phone. Sometimes the calendar leaves this location, but only if Kayla is doing detailed planning. Kayla used to have a daily planner in her purse, but found it was difficult to manually synchronize events between it and the wall calendar.

Kayla is the primary family scheduler and has a strong feeling of ownership over the calendar: she routinely adds events and monitors upcoming activities. Larry sometimes writes down events, but only if they affect the family's routine. For Kayla, the calendar is a tool for staying aware of a variety of upcoming activities and tasks. For example, Ian's soccer games can be seen on the 6th and 8th, and a note about Ken's family visiting spans the 22nd to 25th. Because the calendar was supplied by the school district, it also lists holidays and school activities. Most days contain between one and four events or tasks that Kayla needs to remember.

Kayla tries to use a pencil to write on the calendar so she can easily make changes, but often she will just simply use whatever writing instrument is closest at hand even though

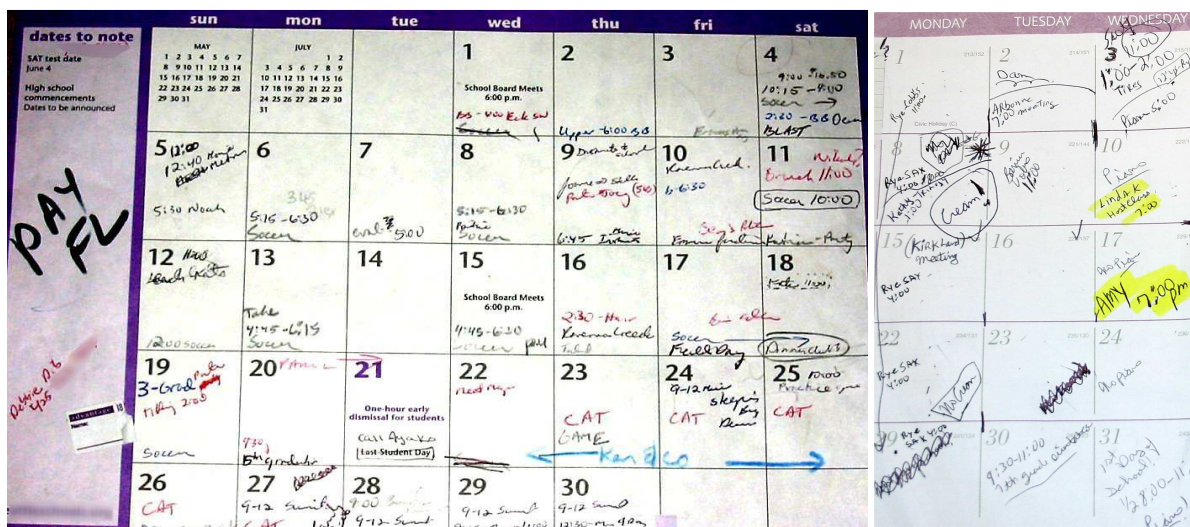


Figure 1. Portions of two participants' calendars.

the calendar can get messy with scribbles and she may run out of space. If a colored pen is available, she will try to write important events using it so they will stand out more. For example, Ian's first 'job' is feeding the neighbor's cat while he is on vacation. Kayla has marked 'CAT' in red ink on the 23rd (and other days) to make sure Ian fulfills his responsibility. Kayla also adds other tasks to her calendar not associated with a particular date like the 'PAY FL' that appears on the left side of the calendar. Sometimes Kayla adds these types of annotations using sticky notes.

Kayla usually checks the calendar twice a day, in the morning to remember what she has to do that day, and then at night to see what is happening tomorrow. Sometimes Larry and Ian will look at the calendar, yet most often Kayla will be the one that tells them if there is anything upcoming that they should know about. Kayla also uses a digital calendar at work, but it only contains family activities if they affect her work schedule (e.g., she has to leave from work to go to an appointment). When Kayla is at work and needs to add something to the family calendar she will usually write it down on a piece of paper and then transfer the information once she is at home. If conflicts arise in the family's plans, Kayla will phone Larry at work or talk to him once they are both at home to arrange alternate rides, work schedules, or change event dates.

Key Findings

Kayla's coordination routine is remarkably similar to many of the mothers we interviewed, though the fine details differ. Here we highlight the key interview findings.

Calendar Type. The types of calendars people use naturally vary based on one's own preferences. Fourteen of our twenty participants used a paper calendar as their primary calendar where ten of these were a typical month calendar like Kayla's and four were personal paper daytimers. The remaining six participants used a digital calendar—one used MSN's online calendar and five used Microsoft Outlook. Only one person had a device (a Blackberry) for accessing the calendar while she was mobile. Several families also have more than one calendar that they use, for example, using the school district calendar as a secondary calendar to stay aware of school activities. Having multiple calendars typically introduced greater complexity into coordination routines as calendars would need to be synchronized so that double booking was not an issue.

Contextual Locations. We found that, like Kayla's family, most families keep their primary calendar in a high traffic location like the kitchen or near other coordination items like the phone or computer (email). Calendars typically only leave these locations when large amounts of planning are being done. Digital calendars were either on a computer at work or a family computer (sometimes located in a common room like the living room or home office). These findings validate [3] and [7]. Despite most calendars being located in the home, people are not often at their calendar. That is, even if it is located 'close by,' checking it only happens

once or twice a day, or when a specific need arises. People generally remember what activities they need to perform during the day or make a list that they can take with them. Yet mobile access to the calendar is still strongly desired for planning upcoming activities like a follow-up appointment with the doctor.

Coordination Routines. While the calendar is a resource for the entire family (containing events generally for all members), the calendar frequently becomes a private object in terms of editing: adding events is typically a restricted activity for only the primary scheduler. In general, participants were surprisingly possessive with the family calendar. When asked if others add events to the calendar one participant responded, "*Oh, no no no, I only put things on.*" Another said, "*It's my brain, that's why I don't want people to mess with it.*" One participant said that it was fine for family members to write new events on sticky notes and leave the notes on the calendar for her to later transcribe, but actually writing on the calendar was forbidden. Another participant used a personal daytimer in her purse as the main family calendar and then manually replicated events on to a month calendar that family members could look at.

When viewing information, the family calendar typically becomes a public object from which other family members can gather some sense of activity awareness. However, the responsibility for reminding people of activities is nearly always left to the primary scheduler. In contrast, in the workplace individuals typically manage their own calendar with some level of visibility on to the calendars of others. [15]. The use of existing digital calendars by our participants appeared to make the calendar less of a public object: it became more difficult for family members to check the calendar because it either required a special login or was not always publicly visible on the screen.

Flexibility. Family calendars contain a wide range of events from birthdays and anniversaries to doctor's appointments, days off from school, and recurring sports games (see Figure 1 for many examples). Some people choose not to include the routine activities that occur frequently, e.g., church on Sunday, the soccer practice that is the same time and place each week. On the other hand, some add these events to the calendar for fear they may schedule something that conflicts with a routine event. For each event, participants typically write its start and end times, and location. Some participants add the name or initials of who the event was for, and sometimes times/locations are dropped for events because family members simply 'know' these details. Events sometimes come in through email (e.g., a child's list of baseball games), requiring people to manually copy them to the calendar.

Several participants developed interesting schemes for using color to highlight particular calendar aspects. Close to half of our participants used colored pens or markers to indicate an event was for a particular person or was a certain type of event; the participant whose calendar appears in the right of

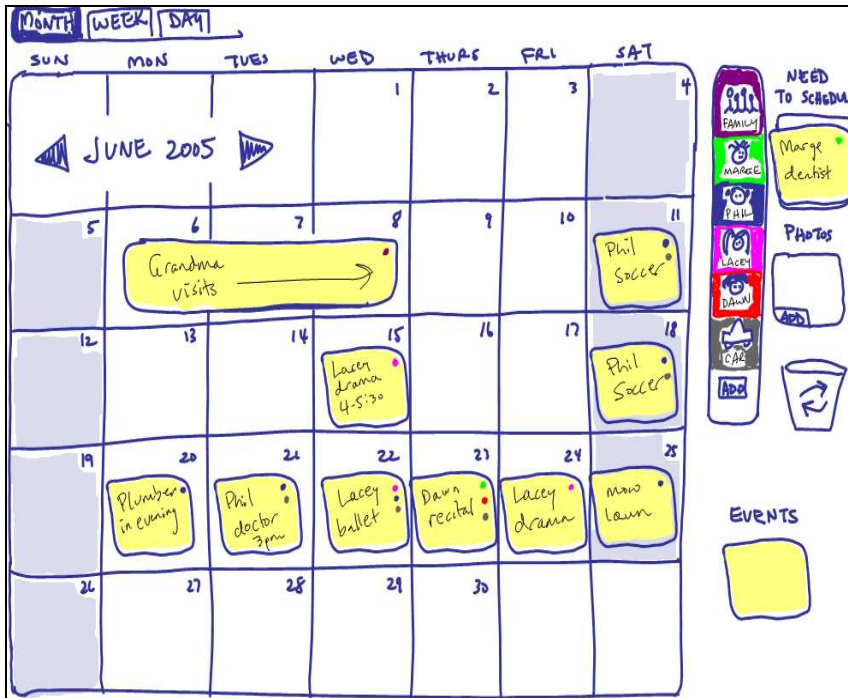


Figure 2. Month View

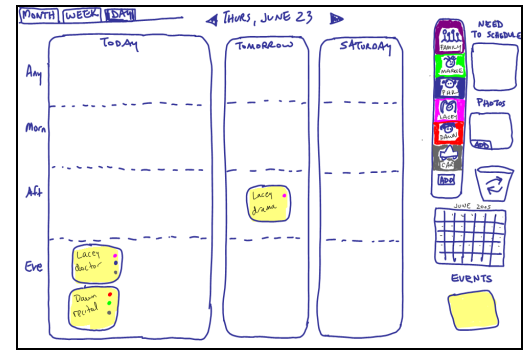


Figure 3. Day View

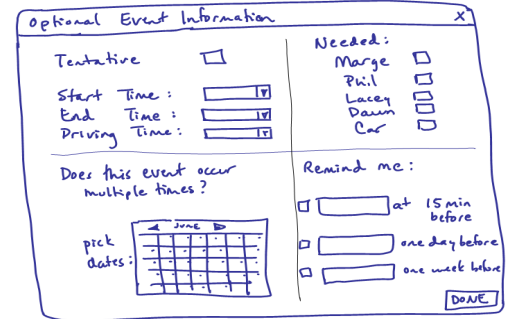


Figure 4. Event Options

Figure 1 used a yellow highlighter to indicate important events like those on the 10th and 17th. Other participants didn't use any particular color scheme, instead using whatever pen was closest. Tentative events also saw creativity from participants. While some would write a tentative event on the calendar just the same as any other event, some people would annotate the event (e.g., writing a '?' next to it) or use a pencil to write it in. It was clear that participants had a wide variety of creative schemes surrounding color, writing instruments, and even stickers.

Calendar events often contained extra information in addition to the standard event description. For example, driving directions to a sports field may be recorded. This 'extra information' was either kept on separate sheets of paper, sticky notes, or written on the actual event. This information was routinely placed so it was ready-at-hand near the calendar either by being on it or next to it.

PAPER PROTOTYPE DESIGN SESSIONS

We now build on our understanding of calendar usage by describing our original paper prototype and findings from the design sessions. At this point, our design was based entirely on our design principles as our first ten interviews occurred in parallel with these design sessions.

Paper Prototype

LINC was designed to be an inkable family calendar where each event is written on a sticky note and placed on the calendar. In this section, we describe how LINC supports each of the design principles.

Simple Awareness Appliance. We designed LINC as an inkable awareness appliance with the intention that LINC

would be always-on. We created three simple calendar views—Month (Figure 2), Day (Figure 3), and Week (not shown but similar to Day view)—which purposely look similar to many existing paper calendar designs. This type of calendar layout is a natural choice as it is already at the core of everyday family coordination—every single one of our participants had a calendar with a view similar to LINC.

We wanted to make the creation of events in LINC as simple as on paper (e.g., writing directly on the calendar), however, we needed a means to compartmentalize the user's handwriting into separate events because we expect future digital versions of LINC to share events between multiple clients (which may or may not appear the same visually). For this reason, users can add events to any of LINC's views by either starting to write on the calendar, which creates a 'sticky note' underneath the handwritten event, or by writing on an existing sticky note under the label 'Events' (Figures 2 and 3, bottom right) and then dragging the note to the appropriate date/time. Double clicking an event opens an Options dialog (Figure 4) where users can set an event as recurring: clicking a day in the calendar (bottom left) toggles it on/off in the recurrence.

We decided to experiment with a simple time metaphor for Day and Week views. Instead of containing rigid times as is often found in work calendars, these views include 'time buckets' for: Any Time, Morning, Afternoon, and Evening (Figure 3, left). For those who desire more rigid times, we left the ability to add specific times in the Options dialog.

Flexibility. We specifically added features into LINC to allow flexibility of routines. These include the ability for users to drag items into a 'Need to Schedule' box (Figure 1,

right) that acts just like a bulletin board or 'To Do' list, or add images to the 'Photos' box (Figure 1, right) which can then be dragged on to any date or event for personalization. We did not include any special integration with other digital organizational systems as our focus at this point was on the user interface of family calendar; this is an area planned for future explorations.

Tools for Coordination. In addition to gathering an awareness of activities simply by looking at the calendar, we provided support for family members to coordinate schedules through the calendar's Option dialog (Figure 4). In the top left corner, users can mark an event as 'tentative,' which creates a jagged border around the event, set specific start and end times, or add driving time to an event. In the top right corner, users can add people or resources (e.g., car) to an event under the 'Needed' label. Checking off a given resource like a family member will assign that person to an event. The note on the calendar will then have a colored dot for each assigned resource. A legend for colors appears on the right of each view (Figures 2 and 3, right). In the bottom right corner, users can create multiple reminders by checking off a reminder box and leaving a handwritten note, which will appear on top of the calendar at the appropriate time interval, either 15 minutes before, one day before, or one week before the event.

Contextual Locations. We designed LINC specifically to be located in the kitchen, which is generally a high traffic area of the home [3]. During the design sessions we showed participants a slate Tablet PC and asked them to imagine the prototype was running on the tablet. We chose to use a stylus as the only interaction tool as keyboards and mice tend not to permit location flexibility, e.g., without a desk or table present they are fairly awkward to use. The choice of a Tablet PC as the display device constrains the design possibilities, yet a larger display would limit the mobility of the calendar and smaller displays would restrict the already small space typically allocated to calendar days.

Participatory Design Sessions

We now detail the key findings from our design sessions. While usability issues with the design are interesting, we instead focus on the findings which suggest larger implications for family calendar design. Despite having supplies available for modifying our paper prototype 'on the fly,' feedback typically came as verbal explanations.

Simple Awareness Appliance. We saw a reasonable acceptance of our first design principle: creating a 'simple' awareness appliance for family calendaring. Participants enjoyed being able to create events in a very free form way, e.g., just by writing on a sticky note or on the calendar. In fact, some commented that the creation of events was almost as simple as their current calendars. We had hoped this would arise as clearly it was our intention. However, there did seem to be a learning curve for participants to realize that this type of very direct event creation was even possible. We found that most participants simply wrote an

event's time right on its sticky note and thus didn't need to set a specific time through the interface, which suggested our notion of simple 'time buckets' was reasonable.

Flexibility. We found that our prototype lacked flexibility when it came to event information. Participants commented that the size of the notes were too small and could not contain a lot of the extra information that participants wanted to add directly to an event's note (e.g., location, driving directions, phone numbers). Participants suggested that the interface should allow larger notes to be added to events so that extra details could easily extend the basic event information. Naturally, participants preferred to write this information on the actual event itself although details like an event's location was sometimes simply remembered rather than having it written down. This highlights the fact that a great deal of tacit knowledge already exists around the family calendar and explicitly adding it to the system would introduce redundancy. We also saw that many participants expected events to automatically appear in chronological order within the time buckets. This somewhat contradicted our underlying principle to keep the design open to the user applying meaning, e.g., moving events to form their own spatial organization where some may make events chronological and others may not.

Tools for Coordination. Our most compelling findings were in terms of coordination tools. In the workplace, coordination is very much done *through* the calendar: people can send meeting requests and then accept or decline incoming requests [15]. However, in the home, we found that assigning people or resources to events was not something that participants found particularly useful. Instead, we found that people generally use the calendar as a tool for gathering an awareness of activities and then, using this knowledge, they coordinate activities using face-to-face or phone conversations. *The calendar is merely an awareness tool in the process.* In fact, one participant even commented that she would not trust a calendar that let you assign people to events, noting that it still would not be clear if someone would *actually* do what they were assigned to and the extra overhead of entering this information into the calendar didn't make it worth the effort.

Our interviews had showed people sometimes use color for highlighting specific activities to aid coordination. While our paper prototype used a single color, we discussed the use of colored sticky notes or colored pens with participants as tools for coordination and awareness. We received mixed reactions from those who thought it would be helpful to those who said that they already know who is scheduled for a particular event and would not need a colored note to more easily see at a glance. Again, this highlights the tacit knowledge that family members naturally maintain surrounding family activities. People also discussed the ability to hide certain people's events.

We learned that reminders are somewhat different when it comes to family scheduling than work scheduling. At work

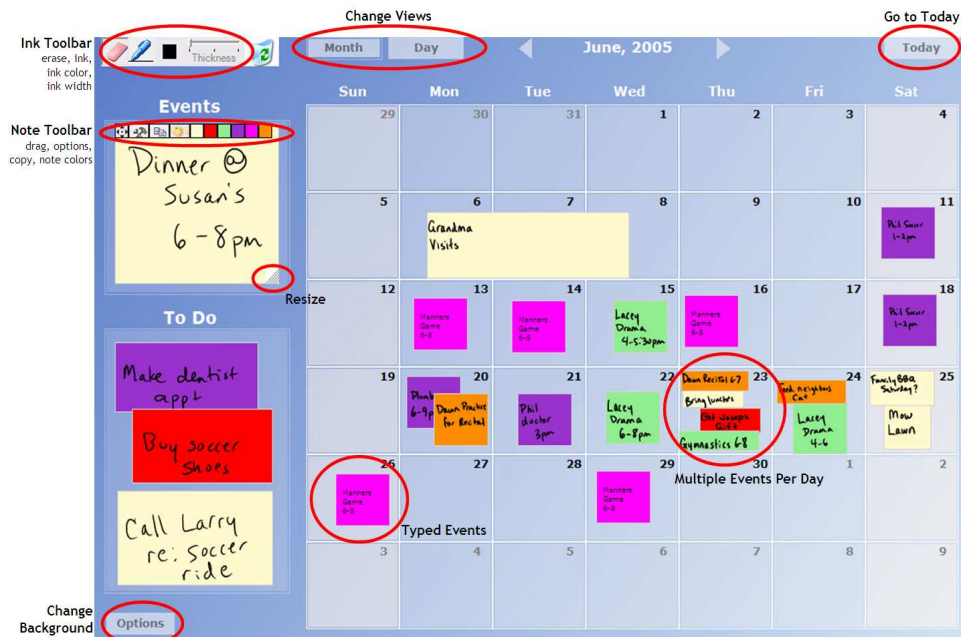


Figure 5. Month View

the default reminder (at least for Microsoft Outlook) is ‘15 minutes before an appointment,’ yet we found most participants say this late of a reminder was absolutely useless in the home. In fact, reminders for actually leaving for an event were really not needed. Most participants would check their calendar at the beginning of the day or the night before and would already have a good idea of where they needed to be or what they needed to get done the next day either through memory or a handwritten list. When used, reminders were instead seen as ways to leave a note as a reminder to bring something specific to an event.

Contextual Locations. Our main finding regarding contextual locations was also about reminders. When it came to the placement of reminders, it was quite evident that pop-up reminders on top of the calendar would simply not do the trick as most participants were not often at their calendar. Instead, participants desired reminders to be delivered to cell phones, placed in locations where people actually were, or were audible when the person was in the home. This confirms our fourth design principle and suggests what information should be made available in other household locations.

DIGITAL CALENDAR AND FORMATIVE EVALUATION

Our next design stage involved using the knowledge we had gathered from our design sessions and interviews (at this point ten of the twenty participants had been interviewed) to implement a digital version of our calendar which could be evaluated by another group of ten mothers. We describe our digital prototype and the findings from its evaluation.

Digital Medium-Fidelity Prototype

Simple Awareness Appliance. The general layout of our digital prototype design remained fairly consistent between the low and medium-fidelity prototypes as we saw no indication that a change was needed. Figures 5 and 7 show

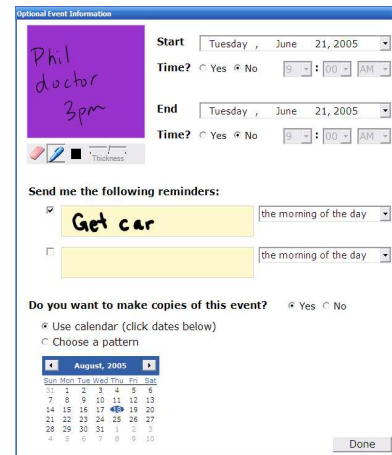


Figure 6. Options dialog

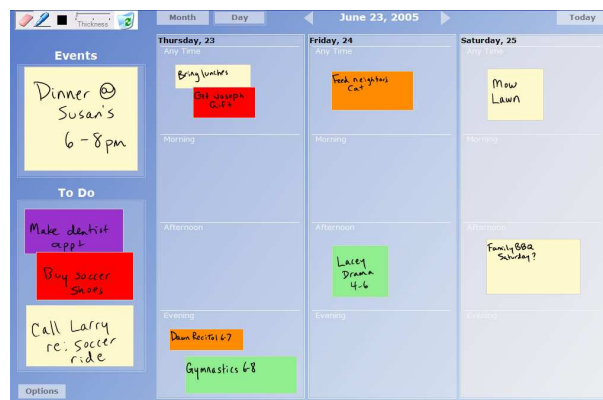


Figure 7. Day View

the Month and Day views respectively for the digital version of LINC. We did not create a Week view as it seemed that it provided little additional benefit beyond the Month or Day views. Like the paper prototype, users can add events to any of the views by writing on a sticky note and then dragging the note to the appropriate date using a control point in the leftmost corner of the Note Toolbar (Figure 4, top left). This toolbar is only shown on a note when the mouse is hovering over it. We did not permit users to write on the calendar to create events as we did in the paper prototype because this would interfere with other functionality, e.g., writing on a day is interpreted as a click that opens Day view. We also stayed with the notion of ‘time buckets’ and relied on the user to spatially position events in a day. Users could open the Options dialog (Figure 6) for a note by clicking an icon in the Note Toolbar (Figure 3, Note Toolbar, second icon from left).

During implementation, we realized that recurring events required a fairly complicated cognitive model to understand if event changes would affect the entire series or just a

single event. To simplify this aspect, we allowed users to create ‘copies’ of events instead by tapping on days in the calendar at the bottom of the Options dialog (Figure 6) or choosing a pattern similar to Outlook’s method. Of course, the downside of this model is that copies of an event are not linked together and changes must be made to each event individually. Despite this, we were interested in seeing how this input style would work for family calendaring.

Flexibility. We increased flexibility in our digital prototype by providing more writing space for notes: resizing a note could be done by dragging the icon in the bottom right corner of each note (Figure 5, Resize). In order to increase space on calendar days, we implemented a zooming feature. Notes appear in full size on the left of the calendar and when dragged on to the calendar they shrink in size to a thumbnail view. Dragging off the calendar causes notes to grow to their full size. The calendar can provide at-a-glance awareness of 3 or 4 events per day (Figure 5, Multiple Events Per Day) if they are sized accordingly; yet more events on a day will cause overlap. This is a caveat of our design; however, bringing a note forward in a stack of notes can be easily done by clicking on a buried note. Next we discuss how we added flexibility in terms of coordination.

Tools for Coordination. Instead of explicitly providing resource management in the Options dialog and as colored dots on notes, we chose to provide users with tools that they could use in their own creative way for coordination. To this end users can change the color of each note in the respective Note Toolbar (Figure 5, Note Toolbar, rightmost icons) and pen color and thickness were available in the Ink Toolbar (Figure 5, top left corner). While we did feel that some people might use explicit resource functionality, we wanted to see if participants would ask for such a feature to be added. We preloaded the calendar with the same events as the paper prototype and colored notes according to who the event was primarily for (e.g., each family member had their own note color). We described our note color scheme to participants and also explained that the notes containing typed events (Figure 5, Typed Events) were baseball games that had been downloaded from the web (this functionality didn’t exist, but is a future consideration). We included multiple reminders, but removed the tentative flag and driving times due to limited use in the previous study. Reminder times included “the morning of the day,” “the day before,” “a week before,” and “two weeks before.”

Contextual Locations. As previously mentioned, LINC was prototyped using a Tablet PC with 12” display. This allows LINC to be easily placed in a variety of home locations. One caveat, of course, is that Tablet PCs are currently prohibitively expensive to dedicate to calendaring, yet we anticipate that our design could potentially lead to the manufacturing of a dedicated cheap information appliance.

None of our participants had any experience using a Tablet PC and were purposely given a minimal description of a Tablet to see how our design would work for a complete

beginner. To simulate the calendar hanging on a wall, we placed the Tablet PC on a shelf approximately 52 inches (132 cm) from the floor and had users do half of the tasks standing (~10-15 minutes). Participants were given the option of sitting down, but none did. The other half of the tasks were done on a table in the room. As our study of LINC was still in a lab environment, we did not implement any location-based or mobile reminders, yet this should certainly be explored in future efforts.

Formative Evaluation Findings

We now describe findings from our formative evaluation, focusing on the significant aspects and shortfalls.

Simple Awareness Appliance. Participants found the digital version of LINC to be generally appealing and our model for handling recurring events as ‘multiple copies’ was well received. Our findings relating to the first design principle were mostly usability issues typically stemming from a lack of user familiarity with pen interfaces. For example, participants experienced problems with stylus modes for dragging notes, inking, and erasing. Users easily understood ‘erase’ mode, but had problems differentiating between drag and ink modes, even with a larger drag region for notes and visual feedback. See Yang et al. [21] for further discussion of mode issues with pen interfaces.

Flexibility & Tools for Coordination. In the digital prototype we had not included a specific mechanism to assign resources to an event; rather, we focused on providing flexibility by allowing colored notes and ink as tools for coordination. This turned out to be quite successful as our presentation of colored notes was the most popular feature within the system. Participants loved the idea of being able to assign colors to individuals or types of activities. In relation, one person asked for either a tentative flag or a pre-specified color for tentative events. Only one participant desired to actually assign people to events and have detailed conflict resolution. This participant had five children and was a heavy Outlook user. For the remaining participants, either using one’s memory or a user-defined color scheme worked fine.

We found participants were easily able to discern an awareness of the whereabouts and availability of their family members with the digital calendar by looking at the events placed on it, yet participants desired an awareness of calendar changes. Given that most calendars are maintained by one person, our expectation was that a family calendar interface wouldn’t need visual cues to show changes. Instead, we found the opposite to be true: the common fear was that someone would change something on the calendar and the primary scheduler would not know about it. With paper calendars, people have fairly strict social protocols in place to guard against this (e.g., the family knew they would get in trouble if they added something to the calendar without telling Mom first). Participants desired some level of access control for the digital calendar, such as a simple list of calendar changes.

Our design of reminders was also well received. Participants found it easy and flexible to create them. Again participants desired reminders to also go to other places such as a mobile device or an email account.

Contextual Locations. Many participants liked the fact that LINC was not intentionally designed for a home office; they liked that LINC could be placed in the kitchen and could be easily written on despite not being familiar with using a stylus. Most also really liked the thought of having LINC accessible from the web (for when a family member is at work). Most participants found it equally easy to use the calendar from both the standing and sitting positions although a couple of participants desired a lower height for it on the wall. The size of the display was also fairly well received; only one participant commented that she would like a smaller display and nobody suggested a larger one.

DISCUSSION

Through the design of LINC, we have brought forward several implications for the design of family calendar systems that extend our initial design principles.

Simple Awareness Appliance. Our design of LINC was centered on the idea that it should be a simple awareness appliance. For the most part, the simple approach we took was successful and it supported typical family routines. The visual appearance of our design was purposely made very much like existing paper and digital calendars in an effort to harness people's existing experiences. Through our design process, we saw no reason for which we should have deviated from this standard layout, though it is always a possibility that a paradigm shift may be appropriate. Our most important finding about the design is in the details; that is, even though the layout is similar to existing systems, *the fine details of how calendaring functionality is supported must be very specific to the needs of families.* We saw interesting transfer effects between paper calendars and our digital system. People sometimes expected features normally found in a digital medium that we did not include in an effort to replicate paper-based systems. For example, some participants expected events to automatically appear chronologically in days or ink to convert to text. Other features found in paper calendars like being able to write anywhere were not supported in our design, yet people expected them to be because our system was very paper-like. This presents a cautionary tale of designing a digital system to replicate and extend an already familiar paper-based one and suggests that *family calendar designs should really aim for the best of both the paper and digital worlds.*

Flexible Tools for Coordination. Through our design process we have found our third and fourth design principles emphasizing flexibility and providing tools for coordination are tightly coupled. From their ethnography, Crabtree et al. [4] argue that families need mechanisms built into the calendar through which coordination can be achieved. More specifically, we have found that these mechanisms are in fact less about resource management and

more about awareness. That is, *the family calendar is a tool that provides family members with an awareness of activities that in turn enables coordination.* Families already have well established social protocols and routines around coordination; therefore, flexibility in the family calendar relates strongly to coordination. *It is important that family calendar systems provide tools which families can use to employ their own coordination routines.* It is also necessary to realize that a large amount of coordination information is part of tacit knowledge that designers need not necessarily replicate in a calendar design. While we could imagine that explicit resource management and automated conflict detection in family calendars would be valuable for some families, our research suggests that if such features did exist most users would stick with using the calendar in a manner that fit with their current routine and these features would be utilized only by power users. More important design features may instead be 'edit' protection for children or indications of calendar changes.

We also saw that *family calendars offer rich stories about the coordination of family activities, but they are not just about the present.* People cross out events, draw arrows to move them, and provide other rich annotations. This information helps families see what has changed and most importantly why it has changed. LINC, along with every other digital calendar that we have seen, does not provide this rich information. Instead, in an effort to make calendaring 'neat' and 'organized,' we have removed vital history. Again, this is a cautionary tale about moving towards a digital system and we strongly believe that *digital family calendars must provide an awareness of calendar changes* in order to show what has changed and who has changed it so that people can then begin to understand why something has changed. It is likely that an awareness of changes can also be used as a basis for social protocol to regulate accountability (e.g., who moved an event) and the synchronization of multiple calendars in varying locations. Work on asynchronous workplace groupware similarly stresses the importance of change awareness [19].

While our findings show that there is usually only one person who schedules events, digital calendars make it easier for multiple people to add and update the calendar. We advocate that although people's routines may currently involve one primary scheduler, it would be a mistake to lock the family calendar so only one person can access it. Instead, providing appropriate change awareness can be seen as an important mechanism to enable families to adapt their routines to utilize the power of technology.

Contextual Locations. Our fourth design principle outlined the importance of contextual locations for design. While our main focus was on the kitchen calendar, we found that *people are not often at their calendars.* While a simple finding, this has serious implications for location-based designs and extends Crabtree et al.'s [4] concept of information anywhere. In addition to having calendar access

while mobile, *calendar information must be accessible from multiple locations within the home*. Extending LINC to provide remote access as well as the placement of information in a variety of home locations is part of our current development plans.

CONCLUSION

Through the participatory design process of LINC, a digital family calendar for the home, we bring forward two significant contributions to the research and design of family calendars. First, we present a proof-of-concept family calendar prototype that shows how we have incorporated related work and a portion of our findings into an actual working digital prototype that can now be refined and evaluated in real-world usage. Until now, studies of domestic culture have not led to the actual design of a digital calendar for intra-family coordination. Naturally, paper calendars are widespread in homes and our intent is not to do away with them. In fact, one caveat of the current version of LINC is that it does not yet offer features like information anywhere that would warrant moving towards a digital family calendar. However, these features are natural extensions of LINC and what we have done is a first step toward a digital family calendar with a user experience that is simple enough not to inhibit adoption.

Second, and perhaps more importantly, we have validated and extended the findings from ethnographic studies of domestic culture with a set of implications for the design of family calendar systems. Specifically, we have identified that coordination is not done through the calendar and people need awareness and flexibility in order to support their own routines. We have also shown that going digital takes away many of the rich social affordances that paper calendars bring including an awareness of changes, which needs to be addressed in any digital family calendar. These are highly significant for they are findings that past ethnographic studies did not uncover and it was only through our design exploration that they became apparent. Our future work includes extending LINC to incorporate more of our study findings and we have plans for a field deployment of LINC in a number of households.

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