A Digital Family Calendar in the Home: Lessons from Field Trials of LINC

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ABSTRACT

Digital family calendars have the potential to help families coordinate, yet they must be designed to easily fit within existing routines or they will simply not be used. To understand the critical factors affecting digital family calendar design, we extended LINC, an inkable family calendar to include ubiquitous access, and then conducted a month-long field study with four families. Adoption and use of LINC during the study demonstrated that LINC successfully supported the families' existing calendaring routines without disrupting existing successful social practices. Families also valued the additional features enabled by LINC. For example, several primary schedulers felt that ubiquitous access positively increased involvement by additional family members in the calendaring routine. The field trials also revealed some unexpected findings, including the importance of mobility—both within and outside the home—for the Tablet PC running LINC.

CR Categories: H.5.3 [**Group and Organization Interfaces**]: Computer supported cooperative work

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1 INTRODUCTION

Family life involves the continual organization and coordination of various activities on an everyday basis [1,11,15,17]. Families use a variety of 'tools' to help them coordinate their activities ranging from calendars [2], notes and lists [17], to technologies including phones, email, and instant messaging [1,2,11]. We focus on studying family calendars as they are most often the central coordination artifact used by families [10,18]. Many families use paper calendars because they are easy to use, mobile, and personalizable [2]. Yet paper calendars have limitations. They are not easily available from the many locations that family members frequent as they go about their activities. While some families use multiple calendars to overcome this problem, this brings additional challenges of synchronization [2,10].

Technology offers promise for enhanced family calendaring. Via networking, digital calendars can make calendaring information ubiquitous and simultaneously accessible from a variety of locations. This could let families more easily view, update, and coordinate activities. However, one must first understand how to best design digital family calendars in a manner that enables them to meet the real coordination needs of families, and to extend what they do in a beneficial way.

We are investigating family calendaring through multiple research stages. We began with initial explorations of family communication [11], and continued to more focused studies of family calendaring routines [2,10] (summarized in Section 2 along with other related work). Study findings, along with participatory

Figure 1. The LINC Family calendar in the Leonard kitchen.

design sessions, led to LINC: an inkable digital family calendar [9]. Our current work describes the experience of moving LINC out of the laboratory and into the homes of everyday families. A field study is critically important to understand and evaluate the effect a digital family calendar like LINC will have—especially if it is ubiquitously available—on the calendaring routines of families.

To conduct our study we first extended the LINC digital family calendar over what was reported in [9] to make it deployable to everyday families (Figure 1). People can now robustly access the calendar from multiple locations using multiple LINC clients, as well as two design probes offering web and mobile phone access to the family calendar. LINC and its new features are summarized in Section 3, along with a discussion of how it differs from other digital calendars. Next, we performed a four week field study of LINC's use in the daily lives of four families. Our focus was twofold. First, based on adoption and usage, we sought to understand whether LINC met the participants' calendaring needs. Second, we looked closely at the families' existing calendaring routines and the effect, if any, of LINC on those routines.

To foreshadow, all four families adopted and used LINC throughout the study period. Participants appreciated that since LINC retained many features of their paper calendar it was relatively easy to adopt LINC into their existing routine. For participants that did not typically handle calendar duties, remote access and the public location of LINC within the home gave them greater visibility and access to the family calendar. By taking LINC out of the lab and into the field, we also saw how some participants moved the Tablet PC running LINC within their home to do calendaring tasks and other activities, such as email, web surfing and casual gaming. In addition, one family even valued the mobility of LINC on the Tablet PC outside of the home where mom would take it to events.

2 FAMILY CALENDARING ROUTINES

Ethnographic interviews, design studies, and surveys of families have articulated important aspects of calendaring routines. To summarize, families use one or more calendars as domestic artifacts central to their coordination routines [10,18]. Nearly all families have one calendar most central to their organization routine, their *primary family calendar.* Most families situate their

primary calendar in a publicly available or high traffic location in the home to promote *public awareness* of the family's activities [10]. Still, some families use calendars that are less than public as their primary calendar as it offers more mobility. Here a *work calendar* (e.g., Microsoft Outlook) [2,10] or *personal mobile calendar* (e.g., PDA, daytimer) may be used [10]. The tradeoff: fixed calendars in the home provide household awareness at the cost of mobility, yet mobile/work calendars provide remote access at the cost of household awareness [10]. In between these extremes, some families use *secondary calendars* to record family activities that already exist on the family calendar. This makes their calendar information accessible in more than just one location [1,3,10]; however, people must now tediously synchronize these calendars (often by manually copying events) to ensure activities are not missed [2,10]. This process can be very time consuming [10].

Families record a wide range of activities on their calendars including extra-curricular sports or music events, school activities, non-routine work events, and tasks [9,10]. They also use a *range of annotations* involving abbreviations, colors and highlights, and symbols (e.g., drawings or stickers) to provide further meaning to their calendar entries and *make particular information stand out at-a-glance* (e.g., some information can be discerned without even reading the details) [3,9,10]. *Coordination is then done by gathering an awareness of calendar activities* (by checking or being told) and using this knowledge to plan and discuss who will attend or drive to events [9,10]. Yet this routine breaks down if family members cannot easily gather an awareness of activities because the calendar is not accessible where they need it (because of a lack of ubiquity).

The level of *family involvement* in performing these family calendaring tasks varies [10]. All families typically have a *primary scheduler:* the person most responsible for maintaining the family calendar [1,2,10]. In most families studied, this is a woman [1,2,10,17] because women frequently take on the role of parental responsibility [8,18]. Primary schedulers are highly involved in the family's calendaring routine, updating the calendar frequently and reminding other family members of activities [10]. The involvement by other family members, known as *secondary schedulers,* varies from rarely to frequently checking or updating the calendar [10]. Some families work well with only one primary scheduler, yet others wish family members would at least check the calendar more often and occasionally add to it [10,18]. This lack of family involvement can easily stem from not being able to access the calendar (e.g., while at work or mobile).

The family calendaring routines we have just described contrast workplace calendaring routines. In the workplace, calendars are typically used to record and present an *individual's* schedule, rather than a small group (e.g., the family) [12]. People can typically check their calendar easily because it is nearly always close by (e.g., office workers are typically situated close to their PC calendar). Attendance is typically more explicit on work calendars as well, when arranging events people are assigned to events as attendees during the event's creation or shortly thereafter [12]. Given these differences, it is clear digital calendars cannot simply migrate from work into the home [3,10]. Yet the common trend for commercial digital family calendar design (e.g., Family Scheduler, Our Family Wizard, Planzo) is to neglect family routines and blindly migrate features from work calendars into family ones. Our approach contrasts this. In the next section, we show how the existing knowledge of family calendaring routines informs the design of the LINC digital family calendar, where the goal is to meet real family needs.

3 LINC: A DIGITAL FAMILY CALENDAR

LINC is an inkable digital family calendar designed specifically to address family coordination challenges of ubiquitous calendar access. The original version of LINC was a standalone client designed for laboratory studies [9]. Consequently, we extended LINC into a form deployable to everyday families: we improved its robustness and usability, and extended its design so that people could access LINC from a variety of locations within and outside the home. LINC's design is based on several design guidelines that emerged from the family routines previously described. We list each here and describe how LINC supports them. To illustrate LINC in action, Figure 2 shows events for the "Isaacs" family from our field study; "Kayla," the mom, is its primary scheduler.

Guideline 1. Support Simple and Flexible Interaction: Families need a simple means to update their digital calendar, and flexibility to utilize their own scheduling practices [9,10,17]. Because of this, LINC's interaction is designed to be as simple and flexible as a paper calendar. To add an event to the calendar, Kayla handwrites on an empty sticky note under 'New Events' with the Tablet PC stylus (Figure 2, top left). Kayla then drags the note on to the calendar where it shrinks to fit into that day. Kayla can also create an event that spans multiple days simply by resizing the note to cover them (i.e., by dragging the note's bottom right corner). The handwriting itself is critical for it lets Kayla and her family freely format notes to fit their personal style [10,17]. For Kayla this is important because the types of events she adds to the calendar vary as well as the information she wants to write down [9,10]. The use of sticky notes allows more events to fit in a day (they can overlap) than would be the case if users simply wrote directly on the calendar.

Guideline 2. Be Publicly Visible and Always-On: Families need to place their digital calendar in a public location where they can walk by and see activities [3,10]. For this reason, the main LINC client is an awareness appliance (prototyped using a Tablet PC). It is intended to be left always-on with the calendar visible where there is no task-switching or computer startup required [9,10]. It can also be placed in a public and high traffic area of the home. The default view shows an entire month, but clicking on the 'Day' button at the top of the screen (Figure 2, top) will show the Day View (not shown) containing the selected day plus two subsequent days. To add to its visual appeal, families can pick an image for LINC's background (e.g., family photos). We also created a screensaver that displays the calendar at approximately one-third size.

Guideline 3. Provide At-a-glance Awareness of Content: Families need to be able to glance at the digital calendar and understand its contents in order to coordinate activities [9,10]. Contents are revealed in several ways. First, Kayla's family uses LINC's flexible color and ink options to provide at-a-glance awareness of which family members have events and to make certain events stand out. She assigns a note color per family member using the note's toolbar and also changes the ink color to make certain events stand out. Kayla and her children also draw pictures (like the face on Feb 2nd) to more visibly represent events. Second, Kayla's family can also create reminders of important events using an Options dialog (not shown); reminders then appear at the appropriate time in the 'Messages' region (Figure 2, left). Third, awareness of calendar changes is also important [9,10,16] because other family members use the calendar in addition to Kayla. While the handwriting reveals who adds to the calendar, it doesn't easily show what has changed. For this reason, Kayla can look at the last change under 'Changes' (Figure 2, left), or the last 100 changes by clicking 'more.' Kayla sees text describing each change and the prior version of the note. Clicking on a change highlights the corresponding calendar event. This change awareness was not in LINC's initial version [9].
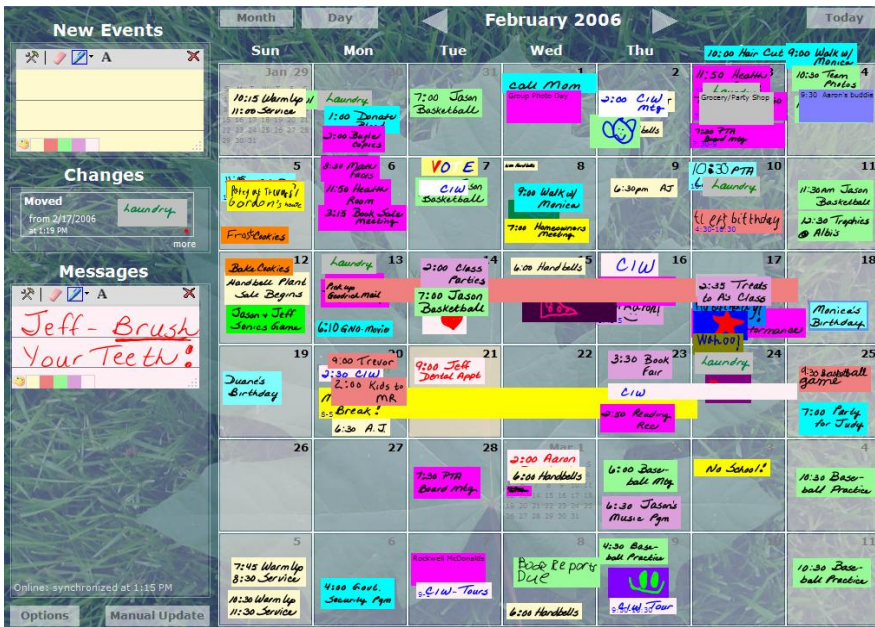
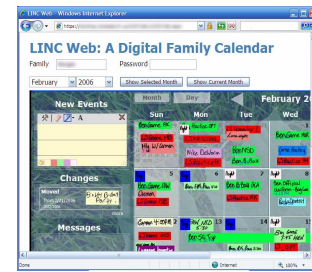Figure 2. The "Isaacs" Family Calendar in Month View.

Figure 3. LINC Web and LINC Mobile.

Guideline 4. Allow Access Outside the Home: Families need to be able to check the family calendar outside the home to coordinate family activities [2,3,10]. Unlike the original version of LINC [9], our modified LINC can be installed on multiple computers. Kayla has installed LINC on her work PC, which synchronizes with other LINC clients using a remote server. This lets multiple LINC clients run autonomously from any location (provided that Internet access is available during synchronization). Kayla can also now type events (reflecting the desktop PC use of LINC), and these appear on notes as typed text. Kayla's husband, Karl, cannot install LINC at work because of security restrictions. Instead, he uses our new, LINC Web client, which displays images of the calendar in a web browser (Figure 3, top).

Families also need to check their calendar while mobile [3,10]. For this reason, Kayla and Karl both run another new client, LINC Mobile, on their Windows Smartphone (Figure 3, bottom). LINC Mobile also displays images of the family calendar. It defaults to showing 'today,' but Kayla and Karl can pan and zoom around the calendar (using the phone's keypad) to see activities on other days. LINC Desktop, Web and Mobile are our first steps at providing family calendar access from any computer or mobile location. Currently only the standard LINC Desktop lets people add or update calendar events; this will be added to the Web and Mobile clients in future versions. In spite of this weakness, these clients give us real world design probes so we can better understand how family members make use of remote access.

3.1 Other Digital Family Calendars

LINC is by no means the only digital family calendar ever designed. Plaisant *et al.*'s [14] InterLiving family calendar addresses the needs of families to share calendar information between multiple families (e.g., grandparents and their children's families); thus, its focus is on *inter*-family calendaring rather than our focus on *intra*-family calendaring. Unlike LINC, it does not support ubiquitous calendar access. Hoefnagel *et al.*'s [4] conceptual "long-term planner" connects family activity "squares" in an activity diagram. While a plausible design metaphor, it does not take advantage of people's existing skills at understanding and using a calendar grid.

Commercial family calendars for the web are also cropping up at an increasing rate (e.g., Family Scheduler, Our Family Wizard)

where they provide a shared family calendar that is accessible via the web. The problem is that most of these calendars are designed for *individual* use based on workplace calendaring where people are assigned to events. Despite offering ubiquitous PC-access, these calendars are not easily made visible within the home for public at-a-glance awareness of events.

We believe LINC is the only calendar to date that directly explores digital family calendar design for intra-family coordination. It is purposely designed to be like a paper calendar to promote simplicity and flexibility, and fit within routines; this deviates significantly from the norm for digital family calendar design.

4 FIELD STUDY METHOD

We deployed our refined version of LINC to four households over a period of four weeks; two families were from Seattle, U.S.A, and two were from Calgary, Canada. We describe each family in the next section. Our goal for the field study was to understand how LINC affected family calendaring routines: 1) did it fit within people's existing routines, and 2) did it extend routines in an appropriate way to overcome existing calendaring challenges? Studying the real-world usage of digital family calendars is critical to our understanding of family calendaring design. We believe that field trials provide the necessary real usage that allows us to understand the real challenges of adopting and using a technology. Lab studies offer complementary findings, yet they cannot draw out this kind of contextual information.

We chose four families in order to see the effects of LINC on several different styles of coordination routine. We based the length of our field study on pilot studies with our own families. These showed that it took about two weeks to get into the habit of using LINC. Thus, a four week field trial would capture the initial adoption of LINC, plus an additional two weeks of regular use that could show how routines further developed around LINC. We gathered and analyzed over thirty hours of interview data describing the adoption and use of LINC based on more than 120 total days of usage by all families. Of course, four families over four weeks does not reveal patterns of extended long term technology use, nor does it capture the diversity of a large group. However, this does not take away from its value: our studies are akin to discount usability methods that reveal critical design

Table 1. Calendaring routines: the first five columns describe routines before LINC and the remaining describe routines with LINC.

	Family Composition	Routine *before* LINC	Existing Primary Calendar and its Location	Stated Successes	Stated Challenges	Benefits *with* LINC	Drawbacks *with* LINC
Leonard (Seattle)	Homemaker and Manager; Children Ages: 10 & 13	Mom is primary scheduler and reminds others of events	AOL Online Calendar; Mom has access from any computer	Mom 'owns' the calendar	Getting others to check calendar because it is digital	Public and multiple home locations allowed others to check the calendar	Didn't always need mobile calendar access
Isaacs (Seattle)	Tour guide and Tech support; Children Ages: 7 & 10	Mom is primary scheduler and reminds others of events	School district paper calendar and notebook stay with Mom	One person in charge; One location with all events	Getting others to check calendar; Synchronizing calendar and notebook	Public location allowed others to check the calendar; Access at work for Dad	Mobile device not the right form factor
Newman (Calgary)	Accountant and Firefighter; Children Ages: 15 & 17	Dad is primary scheduler; All check the calendar	Paper calendar in kitchen on door by exit to garage	Publicly viewable calendar location for all family members	Scheduling remotely	Paper-like attributes allowed it to fit within routine; Access at work for Mom	Didn't have overview plus daily detail; Needed ability to add events while mobile
Chambers (Calgary)	Two teachers; Children Ages: 3 & 3 months	Mom is primary scheduler and reminds others; Dad also checks	Large paper calendar on fridge near phone	One person in charge; Public calendar location for entire family	Synchronizing calendars; Scheduling remotely	Paper-like attributes allowed it to fit within routine; Access at work for Dad	Not integrated with Dad's work calendar; Dad couldn't add events from work

factors even with small numbers of participants.

Initial Interviews and Deployment: We began by interviewing each family at their home where we asked them about their current coordination routine. We kept written notes and audio recordings for all interviews. Children were included only if it seemed appropriate given their age. To ground the questions, we asked participants to describe and show us what artifacts (e.g., calendars, notices) they used for coordinating family activities. Next, families were each given a 12 inch Motion Computing slate Tablet PC without a keyboard that ran LINC for the duration of the study. We spent additional time with each family introducing them to LINC (along with LINC Web) and setting it up in their home. This involved setting up a wireless network in one home; the other three already had an existing wireless network.

The Four Week Study Period: Each family then used LINC as their primary family calendar for four weeks. Mobile phones with LINC Mobile were given to the two Seattle families for the last two weeks of the study to see how the addition of mobile calendar access would affect the family's routine. (Due to the pragmatics of international mobile phone plans, the Calgary families were not given Smartphones). We gave each family a journal for which they were asked to report any findings and thoughts that came up throughout the week. To remind family members to create entries, the journal was initially placed next to the Tablet PC LINC location. At the end of each week, a researcher visited the family's home to discuss how they used LINC over the week. We used contextual interviews where descriptions from the family's journal and events recorded in LINC ground our discussions [5]. During deployment, we fixed minor interface bugs that appeared, but did not perform any major changes. The field study concluded with an exit interview with each family.

Data Analysis: At the study's conclusion, we reviewed the journals' contents, all of our interview notes, and returned to our audio recordings for clarifications. Using affinity diagramming, we categorized our findings across all families based on the type of challenge or success that was reported with LINC's use. This revealed several key themes which are the focus of our results.

5 THE STUDY FAMILIES

We now describe our study families and their existing calendaring routines. The first five columns of Table 1 summarize the routines before LINC. While our families are fairly similar in composition, they differ in a crucial way: *each family has a different*

coordination routine. These routines are also highly representative of family calendaring routines in general, as found by [10].

The "Leonard" Family (Seattle) has adopted AOL's digital online calendar as their primary family calendar. Mom routinely accesses it from the computer at the top of the stairs, but loves being able to check it from different computers, even when out of the house. She will sometimes print it out to take with her. While the family routine works well because Mom 'owns' the family calendar, login and access issues of this digital calendar has made it challenging for other family members to check it. Thus, they rely on Mom to remind them of activities.

The "Isaacs" Family (Seattle) uses a paper calendar as the main family calendar. Their calendar doesn't have a 'typical' location in the house as it generally stays with Mom; she takes it out of the house and to work with her, especially if she knows in advance that she will need to schedule something. This makes it challenging for others in the family to check the calendar. Mom also uses a notebook to track tasks; thus, she faces the additional challenge of keeping the calendar and notebook synchronized.

The "Newman" Family (Calgary) is unique in that unlike most families [1,9,10,[18], the dad is the primary scheduler. This is because his alternating day/night work schedule means he is at home the most. The family says that the best thing about their coordination routine is that the centrally located paper calendar is accessible to everyone when they are at home. Yet adding events to the calendar while not at home is challenging, and often involves leaving messages on the answering machine. Like most families, the family calendar is very important to the Newmans. In fact, during our first visit when we introduced LINC, Dad told us *"[The calendar] is our life line, [LINC] better work."*

The "Chambers" Family (Calgary) has the youngest family, with two preschool-aged children. After having children, the Chambers found a need to have a calendar located in a place that both parents could see, in this case on the fridge door. Mom is the primary scheduler. She maintains the family fridge calendar, as well as a paper notebook calendar, and milestone calendars for the kids. The Chambers like having multiple calendars each with its own purpose and type of events. Yet this leads to synchronization challenges. They find the best thing about their routine is that Mom is in control of it. The Chambers also find it difficult to record events when not at home.

6 EXPERIENCE WITH LINC

All four study families adopted LINC during the course of the field trials and even wanted to continue using LINC after the study finished. The benefits and drawbacks each family experienced with LINC are summarized in Table 1, Columns 6 and 7. In presenting the results of the field study, we organize our findings by our design guidelines and focus on outlining key factors—illustrated by quotes and usage descriptions—that helped families adopt and use LINC as well as those that hindered its use.

6.1 LINC Supported and Enhanced Existing Routines

Our first guideline focused on simple and flexible interaction. Because LINC was designed to be used in ways similar to paper calendars, the Chambers and Newman families were able to *adapt LINC into their existing routine* with only small routine adjustments. The Chambers Mom recorded 21 events on LINC during the month (compared to 13 on their paper calendar the previous month). Mom checked the calendar as per her usual routine and Dad checked it more because he was excited that LINC was a technology (as opposed to the paper family calendar). The Newmans recorded 86 events on LINC (102 on paper calendar last month) with a large number added by both Mom and Dad and several by their children (who were also excited because LINC was a technology). All family members checked LINC as per their usual routine.

The Leonard and Isaacs families also adopted LINC, yet saw *changes in their calendaring routine* as a result. For these families, LINC caused *increased family involvement* in the routine as a result of its paper calendar qualities *and* digital extensions. In both families, more than just the Mom was checking the LINC calendar. Despite this change, both families maintained their existing practice of having calendar updates dominated by Mom. The Leonards recorded 72 events (57 on AOL calendar last month) and the Isaacs recorded 88 events (89 on paper calendar last month). In both cases, most events were added by Mom with infrequent updates by other family members. While one could imagine increased family involvement might cause the primary scheduler to feel their role in the family was threatened, or cause power struggles, the families in our study and, in particular, the primary schedulers welcomed and appreciated the increased family involvement.

6.2 Locations of Use

Our second design guideline emphasized the value of the calendar being publicly visible. We now describe the families' experience choosing a primary location for the Tablet PC running LINC in their homes and the unexpected importance of mobility for LINC.

6.2.1 Flexible and Public Primary Location

We allowed each family to choose the initial location for the LINC awareness appliance (on the Tablet PC), with some interesting results. The Leonards did not previously have a public location for their paper calendar. As a result, LINC initially moved around the home with Leonard Mom. Yet, by the end of the study, LINC had been placed in the kitchen next to the stove with the realization that this location added value to their routine (Figure 1). Because of this public location, the Leonard family saw increased family involvement in the calendaring routine. Family members now checked the calendar because it was in a public location for them to view: *"It's kind of fun referring my family to [LINC] instead of asking me."* Leonard Dad enjoyed the fact that LINC was more publicly visible to see upcoming family events. He commented: *"It makes me more interested in paying attention to the home calendar...I never really accessed the AOL calendar much. [LINC] was something I could access easily without spending a whole bunch of time looking for it...it was much more visible."*

The Isaacs also did not have a set location for their calendar prior to the study. They chose to place LINC on a bookcase next to the kitchen table and also found this publicly viewable location was one of the main benefits of LINC. Isaacs Mom felt that family involvement with the calendar increased as a result of having LINC in a central location. She found the kids were now adding things to the calendar by drawing pictures and would even routinely ask her to make sure an activity was on the calendar.

The Newmans and Chambers already had highly visible locations for their paper calendar. For them, it was critical that LINC be placed in a location that allowed them to maintain their routine. However, LINC's form factor posed some pragmatic challenges. Instead of hanging LINC on their pantry door, like their paper calendar, the Newmans placed LINC on a kitchen counter next to a desk that contained one of the family's desktop PCs; this location was across the room from the pantry door. Despite a less than ideal location, the Newman Dad reported being able to adapt his routine during the first week of the study; he would now walk by LINC during his exit out of the house.

The Chambers family was also unable to place LINC in their most preferred location: on the fridge where their paper calendar was located. Instead, the Chambers placed LINC on a counter in the corner of the kitchen, a good ten feet from the fridge and adjacent phone. This new location proved awkward, although they still modified their routine to look in this corner of the kitchen at the calendar as opposed to the fridge. As Chambers Mom says, location is critical for easy calendar access: *"It's obviously not a good location. For me, I'd like to have a little bit more options of where I can put it ...I make a conscious effort to go over and use it, but it's not my first initial place to look because I'm used to looking at the fridge...[the fridge] is just like second nature."*

Taken together, these findings show that, as expected, having a digital family calendar in a public location is important for calendar adoption [3,9,10]. Our experience also extends previous findings by showing that in real world use *designs must support even greater location flexibility* than the Tablet PC we used for LINC was able to support.

6.2.2 Mobility around the House

While it is certainly advantageous for families to be able to place a digital family calendar in a single public location, we saw that family members also wanted to move the calendar around the home as they went about their everyday activities. The importance of mobility is brought to life by the Chambers. Initially, Chambers Mom disliked LINC on the tablet because she felt her handwriting (*vs.* typing) was messy. Yet, by the end of the study, she began to realize (and so did Chambers Dad) that the mobility of the LINC more than offset concerns over 'messy' handwriting. Mom would now routinely move LINC throughout the home with her. *"Honestly if I didn't have the tablet I know I wouldn't use it because it'd be on my computer in the other room....I'm not going to go in [to the other room] to check it because I have kids in here. I'm not going to go and type it in because my phone is in here, I'm not going to drag my phone around and type it in, that's why I keep my [paper calendar] in here. Mobility is very important, that's why I like the wireless and the tablet."*

On a smaller scale, mobility also enabled families to more easily plan and add things to the family calendar. The Newmans and Chambers preferred to add items to the calendar on a flat surface, both families would routinely move LINC to the surface of the kitchen island. The Isaacs and Leonard Mom acted similarly, often moving LINC to a table to schedule events.

Given this, we now know that while a single public calendar location is important, *families should also be able to move their*

digital calendars around the home. Due to power concerns, participants were typically careful to return the Tablet PC to the primary public location retaining the value of a public location while benefiting from the ability to move LINC around the home.

6.3   Always-On or Easily Accessible

Another important aspect of our second design guideline was the belief that a digital calendar needs to be always on. In the study, we saw support for the notion that families don't want to 'boot up' the family calendar to add events to it or check it. As with paper calendars, they simply want to walk up and use it. The strongest illustration of this arose as a result of a design flaw. In the Newman's home, the parents' bedroom is positioned such that lights in the kitchen can be seen from it. Because we designed LINC to be always-on, LINC produced a glow that could be easily seen by the parents as they tried to sleep. We remedied this using a built-in power feature that turns the display off after 15 minutes of non-use. Thus, in order to see the calendar (regardless of the time of day), one had to tap the screen and wait several seconds for the display to turn-on. This interaction and wait overhead proved excessive for the Newman Dad and he reverted back to walking by the paper calendar (which still had the family's events on it) on his way out of the house, rather than walking by LINC. That is, even minimal overhead to viewing the calendar had drastic consequences for its use.

Leonard Mom also found that having LINC always running was critical for her use of it and she simply wouldn't use it if not available without 'booting the computer': "*I like the way this can just be on all the time. Sometimes you'll be running out the door and somebody will call and say hey will you be able to go to <pause>…I don't want to run back upstairs and turn the computer back on.*"

However, in contrast, Newman Mom felt that having LINC running on the Tablet PC as an always-on display was beneficial but not necessarily crucial. She suggested that *easily accessible* (i.e., some interaction and a short wait) instead of *always accessible* was enough for her to use a digital family calendar. Newman Mom suggested LINC could work as an application on a PC in ways similar to other easily accessible but not always visible applications (e.g., MSN Messenger, which is automatically invoked on startup).

An interesting development during the study was that the families reported trying out the Tablet PC for other activities like checking email, web pages and casual gaming. While particularly surprising given the lack of keyboards on the slate tablets, emails may contain prompts for new activities to be placed on the calendar, and web pages can contain 'extra information' relating to events like driving maps or other schedules (e.g., sports). Accessing these resources was seen as being highly valued by several family members.

These findings show that an always-on digital family calendar is important for actual use [9,10]. They also extend this idea to show that *an easily accessible family calendar that inter-operates with related applications may suffice for some families.*

6.4   Awareness of Calendar Content

Our third guideline focused on the need for families to quickly glance at the calendar and see what is happening.

6.4.1   Staying Aware of Calendar Contents and Changes

Families highly valued the ability to use color and other annotations in LINC. In fact, colored notes were one of the most popular features. The Leonard's calendar contained 9 different note colors, the Isaacs used 15, the Newmans used 11, and the Chambers used 7. On the Isaacs calendar, Mom used pink for school events, green for her son's sports activities, red for doctor appointments, light blue for her own events, and grey for laundry (because she said it wasn't fun). Color coding of events aided all families in quickly knowing *who* had activities on a particular day or if *important* activities were upcoming. Families typically chose the brightest colors available to help events stand out even more. Chambers Mom said, "*I do like the idea of the colors. I can look at [LINC] and I know, all the green is [my husband's events].*" Similarly, Chambers Dad said, "*I just come down in the morning, I look, if there's no colors on there I don't worry about the day. If there's a color on there I know.*"

While colors were important, Leonard Mom also asked for additional ways to visually annotate the calendar, "*You know what would be really nice, if there was little symbols. That's something I've kinda enjoyed with the AOL one. I've got little stickers with the calendar they gave me.*" Yet she soon found she could simply draw pictures on LINC and added a heart for Valentine's Day, "*I liked the colors…I liked how you could draw…it really does look a lot more fun.*" Drawing on events was also a popular feature for the Isaac children and made them feel much more a part of the family calendar activities.

Another aspect of being aware of the calendar's contents is receiving reminders for events. Automated reminders were found to be one of the favorite features for workplace digital calendars [12,13]. Yet none of our four families found much use for automated reminders in LINC. Family members said they had a good sense of upcoming events because they habitually checked the family calendar daily. Newman Dad explains, "*Because we look at the calendar so many times a day that for me a reminder isn't a big deal.*" Similarly, Chambers Mom says, "*We almost don't need reminders. If I were to use reminders it would be to remind [my husband], but then I would just phone him. I'd look at the calendar and 'say do you remember you have this today?'*" While this finding suggests reminders on the main display may not be as valuable, Chambers Mom's use of the phone suggests reminders to mobile devices could be useful.

LINC's change awareness panel also saw very limited use. This was somewhat surprising, for any family member—parent or child—could easily add or change calendar events without others knowing. Yet families reported their existing practices for alerting others of changes worked well. Newman Dad comments on this, "*It would be no different than our paper calendar…I look at it and if it has been scratched out then it obviously isn't happening. I can't honestly say that we would normally add something on the paper and not notice it. We'd usually go, hey, did you notice that. Sometimes we talk about things before we add them.*"

On the other hand, Chambers Dad felt it was important to be able to see changes that happened during the day while at work: "*We get so busy from day-to-day so if something changes I look at it first thing in the morning. If something changes during the day, we're lost anyhow. That would be helpful if it was online if something changed during the day.*"

These findings show that flexible interaction to aid at-a-glance awareness of calendar contents is very important for real world use [9,[10]. We also saw that *for some families, automated reminders are not needed* causing at-a-glance awareness of calendar content to be all the more crucial. When it comes to an awareness of calendar changes, features that *highlight changes done at remote locations* may be most beneficial to families.

6.4.2   Detail plus Context Views for At-a-glance Awareness

We choose to use month view as the default view for LINC because it is the prevailing paper calendar format and would be familiar to participants. However, we found that the views we presented for LINC were not necessarily the best at conveying information at-a-glance. Reading ink in Month View was difficult for some because LINC shrinks the ink to create space for more

events. Notes in Day View were larger and more readable, yet this view did not provide the context of the week or month.

Through their comments and sketching sessions during the final interviews, we found families were willing to switch away from the traditional month and day views to get a view that showed details and some context. Both the Newmans and Chambers suggested a combined Day and Month view, where 'Today' would be visible on the side of the calendar next to the month view. For example, Newman Dad comments, *"We never have it on a month because it's too tiny. For us we just have so much stuff going on in a day that month view is too small...if it had a month view and day view [combined]...I could see where very seldom we would ever change it."*

For similar reasons, our screensaver showing the monthly calendar did not work in practice. Newman Dad suggested, *"If the screensaver defaulted to the current day that would be huge. We're looking for the current day. You could walk by and you wouldn't have to touch it."* Isaacs Dad similarly said that coordination is about 'Today' and not today plus a couple of days. These findings emphasize the importance of at-a-glance awareness of calendar activities in actual use [9,10]. We have begun experimenting with novel calendar views that show an entire month or week combined with a day view.

6.5 Ubiquitous Access

Our fourth guideline and biggest change was enabling ubiquitous access to LINC. We describe the reactions to access at work, while mobile, and the somewhat surprising value the Seattle families found in multiple locations within the home.

6.5.1 Calendar Access from Work

All of the families really liked the concept of accessing the family calendar from outside the home. Both the Isaacs Dad and Newman Mom would check the calendar from work to stay more aware of what activities were upcoming and what was being scheduled (both were not the primary family scheduler). Isaacs Dad found one of the best features of LINC to be its accessibility from work, *"I think what works well is that I can pull it up on my work computer. That was definitely a nice thing."* In response, Isaacs Mom said, *"It pulled you into being a part of it more."*

A crucial feature we had *not* yet developed into LINC Web was the ability to add events. Chambers Dad found the thing he wanted to do most while at work was add things he had thought of to the family calendar. The lack of being able to add events on the web page hindered this process: *"I also had something I wanted to put on it but I didn't remember at home until 4 days later."* Chambers Dad also wanted to be able to view the family calendar in the context of his Outlook work calendar. Similarly, Chambers Mom wanted certain events from her husband's work calendar viewable at home. They cautioned that only some events should migrate between the work and home calendars: of these they wanted to easily discriminate through visual cues between home and work events.

These findings show that calendar access from work is important [2,10] and extend this idea to show that, for some families, *the web is a viable medium for accessing the family calendar while at work*. For others, *integration with existing work calendars is needed*.

6.5.2 Calendar Access while on the Move

The Seattle families had the opportunity to use LINC Mobile for the second half of the study, yet they didn't find it very beneficial. Isaacs Mom found the display on the mobile phone to be too small, which made it difficult to see calendar events, even though the phone could show a complete day. Isaacs Mom did not normally carry a mobile phone and suggested a larger form factor for LINC Mobile, *"I'm going to need something bigger [when outside the home]...I've seen those PDAs, but I'm not sure about the size. I'm used to carrying binders...but thinking about the grocery store I'm not sure I'd want to carry [a tablet]...if I have a PTA meeting I'd take it so [the tablet size] for me and my eyes, it's probably that weening from paper to something similar in size."* As her quote illustrates, Isaacs Mom wanted to take a larger multi-purpose device like the tablet to certain activities. We were surprised that Leonard Mom did actually take the slate tablet to meetings and her son's basketball game.

Another surprise for us was the amount of foresight these moms had into when they would need to view or add to the calendar before they left the house. Before LINC, Isaacs Mom would bring the calendar and Leonard Mom would bring a printout of her AOL calendar, but only when they knew they would need it. Thus, they did not personally feel enough need to have LINC always with them to justify carrying another device.

In our discussions with the Newman family about how they would visualize their preferred mobile experience of LINC, Newman Dad suggested being able to phone the home calendar and leave a voice event. This was similar to how he currently leaves messages on the answering machine to remind himself to update the family calendar. Chambers Dad commented that having the calendar on a device that is always with him is not necessary; he'd prefer to leave the device behind if he didn't see a need for it on an outing.

These findings validate that indeed mobile calendar access is important for families [3,10], yet for some families, *it is more of a secondary need*. Mobile calendar use is also influenced by the form factor of the device and the convenience of using it, which will vary for families. Thus, *families need flexibility when choosing a mobile calendar device*.

6.5.3 Multiple Home Locations

In addition to physically moving the Tablet PC around the home, another way to have the family calendar ubiquitously available throughout the house is to install LINC on multiple computers. For the Isaacs family, we installed LINC on the desktop computer upstairs, and on Dad's laptop which traveled between work and home. Isaacs Mom stressed that people are not always in the same location within the home, and that it was beneficial to have LINC in multiple places: *"Having [LINC] upstairs also was terrific because if things came in email I could modify them right away...I think if anything [multiple locations] helped enhance [our routine] because I am in different locations...I didn't have to scramble and go and find that paper calendar which may not always be in the place I thought."* Despite the Isaacs Mom being the primary scheduler, Isaacs Dad felt his involvement in the family calendar increased because the calendar was now accessible for him to check on his laptop in the locations he needed it *"[Mom] is the master scheduler, but it did pull me in a little more having it."*

For the Leonards, LINC was installed on the den PC and another laptop. Mom most often used the Tablet to create events (because of the ink), yet appreciated that LINC was available on her laptop and looked at it there occasionally.

Multiple locations were important for the two Seattle families, yet it is certainly not necessary for everyone. The Newmans had another computer in a home office where they could access LINC Web, but they never found the need to view the calendar from this location or install the full version of LINC; the publicly visible calendar in the kitchen was enough for them.

Together, these findings extend the notion of digital family calendar ubiquity [9] to show that, for some families, *calendar access from multiple fixed home locations will be valuable*.

7 DISCUSSION

Our field trials of LINC helped us understand how both the role of paper-like design attributes and digital calendar extensions affect family calendaring routines.

LINC was designed based on several attributes of paper calendars: publicly visible, always-on, simple and flexible interaction, and at-a-glance awareness. These *paper-like features were enjoyed by families* and, for the Calgary families, *this allowed them to fit a digital calendar within their existing routines* (with only minor adjustments). Yet sometimes it is beneficial to move beyond the abilities of paper. For example, we learned that at times it would be beneficial to relax the always-on calendar model and allow families to use the calendar device for other tasks. That is, a device should primarily function as an always-on calendar, but it could also allow people to access other programs like email or the web (which often relate to scheduling activities) when needed. After a certain amount of inactivity, the device could revert to the always available calendar display. This is similar to paper in that it is multi-purpose, yet paper clearly does not offer digital information access. While Tablet PCs are still prohibitively expensive to fulfill these needs in practice, we anticipate cheaper dedicated devices could be built for this. Thus, *a digital family calendar design should balance how it exploits the properties of paper while also overcoming its shortfalls.*

We found that digital extensions to a family calendar can actually change family routines in beneficial ways. Ubiquitous calendar access helped increase family involvement in checking the calendar for the Seattle families (reported as a previous challenge for them). While we initially thought that access to the calendar outside the home would be crucial for adoption of a digital family calendar, we found that *family calendar ubiquity within the home is also important including calendar mobility and multiple fixed calendar locations.* Remote access from work is also needed and further explorations should look at the *integration of the family calendar with work calendars.* When it comes to mobile calendar access some *families may not always want to or need to carry a device with them* that contains the full calendar. This suggests further exploration of alternative lightweight mobile technologies: imagine phoning your family calendar to tell it to add an event. More generally, this points to a potential design paradigm for ubiquitous technologies where in-home systems can be remotely queried or updated in a lightweight fashion, rather than being completely accessible with a full suite of features.

8 CONCLUSION

We have presented results from a field study of LINC where we took design guidelines derived from family calendaring theory and tested them in actual real-world practice. As a result, we have gained a deeper understanding of digital family calendar design and use. It is one thing to predict digital family calendar use based on existing routines [2,3,9,10] and it is another to see what happens in actual practice. Our field study revealed the importance of designing calendars to support attributes of paper, while extending them to provide ubiquitous access. Because of this, we saw LINC fit *within* existing routines, while *extending* them in beneficial ways through increased family involvement, particularly for non-primary schedulers. The mobility and other uses of the Tablet PCs we provided with LINC also highlight some general considerations for those developing devices and applications for the home.

Of course, our findings are limited in that they are derived from the specific use and reactions of four families to LINC. However, we took care to choose a diverse set of families in terms of their coordination routines. These routines prove highly representative of middle class North American family calendaring routines in general [10]. Given this, it is reasonable to expect that designing

digital family calendars based on paper attributes and extending them to be ubiquitously accessible will in fact work for the majority of families from this demographic. Naturally, some families will still vary based on geographic region, culture, and lifestyle, and designs will still need to be flexible to meet a range of idiosyncratic needs. Finally, the fact that LINC was a novel technology caused some members of the Calgary families to pay more attention to the family calendar. Of course, one could argue that this novelty would wear off. However, our future calendar users—our children—are increasingly exposed to computers in schools; we anticipate they will be more comfortable with family calendars that are a part of the digital realm in the future. LINC's ability to meet family needs shows promise for digital calendars in the domestic realm.

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Michael A. J. Sweeney Award 2007

Canadian Human Computer Communications Society /
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The CHCCS/SCDHM honours the memory of Michael A. J. Sweeney through an annual award to the best student paper(s) presented at each year's Graphics Interface conference. The winning paper(s) selected by the program committee are chosen from among the papers accepted for the conference for which one or more student authors are presenting the paper.

Best Studnet Paper 2007

In Memory
Michael A. J. Sweeney, 1951-1995

This years winner of the Michael A.J. Sweney Award goes to "A Digital Family Calendar in the Home: Lessons from Field Trials of LINC" by Carman Neustaedter (University of Calgary), A.J. Brush (Microsoft Research), and Saul Greenberg (University of Calgary).

The research reported in this paper is the culmination of Carman Neustaedter's just-completed PhD research on home calendaring systems, done in collaboration with A.J. Brush and Saul Greenberg. A.J. Brush worked with Carman in her role as supervisor during Carman's student internship at Microsoft Research, while Saul Greenberg guided Carman's PhD progress at the University of Calgary.

Abstract

Digital family calendars have the potential to help families coordinate, yet they must be designed to easily fit within existing routines or they will simply not be used. To understand the critical factors affecting digital family calendar design, we extended LINC, an inkable family calendar to include ubiquitous access, and then conducted a month-long field study with four families.

Adoption and use of LINC during the study demonstrated that LINC successfully supported the families' existing calendaring routines without disrupting existing successful social practices. Families also valued the additional features enabled by LINC. For example, several primary schedulers felt that ubiquitous access positively increased involvement by additional family members in the calendaring routine. The field trials also revealed some unexpected findings, including the importance of mobility—both within and outside the home—for the Tablet PC running LINC.

Bio

Carman Neustaedter is currently a researcher at the University of Calgary, Canada, and a member of GroupLab and the Interactions Lab. He specializes in the area of Human-Computer Interaction, where he seeks to understand the socio-technical factors of ubiquitous technology design to support the everyday social practices of individuals and groups. His research spans the broad areas of computer science, cultural anthropology, sociology, and social psychology.

A.J. Brush's main research interest is human-computer interaction with a focus on computer supported cooperative work. She enjoys investigating how technology can help people and groups with everyday problems, such as too much email or family scheduling.

She received her Ph.D. in computer science from the University of Washington in Sept 2002. Her dissertation research looked at annotating digital documents for asynchronous collaboration, in particular using annotations for discussion in an educational setting, awareness of annotations, and anchoring of annotations. Brush's PhD research was primarily done while she was an intern in the Collaboration and Multimedia Systems group at Microsoft Research.

Saul Greenberg is a Full Professor in the Department of Computer Science at the University of Calgary. He specializes in Human Computer Interaction, Computer Supported Cooperative Work, and Ubiquitous Computing. He and his crew are well known for their development of: toolkits enabling rapid prototyping of groupware and ubiquitous appliances; innovative and seminal system designs based on observations of social phenomenon; articulation of design-oriented social science theories, and refinement of evaluation methods. Saul holds the iCORE/Smart Technologies Industrial Chair in Interactive Technologies, a distinguished University Professorship, and was recently elected to the ACM CHI Academy in for his overall contributions to the field of Human Computer Interaction.