

“The Calendar is Crucial”: Coordination and Awareness through the Family Calendar

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Everyday family life involves a myriad of mundane activities that need to be planned and coordinated. We describe findings from studies of 44 different families’ calendaring routines to understand how to best design technology to support them. We outline how a *typology of calendars* containing family activities is used by three different types of families—*Monocentric*, *Pericentric*, and *Polycentric*—which vary in the level of family involvement in the calendaring process. We describe these family types, the content of family calendars, the ways in which they are extended through annotations and augmentations, and the implications from these findings for design.

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1. INTRODUCTION

Family life involves the continual organization and coordination of various activities on an everyday basis, including school events, extracurricular activities, family outings, and appointments [Beech *et al.*, 2004, Sellen *et al.*, 2004, Neustaedter *et al.*, 2006, Taylor and Swan, 2005]. Coordination routines are intermixed amidst everyday life and extend beyond the home to include scheduling while at work or mobile [Crabtree *et al.*, 2003b, Beech *et al.*, 2004, Sellen *et al.*, 2004]. They also involve the use of a variety of “tools”: from calendars [Brush and Turner, 2005, Neustaedter and Brush, 2006], to notes and lists [Taylor and Swan, 2004], to a myriad of technologies including telephones, mobile phones, email, and even instant messaging [Beech *et al.*, 2004, Neustaedter *et al.*, 2006, Brush and Turner, 2005]. Yet despite these tools, family coordination still remains an everyday problem for many people [Sellen *et al.*, 2004].

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Our focus in this article is on understanding how families use their *calendars* as a part of everyday family coordination. This is because family calendars are almost always the central family coordination artifact [Zimmerman *et al.*, 2001 and, to foreshadow, our results reveal this as well] rendering family calendars “crucial.” By *family calendar* we are referring to any calendar used by family members as a part of the family’s coordination routine. This definition, of course, begs the question of what we mean by “family.” In the context of this paper, we are primarily interested in the family as a social unit that has a need to coordinate each other’s activities. Our canonical “family” follows the standard dictionary definition, e.g., a social unit living together, typically parents with one or more non-adult children. A family calendar should include some notion of days, weeks, months, or years in which events can be recorded with an associated date or time.

Naturally our family calendar definition includes the common paper calendar that families hang on the wall in their home [Crabtree *et al.*, 2003] and also includes work calendars, if used for family coordination [Brush and Turner, 2005]. For example, Figure 1 shows a fairly prototypical family calendar found in many North American homes. While this notion of family calendar may appear simple on the surface, this article will illustrate the many nuances of this definition and help to further define family calendars by describing the types of calendars families actually use and the ways in which they are used. Naturally other artifacts are used in conjunction with family calendars and are often very important (for example, see Swan and Taylor, 2005 or Ludford *et al.*, 2006 for the role that lists play). Rather than provide breadth coverage of family coordination including analyses of *all* the tools and techniques that are used, we focus on family calendaring so that we may provide a detailed analysis of this specific facet of family coordination.

Existing studies have shown that many families use paper calendars as a family calendar—they are simple to use, mobile, and personalizable [Brush and Turner, 2005]. Yet paper calendars have limitations. They are not easily available from the many locations that family members frequent as they go about their activities. For example, a paper calendar hanging on a wall in a family’s kitchen is not accessible from one’s work, or while mobile between locations. This lack of ubiquity can cause challenges in checking the calendar and updating it [Beech *et al.*, 2004, Sellen *et al.*, 2004, Brush and Turner, 2005], which in turn can lead to coordination breakdowns. Some families use multiple calendars to overcome this problem, yet this brings additional challenges with synchronizing the calendars to ensure each contains the relevant events [Brush and Turner, 2005].

Technology offers promise for family calendaring. Networked 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. In fact, many companies are now designing online calendars that offer this experience, for example, see Google Calendar, Trumba, or OurFamilyWizard. The problem, though, is that these calendars are often not designed with a clear understanding of family routines and the ways in which families will actually use the calendars. In some cases, they are designed for personal use (e.g., Google Calendar), rather than family use (e.g., OurFamilyWizard). This can easily cause impoverished family coordination routines if families adopt and use these calendars. Our research goal then is to 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 their routines in a beneficial way.

To this end, we have studied the family calendaring routines of 44 middle class families (with children and from Canada and the United States) through contextual interviews and content analysis of family calendars. Our results outline three types of families, a typology of calendars used by families, the process of scheduling and coordinating activities, and calendar content and annotations. This knowledge

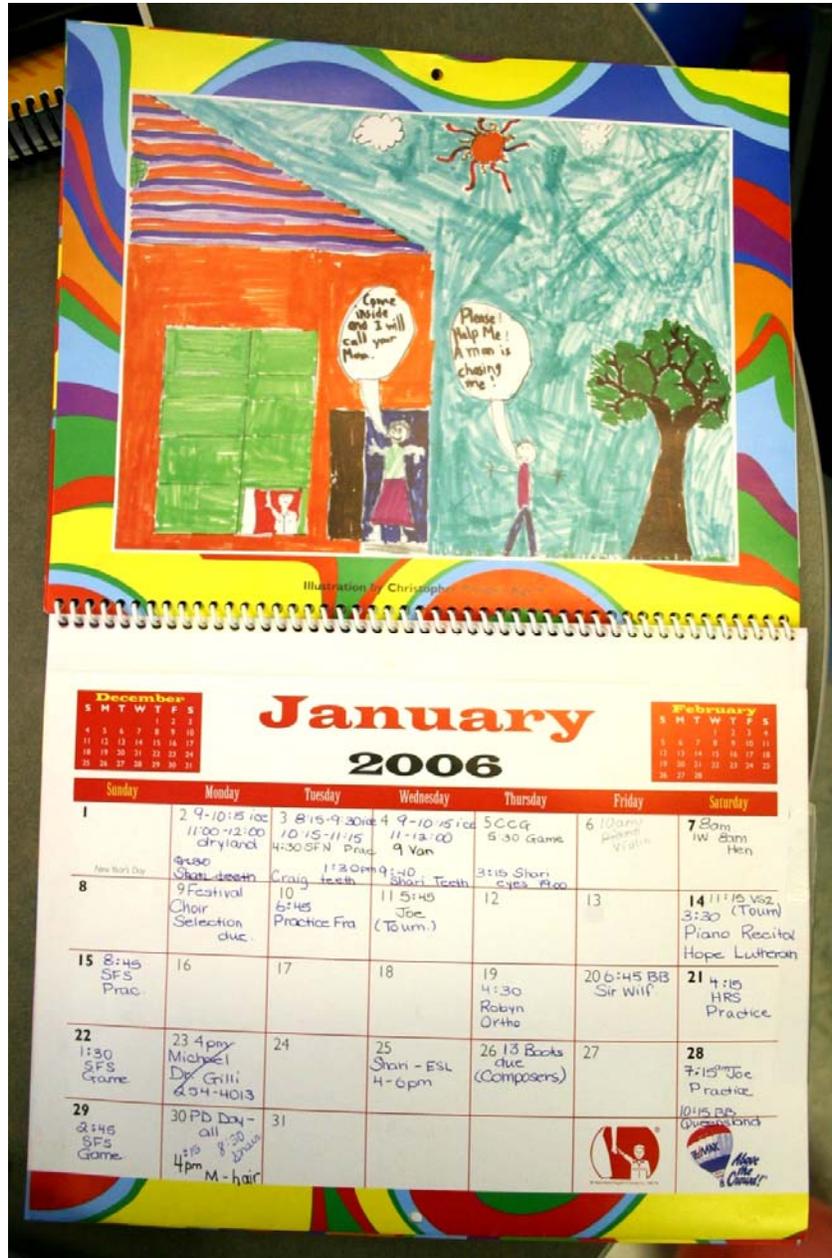


Fig. 1. A sample family calendar.

immediately forms a requirements analysis for designers and practitioners of family calendar designs. It also provides a common vocabulary for discussing family calendars and digital designs, and gives a better understanding of the context [Dourish, 2006] in which digital family calendars will eventually reside. There are, of course, other areas of calendaring that are related and worthy of study (e.g., personal calendaring, calendaring for adults without children), yet rather than expanding in scope to include other demographics and contexts, we have chosen to study one subgroup. In spite of this constraint, our work could certainly be used as a comparative point for future studies.

We first detail our methodology by describing our participants and study process. Following this, we step through the key themes we have uncovered about family calendaring. Throughout our results, we interweave the relevant related work and contrast and compare family calendaring to workplace calendaring. We conclude by discussing the implications from our findings for the design of digital family calendars and analyze several existing family calendar designs. This further highlights the ways in which digital family calendars should be designed to fit within the social fabric of the home.

2. METHODOLOGY

Our article reports on the usage of family calendars from 44 different middle class families using semi-structured interviews that probe into the social culture of the home. We do not consider this to be an exploration using traditional ethnography [Spradley, 1980] although we do uncover cultural processes and meaning. In this section, we describe our participants, interview method, and analysis.

2.1 Family Participants

Our study was comprised of 60 individuals from 44 different middle class families residing either in Seattle, U.S.A., or Calgary, Canada:

- a) twenty families (from Seattle) are from design work by Neustaedter and Brush [2006];
- b) four families (two from Seattle and two from Calgary) are from a field study of digital calendar use in Neustaedter, Brush, and Greenberg [2007]; and,
- c) twenty families (from Calgary) are from a study looking exclusively at existing family calendar routines.

Each of the above studies contained an initial study component that sought to identify and understand families' existing calendaring routines; thus, while each study had a different overall goal, the initial stage was the same for all three. Interviews with the initial twenty participants (a) came first, followed by the next four families (b)—these formed the basis of our thinking. We then followed-up with twenty additional families (c) where we narrowed our focus and uncovered additional detail about family coordination routines. All Seattle participants were recruited using a study recruitment agency, which collects a database of people interested in user studies and contacts them to check for availability and appropriateness for a given study. All Calgary participants were recruited using a snowball sampling technique where emails were sent to colleagues and friends and forwarded on to their contacts, and so on and so forth. Participants in groups (a) and (b) were remunerated with computer software and participants in group (c) received \$20 CAD.

All households were middle class families with children varying in age from three months to 20 years; the number of children ranged from one to six (median 2). Parents ranged in age from their late 20's to 50's. We had 29 dual income families and 15 single income families (the mother was a homemaker). Those working had a large variety of occupations, e.g., teacher, executive assistant, programmer, attorney, accountant, dentist, therapist, child care worker, firefighter. A large majority of families, 42 of 44, consisted of heterosexual married couples. Only two of the families contained single parents. Despite this, we did not notice any major differences in the results between the single parents and the married couples and do not suspect the main findings of this study would differ greatly with a larger number of single parents.

2.2 Interview Method

We interviewed one or more individuals from all 44 families about their existing family coordination routines. Interviews of family members varied: 31 of the 44 involved only the mother (primary scheduler), six involved both the mother and father (primary and

secondary scheduler), two involved just the father (secondary scheduler), 1 involved an adult child living at home (secondary scheduler), and four involved all family members (excluding young children). This variation was based purely on the availability of family members. Interviews occurred either in the participants' homes (23 of the 44 households), our research lab (20 of 44), or in a neutral location chosen by the participant (1 of 44).

A natural critique of interviews is that people are not able to easily describe their routines retrospectively. We avoided this pitfall by grounding our interviews in real domestic coordination artifacts. That is, we asked participants to bring, show and share with us their calendars and any other items they use to help coordinate family activities. We then asked participants to discuss these artifacts and how they were used. We also had a series of predetermined questions that were used throughout this process in case certain things we were interested in did not come up naturally. This technique of situating interviews with real world artifacts is borrowed from contextual inquiry [Holtzblatt and Jones, 1995, Beyer and Holtzblatt, 1998]. Interviews typically lasted about an hour. Audio was recorded for all interviews, while observations and interview responses were handwritten or typed by the interviewer during the interview. With participants' permission, we also photographed all calendars and items used by the families for coordination purposes.

2.3 Observation and Analysis Methods

All interview notes were reviewed and if clarification was needed we returned to our audio recordings. We categorized all interview notes and observations and used open coding [Strauss and Corbin, 1998] to draw out the similarities and differences between households. That is, for each unique observation we coded it with a descriptive stylized label. We then compared subsequent observations with our coded ones, where we marked recurring similar observations with the best matching code. Observations that did not fit were given a new code. For example, when going through our interview notes looking for the locations of the family calendar, we came across the "fridge" as one location. We created a label [F] to represent this location. Each time we came across the "fridge" as the calendar's location we flagged the data with the same code, [F]. If a different location was seen, we created a new code for it, e.g., [P] for "near the phone." We then used our coding and categorizations along with affinity diagramming [Holtzblatt and Jones, 1995, Holtzblatt *et al.*, 2005] to reveal key themes within the data.

3. FAMILY TYPES

Our results revealed that there are two main types of family members when it comes to family calendaring routines. First, we found that every family typically has a *primary scheduler*: the family member who is most responsible for recording family activities on the calendar and ensuring people know about them. In 41 of our 44 families (93%), the mother was the primary family scheduler. Parents in two of the other families said they shared the role of primary scheduler (4.5%); and, in the remaining family (2.2%), the father was the primary scheduler because he was at home most often due to his shift work as a firefighter. This confirms results from several studies [Beech *et al.*, 2004, Brush and Turner, 2005] that also show the dominance of women as primary scheduler given their typical role as household communicator [Hutchinson *et al.*, 2002] and the person most often responsible for the family's children [Leslie *et al.*, 1991, Zimmerman *et al.*, 2001].

Second, we found that other family members, labeled as *secondary schedulers*, are involved in the family's calendaring routine, yet to a lesser extent. This involvement also varies, which allows us to cluster families into one of three main types (grouped by the first author and validated by a second analyst).

1. ***Monocentric Families***: the calendar routine is centered on the primary scheduler with *little to no* involvement by secondary schedulers (39% of our 44 families);

2. **Pericentric Families:** the calendar routine is centered on the primary scheduler with *infrequent* involvement by secondary schedulers (27% of 44 families); and,
3. **Polycentric Families:** the calendar routine is still centered on the primary schedulers, yet secondary schedulers are now *frequently* involved (34% of 44 families).

These groupings validate previous studies that also show that some families have multiple calendar maintainers [Hutchinson *et al.*, 2002, Brush and Turner, 2005]; our work further breaks this down into family types. The definitions of these family types are left vague at this point; the results to follow, in particular Section 5, will fill in the details. We also caution that these are general groupings, and family routines vary within each group. The groupings are at best a general means to compare and understand the differing routines that families undertake when it comes to calendaring. The groupings should also not be thought of as any sort of hierarchy, for some families actually prefer particular coordination routines to others. For example, a family may be Monocentric because the father and mother have clearly delineated each of their responsibilities and one parent is responsible for coordinating activities. Other families may work better with a more balanced load where both parents share the responsibility of scheduling.

We will return to these family types throughout the results, comparing and contrasting them when differences arise.

4. A TYPOLOGY OF CALENDARS USED BY FAMILIES

We found families use a variety of items for coordination including to-do lists, notices or handouts, random pieces of paper, and appointment cards. However, the most prominent and central of the coordination artifacts that we saw used by families were one or more calendars. A sample of quotes from our participants illustrates this:

“The calendar is crucial; it’d be a disaster without it. Anyone can look at it.” – Samantha (P14), Mom and Administrative Assistant

“[The family calendar] is extremely important, we are involved in so many different events I have to be able to map it out or we would forget places, dates, times.” – Mona (P20), Mom and Teacher

Figure 2 gives a broad overview of the calendars we saw, summarizing the number and types of calendars used by each family. Each column represents one family labeled by participant number (e.g., P1, P3 and so on) for easy comparison with other results. Families are further grouped across these columns by their coordination routine: Monocentric (first 17 columns), Pericentric (next 12 columns), and Polycentric families (final 15 columns). Families are sorted by participant number within the groups, again for easy comparison with other findings. Colored squares in each column show the type of calendars used by families, e.g., a paper wall calendar, a digital PC calendar, and so on. Black squares indicate which calendar is the *primary family calendar*: the main calendar used by a family for coordination. The gray squares show *secondary calendars*: the calendars that also contain family events but are not the central calendar used by the family. White squares are calendar types not used by that family. Regardless of the type, all calendars we saw used the fairly ubiquitous Gregorian format. Rows are further grouped into six grids based on the calendar’s main purpose, e.g., calendars for public awareness *vs.* calendars for personal work; we discuss these groupings momentarily. Some families had two of the same type of calendar within a grid so these types have multiple rows. For example, the top two rows both contain paper wall calendars (although only the first row is labeled as Paper Wall).

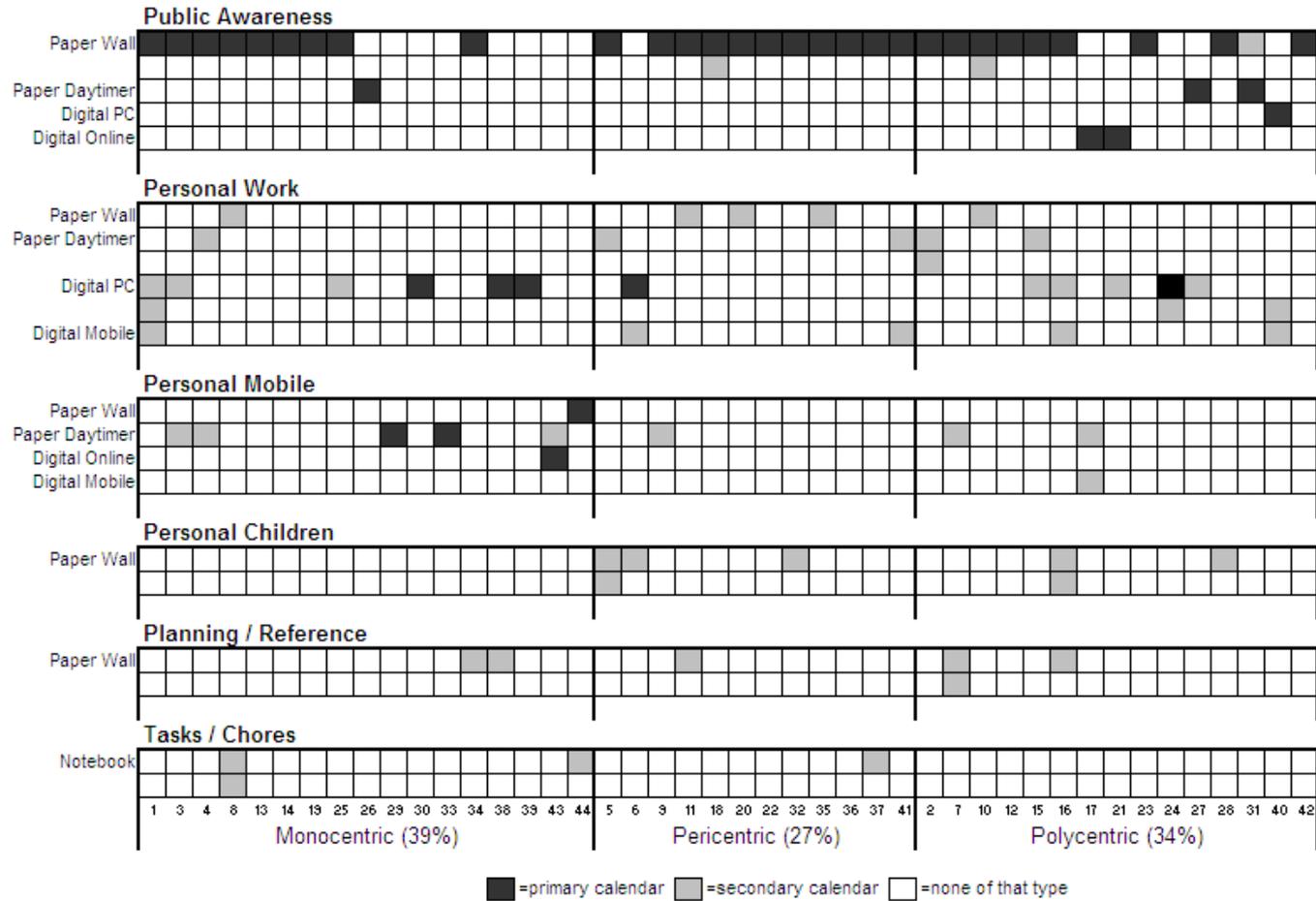


Fig. 2. Each column shows the number and type of calendars (e.g., paper wall, paper daytimer) used by a participant family (P1 through P44). These are grouped by the purpose of the calendar (e.g., public awareness vs. personal work). Black squares represent primary calendars and gray squares represent secondary calendars.

Taken together, each column can now be read as representing one family and the types of calendars they use for family events. For example, we see that the leftmost family (P1) uses four calendars: one paper wall calendar primarily for maintaining public awareness, two digital PC calendars (e.g., Microsoft Outlook) primarily for maintaining personal work, and one digital mobile calendar (e.g., a PDA) also for maintaining personal work. For this family, like many, the primary family calendar (marked in black) is the paper wall calendar. The three other calendars (marked in gray) are secondary calendars for this family.

Figure 2 illustrates many statistics. While 13 families (29.5%) used only one calendar for family coordination, a large majority of families, 31 (70.5%), used more than one calendar. The median number of calendars used for family coordination per household was two (mean 2.2 ± 1.1) with a range from one to six: 17 families (38.6%) had two, 8 (18.2%) had three, 4 (9.1%) had four, 1 (2.3%) had five and 1 (2.3%) had six. As a comparison, Beech *et al.* [2004] found families used an average of four calendars with seven being the most used by one family. For each of our families, one of their calendars was considered the main calendar and often dubbed “the family calendar.” For our 44 families, 35 (79.5%) used a paper calendar as the primary calendar while 9 (20.5%) used a digital calendar. Over all of the calendars families used, we saw six different types of calendars emerge based on the *purpose* or *reason* for using the calendar as part of the family coordination routine (Figure 2 has six grids that group the rows by these types). These types span both paper and digital calendars. The following subsections detail each calendar within this typology and the reason for its usage. Table 1 summarizes the findings.

We stress that this calendar typology is specific to *family* coordination. Even though it contains some calendars geared towards work, they are included because they overlap with family coordination needs. Indeed, we left out other calendar types that people use for work activities if they were not used for family coordination. For example, a person may report using a shared workgroup calendar to plan weekly business meetings, but it is not normally used to coordinate family activities. Thus it is excluded from our typology.

Table. 1. A typology of calendars used by families.

Type of Calendar	Calendar Use and Location
Public Awareness	Calendars placed in publicly viewable locations in the home so that family members can all gather an awareness of family activities. Primary calendars are often used in this manner.
Personal Work	Calendars used for work scheduling where some family events are also recorded because they affect the work schedule. They are located at work, but may move between home and work if in a portable form factor.
Personal Mobile	Calendars that move with a single family member to provide mobile calendar access while out and about. Their primary use is for family activities, not work ones.
Personal Children's	Calendars designed to teach children about scheduling, organization, and the family's activities. They are located in areas where children can easily view them.
Planning/Reference	Calendars used to plan out family activities or provide a reference for dates. They are located in areas conducive to planning.
Tasks and Chores	Calendars used to record family tasks or chores only. They are located in areas conducive to planning or visual reminding.

We also saw that some families use milestone calendars to record children's events as they grow (e.g., first step, talking). While these do contain *family* activities, they were used more for *reflection* and not *coordination* so we do not include them in our typology.

4.1 Public Awareness Calendars

Families often have a calendar that acts as a *shared family information resource* where the calendar is visible for all family members (whether they check it or not). The *awareness* provided by the calendar is used by family members to coordinate activities (the details of which are described in Section 5). We call these **Public Awareness calendars** because of their role and visibility. The large volume of gray and black squares in the top grid in Figure 2 shows that Public Awareness calendars were the most widely used type of calendar for family coordination. In fact, 80% of families (35 of 44) used a Public Awareness calendar as their primary family calendar.

Most often a *paper wall calendar* was used as a Public Awareness calendar (Figure 2, Grid 1, Rows 1 and 2): 29 times as a primary calendar (black squares). While the paper wall calendar dominated, public awareness calendars were also used as primary family calendars in the form of *paper daytimers* and *digital calendars*. Despite these calendars being slightly different in form, style, and presentation, they were all used in the same manner: all were placed in publicly accessible locations for the purpose of providing family members with awareness of their activities. Families don't always start out by using Public Awareness calendars. In fact, several couples told us they transitioned from using personal calendars to Public Awareness calendars as they married and then had children; the need for public access to a family calendar was a clearly visible need.

Locations. The location of Public Awareness calendars varied slightly across families. For all but one family (37 of 38), this translated into a *frequently visited* location of the *home*. A large majority of calendars in home locations, 29 of 37 (78.3%), were hanging on the fridge or wall of the kitchen; four (10.8%) were hanging on a shelf near computers in a home office; two (5.4%) were located in drawers in the kitchen; and two (5.4%) were online calendars accessible on a PC in the living room or home office. Similar locations were also found by Crabtree *et al.* [2003a] and Elliot *et al.* [2005]. The remaining calendar was contained in Outlook and made public by printing and distributing it to family members. Figure 3 shows a couple of common locations used by families.

Unlike PC-based calendars, paper calendars naturally lend themselves to be placed in a variety of publicly accessible locations. One family referred to this type of location as the "hub of the home." For example, Linda's (P3) family calendar is on the wall in the kitchen next to its entrance (Figure 3a, left):

"Can't really miss it there...[what works best is] the fact that it's convenient, it's right there. I don't have to go far to write something. I don't have to dig it out. If it was in another room you wouldn't check it as often. The kitchen is where I spend most of my time, especially in the morning." – Linda (P3), Mom and Administrator

Samantha (P14) told us that while it was very important to have her paper family calendar in a public location at home, she did not think it was very aesthetically pleasing and it would even embarrass her if guests saw it. Similarly, Kayla (P19) says one of her least favorite things about the family calendar is how cluttered the area around it can become. Kayla's calendar is magnetized to the fridge door (Figure 3b, right) along with a variety of other items. While family calendars can certainly become a "mess," it is this mess that becomes very useful, as we elaborate in subsequent sections.



3a. Linda's (P3) calendar next to the kitchen entry. 3b. Kayla's (P19) calendar magnetized to the fridge.
 Fig. 3. Public Awareness calendars located in easily visible places, which are sometimes near other resources.

Some families balance the need for the calendar to be public with the ability to easily update it. For this reason, the Public Awareness calendar will not only be in a high traffic area, but it will also be situated near other important scheduling resources, like the phone or computer where a phone call or new email may trigger adding an event to the calendar. For example, Anita and Doug (P9) comment on their placement of the family calendar in the kitchen right above the phone:

“Usually if someone is calling, you can answer questions about the calendar, whether you can do stuff on [a day], and if they’re calling about something on the calendar you can write it down.” – Anita (P9), Mom and Accountant

The challenge of paper-based Public Awareness calendars is that they are only accessible in one location, which means that family members have to resort to other strategies if they wish to “see” the family’s activities when away from this location. One strategy involves using multiple calendars each in a different location. This is why we see many families using more than one calendar in Figure 2. Another strategy involves using a digital calendar as a Public Awareness calendar.

Digital Calendars. Some families use digital calendars in a way that makes them a Public Awareness calendar, yet digital calendars have different affordances than paper ones. For example, digital calendars are certainly not as amenable to flexible placement on walls and doors, and typically have too large a footprint to be placed atop a kitchen counter. Yet people develop strategies that not only work around these limitations, but take advantages of abilities not possible on paper [Brush and Turner, 2005]. Typically, we saw that the contents of digital calendars are made public through online sharing or printing, where others have their own copies or can access the calendar remotely.

For example, Rebecca (P40) is a trial lawyer with six children (the most in our study). The primary family calendar is in Microsoft Outlook on her computer and laptop. While only Rebecca can access it, she makes it publicly available by printing out copies of the calendar at the beginning of each day and distributing one to each family member (and also the nanny). If events need to be updated, family members can notify Rebecca who will update the calendar and print new copies. On the other hand, Margo (P17) found it increasingly difficult to get her children to write events on the family’s paper wall calendar. For this reason, she transitioned from using a paper-based Public Awareness

calendar to a digital one (an online calendar) that her teenage son told her he would be more apt to add events to. Since then, it has been easier for Margo to coordinate driving her son to his band practices because he has started updating the calendar with his activities.

4.2 Personal Work Calendars

Family activities and work schedules have a tendency to affect and interact with one another. For example, a parent may need to leave work early or start late because of a child's doctor appointment. Parents may also need to know what activities are happening in the evening after work so they can mentally prepare for the evening before leaving the office. Others just like to have family activities that they are responsible for on their work calendar as a reminder or to aid coordination during the day. This is especially true if the family calendar is on paper and only accessible when at home. For these reasons, we found that 22 of 44 families (50%) also used *Personal Work calendars* in some capacity for family coordination, even though the primary purpose of these calendars was to schedule and coordinate *work* activities (see Figure 2, Grid 2). The locations of these calendars vary between work, home, and mobile.

Primary Calendars. Five families (11.4%) used a Personal Work calendar (Microsoft Outlook) as their primary family calendar (the black squares in Figure 2, Grid 2). Each of these families had a fairly intertwined work and family life. In these situations, all activities for the family are recorded in the work calendar, yet the challenge is that the calendar is often inaccessible for family members other than the primary scheduler. One family we interviewed had a workaround that enabled both parents to see the family calendar: Joanne sends all family events as scheduled meetings from her Outlook calendar to her husband Jason's email, which he can then "accept" and move into *his* Outlook work calendar. While this strategy worked for Joanne and Jason, this information was inaccessible for their children. Other families who used a Personal Work calendar as their primary calendar fared even worse than Joanne and Jason, for they were unable to easily share the family calendar's events. In some cases, they even abandoned using their work calendar as a primary calendar because it was inaccessible for others.

Secondary Calendars. The remaining 26 Personal Work calendars we saw (the gray squares in Figure 2, Grid 2) were all used as secondary calendars where they *do not typically contain all family activities*. Instead, these Personal Work calendars contain a subset of family events, usually those that affect the work schedule. Thus, these calendars were used to stay aware of certain family events when at work. For example, Ellen and Oreste (P10), parents of a 9-year old son, both write family activities in their work calendar to stay aware of family events when at work:

"If a family event that is related to my work or affects my work I will also put it on [my work calendar]. If I have a doctor's appointment and I have to leave I'll put it down. If we go to a party on Saturday it won't be on [my work calendar]."
– Oreste (P10), Dad and Technical Sale Representative

4.3 Personal Mobile Calendars

Several families use *Personal Mobile calendars* for family coordination in order to schedule activities and see the family's plans. These calendars are used in a way that makes them both personal and mobile: events are recorded by one person and the calendar is accessible by that family member in multiple locations both inside and outside the home. Recorded events are family/personal ones rather than work ones. Ten of 44

families (23%) used Personal Mobile calendars, two of which used more than one (Figure 2, Grid 3).

Primary Calendars. Four families (11.4%) used a Personal Mobile calendar as the primary family calendar (the black squares in Figure 2, Grid 3): one was a wall calendar, two were daytimers and one was a digital online calendar (AOL's). Each of these calendars was used by one family member, the primary scheduler, where it was either carried with the scheduler (e.g., in their purse if it was paper) or accessed at multiple computers in the case of the digital online calendar. The challenge with having a Personal Mobile calendar as the primary family calendar is that other family members cannot see the family calendar, causing them to learn about the family's activities in other ways (discussed in detail in Section 5). For example, Gloria (P44), mother of two children aged 7 and 10, uses a paper wall calendar as the primary family calendar. Rather than hanging the calendar on a wall, though, it is moved throughout the home by Gloria and even taken with her most times when she goes out. Because of the changing locations of the calendar, her family typically needs to ask her what activities are occurring.

As mentioned before, couples often transitioned away from using their Personal Mobile calendars as a primary calendar when they married and had children because they found it was too difficult to know what other family members were up to. For example, this was the case for Greg and Lana (P7): each maintained a Mobile calendar until they became married and at that point they adopted a Public Awareness calendar as their primary calendar. Their Mobile calendars then became used as secondary calendars.

Secondary Calendars. Eight families (18.1%) used a Personal Mobile calendar in a more secondary role (the gray squares in Figure 2, Grid 3). Here most were daytimers that could be carried in the purse of the primary scheduler when out; its purpose was to have a version of the calendar handy in case something came up that they needed to schedule or check. For example, Linda (P3) carries a personal daytimer in her handbag whenever she leaves home, and will use it to write down events when she is out. On returning home, she will sit down and transfer events from the daytimer back to her primary family calendar.

Alternative Solutions. Some people don't use Personal Mobile calendars, yet they have workarounds that achieve a similar effect. We saw people carry a to-do list or piece of paper that contains a list of things that need to get done that day. Rather than have a full calendar, events are copied down from the calendar to the to-do list and augmented with additional tasks that the family member wants to accomplish. This resonates with findings from Starner *et al.* [2004], which found that people abandon digital devices when mobile and use alternatives like memory or paper because of their simplicity.

4.4 Personal Children's Calendars

Some families have special, dedicated *Personal Children's calendars*, where their purpose is to make children more aware of the family's activities and teach them about organization. These types of calendars were seen less frequently. Five families (11%) used Personal Children's calendars as secondary calendars (the gray squares in Figure 2, Grid 4), where two of these families had a calendar for each of two children. These calendars were placed either in a child's room or a public area of the home like the kitchen or living room. They are *personal* because the calendar is designed specifically for an individual, in this case, a child.



Fig. 4. Cathy's (P11) calendar specifically used for long-term planning.

4.5 Planning and Reference Calendars

Some families use certain calendars specifically for short- or long-term planning. We call these *Planning and Reference calendars*, and 5 families (11%) used them as secondary calendars (gray squares in Figure 2, Grid 5). These calendars serve one of two purposes. First, they can provide a draft space where family activities are planned out before being written on a more finalized calendar like a Public Awareness calendar. Second, they can simply be used as a reference for calendar dates, and in this situation they may not necessarily contain family events. Here the important aspect is that they can provide a long-term view of the weeks and months ahead to see when holidays occur and when certain days are (e.g., what day of the week is August 18th?). Figure 4 shows Cathy's (P11) year-at-a-glance calendar, which is used to check dates.

Of course, Public Awareness calendars could be used as Planning and Reference calendars, and we did see some families use their Public Awareness calendar in a manner similar to a Planning and Reference calendar. However, some families like to have separate specialized calendars for this purpose. This calendar can even be placed in a different location than the Public Awareness calendar, where the location is more conducive to the task of planning or referencing dates rather than being publicly visible.

4.6 Tasks and Chores Calendars

Three families (6.8%) kept specialized household *Tasks and Chores calendars* (gray squares in Figure 2, Grid 6). All were hand drawn on paper (Figure 5), and were considered secondary calendars. These families either did not want to forget about these tasks or chores, or they wanted to keep a record of them. In contrast, most other families simply remembered tasks and who is responsible for them, or sometimes placed them on the primary family calendar (discussed further in Section 6). Task and Chore calendars are usually placed in a high traffic area of the home close to the location used to plan the tasks, such as a kitchen. Thus this calendar serves as a visual reminder about the tasks that need to be accomplished.

Housework Schedule (2 week Plan)

Monday Laundry Day - Clean out Fridge	Tues. Vacuuming (A.M.) Wash floors - Clean Stove Top - microwave.	Wed Dusting / Wipe furniture / kitchen Cabinets - Clean Bathrooms - Empty Diaper Pail	Thur Windexing Windows mirrors - T.V.'s + Tables - Fingerprints off Walls & light switches	Fri Empty Garbages - Empty Diaper Pail - Organize Recycling
Monday Laundry Day - Clean out Fridge	Tues Laundry Day (For Sheets) Vacuuming (A.M.) Wash floors - Clean Stove top	Wed Dusting / Wipe furniture / kitchen Cabinets - Clean Bathrooms - Empty Diaper Pail	Thur. - Windexing Windows Mirrors, Tables, - Fingerprints off Walls & light switches	Fri Empty Garbages - Empty Diaper Pail - Organize Recycling

Fig. 5. Muriel's (P8) biweekly household tasks and chores calendar.

4.7 Discussion

We now reflect on several of the key themes that emerged from our results of the types of calendars that families use for coordination.

Calendar Ubiquity. Clearly the idea of a single family calendar is somewhat naïve. In fact, as previous studies have shown [Hutchinson *et al.*, 2002], families often use multiple calendars in both primary and secondary roles. Previous research has identified two main types of calendars used by families: Public Awareness [Crabtree *et al.*, 2003b] and Personal Work [Brush and Turner, 2005]. We have further defined these two types and also outlined four additional types: Personal Mobile, Planning/Reference, Children's, and Tasks/Chores. This typology of calendars is used in order to have calendar information in different locations. Sometimes the information contained on the calendar will vary between locations. For example, a Public Awareness calendar will contain events of which the entire family should stay aware. A Tasks and Chores calendar may contain only events that are related to household tasks. While previous research has identified the importance of calendar ubiquity outside of the home [Crabtree *et al.*, 2003a, Beech *et al.*, 2004], what is most surprising is the need for ubiquity within the home in multiple locations (e.g., more than one Public Awareness calendar, a Task/Chores calendar, a Reference calendar, etc). We have also found that enabling ubiquitous access to calendar information is not the only factor when choosing calendars; there is also at least some care taken to choose aesthetically pleasing calendars and locations for them.

Comparing to Workplace Calendaring. These findings are similar to workplace calendaring; in the workplace, multiple calendars are used to have calendaring information in different work locations or for different purposes [Kelley and Chapanis, 1982, Kincaid *et al.*, 1985, Payne, 1993, Palen, 1998]. Yet, family calendaring and workplace calendaring will each involve using a different set of calendars, although these sets may overlap. For example, someone's primary work calendar may contain some family events and thus be classified as a Personal Work calendar. On the other hand, a calendar used for an entire work group would likely not. Similarly, some calendars used at home may contain some work events, but likely not a complete work schedule. Other

home calendars may not contain any work content (e.g., a children's calendar); thus, they would not be part of the work calendar set.

In the workplace, networked calendars were adopted because people needed an easy means to share their calendars for coordination [Palen, 1998]. Thus, moving from paper to digital calendars made workplace coordination easier. Yet reflecting on our findings about family calendaring we see the opposite. Paper calendars are very easy for families to make publicly available: they simply place the calendar in a location of the home that receives a large amount of household traffic. Families who use digital calendars as their primary calendar on the other hand are often not able to make their calendar publicly available for family members unless they go to extensive effort (e.g., printing and distributing paper copies) or require family members to adopt a Polycentric routine (e.g., having all family members add events to a shared online calendar). This highlights the important realization that using digital calendars not specifically designed for family coordination can easily cause family routines to become less than desirable.

Family Types. For the most part, we did not find any strong correlations between the three family types—Monocentric, Pericentric, and Polycentric—and the different types of calendars being used. Figure 3 illustrates the diversity of calendars used by each of the family types. We believe that family routines are fairly idiosyncratic, where patterns emerge within families for a large number of reasons. Still, a particular mix of calendars used by a family could make high family involvement (Polycentric) more challenging. For example, our findings show that only Monocentric families use Personal Mobile calendars as the primary family calendar (Figure 2, Grid 3 has only black squares for Monocentric families). This makes sense, for secondary users cannot use the calendar if it is absent. Families who use Personal Work calendars as the primary family calendar also appear to have low family involvement (4 of 5 families are Monocentric or Pericentric) likely caused by the inability for secondary schedulers to access the calendar. The only Polycentric family who uses a Personal Work calendar as their primary calendar (P24) has a special setup that allows them to share their Outlook calendars; such a setup may not be easily available for most families, though.

It is also easy to speculate about the reverse: perhaps having a Public Awareness calendar as a primary calendar could increase family involvement. Yet our data shows this is not the case as many families with Public Awareness calendars are Mono/Pericentric (Figure 2, Grid 1 has many black squares for Mono and Pericentric). However, the results do show that only families with moderate to high involvement (Peri/Polycentric) have Children's calendars. This is likely because parents are making an extra effort to involve their children in the family's scheduling routine. Even still, it is more likely that a family's routine somewhat influences how they select calendars, rather than the other way around. For example, a Monocentric family may opt for using a Personal Mobile calendar as the primary calendar simply because they know their routine is centered around the primary scheduler anyways. Children's calendars may be used because children are already involved in the routine and want their own calendar.

In the next section, we discuss how families add content to their various calendars and use them to coordinate activities.

5. WHY COORDINATING FAMILY ACTIVITIES IS NOT SO SIMPLE

Family calendars provide a place to store and retrieve family activity information, where this knowledge is used to coordinate activities. While this may appear simple on the surface, families actually follow a more complicated multi-step process that has evolved over time through trial and error, repetition, and iteration. We formalize these steps in this section; Table 2 summarizes our findings. The first three steps involve the actual

Table 2. Scheduling and awareness activities.

Activity	Process
Batch Update	The primary scheduler places a large portion of events on the family calendar. This activity is triggered by changing time periods (month, year, season) or the arrival of school or extra-curricular activity notices.
Continuous Updates	Family members update the calendar as needed throughout the month. This activity occurs in various locations, including the home, work, or while out and about.
Synchronizing Calendars	Family members copy events between multiple calendars to ensure each calendar contains relevant family events.
Awareness Acquisition	Family members check the calendar or get told about its contents in order to understand what family activities are occurring.
Coordination	Family members use their awareness of family activities to discuss who will be responsible for events or who will attend them. Sometimes explicit coordination is not needed, as activity responsibility comprises tacit knowledge.

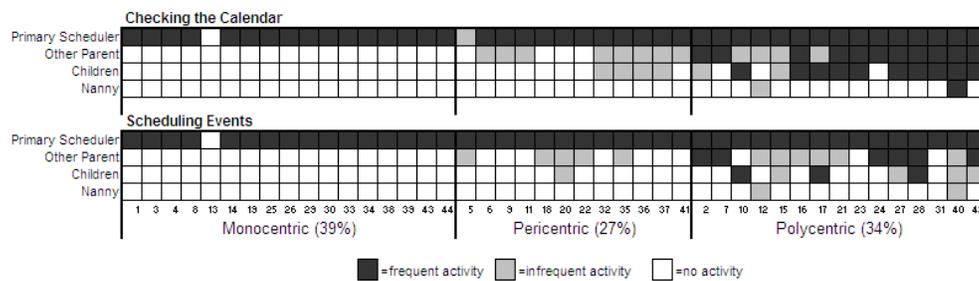


Fig. 6. Three different family types and how each family’s members schedule and check the calendar.

scheduling of events: *batch updates*, *continuous updates*, and *synchronizing calendars*. The next two steps involve becoming aware of the calendar’s contents, *awareness acquisition*, and then using this knowledge to plan the family’s day-to-day activities, *coordination*. We present these steps as being distinct, yet in fact they are often intermixed and certainly not always as systematic as we describe them. What is important is that each family generally employs these techniques and steps in some form or another as part of their calendaring routine.

Another factor is *who* in the family performs these steps. *Primary schedulers* are engaged in all five family calendaring steps, yet the involvement of *secondary schedulers* varies among families. This is summarized in Figure 6: each column shows which family members participate in scheduling (bottom grid), and which family members actually checked the calendar (top grid). Black squares indicate frequent activity, gray indicates infrequent activity, and white indicates no activity. The range in family involvement is evident in Figure 6 by the differing number of shaded squares between families. The family in the leftmost section, P13, that does not have any schedulers (no shaded squares) does not use a family calendar; we discuss this outlier in Section 6.6.

Next we go through each of the five calendaring steps and highlight when and how this process varies for the different family types and what challenges are faced.

5.1 Batch Updating the Calendar

The *primary scheduler* typically spends a significant portion of time placing a large number of events on the family calendar all at once (although other household activities may occur intermittently throughout this process). The point at which this *batch update* takes place varies between families, but the existence of the batch update is fairly widespread. This was also found by Zimmerman *et al.*, 2001. Batch updates do not differ based on the family type (Monocentric, Pericentric, and Polycentric); in all cases, batch updates are performed by just the primary scheduler. Some families perform a batch update at the beginning of each month and place all known events for that month on the calendar. Other updates are triggered by a school notice at the beginning of the school year. Some families even do this type of batch update for the entire calendar year (e.g., adding all birthdays). A primary scheduler describes her process for batch calendar updates:

“Before my month begins I will write down things that generally happen...My daughter has Brownies every Monday night so I write down Brownies for every Monday night. Tuesday night I have my course from 4:45 to 6:45, so I write that down... I used to be the main person for the kids’ program at the church, so I’d write that down. And then I’d add things like dentist, things from the month before.” – Kayla (P19), Mom and Homemaker

The main challenge that families face with batch updates is, at times, there can be a large amount of items that need to be added, thus creating a burdensome task. For example, this situation typically arises at the beginning of the school year when important dates for the entire school are sent home on notices. To get around this problem, we saw several families use a calendar that already contains pre-filled information. For example, a number of our Seattle families reported that they used the local school district paper calendar as their primary family calendar because it already contained the school holidays. Yet the problem remains for families where these types of calendars are not available.

5.2 Continuous Updating of the Calendar at Home and while Mobile

Throughout the month, families must update events on the family calendar as they find out about them or plans change. One may imagine a simple process of just writing or changing the event on the calendar, but in actual practice updating the calendar is much more challenging. Family members find out about needed calendar changes throughout the day and people are not necessarily at the calendar to update it when they find out. Existing studies have found similar findings [Beech *et al.*, 2004], yet we extend them to show how this varies by family type and between locations.

Family Types. The bottom grid in Figure 6 shows who adds events to the calendar for families in each family type. In Monocentric families, the primary scheduler is the only person who performs continuous updates of the calendar. For example, in Kayla’s (P19) family nobody else adds events to the calendar, yet this low level of involvement in scheduling is actually desired by Kayla. In fact, she told us, *“I won’t let [my husband] write on it, he’s too messy.”* Kayla’s children are aged 8 and 10 and also do not add to the calendar. She told us that, for her, updating the calendar is a spontaneous process that happens throughout the day.

In Pericentric families, the primary scheduler still updates the calendar regularly, yet secondary schedulers are also somewhat engaged in adding events to it, albeit infrequently and/or in a restricted way. For example, Carrie (P35), mother of one child aged 9, told us when asked who adds to the calendar, *“Oh, no no no, I only put things on.”* The calendar was *hers* for modifying, although it was still placed in a publicly

viewable location for the rest of the family. Still, Carrie *would* let her family members write on sticky notes that they could stick on the calendar for her to transcribe later.

In Polycentric families, all family members update the calendar, although the primary scheduler performs the majority of updates. Here families are less restrictive in who updates the calendar. For example, Elaine (P12) told us that her husband would normally write something on the family calendar about once a month. Her nanny also added information, usually weekly, although it was typically to show which days she would be unable to work. In Brad and Jennifer's family (P2), all family members including both parents and their two teenage children add events to the calendar weekly.

Mobile Updating. Events that should be recorded sometimes arise while family members are out and about. This poses a particularly challenging situation because most family members do not actually have their primary calendar with them to update, or to check when they are free [see also Hutchinson *et al.*, 2002]. As a result, family members either use additional calendars, or have strategies that help them remember or record the activities while remote, and then transfer these activities to the family calendar when they get home.

Like many people, Ellen and Oreste (P10) receive appointment cards for future appointments for themselves or their son during the current visit to the doctor. Once home they can then copy this information onto the family calendar. For other types of events that do not come "pre-recorded" on a card, they will just try to remember the event and then write it on the calendar when they get home. Kayla (P19) uses a similar "hit-or-miss" strategy:

"I won't know, usually I just schedule and then when I go home if I see there is a conflict I will call back and reschedule. I know this is awful. So I'd like to have a PDA so I can synchronize then I don't have to... it would be good if I could have it incorporated into my cell because I carry my cell phone. I try not to carry anymore than that." – Kayla (P19), Mom and Homemaker

While this strategy often works, it is certainly error prone. Mona (P20), like some others, prefers not to guess when she is free. Instead of scheduling something while on the move, she will phone back once she checks her calendar at home.

Some families are quite creative and will use people or technology as resources for scheduling when not near their family calendar. When Samantha (P14) needs to add something to the calendar while she is out, she phones her children and (if they are at home) has them add it to the family calendar. Paul (P42), father of two teenage sons (and coincidentally the only male primary scheduler we found in our study), phones home when he is out and leaves a message on the answering machine with event details for the family calendar. Once home, he will copy the details on to the calendar. If one of his sons answers the phone when he is trying to do this, he will tell them to hang up and not answer the phone, and then he will call back and leave the message.

5.3 The Pain of Synchronizing Multiple Calendars

Over 70% of families use multiple calendars (discussed in Section 4) to record family events. This comes with a need to synchronize these calendars. Good synchronization ensures each calendar has the appropriate events on it, so that double booking does not occur and events are not missed [Brush and Turner, 2005].

Paper Calendars. Synchronizing with one or more paper calendars can be painful: events must be manually copied multiple times. In fact, many families reported this as being one of the key challenges faced in their coordination routine, reported by all Monocentric, Pericentric, and Polycentric families that use multiple calendars. The only

difference between these families is who is involved in the synchronization, and this depends on whose calendar needs to be synchronized.

For example, Wanda and Dale (P15), parents of children aged 10 and 15, both have a Personal Work calendar. Dale uses a paper daytimer and Wanda uses Outlook. Dale transfers events when at home from the family calendar to his work calendar if they affect his work schedule. Wanda doesn't have the luxury of being able to copy these events at home because she uses Outlook on her work computer. As a result, once a month, Wanda takes the family calendar in to work along with any other sheets of paper containing schedule information. She then types them into her Outlook calendar. Throughout the month, Wanda occasionally calls her work voice mail to leave a message for herself to add an event to Outlook. Dale and Wanda also email each other regularly to tell the other to add something to their work calendar.

Digital Calendars. While paper calendars are clearly hard to synchronize, we would suspect that digital calendars would alleviate this problem because synchronization can be automated (if the technology supports it). Yet we found some people still find this process not to match their needs: the detail in one person's calendar is not necessarily appropriate for the family calendar. Brush and Turner [2005] also report this problem. Synchronization can also be risky, confusing or even scary. For example, Sidney (P6) finds it a challenge to synchronize Work calendars (one of which is the primary family calendar). Both Sidney and her husband use Outlook but are fearful of trying to synchronize these calendars in order for her husband to see family events:

"[My husband and I] could probably have a shared calendar...it isn't something we've done yet. Neither one of us want our calendar screwed up. I don't want all his meetings for work in my calendar, he doesn't care who my clients are. He just cares when I have them. So there is detail on here that he doesn't want and I'm sure there are details on his calendar that I don't want." – Sidney (P6), Mom and Therapist

This concludes how calendars are updated. In the next sections, we describe how families stay aware of what is on the family calendar and use the information to coordinate everyday activities.

5.4 Direct or Indirect Awareness Acquisition

The family calendar provides family members with an awareness of what activities are occurring. The first way in which this knowledge can be gathered is by directly checking the calendar. The way this is done depends on the calendar. For example, digital calendars have automated reminder features: people can be notified of key events, but this only works if the person is at a computer. While such notifications are reasonable in a workplace for those who spend most of their time in front of the computer, this is less than ideal in the home setting where computer use tends to be much more occasional (unless one is telecommuting). Paper calendars do not have active reminders; for this reason, family members must actively monitor the family calendar and check its contents on a regular basis or when adding events. For some, this involves checking multiple calendars. The top grid in Figure 6 shows who checks the calendar in each family for the three different family types. Primary schedulers dominate, regardless of family type.

Primary Schedulers. We found that primary schedulers in all families (regardless of the family type) have a fairly common pattern when it comes to checking the family calendar. They check the calendar daily, in the morning or evening, in order to plan out events, and then also when they schedule events. This is evident by a solid black square appearing next to each primary scheduler in Figure 6. The two exceptions are P3 where

the family doesn't use a calendar and P5 where the primary scheduler checks the calendar infrequently because she usually remembers activities after writing them down. For all other primary schedulers, checking the calendar usually becomes a habit, or occurs simply because the calendar is in a noticeable location. A primary scheduler comments:

"[The wall calendar] doesn't remind me, I have to check it. That's why I like the electronic calendar at work because it sends me an email as well to remind me... I check [the family calendar] if not every day at least every other day, it's kind of a habit to glance at it every morning to make sure I'm not missing anything." – Linda (P3), Mom and Administrator

Secondary Schedulers. The second way that people stay aware of calendar contents is through intermediaries. In Monocentric families, secondary schedulers find out what activities are occurring by having the primary scheduler *remind them* of activities pertinent to them. While some families view this as problematic, others find it beneficial. For example, Mike (P1), father of two children aged 8 and 12, is in just this situation. Mike does not check the family calendar because he and his wife have a fairly clear delineation of family responsibilities. Mike's wife is in charge of ensuring the children make it to their activities, and if necessary, she will let Mike know if there are activities that he needs to be responsible for. Other Monocentric families feel their family members should check the calendar more often. For example, Linda (P3) comments *"My family members don't check [the calendar] often enough. I suppose I would tell [other family members] but again it's up to them to check the calendar."*

In Pericentric families, secondary schedulers gather an awareness of family activities through several means: the primary scheduler reminds them about activities, they ask the primary scheduler, or they infrequently check the calendar. Unlike Monocentric families, secondary schedulers are moderately engaged in finding out what activities are occurring. For example, Anita's (P9) husband, Doug, will often phone her during the day while he is at work to ask what is on the calendar for the evening.

In Polycentric families, reminding by the primary scheduler still occurs, but secondary schedulers also check the family calendar fairly frequently. For example, Charity's (P16) husband Bruno describes how their daughter, aged 5, checks the family calendar:

"We have a breakfast nook. [My daughter] sits at one end of the table and the calendar is at the other end of the table. She'll look at it while we're eating dinner and say, 'oh on Saturday we're doing that' so she definitely looks in at the calendar." – Bruno (P16), Dad and Systems Administrator

In some cases, rather than checking all events, secondary schedulers in Polycentric families are more selective in what they check. This is the case for Bruno who looks for the end of recurring activities in order to catch the final performances or classes.

Calendar Archives. The third way that family members stay aware of activities is through an archive or record of past calendars. Some families will store calendars from year to year and then return to them to look up past events. Elaine (P12) keeps all of her past calendars on a shelf near the computer, which is also near her current family calendar. Elaine keeps the calendars mostly for tax purposes because her husband travels frequently as part of his work as a surgeon.

5.5 Coordinating Activities through Awareness

Once family members have some semblance of awareness of activities, they use this knowledge to coordinate who is responsible for what. Unlike workplace calendaring, the

people attending the event (other than possibly the person whose event it is) are not necessarily decided at the time of scheduling the event. This is the act of *family coordination* that occurs much closer to the scheduled event.

Process. Primary schedulers generally coordinate activities with those family members involved or affected by the activity; this does not differ by family type. Children are not normally involved unless they are teenagers. Coordination involves discussing activities face-to-face if all parties are at home, or using technologies like the phone, email, or instant messenger when they are not at home. Sometimes the calendar is used as a discussion artifact where it may be moved from its normal location, while other times the knowledge people acquire and retain from the calendar suffices.

For example, Brad and Jennifer (P2) coordinate their family's activities (such as rides to activities for their children) each evening for the next day by talking at home. If things come up during the day, Brad and Jennifer will discuss the activities on the phone:

"In the evening we'd be checking it to make sure we're coordinated for tomorrow. We have to coordinate for early morning ice times, we'll switch vehicles, then I'd have to get up early and drive all the boys to practice and then work. It's a coordination that way. Then the odd time I might have to pick them up." – Brad (P2) Dad and Architectural Technician

"We can't coordinate the morning of the day because I'm at work before they're even up so we have to know before...Sometimes [coordinating] is two or three conversations, figuring out maybe we can do it this way or maybe this other way...we're good at working on the fly." – Jennifer (P2), Mom and Government Clerk

Certain activities do not need to be coordinated because family members simply know who will be responsible for an event through tacit knowledge. For example, Brad and Jennifer both know when the other person has routinely finished work and in some situations there is only one person available to drive the children anyhow.

Scheduling Conflicts. Many families try to avoid scheduling conflicts or overlapping events, but sometimes they do arise. In cases where events do overlap, plans must be rearranged. If an event needs to be cancelled, usually an implicit priority system is used. Anita and Doug (P9) check to see which event is most important. Sports games are considered more important than practices, but if the practice involves Doug as the coach, then he must attend. For Lana (P7), this involves seeing how many people the change will affect, where she tries to reduce the number. Sometimes changes will affect just her, but other times they may affect both her and her husband as well as her babysitter.

As we saw with Lana and her babysitter, resolving scheduling conflicts also involves more than just family members. For Sidney (P6), resolving conflicts often involves her friend, Rebecca. Each regularly watches the other's children at least one day per week. Coordination also sometimes involves parents splitting the activities in which the family is involved. For Mona (P20), if their children have events at the same time, her husband will take one child and she will take the other child.

5.6 Discussion

We have shown that family calendaring involves scheduling events on a variety of calendars in large batches, throughout the day, and even while mobile. In addition, there is often a time-demanding synchronization process that occurs. These findings validate previous studies [Zimmerman *et al.*, 2001, Hutchinson *et al.*, 2002, Beech *et al.*, 2004, Brush and Turner, 2005, Plaisant *et al.*, 2006]. We have extended this by showing the

importance of family calendars for acquiring an awareness of family activities, and also the roles that primary and secondary schedulers play in this process and how this varies for the three family types.

Comparing the Acts of Scheduling. When we compare family scheduling to workplace scheduling, we can see several similarities as well as some differences. First, workplace scheduling also involves batch updates of the calendar [Palen, 1998] where these can often be handled by importing event packages into digital calendars. This could similarly be done for family calendars if they are digital. However, we did not find many organizations (e.g., schools) that were either aware of this, or had expertise to enable such features. Consequently, some families would receive long lists of events in their email; even though they were “digital,” the format was not one that could be readily incorporated into a calendar. This likely will change in the future. Second, continuous updates to calendars also occur in the workplace [Kelley and Chapanis, 1982, Kincaid *et al.*, 1985, Payne, 1993, Palen, 1998, Palen 1999]. The difference here, though, is that most often people are situated in one location, especially if they have a “desk job,” where they are close to their digital work calendar. Requiring access to the calendar while mobile is likely a less frequent need. Third, multiple calendars must also be synchronized in the workplace [Kelley and Chapanis, 1982, Kincaid *et al.*, 1985], however, unlike the home, there is currently an assortment of digital calendars designed specifically for the workplace that offer synchronization between device calendars (e.g., PC calendars, mobile assistant calendars).

Comparing Coordination. The largest difference we see between the workplace and family calendaring is our fourth comparison: coordination is handled very differently by families when compared to work colleagues. Both work and family calendars act as social artifacts to coordinate activities, but this act is centered on an individual in the workplace, as compared to the family in domestic calendaring. At work, individuals maintain their own calendar and then provide some level of sharing or access to others [Palen, 1998]. Here they must carefully balance their privacy concerns with the need to present activity awareness to others [Palen, 1998, 1999]. Co-workers then list and invite attendees when setting up a meeting or appointment [Palen, 1998].

Family coordination is much different than this. None of our participant families kept records of who was needed to attend a family event. Instead, it is crucial that family members are able to gather an awareness of activities from their calendars (directly or indirectly through others) so they can coordinate through discussions in person, or by using technologies like the phone, mobile phone, email, or instant messenger. Thus, families do not coordinate *through* the calendar as is the case for workplace coordination; instead, family calendars are awareness tools that facilitate the act of coordination. All families coordinate in this manner regardless of the family type, although the means for actually discussing activities and who is involved will vary depending on the family, the activities needing coordinating, and the time at which coordination is done. Crabtree *et al.* [2003a] also point out that families must negotiate events through discussion where the calendar provides shared knowledge. This is a somewhat surprising finding as this aspect of family routines is a stark contrast to the way in which most digital calendars are designed (e.g., most designs assume individuals will add themselves as “attendees” to events). In fact, given that most next-generation digital calendar designs continue to focus on coordinating through the calendar [Mueller, 2000, Mynatt and Tullio, 2001, Tullio *et al.*, 2002, Brzozowski *et al.*, 2006], it is clear that another design direction is needed to address family coordination needs.

Cultural Comparisons. We did find one family of five children who has a Public Awareness calendar yet does not really use it. Instead, Fiona and Orlando's (P13) family relies heavily on communication between family members to remember, plan, and coordinate activities. We stress that this was the only case out of 44 families where the family calendar was not crucial to the family's coordination routine. In this situation, we feel that the lack of family calendar use reflects the cultural background of the family, originally from Central America. In many regions of the world, particularly Central America, notions of time are much less structured and the tempo of life is not as fast paced as highly industrialized nations [Levine, 1997]. In these regions, the importance of a calendar may be much less. This calls for additional research to study the calendar routines of people from these areas in order to provide cultural comparisons with the data we have presented.

6. CALENDAR EVENTS, ANNOTATIONS, AND AUGMENTATIONS

When you ask someone what events they write on their family calendar, a typical response is "everything under the sun." And, to families, it most certainly feels that way. To better understand what families are *actually* putting on their primary family calendar and how much they are adding, we performed a content analysis of one month from the primary calendars of our final group of 20 families (Section 2.1, group c). All families from this analysis used a Public Awareness calendar as the primary family calendar. The months we analyzed were either January or February 2006, depending on the time of the interviews. We would have preferred to analyze more than this single month (for example, to see seasonal events), but this was impractical as many families had discarded their past calendars. Future studies run at the end of a calendar year rather than its beginning could overcome this issue. Still, the single month suffices to show strong patterns. Throughout this analysis, we did not see any relationship between calendar content and the three family types. This was surprising, yet suggests again that family routines are fairly idiosyncratic.

6.1 Content on the Family Calendar

Families place a variety of information on the family calendar including extra-curricular activities like sports or music lessons, school activities, work activities, social outings, holidays, and birthdays or anniversaries [see also Hutchinson *et al.*, 2002]. All families regardless of the type will record events of these types, although some will have more than others. Most families typically have fewer than five events per day on their calendar, with most days containing only one or two events. This is not to say that families only wish to place that many activities on the calendar; space often becomes a factor [Hutchinson *et al.*, 2002]. The information written for an event will vary, but typically includes one or more of: a description, the name of who the event is for, a time, and a location.

What is common about all of the events placed on the family calendar is that they affect the *family* in some way. First, activities can directly affect the family where *more than one family member is involved* in the activity. For example, a family outing for dinner would include more than just one family member just as driving someone to an activity would. Second, activities can affect the family more indirectly by being *activities that others should know about*. This could involve activities that affect ordinary routines, such as a change in work hours. If activities affecting the family are *routine events* that occur the same time and day each week, families may or may not continue writing them on the calendar after an initial time period. This depends on the idiosyncratic routine of each family. Families also sometimes place household tasks and chores on their primary

Table 3. Annotations and augmentations found on family calendars.

Type of Annotation	Description
Changes	Markings left on a calendar after changes are made (e.g., crossed out writing). These implicitly provide change awareness.
Abbreviations	Portions of event descriptions are abbreviated to overcome space limitations on the calendar and reduce the need to write long descriptions. These implicitly provide at-a-glance awareness of calendar content.
Colors and Highlights	Events are highlighted or written in different colors to make calendar information stand out or be discernable at-a-glance.
Extra Information	The unassigned space on calendars (outside the date range) is used to write additional information related to events, or the information is attached to or placed near the calendar.
Symbols	Visual representations like drawings or stickers are used in place of words to provide more detail or to represent an event so that information is discernable at-a-glance.

calendar, although these are more specific to one individual family member. Further analysis of family calendar events can be found in Neustaedter [2007].

In addition to calendar events, we also saw a variety of ways that family calendars were extended through annotations and augmentations. This reflects the fact that family calendars do not come “out of the box” with all the features that people need. As a result, the calendar as an artifact is appropriated as needed by families to overcome their idiosyncratic challenges. The next sections detail the five types of annotations and augmentations we saw; Table 3 provides a summary while Figure 7 shows which families used each type of annotation and augmentation.

6.2 Changes: Imprinting the Calendar with Change History

Family members routinely tell each other about changes made to the family calendar that affect them. Yet for many families, the calendar also provides its own change history [Tam and Greenberg, 2006], where family members can gain some sense of what has changed on the calendar just by looking at it. We found that 75% of families (15 of 20) leave visual marks on the calendar when moving or removing events, usually because they simply cross out these events or write words like “cancelled” next to them (Figure 7, Row 1). For example, Kayla (P19) removes events from the family calendar by crossing them out. Changing the date of an event is done similarly by crossing it out and then writing it on a new date. Figure 8 shows a portion of Kayla’s family calendar: on the 16th, 17th, and 18th we see events that have been removed.

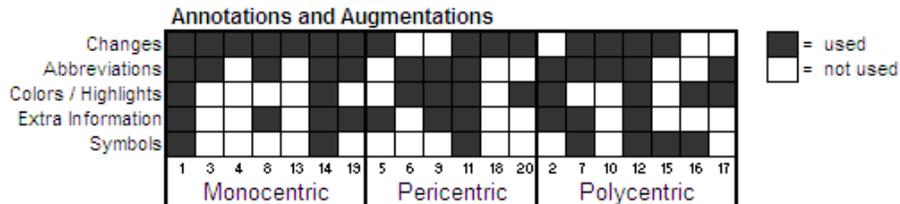


Fig. 7. The five types of annotations and augmentations used by families.

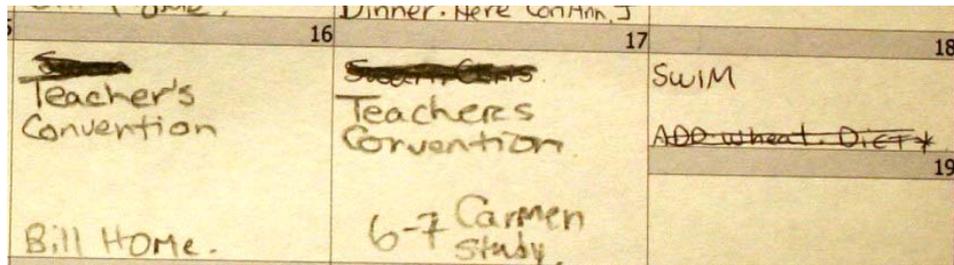


Fig. 8. Kayla (P19) crosses out events on her calendar to remove them or change the date.

The remaining 25% of families (5 of 20) remove or move events by erasing or using Wite-Out®, where the visual indications of the change are mostly lost. Here family members must rely solely on the person making the change to notify others. Change history is also nonexistent for *all* families when the change is the addition of an event, unless family members are able to recall what events used to be on the calendar compared to what is currently there.

Unlike paper calendars where editing naturally produces a change history, the editing capabilities of current digital calendars means that changes are often invisible. Although this is an apparent disadvantage, the families using a digital calendar as their primary family calendar did not find this problematic. This is likely because the responsibility of modifying the digital calendar was still mainly that of the primary scheduler, who could easily keep track of changes by memory. As well, families are fairly good about keeping each other aware of what has changed on the calendar simply by communicating.

6.3 Abbreviations for Locations, Names, and Repetition

People often *abbreviate* information on the calendar. They do this because the space within most calendars' days is limited, and because of the high effort required to write repeating events and long location names. We found 65% of families (13 of 20) abbreviate information about an event on the calendar (Figure 7, Row 2). Not included in this count are "radical abbreviations," where the scheduler simply leaves out information; nearly all families do this.

Typically, the scheduler shortens the location or the name of the person associated with the event. If understood, terse abbreviations are an economical way for people to quickly look at the calendar to acquire an at-a-glance awareness of upcoming events. Yet those individuals not as familiar with the abbreviations get only a limited understanding of the calendar's contents. For example, Brad and Jennifer's (P2) family is very busy with extra-curricular sports activities. Figure 9 shows how the family calendar contains abbreviations for the location of hockey practices and games. They do this because of the lack of space on the calendar and the long length of location names (usually schools or community arenas). On the 31st, "FV" is an abbreviation for a practice's location, while "FM" abbreviates a game's location. Many families also abbreviate multi-day events that span contiguous days by drawing an arrow to show the duration of the event, rather than writing it on each day that it occurs.

6.4 Colors and Highlighting to Make Events Stand Out

While people often use the closest pen at hand to write events, we found that 50% of our families (10 of 20) go out of their way to use specific colors (Figure 7, Row 3). These families said they use colors to make particular events stand out, be it for the type of activity or the person involved in it. The benefit is that colors make the calendar more

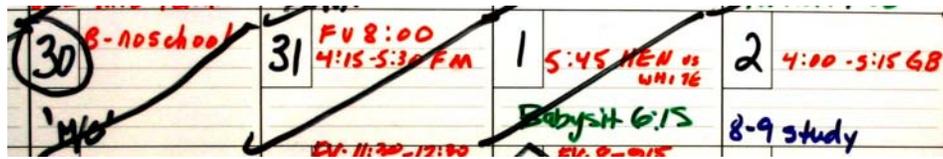


Fig. 9. Brad and Jennifer (P2) use abbreviations for locations and a color for each family member.

readable, where they can quickly look at the calendar to gain an at-a-glance awareness of the family's events.

For example, Brad and Jennifer (P2) use different colored dry erase pens on their family calendar (Figure 9): red is for their son, blue is for their daughter, green is for Jennifer, and black is for Brad. They explain that these colors let them easily see at a glance who has activities on a given day. Both parents find the colors to be one of the best things about their family calendar. Brad comments:

“When [our daughter] had soccer and [our son] had hockey you knew which one of the two of them you had to worry about. And one of the better things about that is you knew what time of day depending on which [child]... The color is the best part, that's why we do the color.” – Brad (P2), Dad and Architectural Technician

Sometimes events are highlighted to make them stand out at-a-glance. There is also the extreme case where color and nothing else is used to show that an event is taking place. For example, the number on a calendar day may be highlighted to represent an event on that day. Paul (P42) highlights the days he works in this way.

Despite really enjoying the use of colors, families who do color events often end up stopping after time. We interviewed several people who used to use colors but who did not currently. This is not to say people do not continue to use colors, but many who do use colors at some point end up finding it to be cumbersome. Colored pens can be easy to lose or hard to find and it is often much easier just to grab whatever pen is available. For example, Anita (P9) used to use color on her calendar: a color per person and a highlighter for birthdays. Anita finds she just does not have the time to be this meticulous with adding events to her calendar now that her children are involved in more activities.

6.5 The 'Extra Information'

Family calendaring is about more than just the actual events written on the calendar. There is often an abundance of other information that must be kept along with the events, or information that is not necessarily associated with a particular calendar day like additional schedules, maps, phone numbers, and tasks. This information is important but people often struggle with where to put it because it often does not nicely fit on the calendar. Sometimes it even needs to travel with people because it describes the details of how to use the event on the calendar, for example, how to get to a particular location. We found that 50% of families (10 of 20) either write this information in the margins of the calendar, or augment the calendar by attaching information directly to the calendar (Figure 7, Row 4). This keeps the information close at hand to the calendar, and provides quick access to it.

For example, Anita (P9) slides pieces of paper into her calendar (Figure 10) to store handouts for the various extracurricular activities her children are involved in. When mobile, she will then take the extra information that is needed and place it in her purse. Anita describes the challenges of the “extra information”:

“The only thing that is missing is all the other details that I have like how do

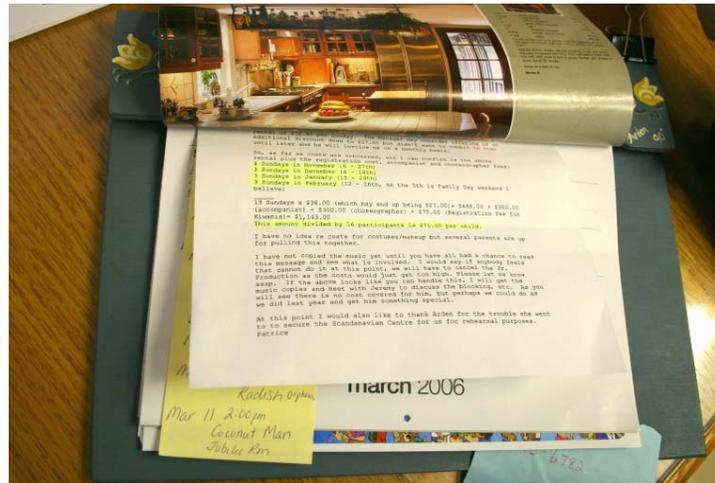


Fig. 10. Handouts, notices, and other pieces of extra information are slid into Anita's (P9) family calendar.



Fig. 11. Brad and Jennifer's (P2) calendar on the fridge along with information relating to it.

you get to this place, where is that, all the extra stuff. It'd be nice with all the extra stuff if you had it in one place then I wouldn't need my purse file. I used to have extra things stuck to the fridge, now they're stuck in the calendar. We used to have their soccer schedules on the fridge. I think it's trying to get it all in one place." – Anita (P9), Mom and Accountant

Families who do *not* augment their calendar to hold the “extra information” will often find nearby locations for it. Brad and Jennifer's family (Figure 11) ends up with this information stuck on the fridge next to the calendar; thus, the fridge becomes an ecology containing both scheduling and associated information.

6.6 Symbols: Stickmen, Stickers, Etc.

Some families also place symbols on their calendars, like drawings or stickers, to serve as abbreviations, to highlight activities, to indicate the status of an event, and even to make



Fig. 12. Charity (P16) uses symbols on her calendar for her children who can't read yet.

calendar more fun. Here the symbol either replaces text or augments it. We found 35% of families (7 of 20) used symbols on their calendar (Figure 7, Row 5), where these visual representations benefit families by again providing an at-a-glance view of what activities are on the calendar.

For example, Charity (P16) has developed a very rich symbol system for her family's calendar (Figure 12) so that her children, aged 3 and 5, can learn and understand what activities are on it. The upside-down stickmen (23rd and 2nd) represent gymnastics for her daughter, the books mean school, the dog means dogsitting, and so on. Even though the symbols were originally intended for the children, Charity's husband, Bruno, says they also provide him with an at-a-glance view of what activities the family is doing. Mona (P20), like some other primary schedulers, tries to achieve a similar effect through the use of stickers. Mona's calendar comes with a set of generic stickers like "Important," "Birthday," and "Activity" that she will place on the family's calendar.

6.7 Discussion

We have shown that family calendars inherently store content that affects family members at some level. Early studies of workplace calendars show similar types of events being recorded on work calendars when compared to family calendars [Kincaid *et al.*, 1985]. The main difference would be that work calendars mostly contain events specific to an individual rather than a small group (e.g., a family).

Our study also found that families provide additional meaning to their calendars' content through various annotations and augmentations. Crabtree *et al.* [2003b] also found that families use annotations; we extend this by outlining five specific types. Some of these take away content that could have otherwise been placed on the calendar (e.g., abbreviations), while others add content (e.g., changes), or are used as substitutes for content (e.g., color). Early studies of workplace calendaring also found symbols being used on paper calendars [Kelley and Chapanis, 1982], although this is much less likely the case currently with such a large proliferation of digital workplace calendars (that typically don't support symbols). One could also imagine that abbreviations, colors/highlights, and extra information (e.g., URLs) are found in abundance in workplace calendars, although again no data is available for comparison. It is also likely that such annotations are used in ways very similar to family calendaring.

What is most important about the annotations families use is the fact that they enable family members to glance at the calendar and quickly discern its contents, whether the annotations are used to add content, or remove the need to include specific written details. This renders annotations crucial for family members to acquire an awareness of calendar content in a timely fashion. It also highlights the role of tacit knowledge in family calendaring. That is, not all information related to a family's activities is recorded

on the calendar. Instead, families record just enough information for the content to serve as a memory trigger to full details about an event. Given that there is a large range in family member involvement in families' calendaring routines (the three family types) this can certainly make calendaring challenging. In some families, only certain individuals may actually have the tacit knowledge associated with the calendar, while others would need to explicitly rely on these individuals to provide them with this information.

7. DESIGN IMPLICATIONS

As social science research, our study findings contribute an understanding of the everyday social routines of family calendaring. Focusing on human-computer interaction concerns, we can contribute even more value by using our findings to suggest empirically based guidelines for the design of digital family calendars. As we have seen, families have developed their own routines within a family type (Mono/Peri/Polycentric). Rather than force people to change their routines or the nature of their family types, our goal is to enhance what they currently do.

We now list and discuss each guideline along with sub-guidelines that highlight further details; Table 4 provides a summary. The premise of our guidelines is to *provide family calendar access from multiple locations—both inside and outside of the home — where calendar content is discernable at-a-glance*. We stress that our guidelines are preliminary. There are likely several ways of interpreting our social science results that could have led to other guidelines. It could also be the case that implementing certain guidelines can introduce other problems and/or change the “workflow” of calendar use in fundamental ways. Still, they are a reasonable starting point for framing the expected usage patterns of family calendars, thinking about calendar design (with the guidelines being the outcome of a requirements analysis), and critiquing existing family calendars (as we do in Section 8). As new family calendars are developed and deployed, we can also perform field studies of actual usage that can validate or challenge our guideline assumptions; this is left for future work.

Table 4. Design guidelines for digital family calendars.

Guideline	Description
1: Public and Accessible	Provide a publicly available client in high traffic areas of the home that is always-on and accessible with interaction suitable for non-desk locations.
2: At-a-glance Awareness	Provide free-form event creation to allow users to input content in a flexible manner and provide annotations that make the family's activities visible and discernable at-a-glance.
3: Work Access	Provide synchronization between home and work calendar clients where events can be marked for synchronization, visibility, and privacy control. Interaction techniques should be suitable for desk locations.
4: Mobile Access	Provide access to view the family calendar and edit events while mobile through a mobile device or utilizing other technologies located nearby.
5: Multiple Home Locations	Provide access to family events from multiple locations within the home where each location may show a subset of the family's events.

7.1 Guideline 1: Public and Accessible

Family calendaring relies on families being able to acquire an awareness of calendar activities in order to coordinate. One very important way this is done is by using a Public Awareness calendar within the home. Given this, we suggest that: *digital family calendars should have a publicly available client in high traffic areas of the home that is always-on and accessible* (Guideline 1, Table 4, Row 1). This relates to three sub-areas:

a. Form Factor and Location: Digital family calendars must allow the placement of the calendar in a variety of locations that families would normally want to place Public Awareness calendars. Thus, rather than providing a client for a PC, *digital family calendar clients should be designed for devices that can easily be located in high traffic locations of the home*. Beech *et al.* [2004] suggest a wall-mounted large display for the family calendar, yet reflections on paper calendars suggest this size of digital calendar may be cumbersome to use. People routinely take wall calendars down to write on them, and sometimes move them to various locations in the home for discussion or planning. Instead, *family calendars need portable form factors* that can easily be moved. One could imagine Tablet PCs or similar devices fulfilling both of these needs (portable and suitable for flexible locations). Of course, they would need to be much cheaper if they are to be considered for this dedicated use.

The location needs of the calendar also mean that traditional interaction through a mouse and keyboard may not be easy. Instead, *digital family calendars should use pen or touch interaction*, which are better suited for locations away from a desk like the kitchen wall or counter. This type of interaction takes advantage of the actual physical and social context of which the user is present [Dourish, 2001].

b. Always-On: Much like paper wall calendars, the calendar should be accessible with minimal interaction so one can simply glance at the calendar. This suggests a design based on an information appliance model where *the device is dedicated to the specific task of calendaring*. Neustaedter *et al.* [2007] add to this by showing that an *easily accessible* family calendar may be suitable for some families. In this case, 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.

c. Access Rights: Within the home, family calendars need to *remove any access restrictions*, which would require family members to login or request access to see the calendar. Family members are used to having their calendar shared so these features would not be needed. Crabtree *et al.* [2003b] suggest digital family calendars should incorporate access rights for extended family or friends to view the family calendar from outside the home. Yet nobody in our study suggested this feature. In fact several participants felt their calendar was not appropriate for public viewing outside the home because it was messy. While one could extract event information and provide it “out of context” for others, we emphasize nobody from our study suggested this. That being said, other studies [Neustaedter *et al.*, 2006, Plaisant *et al.*, 2006] show that families wish to share activity information with intimate and extended contacts at some level. What may be the case is that people do not tie this desire to their calendars. Other lightweight technologies besides digital calendars may be more appropriate vehicles for displaying this information (e.g., awareness appliances [Neustaedter *et al.*, 2006]).

7.2 Guideline 2: At-a-glance Awareness

Families also need additional ways to make calendar content discernable at-a-glance beyond just having a publicly visible calendar. Our second guideline states that: *a digital family calendar should provide at-a-glance awareness of activities and calendar changes for easy awareness acquisition* (Guideline 2, Table 4, Row 2). We discuss this in relation to three specific areas:

a. Simple and Flexible Interaction: People already use various annotation techniques on their calendars to achieve at-a-glance awareness. Crabtree *et al.* [2003b] suggest supporting rich annotations; we extend this by calling for designs to *support the use of symbols, colors/highlights, and abbreviations*, and *provide a change history*. In order to achieve this, the most natural means is to *support free form event creation*, where the scheduler is able to choose what information is added for calendar entries to create their own meaning for calendar events. Changes could be represented through visual cues embedded in events or as changes lists, although the former would be more natural as it reflects the way that changes are currently embedded within calendar content on paper calendars.

Designs should also *permit adding “extra information” to events*. This could be achieved by increasing the amount of space available to add information through visualization techniques like semantic zooming [Bederson *et al.*, 2004]. Events could also link to systems that allow the creation of lists [Ludford *et al.*, 2006, Sellen *et al.*, 2006, Elliot *et al.*, 2007] or provide a means to link to emails and web URLs that may contain relevant information, like sports schedules or maps to locations. Of course, an open problem is what to do with current paper-based information, for it is more difficult to link this to a digital calendar unless the information is scanned in.

b. Location-Based Reminders: Some family members may not check the calendar enough or at all; this happens for secondary schedulers in Monocentric families and could also happen to family members from other family types when they neglect to check the calendar. In these cases, providing visual features within the calendar to make information stand out will not help. Instead, automated reminders may be valuable. To be effective, *reminders must be sent to an individual or location* where they will actually be seen [Beech *et al.*, 2004; Elliot *et al.*, 2005]. For example, reminders could be sent to an exit leaving the home, the fridge door, or a mobile phone of a family member [Kim *et al.*, 2004, Sellen *et al.*, 2006, Ludford *et al.*, 2006, Elliot *et al.*, 2007].

We also need to recognize that primary schedulers are involved in most events directly or indirectly by having to remind others about them. Thus, *most events could also have reminders sent to the primary scheduler* so he or she can inform others, although some balancing would be needed to avoid interruptions. However, sending automated reminders to other family members is likely problematic, as people do not assign family members to events ahead of time. Thus, it would not be clear which events are relevant to which family members. While software could attempt to infer this information, it would be subject to errors. Alternatively, location-based reminder systems could *provide features to allow the primary scheduler to forward reminders* as needed. Such features could lessen the reminding burden on primary schedulers, especially in the case of Monocentric families that rely primarily on this person to tell others what is going on.

c. Negotiation Protocols. Crabtree *et al.* [2003b] suggest providing negotiation facilities in digital family calendars to help family members plan events and decide who will attend events. This is similar to what is provided in digital workplace calendars [Palen, 1998]. Yet we argue these types of features would not be used by most families. As we

saw, secondary schedulers in Monocentric and Pericentric families do not check the calendar frequently enough (if at all), rendering any form of negotiation protocol mostly useless. Plans are also changed too frequently in some families and, if used, negotiation protocols would simply increase the workload needed for coordination. One may be tempted to include such features in a digital family calendar just in case a family may wish to use them, and, this is certainly plausible and may work for Polycentric families. However, this functionality could easily “get in the way” of the simple tasks families need to do and force them into writing down tacit knowledge, which could again increase their workload. Even worse, event negotiation features could force a family into thinking this is how they *should* approach family calendaring regardless of whether it works for their routine or not. For this reason, we suggest *designs should not support negotiation protocols*, which are based on workplace calendaring routines and not family ones.

7.3 Guideline 3: Work Access

Family calendaring is often intermixed between work and domestic life. Our third guideline states that: *a digital family calendar should be accessible for viewing and editing family events while at work* (Guideline 3, Table 4, Row 3). This relates to two sub-areas:

a. Calendar Synchronization: Family events often affect the work schedule, just as some work events affect the family schedule. Sometimes family members may also think of events to add to either their work or home calendars when at the opposite location. Thus, there needs to be an easy means for family members to somehow integrate the two or provide remote access [Crabtree *et al.*, 2003b, Beech *et al.*, 2004]. This could be done most naturally by *allowing one to synchronize events between a home calendar client* (e.g., a digital family calendar) *and an existing work calendar* (e.g., Microsoft Outlook). To do this, there first needs to be an easy way to synchronize events between different digital calendar systems. Common calendar file formats like iCal are beginning to take steps in this direction. We also know that not all events will be relevant on each calendar; thus, systems should *permit users to select or tag the content that should be synchronized* (also suggested by Brush and Turner [2005]). The need for viewing family or work events may also come and go. For this reason, we suggest that designs *provide the ability to toggle the visibility of sets of events*.

This also has implications for privacy. Family events that appear within one’s work calendar often require different levels of privacy control than one’s work events so that colleagues cannot see personal information [Palen, 1998]. Thus, designs should *provide user-selectable privacy settings for family events*. A default value, likely being “private,” would also be necessary, as many people do not adjust the default calendar settings [Palen, 1998].

b. User Interaction: We know that calendar interaction for work environments is well suited to a mouse and keyboard where PCs are situated on desks; therefore, family calendar clients for the office should *permit mouse and keyboard interaction*. Yet calendar events created at work may be sent to a home calendar where the use of annotations is vital. Given this, work clients should *provide support to create rich annotations* using keyboard and mouse interaction. Similarly, content migrating from a home calendar to a work one may contain content other than text. (e.g., symbols). Thus, work clients must *provide a means to display rich content* coming from home calendars. This can certainly be a challenge, however, given that many work calendars only support textual content (e.g., Microsoft Outlook).

7.4 Guideline 4: Mobile Access

Family calendaring also occurs while one is mobile and not at home or work. Our fourth guideline states that: *a digital family calendar should provide a mobile interface for viewing and editing family events* (Guideline 4, Table 4, Row 4). Other researchers have also suggested mobile calendar access, although interface suggestions were out of the scope of their work [Crabtree *et al.*, 2003b, Beech *et al.*, 2004, Brush and Turner, 2005].

a. Form Factor. Not surprisingly, nearly all family members who had a Personal Mobile calendar (91%) used a small daytimer calendar (e.g., only several inches large). Those who did not have a Personal Mobile calendar had fairly practical workarounds that did not require them to actually carry a calendar. This suggests two possible designs, both of value. First, some people will desire carrying a full family calendar with them; thus, designs should *provide a calendar client that runs on a small mobile device that can be easily carried* (e.g., a PDA or cell phone). For others who prefer not to carry a device, digital family calendars should *provide an alternate means to access the family calendar remotely*. One strategy some families used already was to call home and record answering machine messages or to ask family members to update the calendar. Extending this strategy, digital family calendars could *make use of devices currently around a user* for remote calendar access. For example, one could use a nearby phone to call their family calendar and interact with it. One could also use a web interface if a kiosk computer is available.

b. User Interaction. Users carrying a mobile device with a family calendar client most certainly would want to view and interact with an entire calendar. Space limitations on mobile devices naturally call for information visualization techniques like semantic zooming [Bederson *et al.*, 2003] if an entire calendar is to be viewable. In the event that an entire calendar is not viewable, designs should *provide users with a means to easily query the calendar* for free times, or information about specific events. Conversational input techniques proposed by Lyons *et al.* [2005] could be valuable for this situation. Technologies that send lists of task information to mobile phones [Ludford *et al.*, 2006] could also be augmented to send relevant calendar information to the mobile device when needed.

Interaction for users who choose not to carry a calendar would differ based on the available technologies around them. Given their ubiquity, telephones could certainly be used where digital family calendars could again *provide conversational input* and the ability for people to “call their calendars” [Ludford *et al.*, 2006]. Web interfaces to the family calendar should *provide rich forms of interaction* similar to what families would find in their in-home calendar client (in order to add rich annotations).

7.5 Guideline 5: Multiple Home Locations

We saw that families also place calendars in multiple locations in the home where each location often fulfills a specific purpose. Our fifth guideline states that: *a digital family calendar should be accessible from multiple locations within the home where the information displayed may vary* (Guideline 5, Table 4, Row 5).

a. Form Factor: Many families had more than one calendar in their home where each was used in a different location or for a different purpose. With this comes a need to have calendar clients that can be easily placed in a variety of home locations, either on PCs, laptops, Tablets, or other devices. This is similar to Guideline 1a.

b. Calendar Synchronization: We suspect that families who do not have multiple calendars in the home do so because synchronizing them would currently be tedious. Yet synchronization is easy with digital calendars (if a design adequately supports this feature in a usable fashion). This suggests the need to *provide multiple family calendar clients within the home*. Not all locations would need to display the same information, however; *clients would need events to be selectable for information display*. For example, a Children’s calendar displayed in a child’s room could show only events relevant to the child. Events on a Planning calendar could be displayed on a Public Awareness calendar once they are finalized, or a Reference calendar could show a high level view of the entire year highlighting days with large amounts of activity. Reminders for tasks already appear on many Public Awareness calendars and again could easily move between dedicated Task and Chores calendars and a Public Awareness calendar.

8. ANALYZING DIGITAL FAMILY CALENDARS

Currently digital family calendar design is dominated by online calendars ostensibly designed for family or personal use (e.g., 30Boxes, Family Scheduler, Google Calendar, OurFamilyWizard, Planzo, Trumba). In this section, we use our guidelines to analyze existing digital online calendars along with two research prototypes, the Interliving Family Calendar [Plaisant *et al.*’s, 2006] and the LINC digital family calendar [Neustaedter and Brush, 2006, Neustaedter, Brush, and Greenberg, 2007]. The goal of our analysis is to provide further illustration of how the guidelines could be used by designers for digital family calendar designs. Table 5 summarizes our analysis.

8.1 Digital Online Calendars

Digital online calendars are disadvantaged when it comes to many of the guidelines, as they are often not designed based on real family routines.

Guideline 1: Public and Accessible. Digital online calendars do not typically provide a publicly available and accessible family calendar (Table 5, Guideline 1). This is because they are designed for desktop PCs, a form factor that is not well suited for family routines (1a). Desktop PCs are often placed in spare bedrooms/home offices away from most family activity where they are not easily made portable. Family members must then explicitly go to the PC, launch a web browser, and login to the family calendar. This reflects the fact that they are often not easily accessible (1b) with restricted access rights (1c). While this inaccessibility could work for a Monocentric family, it would likely force other family types into monocentric behavior and probably prevent other family members from engaging with the calendar.

Of course, there are workarounds that could help alleviate some of these problems. Families could place a PC in a location like the kitchen, possibly using a small form factor like a laptop to gain portability. A family could use one login account for all members, and leave its web page always-on; this would work for some families who felt that an easily accessible calendar is good enough. Yet interaction would still be a challenge, as these locations do not lend themselves naturally to mouse and keyboard interaction (1b). While a Tablet PC form factor does promote stylus interaction, existing web interactions often make stylus use more, rather than less, cumbersome.

Guideline 2: At-a-glance Awareness. Digital online calendars also do not always match the needs of families to gather awareness at-a-glance in order to coordinate (Table 5, Guideline 2). First, all of the online calendars we looked at restrict the information that people are able to add for an event (2a). For example, most restrict people to typing; people cannot draw pictures, symbols, or include a visual image like a sticker to represent

Table 5. Analysis of existing digital family calendars. 👍 = meets guideline, 👎 = doesn't meet, ~ = mixed.

Guideline		Online Calendars	Interliving Calendar	LINC Calendar
1: Public and Accessible	a. Form Factor	👎 Hard to situate publicly; mouse / keyboard	~ Hard to situate publicly, but pen-based interaction	👍 Portable, situate publicly, pen-based interaction
	b. Always-On	👎 PC-based making it not always-on	👎 PC-based making it not always-on	👍 Information appliance is always-on
	c. Access Rights	👎 Separate login for each family member	~ Access for extended family	👍 No login restrictions
2: At-a-glance Awareness	a. Interaction	👎 No rich annotations	👍 Free form entry, rich annotation with pen	👍 Free form entry, rich annotation; more space for extra info.
	b. Reminders	~ Reminders sent to mobile phones, but only one	👎 Reminders on calendar, not location-based	👎 Reminders on calendar, not location-based
	c. Negotiation	👎 Assign family members to events	👍 Rely on tacit knowledge for coordination	👍 Rely on tacit knowledge for coordination
3: Work Access	a. Synchronization	👎 No integration unless it is the work calendar	👍 Synchronize through server	👎 No integration with work client
	b. Interaction	~ Mouse/ keyboard, but no annotation	~ Mouse/ keyboard, but no annotation	👍 Mouse/ keyboard; rich annotations
4: Mobile Access	a. Form Factor	~ Web interface for PCs, but no mobile device support	👎 No mobile interface	👍 Mobile phone and web interfaces
	b. Interaction	👎 No rich annotations	👎 No mobile interface	👎 Cannot update the calendar
5: Multiple Home	a. Form Factor	👎 PC-based so hard to place	👎 PC-based so hard to place	👍 Easily place in many locations
	b. Synchronization	👍 Selectively view sets of events	👎 Clients show same content	👎 Clients show same content

events. Some allow users to assign colors to events (e.g., 30Boxes, Family Scheduler, Google Calendar), although some do not even provide this (e.g., OurFamilyWizard, Planzo, Trumba). Digital online calendars' use of automated reminders also does not match the needs of families. While many permit sending reminders to email or a mobile phone (e.g., 30Boxes, Family Scheduler, Google Calendar, Trumba) at a designated time, they are restricted to just one email address or mobile device, rather than a plethora of devices that would be needed for proper family-oriented location-based messaging. Given this, digital online calendars could certainly be improved by utilizing a more flexible means for creating events while providing enhanced reminder features that permit location-based reminding.

Many online calendars provide explicit event negotiation, where individuals are invited and assigned to events (e.g., Family Scheduler, OurFamilyWizard, Google Calendar, Trumba). We stress again that while this is reasonable for work scheduling, this is not how families coordinate (1c). These calendars are also most often designed specifically for individuals (Family Scheduler is a notable exception): the underlying assumption is that each person will have their own online calendar while still being able to view the calendars of others overlaid on one's own. This idea is obviously imported from work calendars, and we believe it would create unnecessary authentication and sharing issues if one is to try to view all activities relevant to the family from a number of different calendar accounts.

Guidelines 3: Work Access. Online calendars are well suited to provide access to family calendar events while at work (Table 5, Guideline 3); they are, after all, designed for traditional desktop PCs (3b). Another nice feature is that no special software is needed because these calendars run in standard web browsers; this could alleviate potential security constraints that disallow installation of personal software at work. However, the main downside is that all are designed as separate calendar clients and still are not easily integrated with existing work calendars (3a), unless, of course, one was used as the actual work calendar. Some online calendars permit grouping of events (e.g., Google Calendar) where you can toggle their visibility. This would work well for a combined family/work online calendar.

Guideline 4: Mobile Access. When it comes to mobile access (Table 5, Guideline 4), digital online calendars typically do not provide the mobile family member with a good calendar access experience. One could navigate to the calendar's web page on a mobile phone or PDA, which would be a suitable form factor (4a), yet viewing would be difficult. Most online calendars have web pages that are designed for a standard PC display and not a small screen. Improvements could be made by creating online versions specifically designed for mobile devices, and this is certainly a future plan of some companies. On the other hand, for those not wanting to carry a mobile device, online calendars provide a compelling experience; if there is a PC located nearby one can easily check or add to the calendar. However, rich forms of interaction will still not be available (4b).

Guideline 5: Multiple Home Locations. As previously mentioned, digital online calendars are designed to run on standard mouse-based PCs, which compromises how they can be positioned in multiple home locations (Table 5, Guideline 5a). Again, laptops could be used in multiple home locations to get around this, although the interaction modalities would be limiting. Online calendars that allow one to group events and toggle their visibility (e.g., Google Calendar) would help users show the appropriate events in each location (5b).

Given this analysis as a whole, we clearly need an alternative calendar design that more adequately meets the needs of families. Next we describe the two research prototypes that more effectively meet the guidelines, albeit some better than others.

8.2 The Interliving Family Calendar

The Interliving Family Calendar [Plaisant *et al.*, 2006] is a digital family calendar designed to share calendar content between extended families. Figure 12 shows the main interface in the week view, where each calendar row shows a different family's calendar. In the figure, the top row shows one set of grandparents' events, the middle row shows their children and grandchildren, and the bottom row shows another set of grandparents.

Guideline 1: Public and Accessible. Because the Interliving Family Calendar runs on a desktop PC, its form factor creates similar issues as digital online calendars in regards to being public and accessible for families (Table 5, Guideline 1). It is more difficult to place the calendar in a high traffic location of the home (1a) and make the calendar always-on or accessible (1b). Again, similar workarounds could be used as online calendars such as using a laptop with the calendar always running. Interaction is handled primarily by mouse and keyboard; however, a second input method allows users to write on special digital paper with a printed version of the calendar using a digital pen. When one has finished writing, the pen is docked in a holder attached to the PC and the written information is transferred to the calendar onscreen. This enables users to more naturally add content to the calendar in a way well situated for domestic locations (1a). Access rights are open for family members and inherent in the design is full access for selected extended family members (1c). In some instances this can be seen as a benefit, but in other cases this may be more access than some families desire to provide for all of their family events [Neustaedter, Elliot, and Greenberg, 2006]. Alternative design strategies like providing selectable content for extended family members would help alleviate potential concerns.

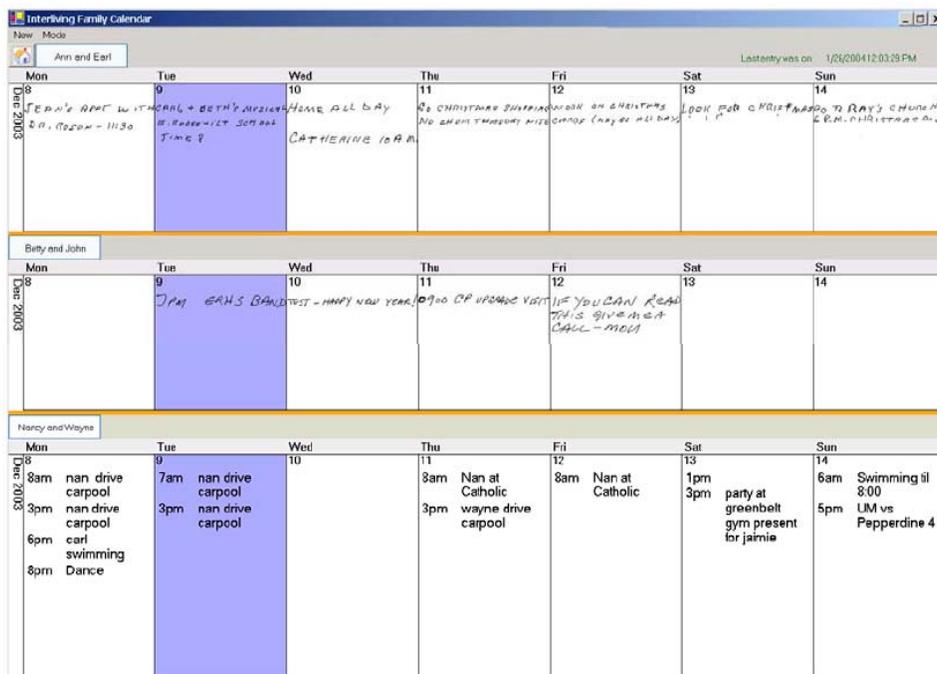


Fig. 12. Plaisant *et al.*'s [2006] Interliving Family Calendar (copied with permission).

Guideline 2: At-a-glance Awareness. The Interliving calendar adheres to Guideline 2 (Table 5) by allowing users to enter event information in free form—including rich annotations—using a digital pen (Table 5, Guideline 2a). However, this activity is somewhat restricted for users who only use a mouse and keyboard for interaction. Family members are also disadvantaged if they do not check the calendar because reminders are sent to the calendar rather than individuals or contextual locations (1b). Despite this weakness, the calendar does meet family needs when it relates to coordinating events: users are not forced to assign individuals to events (1c) and instead allows families to rely on tacit knowledge for coordination, much like they do currently.

Guidelines 3, 4, and 5: Ubiquitous Access. The Interliving calendar receives mixed reviews when it comes to providing calendar access while at work (Table 5, Guideline 3), mobile (Table 5, Guideline 4), or in multiple home locations (Table 5, Guideline 5). Its strength lies in providing access at work and integrating with existing work calendars (5a), given that it builds atop a Microsoft Exchange server, which can synchronize between the Interliving calendar and Microsoft Outlook (a work calendar). Interaction is supported with a mouse and keyboard, albeit there are no easy ways to provide rich annotations from work (5b). In the case of mobile calendar access, no mobile interfaces exist for the calendar currently (4a and 4b) although extensions with DateLens for mobile devices is possible [Bederson *et al.*, 2004]. Placing the calendar in multiple home locations is also problematic as, again, the calendar is PC-based (5a) and there is no means to selectively display events in different locations (5b).

8.3 The LINC Digital Family Calendar

LINC is our own digital family calendar prototype, designed and evaluated in parallel to the studies presented in this article. A video of the system is available in Neustaedter, Brush, and Greenberg [2006]. Figure 13 shows the main interface (13a) along with the mobile interface (13b), web interface (13c), and the in-home client on a Tablet PC (13d).

Guideline 1: Public and Accessible. LINC is designed as a dedicated information appliance—prototyped using a Tablet PC (Figure 13d)—that makes it easy to place LINC in any home location that fits within a family’s current routine (Table 5, Guideline 1a). Pen-based interaction—writing on notes and dragging them to the calendar—makes it easy to update the calendar in these locations (1a). LINC’s appliance model also makes the calendar always-on so it is easily accessible (1b); family members can simply walk by the calendar and glance at its contents. Family members initially login to the calendar using a single family account (1c) so there are no access restrictions.

Guideline 2: At-a-glance Awareness. LINC supports at-a-glance awareness by allowing users to create rich annotations (Table 5, Guideline 2a). Using a stylus, people can create their own free form representation of event entries, where they can use various annotation styles including note and ink colors (2a). This allows family members to use their own pattern of annotations to support tacit knowledge for coordination, rather than using negotiation protocols (2c). Notes can also be resized to accommodate any level of detail or “extra information” (2a). The main weakness in this category for LINC is its limited reminder capabilities; rather than send reminders to people or locations, they simply appear on the calendar and can be easily missed by secondary schedulers (2b). Extending LINC to send reminders to mobile devices as well as specific locations would certainly benefit family members.

extensions to realize this. For the web client, interaction could be similar to the information appliance client (e.g., stylus input). For the mobile client, alternate forms would be needed, perhaps relying on conversational input [Lyons *et al.*, 2005].

Guideline 5: Multiple Home Locations. LINC is adequately equipped to be placed in many different home locations (Table 5, Guideline 5) given its information appliance model (5a), albeit there is currently no way to selectively view certain events in particular locations (5b). This could be easily done, though, by allowing users to tag events for locations where the visibility of tagged items could be toggled in each location.

In summary, it is clear that each of the different forms of digital family calendars have their advantages in particular areas and disadvantages in others. Certainly the two research prototypes offer many more strengths than online calendars. This is to be expected for both specifically focus on family needs. Given this, it is clear that digital family calendar design can be enhanced by understanding family routines and applying this knowledge to design. Future design work should continue along this track.

9. CONCLUSION

Family calendars play a pivotal role in the everyday coordination of family activities. We have presented, through the study of 44 different families' routines, the core attributes of family calendaring. Yet it is vital to realize that the processes and routines we present are by no means static and have evolved, in many cases, over years of trial and error, repetition, and iteration. Family routines do not simply happen; rather, they come about as a result of households trying to organize their daily activities [Hughes *et al.*, 2000]. Our findings also immediately suggest guidelines for the design of digital family calendars, which can inform designs as well as be used for critiques of existing ones. However, our guidelines are but one interpretation of our study's findings. There are certainly other ways to move from real world practice to design; we have outlined one possible step. Despite this caveat, we believe a digital family calendar can and should be designed to fit within the existing routines of families that we have articulated; otherwise the digital calendar will simply not be adopted by families.

Our study looks specifically at the family calendaring routines of middle class families in Canada and the United States. We expect that our results generalize to middle class Western culture given the fact that social psychology studies have shown that most industrialized nations exhibiting strong economies have fairly similar tempos and notions of time [Levine, 1997]. However, there will naturally be exceptions based on one's location (e.g., rural vs. urban), personality (e.g., Type A vs. B personalities) [Levine, 1997] and context (e.g., living alone, or dysfunctional families). Thus, while the specific needs of families and individuals within middle class Western culture will differ, we believe the main principles we have uncovered will stay the same.

We leave the investigation of the calendar usage of other cultures to future studies rather than broadening our article's scope, although our work could be considered a precursor to this comparative study. Many cultures exhibit very different notions of time (e.g., Third World nations) and as a result will use very different methods for coordinating activities, if activities need to be coordinated at all. We encourage others to continue on with this research to broaden the knowledge base surrounding coordination routines.

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