

Locating Family Values: A Field Trial of the Whereabouts Clock

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Abstract. We report the results of a long-term, multi-site field trial of a situated awareness device for families called the “Whereabouts Clock”. The Clock displayed family members’ current location as one of four privacy-preserving, deliberately coarse-grained categories (HOME, WORK, SCHOOL or ELSEWHERE). In use, the Clock supported not only family co-ordination but also more emotive aspects of family life such as reassurance, connectedness, identity and social touch. This emphasized aspects of family life frequently neglected in Ubicomp, such as the ways in which families’ awareness of each others’ activities contributes to a sense of a family’s identity. We draw further on the results to differentiate between location as a technical aspect of awareness systems and what we characterize as “location-in-interaction”. Location-in-interaction is revealed as an emotional, accountable and even moral part of family life.

1 Introduction

The continued importance of positioning and location as core topics in Ubicomp should come as no surprise. We spend a great deal of our lives in transit, and location, of ourselves and others, is a common feature of conversation [15], highlighting the extent to which it is a fundamental concern in daily life. The technical problems involved in tracking individuals and devices has generated a rich body of research, with different radio signals in particular (GPS, wifi, GSM, FM radio) offering a range of trade-offs in location accuracy and performance (e.g. [4]). Alongside this research, user studies have explored what new applications might exist for tracking systems [5]. These applications, known broadly as “location-based services”, tailor and deliver services based on a user’s locale. Primary amongst such services has been the support for awareness of one’s own and others’ position, an area explored extensively in both commercial and research systems [8]. Studies of these systems have generated a range of issues for design, in particular how location awareness can conflict with privacy needs.

Despite this rich body of work, the commercial success of location awareness applications has been limited. One reason may be that we have yet to design systems that deliver compelling value for users, and that we have yet to gain a deep

understanding of how location awareness is used in different social groups. In an effort to begin to address this, this paper presents the results from a long term trial of a distinctive location awareness system designed specifically for families called the “Whereabouts Clock” (or WAC). The WAC is a device intended to be situated in the home in the form of a clock that allows family members to see where other members of the family are in four broad categories (“home”, “work”, “school” and “elsewhere”). Family members are tracked using cell phones, with users choosing what geographical locations correspond to each category and thus what is displayed on the Clock at home. Following the design principle of “less is more”, we deliberately designed the WAC to offer less functionality than existing systems – both communicating less about location than existing systems (essentially only two bits of information), and displaying information only within the home environment.

We present results from a trial of the Clock with five families (26 users) over a total period of six months. In practice we found that the particulars of its design successfully addressed any potential privacy concerns the families might have had. More important, however, was how the trial revealed aspects of location awareness previously neglected in the literature. Up until now, research has focused on how awareness systems can be used for the communication of location and activity, supporting coordination within social groups. However, for these families, location awareness was less about coordination and more about family members’ emotional connection to one another. In other words, the WAC was not really about communicating geographical location or even activity. Rather it was about displaying information to support what families *already know* about each other and already share. More specifically, the value of the Clock came as much from the reassurance that knowing things are as one expects them to be than it did from dealing with exceptions or changing plans. This, we argue, is part and parcel of family life. Part of the “work” of being a family is to know what goes on, and to know how things are. With the WAC, we found that mothers in particular (but other family members too), used location as a way of demonstrating their care and attention to others.

Drawing on this we argue that the existing functionality of many location awareness systems fails to take into account how awareness is managed and monitored in family groups. Indeed, the current literature frequently presents an anodyne version of what position and location are, in practice, for end users. Location awareness can instead be understood for how it supports the routine and regular arrangement of family life – characterized by familiar events and familiar exceptions. Family members’ positions are both *read* through these routines, but also *produced* with an awareness of that reading. In this way, the presentation of one’s location is an “accountable” matter in that one can be called to account for where and why one is at certain places at certain times. In our trial, participants thought about and managed how their location appeared to others displaying sensitivity to how their location was seen. This leads to a number of implications: existing location awareness systems have been focused around supporting co-ordination between individuals, and accuracy of location has been a paramount concern. Instead this study shows how location awareness, as part of family life, is an emotional and moral affair rather than simply a tool for co-ordination or practicality. This opens up new technological possibilities for supporting home and family life.

2 Related Work

With regard to the underlying design of the technology, the WAC sits at the cross-section of location-based services and situated displays. As well as a longstanding research topic, there are now a number of commercial location-based services available in the marketplace, many of which provide a variety of ways of monitoring children and friends. For example, many cell phone service providers and operators are now leveraging location information as value-added services for their customers. Sprint's FINDME and Helio's Buddy Beacon [7] allow people to locate other cell phone users in the same network cell. Other systems, such as Dodgeball (www.dodgeball.com), which do not rely on operator support, have a fringe following of dedicated users, but are far from widespread. Many factors have impacted the broad adoption of these systems, including privacy concerns, technical issues, lack of a user base, and more general usability issues with the technology.

Location and user tracking are also prevalent areas of research in the Ubicomp and mobile computing literature. An early example was the Active Badge system, originally concerned with the ways in which the capture of real-time location information could support life within office buildings [8]. More recently, with the advent of wireless networks, many different kinds of applications have been developed, but more centered on the consumer than on the office or mobile worker. Some use location as a way of delivering context-sensitive information to tourists and shoppers [2]. Others are more properly called "tracking applications" in that they focus on the delivery of location information itself. Popular applications here include ways of supporting gaming, friendship and family [18]. Further, because of the potentially sinister connotations of "tracking" or "monitoring", much of this research is preoccupied with aspects of privacy [10]. Common to all of these applications is that location information is typically delivered to the same hand-held devices that generate that information (such as to cell phones or PDAs).

In contrast, the situated display literature reports an altogether different set of concerns, many of which have to do with the use of large displays designed to support community, whether it be in corporate life or urban settings [13]. A few have explored ways of presenting information about location, but these do not normally relate to real-time data, confining themselves instead to calendar-based information, where, for example, grandparents are offered views of events affecting their grandchildren [12].

The separation of these two literatures can be linked to the different affordances being leveraged in each case: for the location-based services literature it tends to be about the production and display of accurate information "on the hoof", where having that information in hand is paramount. For the situated display literature, the topic is how the persistent and "at-a-glance" display of information provides benefits in locations where the information is public or shared and is stable through time. In this research, the WAC brings these two sets of concerns together by combining the use of situated displays that afford persistent, at-a-glance access to information with the dynamic, real time production of that information.

3 Designing a Location Awareness System for the Family

In our own previous trials of prototype systems, as well as system trials more broadly, it is common for research prototypes to focus on providing robust functionality, with applications frequently designed by the programmers themselves. Little attention, as a result, is given to their usability and aesthetic design. In our own past experience, we have observed how shortcomings in design can impact on users' experiences and opinions of a system. In developing the WAC, we therefore sought to iterate through a number of different interfaces and physical forms in order to produce a prototype that families would be drawn to and want to have in their homes. An important step was an internal trial with an early version of the Clock that we tested with our own work group [16]. Another key step was to take early versions of the Clock home to try out over extended periods of time in our own households. As a result of this early testing, we made many refinements both to the underlying technology and the design. However, the essential nature of its design, including the use of the clock metaphor, remained unchanged. The idea of a clock displaying location rather than time, of course, is not new. In the Harry Potter books, the "Weasley" family has a magic clock with hands for each member of the family indicating their location or state. Yet using a clock as a situated device to display location information has some interesting properties, and guided many of our design decisions:

First, the WAC is a situated display designed to be located in a place in the home (like the kitchen) where it becomes part of the routine of family life, much as a clock does. The interface is designed to let families see information "at a glance"; that is, without time spent turning the device on, or changing the settings to view its status. This also means that the WAC's display is "always on", persisting in the periphery of vision in the way that information on a clock persists.

Again, as with a clock, the WAC is designed to broadcast information to anyone in sight of the device. This can be contrasted with a watch, for example, which is a personal device. However, although information is "publicly available" within the house, we decided that it should not be viewed remotely. This decision was one of our attempts to deal with the privacy issues that plague location-based systems. Since the WAC could only be seen when physically in the home, only people entitled to be in the home can see it. This acts as a crude, yet very straightforward, form of access control which we thought would help to allay families' concerns about privacy (even though, as we discuss later, this concern was perhaps overplayed in our design).

Lastly, the WAC displays only coarse-grained information (i.e., it shows only that a family member is at "home", at "work", at "school", or in an unlabelled region meaning "out" or "elsewhere"). We reasoned that for much of family life, precise location isn't necessary: planning a meal, knowing someone is on their way home, or being reassured a child is at school, can be done with a relatively crude indication of location. Precise information might also be more intrusive of people's privacy. While this aspect is not necessarily clock-like, we felt it to be an important aspect of its design. The WAC in a sense gives as *little* information about location as possible, rather than striving for accuracy or completeness.



Fig. 1. Whereabouts Clock in case (a), interface (b), close-up of message window (c).

Figure 1 shows the final design of the WAC. The Clock itself is displayed on a tablet PC with touch input encased in a box made to look similar to that of a mantelpiece clock. The tablet is wirelessly connected via a GSM modem to a cellular network. In addition, a small physical “flap” hides softkeys for controlling both the volume of the Clock’s chimes as well as the brightness of the display; a moving “pendulum” also showing signal strength. The Clock interface presents an animated representation of family location where members of the household are represented by icons linked to the location of their cell phones. Because we wanted engagement with the device to require minimal effort on the part of users from day to day, users have only to switch on their cell phones and the bespoke application starts running. When this happens, each user’s icon appears bright and animated (appearing to “float” within each zone). If a user either switches off the application or the phone, their icon fades and becomes static. The WAC uses GSM cell ID available on cell phones to provide the location data. In this version, participants used Windows Mobile Smartphones running a custom client application (usually in addition to their own phones).

When at home, work or school, users need to first register or label these zones on their phones through a simple menu in the phone application. Upon registration, the Smartphone application records the underlying cell tower IDs within proximity for that particular zone. Whenever the phone is switched on, the application continually scans for cell towers in range, and maps the ID with strongest match onto a registered zone (indicating it as “out” if no zone has been registered for that ID). Updates are sent via SMS to the WAC display whenever the application determines that a person has moved from one registered zone to another. When this occurs, the Clock chimes to draw the attention to the move. After registering or labelling certain key locations using the phone as one of the three named zones, there is no further need to interact with the application. However, users were told that if they wanted they could change at any time what places they had set for the three different labels of “home”, “work” and “school”. For example, they could re-register any place as “school”.

A final feature of the Clock was the ability for family members to send text messages from their cell phones to the Clock at home, a feature we added as a result of our initial trials. When a new text message arrives, the first couple of words rotate around the icon of the person who sent it and its arrival is signalled by the sound of a cuckoo clock. People at home can then touch the icon, and a window appears showing the whole message, time it was sent, and labelled location from which it was sent.

With this window open, users can also look back at past messages, and delete unwanted ones. As a final part of the design, to include family members without cell phones (such as small children) we added icons which could be moved by hand, and which played random animations and sounds when touched.

4 Trial Methods

With a novel technology entering family life, we expected that it would take considerable time for a household to find its own uses for the Clock, and for these uses to stabilize. Therefore, rather than conduct short trials with a large number of families, we installed the Clock in five family homes for a period of at least one month with each family. Two of the families were particularly enthusiastic about the technology, so we left the Clocks with them for two months. In total, we ended up studying 26 family members with use ranging anywhere from 4 to 9 weeks. Households were selected from the local Cambridge area in which at least three members of the family owned cell phones, and which had established practice of 'texting' (or sending SMS messages) via their cell phones to each other. Families were informed prior to participation that we would have access not only to their location data but also to any messages sent to the Clock, but were reassured about the protection and privacy of their data. The households we selected cut across socioeconomic class, and were idiosyncratic in many respects (as we will discuss):

- **Household A** consisted of two parents with two boys, aged 11 and 13, and a lodger in his 20's. All had cell phones. The mother worked at a local school in Cambridge. The father, a vicar, lived 3 days a week in his parish vicarage in north London (an hour's drive away), but the main family home was in Cambridge. The youngest son was in boarding school during the week in Cambridge, coming home only on weekends. The other son attended the local secondary school. The Clock was installed in the Cambridge house.
- **Household B** consisted of two parents with two boys aged 11 and 18, and one daughter aged 17, all living at home. The mother worked in teaching support and part time for a local charity, and the father worked as an aerospace manager, having a long commute to and from work. The children were all at school. All three, but particularly the eldest two, were very active and relatively independent from the rest of the family.
- **Household C** consisted of two parents (a nurse and an IT consultant) and four children, a young boy aged 9, an older boy aged 12 (who lived with his mother outside the home we studied), a daughter aged 15 and a daughter aged 17 who had just started university in a different town, but who came home outside term time.
- **Household D** was a family of five: two parents, two daughters and one son (aged 13 and 15 years, and 10 months respectively). The father worked full-time in technical support at a small company and the mother part-time from home, welding parts onto circuit boards. Compared to the rest of the households, this family had the most unvaried routine. The daughters attended a nearby school and reported no extracurricular activities. The mother spent most weekdays at home looking after her young son and housekeeping.
- **Household E** consisted of two retired parents and one 18 year-old son living at home. Two WAC enabled phones were also given to this family's 22 year-old daughter and her boyfriend, who lived together several miles away. The father spent much of his time at home, while the mother walked the household dog several miles each day and spent time gardening, either at home or in a garden allotment some distance from the house. The son was in the last year of high school and also worked part-time. The daughter worked locally

and would visit several times a week after work and before returning to her boyfriend's. The boyfriend worked in a city 1 hour away by train and often returned home late.

On the first visit to the households, the WAC was installed and family members shown how to use it. In addition they were provided with an instruction and troubleshooting sheet. Data were gathered through a series of interviews at approximately one week intervals which we scheduled with as many members of each family present as possible. On these visits, the families were asked questions about how they had used the Clock, how they felt about being tracked, and whether they had sent text messages to the Clock. In addition, printouts of the sent messages provided a focus for further discussion. Questions were also directed at how, if at all, the Clock and messaging facility interleaved with household activities and routines. In the final interview, we asked all family members to imagine different possibilities for a whereabouts device, seeking comments and criticisms and directions for novel design ideas. All interviews were audio-taped for later review and the interviews transcribed.

5 Uses and Values of the Clock

Generally, we found each household made substantial use of the Clock, although family members did at times forget to carry their extra cell phones with them or to keep them charged. On average, participants' phones were tracked on 72% of trial days, ranging from a minimum of 47% to a maximum of 80% of trial days. In addition, each family member sent on average 1.6 messages per week to the Clock during the trial. However, perhaps a better testament to the use of the Clock was some families' distress at losing the Clock at the end of the trial. As one family put it: "We're going to miss it" – the Clock had become an almost integral part of their routines. Despite this, all of the families also commented on various ways in which the design of the Clock could have been improved. For example, there was general agreement on how useful it would be to be able to send messages back *from* the Clock to individual people. In addition, the technology was not always as robust and reliable as we hoped – in particular sometimes family members were seen to move in and out of different zones due to technical problems. As we will discuss later, these problems sometimes caused needless anxiety. Nevertheless, from the interviews, it is clear that different patterns of use developed around the Clock in each household showing various ways in which it provided value within each family context.

We discuss these findings in three sections. In this section we give an overview of the uses of the Clock. This section describes not only the uses of the Clock for *coordination*, but also how it highlighted a set of values more emotive in nature. In particular, we will discuss the Clock as a tool for *reassurance*, *connectedness*, *identity* and lastly *social touch*. In the next section we discuss how the Clock's trial deepened our understanding of family life – revealing aspects of families frequently ignored in Ubicomp research. Lastly, in the final section we explore the implications for Ubicomp from this work. In particular we discuss how location-in-interaction, as supported by awareness technologies such as the WAC, differs from location as a technical feature of system design.

5.1 Co-ordination and Communication

The focus of most work on location awareness has been to support co-ordination and communication. By conveying information about their location and activity to one another, users can make decisions and better plan their activities. Support for co-ordination in this way was established early on in CSCW research, perhaps most classically with the Active Badge system [8], but also receiving more recent attention [5, 17]. Because of this, we fully expected the WAC to be used in the co-ordination and management of family activities. Indeed household members spoke of the ways in which they could better plan activities such as preparing meals by being able to see when someone was on their way home. In one case, a father reported how the WAC had informed him of his wife's early return home when he had expected her to miss dinner. This allowed him to offer an affectionate gesture by having dinner ready for her when she walked in the door. Households also made a number of references to what Household E called "put-the-kettle-on" movements on the Clock. Here, household members leaving a region or moving into HOME on the Clock (before they had physically arrived) would prompt those at home to put the kettle on for tea. Important here was an awareness of the household's rhythms: movements were "read" in different ways depending on the time of day and knowledge of the household routines. Trisha, the mother in Household E, captured this in describing an example of Clock use related to her son, Jon:

A few times Jon has not left a message and around about quarter to six-ish I've seen his photo move up to HOME and I've thought "ooh, Jon is coming home," and I've had a cup of tea ready for him before he's even walked in the house.

Significantly, with the coarse granularity of position that the Clock communicated (not least to mention the underlying positioning algorithm), we noted that nearly all these readings of the Clock were 'fail safe' – in that if they were wrong the cost would be very low (such as a kettle boiled in vain). However, the messaging feature of the Clock was often used in coordination tasks when more precise information might be needed, or in order for someone to account for their location on the Clock. Messages such as: "Just at the train station. X"; "In a meeting 4 next few hours"; "M11 accident, taking back roads" and "Jus walkin down road now. Sum1 stick kettle on. ; -p" fell squarely in this category. The last of the messages above also illustrates that not only could people reading the Clock use this information to plan activities, but those sending messages home could try to direct other people's activities more explicitly. Thus with the messaging, we saw a number of "calls to action" such as "Mum phone"; "Shopping done help please"; and "Time for bed".

5.2 Reassurance

While co-ordination is perhaps the most obvious use of an awareness technology, the Clock was distinctive in that the most remarked upon benefit was the *reassurance* it provided for family members. Families regularly described, in both explicit and implicit ways, the Clock as reassuring:

So I just come in and you know, ‘yep, everybody’s in the right place. All’s right with the world’, you know, just at a glance... It’s just umm, it is just nice. It’s not checking up on people. It’s just a nice little reassurance. Everyone’s where they should be and everything’s right, or at least their phones are in the right place [laughs]. I mean, you know, you can take these things too far... but you’re not using it as a security device like that.

The WAC invoked not simply a reassurance of family members being at the right place at the right time, but also an overriding sense that everything was *going to routine*, that *all was well*. As expressed above there is a sense “that everything’s right” in looking at the Clock and seeing that everyone is where they should be. Rachel, the mother in Household C, expressed, evocatively, something similar in talking about her eldest daughter away at university:

When you can’t visualize where your offspring are, you have this ridiculous sense of anxiety that’s just bubbling very quietly. [...] I think in some way the Clock helps me think ‘yes, they’ve definitely got there, and they’re definitely there now, and they’re on their way home.

The Clock, then, appears to put Rachel at ease, providing reassurance of her distant daughter’s whereabouts. Again, it was not that the Clock did this by providing precise geographical coordinates. As Rachel put it, the Clock was simply an additional tool for visualizing – a means of gleaning just enough information, as it were. Something we had not expected was how the Clock’s chimes also played into this sense of reassurance. The Clock would be glanced at or approached when it chimed to see who it was that had moved and where they had moved from and to. Indeed, families spoke of being drawn almost compulsively to the Clock because of the chimes it made—parents who spent large portions of their days at home felt particularly strongly about the chimes. Meg, for instance, chose to place the Clock in her living room so that she could easily glance over to it whenever it chimed:

There’s just some sort of thing where you’ve got to see what- you know, it makes that noise that someone’s moved and you just have to look. I don’t know why. You just have to look.

Whatever the underlying motivations, it appears reassurance came from being able to see the family as active and from seeing a family’s movements, at a particular level of granularity, to be in keeping with known-about routines. The coarseness of the location *works*, so to speak, because the ways of seeing or reading the Clock are deeply enmeshed with what family members already know and indeed have rights to know. What we see through the use of the Clock is that family members are able to intuit a state of affairs using relatively crude types of information. It is unclear in the design of the Clock whether more detail or a higher level of accuracy in location would have provided a greater degree of reassurance. This led us to further explore location not purely as geographical coordinates, valued for how precise those coordinates can be, but rather how location fits into the “family geography” of where the family is or more particularly, where the family *should be*.

5.3 Connectedness and Togetherness

Tied closely to the sense of reassurance associated with the Clock was another salient theme that emerged from our interviews, that of *connectedness* and *togetherness*.

Whilst having the Clock, family members spoke of how it helped them to feel connected to those out of the house. In Meg's glances at the Clock (noted above), for example, she gained a sense of what other family members were "up to" and, in turn, gained a sense of connection with them. For Trisha (mother in Household E), the persistently displayed information also provided a way of feeling connected to those who were out. In her words, "It just keeps you that little bit closer all the while."

Other households adopted a more purposeful approach to using the Clock as a means of connection. For Household A, distributed across three different "homes", the mother, Jo, expressed a particular sense of how the Clock allowed her to feel connected to her family even when they were apart. She talked about how seeing the family members together on the Clock presented everybody being in the same place even when they were not – a virtual sense of everybody together. The Clock explicitly connected family members who while at homes in different parts of the country, were still connected with what Jo saw as their *real* home.

This fleeting yet emotive aspect of the Clock was reiterated time and again in our interviews. In a fashion reminiscent of displayed family photos, the Clock provided a recurrent visual reminder of a family's togetherness. Indeed, the temporal rhythms that the Clock visualized brought out these moments of togetherness – particularly at poignant times such as dinnertime. As Dan, the father in Household C put it, seeing everybody "nestling" together at the top of the Clock each night (even though some of his children were in different homes), gave him a strong sense of family unity.

One issue was that the reverse was also true in that it could instill moments of anxiety and separation from family members. Householders reported feeling worried when others in the household appeared where they shouldn't be or moving when they should be in one place. These feelings were elevated when, on occasion, the positioning algorithm would find itself on an edge, and "flutter" between two different locations.

5.4 Expressing Identity

So far we have noted important ways in which household members came to see or "read" the WAC. We also found participants giving thought to how they were represented on the Clock to others. Common was the way in which households appropriated the Clock's three location labels, HOME, WORK and SCHOOL, to control how they were seen and to suit their particular needs. Household E (where neither parent worked) presented perhaps the most extreme example of this. All but the son, Jon, labeled places in unexpected ways; the daughter assigned both her boyfriend's house and family house as HOME, and the local train station, where she picked her boyfriend up after work, as SCHOOL. The mother, who wasn't working, used SCHOOL to refer to her walking the dog (registering several spots along her usual walk as SCHOOL). She also used WORK to refer to gardening either in the garden attached to the house or in the family's garden allotment some distance from their home. While at home, the retired father would regularly use his cell phone to register himself as either at WORK or HOME depending on what he was doing.

Striking, here, was the ease with which they incorporated these inflexible labels into their household routines. We gave only minimal instructions to families on how

to assign different geographical locations to the three available labels. Even so, all but one of the households used the labels to designate something else, or assigned multiple geographical locations to one label, and did so with no apparent problems or need for technical assistance. These adaptations were often based on subtle use of geographical location. Registering two different gardens as the single label WORK, and an activity (dog walking) rather than a distinct place to SCHOOL seemed, if anything, a somewhat playful use of the Clock for Household E's mother, Trisha (a self-professed technophobe). It was also dealt with in stride by the rest of the family who knew what these labels meant and had no difficulty knowing where she was or what she was doing. Arguably, it was the coarseness of detail on the Clock that prevented the complexity from being overwhelming. It would seem the detail was sufficient to allow for a rough idea of location to be simply deduced. As several of our participants reported, if more detail was required, other channels of communication were available, such as a text message to the Clock.

Indeed, some family members went as far as to use their reported location as a way of identifying their activities and expressing them to others. The father in Household E, Ted, moved himself on the Clock between WORK and HOME – re-registering his location each time he moved from using his computer to watching television – not unlike the use of availability messages in Instant Messaging. However, it also actively asserted a sense of social position, or what might be termed, rather grandly, *identity*. Ted, if you like, was demonstrably composing his position *vis-à-vis* his family. This marking of social position in the home parallels the practice of *broadcasting identity* we have written about previously [17].

5.5 Social touch

A final recurring use of the Clock worth noting amongst the households relates to what we have in the past referred to as “social touch”, where technology is used as a channel through which family members express affection for one another [17]. In essence, many of the examples of coordination we have described have strong elements of this, such as having a cup of tea or a meal ready for someone when they come through the door. However, this showed itself most explicitly in the messages family members sent to the WAC. There were obvious examples such as “Good morning all ;-p” and “Nite nite every1. Cold nite here. B careful on the roads 2moro.” In other cases, messages would be sent for some other purpose but would incorporate an element of social touch, a flourish, if you like, denoting one's thought for others. A particularly nice example of this was sent by Peter, the lodger staying at Household A. His message is to one of the family's young sons: “Harry, there's some hot chocolate in my cupboard if you'd like some. Hope you're not feeling too poorly, Peter”. Peter is clearly making a thoughtful gesture in offering his hot chocolate to Harry. Interesting for us is his use of the Clock to do so. As with the ‘fail-safe’ use of the Clock for coordination, it appears such messages are not critical and have no immediate function. Instead, they simply add a distinct feel to a family and the relationships its members have with one another. From this perspective, it is worth noting that some of the households were far more emotionally demonstrative in their messaging on the Clock. Households A and E, for example, routinely sent messages appearing to supplement the “all is OK” status

suggested by the display of people's whereabouts. On occasion, then, we saw the messaging via the Clock, perhaps unsurprisingly, weave its way into family relations, playing its part in the emotional repartee between family members; as with so many practical things in the home [19], the Clock came to offer a resource for playing out the social organization of home.

6 Understanding the Clock as a Family Device

Now that we have covered the basic ways in which the Clock was used, we move on to examine in more depth how the Clock found its place within family life. Our goals in running this trial were not simply to evaluate the success of the WAC but rather, through its adoption, we hoped to reflect anew upon location-centric technologies, and understand location as a feature of family life. We develop this analysis further in three main themes. First we discuss family attitudes toward privacy and their focus on sharing rather than intrusion. Second, we address the ways in which the Clock not only integrated into family life but supported what we will call 'the production of family life'. Lastly, we discuss the nature of location that the Clock supported, making a break from the technical notion of location prevalent in Ubicomp and arguing instead for the importance of understanding how location manifests itself for end users.

6.1 Privacy

If there has been a single topic that has dominated location awareness research it is privacy (e.g. [10]). In part, this is due to the growing concerns with the ways in which our lives are tracked electronically and considerable public worry about how such information could be abused. Privacy measures thus have featured prominently in location awareness prototypes. In the design of the WAC, we sought to address these concerns through both the fixed single location of the Clock, at home, and the limited coarse-grained information it shared.

At the very least, privacy concerns did not seem to inhibit the family's usage of the Clock. Indeed, despite repeated questioning, none of the families reporting being concerned about a loss of privacy. In part, participants' comments led us to believe that the coarse-grained resolution of the tracking information helped considerably. One teenager put it this way:

Yeah, so a lot of my friends have said "So your parents are checking up on you" like. I said nah this is not that. It's not accurate enough. It doesn't tell you exactly where I am so I can go places and they won't know where I am.

But further than this, our repeated questioning around privacy was met with puzzlement by the families. As they explained, the Clock displayed information that they already shared. Thus the WAC was not seen as intruding any further into what they already knew or needed to know. Even questions about access to the Clock from outside the home failed to provoke worries about privacy. When asked about losing a phone that could display the Clock's information, Kris phrases this point well:

Well you get over don't you? It's the same thing as losing your phone anyway. And anyway, would it really matter? They don't know who it is, they don't know what 'home' means, they don't, you know it doesn't bear any relation to anybody else that doesn't know.

It was only when we suggested radically more open designs – such as sharing location information with everybody on the Internet (“like MySpace” as one family put it) that we could get families to object. As for the possibility of hackers, or malicious access to the tracking information provided by the WAC, again it was pointed out to us that the level of detail the Clock provided was only something that really made sense to those who knew a household's routines; namely, close family and friends.

While not to downplay the tensions and pressures of family life, the reactions we received around privacy reflect the fact that family life is built, significantly, around shared awareness, without which much of the everyday co-ordination of the family (eating, driving children around, sharing costs and so on) would be impossible. As Martin [11] describes so astutely, the knowledge and control of a household's comings and goings are concerns continually being brokered, but, nevertheless, the very idea of home is built upon knowing and controlling just such matters. While it is possible that the families we studied were atypical, it could also be that privacy is more of a concern for us as researchers than it is of practical concern to families.

6.2 The Production of Family Life

In studying families, and looking at how technologies such as the WAC are used, it is all too easy to take the family for granted as an entity – to take the social arrangement or organization of a family as a given. With an eye on the technology, we can lose sight of the social phenomenon [3]. However, in many senses families are a “work in progress”, with at times strenuous work needed to keep its members together, to keep in touch, and to maintain a common identity. In short, being in a family relies upon the work of its members to organize, in some recognizable fashion, itself as a social group. As we have already suggested, one aspect of this work – and something that family members undertake as a matter of course – is to know each other's whereabouts, what each other's routines are, and what each person's roles and accountabilities are (as it can be amongst other social and organizational groups). Sacks refers to one aspect of this as “private calendars” – the shared schedule of events both past and future [14] that families have in common. We can expand on this to describe our participants' “private geographies” – the shared, in-common knowledge of the different parts of their city, and what that meant for different family members. Naturally, particular members may fail at times in this organizational duty to the frustration of other family members. However, what is evident is that there is an obligation amongst family members, and particularly parents, to watch out and attempt to maintain their shared geography and calendar. Any family would be remiss, and crucially be seen as such, if it did not attend to such an obligation [9]. Here the WAC was readily incorporated into these practices: by revealing the routines of those distant, it helped to cement together each family's identity as not merely a group who share a living space, but who have an emotional bond of support and care.

Indeed, at one and the same time, the Clock revealed those practices to us – how a shared calendar can come to be demonstrably enacted as a feature of a household's

organization *as a household*. So by presenting a view of the family through their locations, the Clock helped in letting family members monitor each other's behaviors and routines. It also enabled people (such as mothers and fathers) *to be seen* to monitor that activity. It was both the monitoring and its "performative" achievement that did the work of cementing family relations, contributing to the "production" of family, as it were [6]. We would not over-emphasize the role of technology, or the Clock, in this socially organizing work. Rather the use of the Clock foregrounded for us as researchers how the family is as much an *aspiration* or something that is worked toward, as it is a particular group of people. Likewise, home is not so much a place as it is *an idea*, an idea is bound up with being together, being cared for, and being safe.

6.3 From Location to Location-in-Interaction

As we discussed earlier, the majority of work on location awareness has focused on easily quantifiable – and thus comparable – performance measures of location-based systems, such as accuracy, resolution, coverage and so on. In these terms, the WAC was very limited – its resolution was crude, and its accuracy and coverage certainly no better (and on the whole worse) than many existing solutions. Yet the reception of the Clock by its users – and the important values it supported – led us to reflect again on how it is that location awareness plays out in use. That is to say, the WAC let us explore location not as a technical feature of a system, but as something interleaved with a family's interactions with each other. We would argue that the value of location technologies are seldom simply in their ability to track objects and people, but rather in how that tracking is, in the end, *used*. For location awareness, whether it is of family members or delivery trucks, this means *in interaction*. It is seldom the autonomous tracking of position that is important but what that tracking means to others involved – such as when a truck driver needs to explain to management the extra long route they took, or just a family member explaining why it took them so long to come home. Location, and thus location tracking systems, move from technical curiosities to valuable systems in how they support these activities. Our focus was therefore on *location-in-interaction*: how it is that location is used, read, viewed, and manipulated by groups, and what this can support. These activities are directly connected to the accuracy, resolution, or whatever, of a positioning system, but these technical aspects can only ever be a partial account of location's role. Our point is not that inaccuracy is unimportant – as we have mentioned, the inaccuracies of the WAC (or more specifically: its flutter) caused unnecessary distress. It is rather that it remains to be seen what accuracy is in a specific interactional situation, and we should not simply assume accuracy is a uniform concept.

For example, even the simplest glances at the Clock were informative in developing these ideas around location-in-interaction. When family members looked at the Clock to see another's whereabouts, they in a sense "read" what this meant about the recipient, taking into account what they knew and understood about that family member's context. In one example reported to us, the mother of Household A, Jo, cycled home after work over a bridge that crossed a local river. This area she had previously labeled as SCHOOL as this was the regular site where she practiced rowing. SCHOOL was therefore known by the family to mean "Mum is rowing". Yet as she

cycled home that night, the brief appearance of her on the Clock as being in the region of SCHOOL was not interpreted by the rest of the family as rowing, but rather as where in particular she was on her route home from work. Through such examples, we see location as actively produced in interaction. Originally, we had worried about how an automatic tracking system might lead to confusion or undermine communication. Indeed, earlier work had gone as far as to argue that automatic functions are not desirable or useful in awareness systems [18]. Yet in practice, location generated by the WAC was flexibly read by participants taking into account its automatic nature. Location was understood, even at a glance, in the context of what that person ordinarily did, and their ordinary patterns and routines.

That people infer activity from location and do so as a matter of course has been discussed before in the literature [18]. However, on the basis of this research we want to develop this point further. Location for our study's families was not only meaningful in terms of their intimate knowledge of one another, it also had moral connotations. By this we mean that there were "right" places to be and "wrong" ones. Returning to the idea of location-in-interaction, we don't mean here that there were right or wrong geographical places to be. Rather, the use of the Clock revealed to us that, through location, judgments are made about whether others are doing what they should be; whether, in the case of family households, they are behaving appropriately as a member of the family. The most straightforward illustration of this is the way in which these families used the WAC to account for their actions. If they were late or made changes to their routine, they felt the need to explain these aberrations. This is something that the families used the text messaging features of the Clock to address: family members would text to say why they were late, and why the Clock showed they were in one place when it was expected they would be in another.

That location has a moral component means that one's status or activity has moral implications for others' view of oneself. The interesting use of the Clock's labels we wrote of in Section 5.4 is illustrative of this. By registering her gardening as WORK and re-registering his physical presence at home as WORK, Trisha and Ted were not merely appropriating the labels for convenience. Along with the use of these labels come certain rights of access and prescribed relations with others. Ted's re-registration, for instance, was redundant for all practical purposes; his computer desk where he worked at home was meters away from the Clock. What it achieved, however, was a social and moral positioning relative to the categories displayed on the Clock. Nigel, if you like, was demonstrably composing his position *vis-à-vis* his family, broadcasting his participation *in-work*. To say therefore that location is read as activity, or that it is activity that needs to be communicated rather than location, is to gloss over much of the complexity of what location means and how it is used in terms of family life and in the course of interaction.

7 Implications and Discussion

So far we have highlighted a number of differences between the results of this research and previous Ubicomp work on location and awareness. Certainly, through designing the Clock specifically as a family locating system, as well as one with a

relatively simple design, the WAC and the results of the trial explore new issues for design, and uncover new values that users can derive from such systems. But the research also has some broader implications for Ubicomp, and in particular, how we conceive of and develop systems for location awareness.

One main implication of this work is that a deeper consideration of what location-in-interaction means for people may lead us not to simply optimize the underlying technology, but rather to optimize the fit between the technology and users' values and practices. This may lead us to develop different kinds of technical solutions, with new mechanisms and features. For example, the artful use of location labeling by our trial families suggests that this kind of mechanism may be as important a feature as accuracy in tracking. Recent work on qualitative location tracking is a relevant and insightful development here [1]. As another example, there has been a considerable body of work on optimizing tracking within buildings, as an extension to traditional GPS which on the whole only works well outside. Yet from a consideration of what location means in interaction, it may be that whether we are indoors or outdoors and what address we are at can be of more importance than our spatial location within a building. We might only want to know if one is inside a commercial establishment, waiting outside, or at a house next door. The importance and nature of a particular locating problem may be much transformed by considering what users want to know and why they want to know it. As our results have shown, location-in-interaction might be as much about emotion – reassurance, connection and the like – as it is about the communication of accurate information. The WAC deliberately offered a *lower* resolution of accuracy than was possible with the technology. As we discussed above (an established finding of design theory, if not Ubicomp), systems that provide value to end users can often feature less functionality rather than more.

A second implication of this work has to do with a different perspective on how we conceptualize the home, as it becomes a growing topic of concern for Ubicomp. Our research suggests we need to move beyond the notion of smart technologies, used in “smart home” visions and the like. The term implies technologies that do the work *for* people and, in the case of smart homes, the work of families. On the contrary, this research suggests that we develop technologies that *let people be smart*. In other words, when we look at how families derived value from the WAC, it is clear that this is a technology that helps *families* do the work of “being a family”. This, then, we would claim, opens up the way for a different kind of design philosophy as well as a new research approach. This approach looks to support what people in homes *already do*, not to do it for them. It looks to provide families with new tools as resources for those already engrained activities. This not only takes us away from notions of predicting people's behavior or automating tasks, but also makes us think more deeply about what are the human values we want to support. These may not necessarily be about productivity and efficiency and getting tasks done. As we have seen, they might equally be about affection, reassurance, identity and togetherness.

On a final, broader note, this research provides a complementary contribution to existing research in other domains and with other types of social groups in Ubicomp. The settings and contexts in which we studied the use of the WAC are different from those of earlier studies exploring location systems. Perhaps for this reason, the importance of privacy was not echoed in our fieldwork experiences, and, unlike previous work, we found automatic locating technology to be both valuable and

useful for the families we studied. Our findings have also touched on very different aspects of location – its emotional, accountable and even moral characteristics – than existing work. Rather than contradicting earlier work on locating technology, we suggest that our differences come from our different domain of enquiry (the family), the different nature of the prototype (as a situated, awareness device), as well as the different values and themes we have focused on in our study.

8 Conclusions and Future Work

In this paper we have focused on how a particular technology – the Whereabouts Clock – was integrated into family life. An extensive trial with the Clock in five households uncovered how it supported not just co-ordination and awareness, as commonly associated with location awareness systems, but rather reassurance, connectedness, expression of identity and social touch. These were not so much functional benefits of use as emotive ones – a feeling, as one of our participants put it, that “all is right with the world”. The WAC supported these values without generating privacy concerns. It did this, in part, because of the coarse-grained information it communicated – an example of “less is more”, offering enough functionality to fit with users’ practices, but not more than they needed or were comfortable with.

More generally, we have argued that the use of the Clock helps to reveal practices around what we characterized as “location-in-interaction”. We contrasted this with a focus on technical features of location systems (accuracy, resolution, coverage), and while they are of course interdependent, location as it plays out in interaction is more than simply a matter of technology. We suggest that understanding the value of location-in-interaction may lead to technical design distinct from optimizing the underlying technology, such as less accurate but more meaningful location information.

In our future work we plan to redesign the WAC to take into account the lessons of the trial. In particular, while our restricted set of location categories successfully dealt with privacy concerns, we suspect this was, if anything, an over-reaction to those concerns. Giving families more flexibility in labeling locations could have a number of interesting effects, particularly if labeled locations could be shared amongst family members. We are also exploring what it might mean to move from a clock to a watch – making the visualization portable and available on a user’s phone. Again, this is potentially moving in a very different direction from the original design. However, broadening the design space will allow us to further explore the values supported by the WAC. More generally, further prototypes will allow us to understand how to best construct new technologies for the home. The complexities of family life are such that supporting it will involve technology embedded as much in the moral, emotional and caring aspects of family life as the functional or technical. It is here we see the most interesting set of new challenges.

Acknowledgments

We are indebted to the families who gave generously of their time for this study. We are also grateful to Richard Harper and Ken Wood for their valuable commentary and

advice on the paper. In addition, one anonymous reviewer gave us the wittiest review we have ever received, reminding us why we do this job. Thank you.

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