

**Embodied Interaction and Seamless Design:
Social Hierarchy and Interactivity in People-Finder Services**

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Introduction

Interfaces are not what they used to be. The computer-human interface is both *more* and *less* than it was a few years ago. Interfaces are not only, or even primarily, a screen anymore. Yet, screens remain important to most design efforts, even though interfaces are increasingly part of the environment itself. The challenges resulting from these changes require new design insights and techniques as well as distinct approaches to researching the way people experience technology.

The gadgets we use to manage our connections with others increasingly make a distinct space of experience available, as digital products, connected, but without a delimited interface (Armitage 2003). A fact sometimes too readily apparent in the way we apply them. Interface design emerged in the 1980s and increased in significance once the initial desktop metaphor implementations of the Xerox Star, Macintosh and, later, Microsoft Windows became dominant in both domestic and business settings.¹ With its emphasis on eye-hand coordination (drag and drop, point and click), the desktop metaphor replaced the strictly taxonomic concerns of character-based interface design, i.e. organizing input fields and function key triggers on the screen. The graphical user interface brought with it a focus on layered complexity in human-computer interaction keyed by computing events (McCullough 1996).² People increasingly organized their use of computers through the interactivity its interface afforded. Graphical user interface design was an initial step towards acknowledging the importance of the experience of people using computers (Grudin 1990).³

Over time, the processing power of mainframe and mini computers came out of their rooms and onto our desks as hardware costs fell, local and wide area networking developed, and software interfaces improved. The development of the Internet extended a focus on the *layered complexity* of information sharing across location and time. Currently, computing power is embedded in everyday things, i.e. ubiquitous computing, in a way that changes important features of information technology design as well as the design of products in general (Hallnas and Redstrom, 2002).⁴ As Hook, Benyon, and Munro note: "Computers are... 'disappearing' into

everyday objects. They are becoming increasingly small, so much so that they are now wearable. They are increasingly able to communicate with each other,” (2003, p. 1).

Ubiquitous computing results when desktop or mobile computing devices, such as PDAs and cell phones, communicate with pervasive computing devices such as sensors, typically using radio frequency chips or RFID (Lyytinen and Yoo 2002), Bluetooth, WiFi hot spots, cell towers, or satellite-based global positioning systems (GPS). As deployment of ubiquitous computing occurs, the metaphor and mental model conveyed by the desktop no longer provides the range of understanding needed to design digital products for people's activities (McCullough 2004; Rehman, Stajano, and Coulouris 2002).

Norman (2005a) pointed out that most human-computer interaction (HCI) research and practice has focused on user tasks, rather than user activities in context. This paper's main point is that the growth of ubiquitous computing makes context, including socio-cultural practices, increasingly important to designing for experience with mobile communication devices.⁵ Our discussion provides an analysis of the experience design challenges of a specific type of ubiquitous computing, location-based services focused on *people finding*. We highlight the importance of *ambiguity* about context, particularly socio-cultural practices, to the design of such location-based services. To begin, the analysis details two basic approaches to studying the relationship between context and the design of location-based services, the **representation** approach and the **interaction** approach (Dourish 2001a).⁶

Dey, Abowd, and Salber offer a definition of context that makes it equivalent to representations of information on “the location, identity, and state of people, groups, and computational and physical objects” (2001, p. 106). In its strongest form, the representation approach aims to design user interaction out of the context of use by developing a *seamless interface* to the underlying technology, automatically adapting its functionality to the location and situation of the person using it based on pre-defined rules, or machine learning of rules, taken to govern activity within

those spaces.⁷ In other words, the representation approach assumes a stable separation between contexts and activities. In the representation approach, the activity happens “within” a context. Or, as Dourish (2004) puts it, in the representation approach, “I might be engaged in a conversation, which may be happening in a location; the conversation is my activity, while the location is an aspect of the context” (p. 22). Indeed, even in work done using the representation approach that remains sensitive to the contributions of a focus on “situated action”, the emphasis is on the persistence of structures and the challenge of representing them while maintaining the precedence of goals over activity (Kaptelinin and Nardi 2006; Nardi 1996).

Alternatively, the interaction approach aims to provide insights into the way people’s actions embody emergent properties of context when they design or use technologies. Structures are persistent, but do not persist on their own separate from the practical activities of people. Structures have their representations, in documents, computer programs, graphs, charts, PowerPoint slideshows, flash presentations, etc. Yet, people use those representations of structure in specific situations in which, typically, several points of view are advanced and, when necessary, a common meaning negotiated (Irons 1998). Dourish adds that, “conversations are embodied phenomena because their structure and orderliness derives from the way in which they are enacted by participants in real-time under the immediate constraints of the environment [context] in which they unfold” (2001b, p.234). In other words, structure does not persist without action embedded in a context, *an infrastructure*.

We follow Dourish (2004), noting that the analytical strength of the interaction approach is in using the concept of embodiment, defined as the *availability for engagement*, to specify the seams in interfaces to ubiquitous computing applications, as opportunities for experience. Dourish (2001a) maintains the embodied interaction approach informs design by providing “conceptual tools for understanding how the interface might move into the background without disappearing altogether” (p. 203). Dourish (2001a) thinks that people designing for experience can reconceptualize the inability of ubiquitous computing applications to provide a seamless

interface. Indeed, Dourish and Bell (forthcoming) maintain that cultural practices are as real in shaping mobile communications in context as the technology itself. Thus,

Everyday spaces are not simply spaces for working or meeting, but spaces for waiting, for reading, for loitering, for watching, for loving, for remembering, and more...The rhetoric of seamlessness is often opposed to the inherently fragmented nature of social and cultural encounters with space (Dourish and Bell forthcoming).

Following Weiser (1994), Dourish (2004) argues for an approach to manage decisions about when to use *seamful* design and when to use *seamless* design, while explicitly recognizing cultural practices as infrastructure for ubiquitous computing (Dourish and Bell, forthcoming).

Research Problem and Approach

Recently, Greenfield (2006) provided a set of design guidelines, largely derived from insights of the embodied interaction approach, to support the experience of people using mobile communication devices within ubiquitous computing spaces. The guidelines relate to how designers can exploit the *seams* in the interface of services that rely on ubiquitous computing, rather than focusing on how to build seamless interfaces. The analysis below looks specifically at current research, and selected services offered in the United States, that exemplify when and how to provide resources for subscribers to manage a location-based service, specifically applications designed to locate people. In doing so, this paper examines the design guidelines offered by Greenfield (2006) and others (Iachello, Smith, Consolvo, Chen, and Abowd 2005), relating them to recent research on location-based services offered by several mobile network operators in the United States.

The U.S. Federal Communications Commission's *Enhanced 911* requirement stipulates that cell phone companies implement the underlying network technology, Automatic Location Identification (ALI), involved in *people finding*.⁸ Therefore, the basic design of location-based services, in this case *people finding* applications, must support activities such as coordinating individuals' actions relative to location, to facilitate first responder navigation to find a caller in need of help.

Moreover, mobile network operators are attempting to leverage their investment in infrastructure

required by *Enhanced 911* by offering location-based service offerings targeting specific market segments.

Location-based services that find people, as opposed to offering navigation information, also provide a straightforward way for people responsible for the activities of others to access information about the location of those people without entering into a conversation. A manager of a field service organization may want to know where a technician is currently located. Whereas, a mother or father may simply want to know their child reached school or home okay, i.e. Anna typically comes home from school at 3:30pm.

The research here draws from ethnographic observations gleaned by the author who used one of the services analyzed, while also using online resources to augment the participant observation. Over a three-month period, the author engaged in an ethnographic study of a location-based service in collaboration with his son who agreed to participate in the research while attending a university in Peoria, Illinois located several hundred miles away from the author's home in St. Louis, MO. The author researched in a *participant as observer* role, in the traditional way of distinguishing the degree to which an ethnographer's activity is a part of the activity researched (Gold 1958). The research encountered the typical problems faced by people using the Sprint FLS, involving both the advantages and limitations of its technical architecture. Additional ethnographic insights came from the online community of Sprint's *Family Locator Service* (FLS), drawing from messages beginning in April 2006 about the same time that the service began. The analysis below reports on the most salient issues about the routine use of the Sprint FLS discussed by subscribers, relating those uses to prospective guidelines for seamless design in ubiquitous computing derived from Dourish (2001b), Greenfield (2006), and others.

The discussion compares four location-based services that provide subscribers with the ability to find people. Specifically, the research examines Verizon's *Chaperone Service*, The Walt Disney Company's *Family Phone*, Sprint's *Family Locator Service*⁹, and *Dodgeball*. These services run

the gamut from family focused “child location” services (Chaperone and Family Phone), to services marketed across age groups inside and outside families (Family Locator Service) to social networking services (Dodgeball).

Designing for Spaces of Experience

Digital products that include ever-smaller and more powerful processors and power sources, along with ever-larger storage capacity connected wirelessly, whether using cell towers, RFID, WiFi, or GPS, are increasingly part of our work and play routines in everyday life (Greenfield 2006; Morville 2005; Armitage 2003). These digital products are present in our environment, cell phones, personal digital assistants, automobiles, clothing, tote bags, pens, etc., while connecting places with institutional practices in new ways. Agre notes that, “By allowing any social institution to structure activity in any place, wireless information services break down the traditional mapping between institutions and places” (2001, p.177). The most obvious recognition of this design challenge is in location-based, wireless services. Indeed, ubiquitous computing design aims to make location-aware devices recognize the kind of place they are in, thereby supporting “context-aware services that utilize the location of the user to adapt the service accordingly” (Armitage 2003, p. 70). The basic idea is that if you know the context, not just the physical location, then you can design in a way that minimizes, or eliminates, the need for attention to the device from people using it.

Drawing inspiration from Weiser’s point that, “a good tool is an invisible tool” (1993, p. 1), designers of ubiquitous computing devices often aim for an ideal involving a seamless, intelligent interface that, in the extreme, allows people to remain inactive and inattentive while using it. As LeMoine (2003) noted of context-awareness in cell phones, “the ideal interaction between user and phone settings is no interaction.” Also, consider the example offered by Canny (2006).

“Context-aware interfaces use everything they can. This is particularly relevant to mobile phones. When you’re using a phone, you’re either in some ‘place’ (café, restaurant, store) where you do rather specific activities, or you’re moving between places. If the phone can figure out what that place is, it can also provide services that you want there, or that complement services that place provides...When you’re between

places, the phone can use other pieces of context to figure out what services to offer, or it can wait for you to ask (2006, 28).”

Indeed, the design standards implied by a focus on goals and tasks make a seamless, transparent interface synonymous with an ideal interface. Much of what we understand as usability studies incorporates this crucial assumption about people’s use of digital devices, such as computers, specifically that the optimal interface is seamless and involves minimal interaction from people using it to complete tasks.¹⁰ Yet, as Hong, Chiu, and Shen (2005) note, “ubiquitous activities are not so task-centric while the majority of usability techniques are” (2005, 590). Thacara (2005) adds the point that, “Wireless access to the Internet increasingly renders the whole city – not just its buildings, equipment, and furniture – an interface” (p. 83). In this situation, people embody the experience of the interface in specific contexts, by engaging in connected activities with mobile communication devices, and taking advantage of their own way(s) of using the technology (Dourish 2001a).

Ubiquitous computing is disruptive to the conventional understanding of how interfaces work while, simultaneously, drawing directly from traditional concerns with functionality and usability. McCullough, for instance, contends that, “No longer just made of objects, computing now consists of situations” (2004, p. 21). The point cannot be overemphasized. These developments heighten the importance of context to designing for experience. As Coutaz, Crowley, Dobson, and Garlan (2005) note:

“In the conventional GUI genre, designers have typically developed prepackaged solutions for a predetermined interaction space. In ubiquitous computing, the interaction space is ill-defined, unpredictable and emerges opportunistically” (2005, p. 50).

Dourish (2001a) asserts that designers of ubiquitous computing services typically choose one of two basic ways for approaching context. Specifically, experience design for ubiquitous computing runs a gamut between two quite distinct conceptions of context, as either a challenge of *representation* or *interaction*, with each framework committing the resulting analysis to specific assumptions about how to deal with context in the design of digital products (Dourish 2001a). In particular, each considers the *ambiguous* nature of context in fundamentally different ways. By

ambiguous we refer to the fact that multiple interpretations apply to each context as people use mobile communication devices (Gaver, Beaver, and Benford 2003).

Experience design that focuses on representation views the ambiguous nature of context as an obstacle to overcome in providing a seamless interface to ubiquitous computing services. On the other hand, experience design focusing on interaction views the ambiguous nature of context as a resource for people using mobile communication devices to engage with others, focusing on the seams of the interface and making them manageable rather than overwhelming (Gavor, Beaver, and Benford 2003; Dey and Mankoff 2005).¹¹

Dourish (2004) and Greenfield (2006) each offer insights on the challenges involved in “seamful” design. Designs for ubiquitous computing typically construe seams as technical in nature, i.e. parts of the technical architecture that cause the service to fail. In other words, instances in which the technical artifact, say a cell phone, loses its signal also shift the attention of the person using it from continuing with their activity and forces their attention to the signal strength and whether they can regain it by changing location (Chalmers and Galani 2004, p. 245). A seamful design might provide the person using the phone with the ability to know when signal differences exist between adjacent wireless cells, rather than making the information inaccessible and “handled automatically at a level beneath presentation of the interface” (Greenfield 2006, p. 138).

Yet, the infrastructure of context in ubiquitous computing also consists of the routine ways in which people encounter spaces of experience. The seams between components of physical infrastructure are not the only basis for spaces of experience. They also relate to the way designers embed those infrastructures into existing cultural practices. Designing a space for experience involves more than defining a set of rules governing activities by people who occupy particular positions in three-dimensional space, say a longitude and latitude, and automatically adjusting the feature sets or capabilities of a mobile communications device to accord with the place. In other words, developing mobile communication devices with different modes that allow

users to prioritize different settings depending on the context, i.e. work, entertainment, personal, social, static, mobile, is certainly feasible, as long as the device's location sensing is precise enough (seldom the case) and people are willing to go through the process of managing the settings (Schybergson and Beeston 2006). However, automatically triggering the mode based on the person's physical location is not likely to work smoothly when people mix modes, which people do because the technology affords it. People bring work home and bring home to work. They even take work to the playground while their children play. On good days, they sometimes bring play to work.

Designing for a space of experience involves providing opportunities for engagement that permit people to make sense of their current place. "Place derives from a tension between connectedness and distinction, rather than from a three-dimensional structure" (Harrison and Dourish 1996, p.67). In other words, a sense of place results from the practical actions of people in spaces, resulting in the transformation of those same spaces. "Space is the opportunity, and place is the understood reality" (Harrison and Dourish 1996, p. 70).

Putting Embodied Interaction and Context in Place

Experience design practices aiming to predict how and when people need to use technologies attempt to represent context as an information structure, and aim to manipulate that structure so that it automatically adjusts to the actions of individuals. Those applying the representation approach treat context as if it is equivalent to "a set of features of the environment surrounding generic activities, and that these features can be encoded and made available to a software system alongside an encoding of the activity itself" (Dourish 2002, pp. 3-4).¹² Using the *context as representation* approach, designs intended for situations where "the task is well specified and the approach relatively well understood" (Norman 2002, p. 41) attempt to make decisions about how to adjust a device's functions in a specific situation (Byun and Cheverst 2004). Yet, as Rehman, Stajano and Coulouris note, "because the computer is invisible, the user lacks an appropriate cognitive model for it" (2002 p. 213). Therefore, in implementations of ubiquitous

computing designed with intelligent user interfaces, designers assume that learning how people use a technology makes it feasible to embed context-dependent decision capability into devices, making generalized mental models available to people using it increasingly less necessary.

Paradoxically, much of the effort to build intelligent, seamless interfaces to ubiquitous computing devices/services stands the concept of interactivity on its head. In this approach, the goal is to minimize the active engagement of the people using mobile communication devices supporting practices of relaxation, play, and work in everyday life.¹³ Interestingly, Weiser (1993) did not think his concept of a seamless, or invisible, interface required any breakthroughs in artificial intelligence. Moreover, Grudin (2006) recently contended that human-computer interaction (HCI) and artificial intelligence developed more or less independently. However, it is indisputable that a seamless interface for context-aware devices necessitates breakthroughs in artificial intelligence, as well as precise location sensing (Meyer and Rakotonirainy 2003).¹⁴ Suchman (2007) recently characterized the effort as a utopian dream: “That is the fantasy of the perfect, invisible infrastructure: in this case, one that joins together the promise of intelligent machines with the needs of a service economy” (2007, p. 217).

Ambient intelligence is the term used to refer to the context awareness required of mobile communication devices or environments that aim to design the human out of the interaction. It includes the intelligence capability designers hope to build into ubiquitous computing devices. As Tscheligi (2005) notes, “Ambient intelligence anticipates user needs, adapts to user behavior, and dynamically optimizes user experience” (2005, p. 20). Vanhala, Mäyrä, and Koshinen (2005) refer to similar context aware capabilities as proactive computing, “an ability of the system to anticipate the needs of the user, and on the other, an ability to take control of the situation whenever the user is unable or unwilling to act appropriately” (p. 20). Consider, for example, the formulation offered by Meyer and Rakotonirainy 2003) who note that, “The seamless integration of people, devices and computation will soon become part of our daily life. Sensors, actuators, wireless

networks and ubiquitous devices powered by intelligent computation will blend into future environments in which people will live” (2003, p. 1).

Whether the focus is on how best to time interruptions by a mobile device requesting an individual's attention (Ho and Intille 2005, Wiberg and Whittker 2005), how closely an automobile allows its driver to follow another vehicle (Norman 2005b), providing a conference room that automatically provides electronic links on an electronic whiteboard to all the documents accessed by that group at its last meeting (Want and Pering 2005), or any number of other scenarios of ubiquitous computing, the challenge comes down to the same issues faced in efforts to build artificial intelligence applications. The commonsense, ordinary, unremarkable knowledge about context that guides practical action by people is achieved one situation at a time, making development of a seamless interface as elusive as the goals of knowledge engineering for expert systems in the 1980s that failed to accumulate common-sense knowledge from one domain to another (Irons 1992).¹⁵

Greenfield (2006) is on target in asserting that the computing challenges outlined above are “Al-hard.”¹⁶ He offers a quote from HP's Gene Becker that succinctly describes the challenge facing those attempting to design ambient intelligence into ubiquitous computing environments.

“The potential uses and benefits of ubicomp often seem ‘obvious’; most of us in the field have spun variations of the same futuristic scenarios, to the point where it seems like a familiar and tired genre of joke. ‘You walk into the [conference room, living room, museum gallery, hospital ward], the contextual intention system recognizes you by your [beacon, tag, badge, face, gait], and the [lights, music, temperature, privacy settings, security permissions] adjust smoothly to your preferences. Your new location is announced to the [room, building, global buddy list service, Homeland Security Department], and your [videoconference, favorite TV show, appointment calendar, breakfast order] is automatically started.’ And so on. Of course, what real people need or want in any given situation is far from obvious,” (quoted in Greenfield 2006, p. 191).

The design of ubiquitous computing devices exhibiting ambient intelligence aims to sense features of the environment and act automatically on that sense data (Tschegi, 2005; Erickson, 2002). As a result, designers develop mobile phones and other devices to sense certain

conditions in the environment, and cue the user to either change its ring setting, or take an autonomous action like failing to pass calls through to the user if they are in specific kinds of places, e.g. a movie theatre (Erickson 2002). Whether the actions taken by a context-aware device are appropriate depends largely on the ability of the designers to represent the functionality needed in a particular type of context and determine when people using a mobile communication device are in that sort of context, while learning relevant personal preferences from those using the device (Byun and Cheverst 2004).

The overarching assumption of the representation approach to context is that the rules we use in a context provide a governing framework for the way we engage the properties of it, i.e. situated actions. The approach assumes those rules are intelligible ahead of the situation, or readily learnable by the machine through observing activities in the situation. Alternatively, the embodied interaction approach notes that rules do not govern situations ahead of time, but only through the practical activity making up the context. Indeed, this was one of the central points made by Suchman's (1987) conception of *situated-action*. As Chalmers (2004) notes:

“...a system, like any formal and finite construct, necessarily involves under-specification of the situation of its use, and therefore openness to interpretation and variability of its normative effect. This allows the individual user to conform to a script-like pattern of actions, or to treat the system as flexibly interpreted, map-like resources for situation action. People accommodate the characteristic affordances of a new tool, but they may also appropriate it to suit and adapt the practices and priorities of their own contexts and communities of use” (2004, 233).

Agre (2001) adds to the point, noting one implication of ubiquitous computing is that places, i.e., work, home, theatres, libraries, etc. are no longer strongly coupled with the distinct practices that go along with those physical locales. Viewing context as a representational problem directs attention from the fact that the institutional rules that go with places are shifted by ubiquitous computing, making it even more difficult to represent the action in specific contexts.

In many ways, the effort to represent situations so that a device recognizes them based on the kind of place it is currently located, provides an attempt to re-couple the distinct practices that

went along with locations before mobile communication came along. Yet, in numerous instances, a device's response to a context is just flat out inappropriate, such as an automobile safety feature that locks the doors if the driver gets out of the vehicle, closes the door, and leaves the engine running (Erickson (2002)).¹⁷

Alternatively, viewing context as embodied interaction, as users doing things with technologies, focuses analysis on peoples' routine activities and emphasizes the relationship of context to them over time. The embodied-interaction approach implies that the institutional characteristics and the embodied nature of context-aware computing make it difficult, if not impractical, to design computing devices that act appropriately, sociably, in most everyday situations, largely because the people involved in a situation typically negotiate what is appropriate in the context through a sequential ordering of activity. In other words, ordering spaces for experience is a **cultural and practical activity**.

The embodied interaction approach treats *information*, *ambience*, and *intelligence* as cultural categories, observable as properties of sequentially ordered activity (Dourish, Brewer, and Bell, 2005). Consider the observation of Dourish (2004) that,

“...the major design opportunity concerns not use of predefined context within a ubiquitous computing system, but rather how can ubiquitous computing support the process by which context is continually manifest, defined, negotiated and shared?” (2004, 26)

Focusing on embodied interaction directs attention to the place of products and services in the routine activities of people in their everyday lives. Experience design that focuses on designing the engagement of people *into* the ubiquitous computing situation draws heavily from the idea that, since people's needs and activities are heterogeneous, they adapt technology to the context within which they put it to use (von Hippel 2005). The cell phone manufacturer does not intend for a mother to play a ring tone and hand the cell phone to her infant for use as a rattle, but situations arise in which such actions offer a practical response to a baby crying. People do unpredictable

things with new technologies, and design can approach that fact as a resource to inform new product development, or as an impediment to overcome.

Rather than attempt to design human agency out of situations, the embodied-interaction approach supports designing people into situations by understanding their activities as mutually constitutive of context. As Dourish (2004) noted,

“Embodied interaction encompasses more than simply physically-available interfaces. Embodiment is not about physical reality, but rather about availability for engagement. The embodied-interaction perspective is concerned with the way in which the meaningfulness of artefacts arises out of their use within systems of practice” (p. 28).

We follow Greenfield (2006) in characterizing as “AI-hard” any ubiquitous computing services that aim to anticipate the needs of people using them, rather than provide people with easy ways to manage the services provided within particular spaces.¹⁸ So, what does maintaining an embodied-interaction approach to context mean when designing spaces for user experience? Largely, it means designing for the *seams of the interface*. As Greenfield notes, “Visible seams...expose the places where users can ‘reach into’ a system and tune it to their preference” (2006, p. 139). ***The challenge is to inform design choices between developing the automatic features of a location-based device, on the one hand, and developing access for people to alter their interaction with devices in a straightforward way without information overload.*** The more ways digital products work together ubiquitously, the greater the need to determine what degree of control people can exercise in adapting them to their activities. As Greenfield observes, “seamlessness deprives the user of meaningful participation in the decisions that affect his or her experience” (2006, p. 138).

Seamful Design for Location- Based Services

Designers who attempt to build ambient intelligence into ubiquitous computing devices, with the goal of designing the user out of the situation, would do well to consider the point made by Norman (2005a) regarding overautomation in the design of automobiles. Specifically, using the example of automobiles, he asks, “How do we automate sensibly, controlling some parts of the

driving experience, but ensuring that drivers are kept alert and informed – ‘in the loop’” (2005, p. 45). Norman (2005a) supports the notion that experience design contributes more insight when done to fulfill the needs of an activity rather than the particular people engaged in the activity. Yet, he also points out that human attentiveness provides a fundamental property for the activity of driving, without attentiveness we cannot meaningfully speak of a “driver.”

Suchman (2007) recently pointed to the continuing difficulty faced in designing “responsive spaces,” what we call herein *spaces for experience*, in which smart devices personalize their interactions and support for people. She notes, “The focus of research and development is on new technologies of location and tracking, standards and protocols for interoperability between devices and other ramifying complexities of system engineering. But more fundamental questions – of what it could mean, in all senses of the word, to be recognized by our environments – remain” (2007, p. 222).

Many processes in everyday life require the active engagement of people in order to remain ordinary, routine “activities.” In fact, the active engagement of people is what makes them activities. Indeed, this is what Dourish refers to when he asserts, “context and activity are mutually constitutive” (2004, p. 28). As Dourish and Bell (forthcoming) observe:

“It is not simply that people behave differently in different spaces; rather, it is that being able to act different in different spaces, and to be able to recognize and respond to the differences between one setting and another, is part and parcel of what it means to be a competent member of society. The problem with technologies that erase these boundaries then is not simply that they fail, themselves, to recognize socially relevant distinctions, but that they undermine the mechanisms by which members of society can demonstrate, to each other, their sensitivity to these nuances.”¹⁹

Consider recent research on how people communicate in specific contexts about their location when using mobile communication devices. Telling another person your location occurs more often than not in mobile communication, and usually at the start of the conversation. Studies indicate that location telling takes place in a range of contexts involving distinct activities. Arminen

(2006) outlines five types of location telling, including as “an index of interactional availability, a precursor for mutual activity, part of an ongoing activity, or it may bear emergent relevance for the activity or be presented as a social fact” (2006, p. 320). Moreover, Arminen (2006) reports that 83% of mobile calls in the study involved one or the other party stating their location

Esbjornsson and Weilenmann (2004) analyzed the use of mobile phones by sales employees who spend most of their time on the road, visiting customers. They investigated “the ways in which a place is interactionally constituted as appropriate, or not, for a mobile phone conversation” (2004, p. 1), or in other words, *available for engagement*. In their study, the place is an automobile that serves as a mobile office. However, it is worth pointing out that a representation approach to designing mobile communication devices would emphasize the need to relate to the type of place it is in, to “fit in” and operate appropriately, independent of the person using the device. Consider, as an example, efforts to build capabilities into mobile phones to decide whether the user is *interruptible* and available for engagement.

Esbjornsson and Weilenmann (2004) note that the, “problem with many of these systems is that they rely on the idea that it is possible to build into the design an understanding of what is ‘an uninterruptible activity.’ Context is seen as a more or less stable entity” (2004, p. 2). Alternatively, the embodied-interaction approach to experience design offered by Esbjornsson and Weilenmann (2004) treats context as a space in which placing an activity as “interruptible” emerges from the situated order of interaction, *the experience*. No overarching rules govern situations to make their representation unambiguous regarding whether the activity is “interruptible.” Indeed, the very embodiment of the conversation provides the participants with a sense of place for their communication, independent of specific locations.

Specifically, Esbjornsson and Weilenmann (2004) analyze the way sales people talk to clients while they drive. To exemplify their point about context, they review a mobile phone call in which one caller (Eric) initiates a call to a customer (Frederic) who is busy. Yet, Frederic answers the

call anyway and asks Eric if he will be in the car long. In other words, Frederic offers to return the call without saying so explicitly. Eric, nevertheless, hears the question as an offer to call back because of what the two of them know about the question, its mutual intelligibility, and responds accordingly.

Similarly, in their field studies of how teenagers use mobile phones Berg, Taylor, and Harper (2003) describe the embodied character of the way communication happens. They note that, “Amongst the teenagers, the phones were regularly used as a way to embody particular thoughts, feelings and meaningful events...it was evident that phones enabled teenagers to meet what are termed the social obligations of exchange: to give, receive and reciprocate” (2003, p. 434). The embodied nature of conversation provides participants with resources of understanding that go beyond what people say, to what is mutually intelligible in their practical activity.

The point applies equally to hardware and software infrastructure, i.e. technical infrastructure, and socio-cultural infrastructure, i.e. routines of activity. Tolmie, Pycock, Diggins, MacLean, and Karsenty (2002) provide a useful conception of what it means to describe an activity or practice as *routine* for a family. They note, “Routines mean that people can get out the door, feed themselves, put the children to bed, and so on, without having to eternally take pause and invent sequences of action anew or open up their every facet for inspection or challenge or to constantly have to account for what they are doing with explanations or rationales” (2002, 400).

Essentially, action and structure are recursively related through the routine cultural practices comprising infrastructure, calling attention once again to the relevance of seams for interface design in ubiquitous computing applications. In families, this means that some members, i.e. parents, occupy hierarchical positions relative to other members, i.e. children. As Dourish and Bell (forthcoming) note of the term “infrastructure”, “we will take the term more broadly and literally as pointing to the structures that lie below or beneath the surface of applications and interaction.”

Indeed, Greenfield's (2006) conception of privacy, like other socio-cultural practices, as a "boundary condition" for ubiquitous computing supports the point. "Many of the boundary conditions around the development of everywhere will be socio-cultural in nature" (Greenfield 2006, p. 170). Indeed, social institutions such as families involve structured relationships between one or more equals and, if children are part of the family, one or more dependents. Research on the uses made of mobile phones indicates that families follow routine activities on a day-to-day basis.

Yet, to say that families follow routines does not mean the activities involved are inflexible. As Ling (2005) points out from studying Norwegian families, the routines are re-arranged when exigencies arise. If a child gets sick at daycare and the mother who usually picks up cannot break out of her work routine, the father often steps in to pick up the child and care for them. The mobile phone increases the family members' ability to coordinate activities around such exigencies. As Ling (2006) notes:

"The rules may be well-understood, but they can also be loose. The pattern need not be exactly the same. One day the man might make the children's lunches and then next day it is the woman who washes the dishes since he needs to help the children with a school project. But so it goes...The rules are refined and change as the situation of the family changes. However...one is struck by the fact that the routines are in place and that they form the tools with which the family tackles the demands of everyday life" (2006, p. 4).

As noted in the discussion above, socio-cultural practices are significant infrastructural resources for location-based services, especially *people finder* services. A seamless design approach allows people to manage the boundary conditions between ubiquitous computing and routine cultural practices. Indeed, Greenfield (2006) advises, "seamlessness must be an optional mode of presentation, not a mandatory or inescapable one" (2006, p.238). In *people finder* services the key question revolves around who is locating whom. Services that permit parents, or employers, to locate children, or employees, can provide a seamless interface for the activity. In doing so, the services mimic the hierarchical relation of parents to children, and employers to employees.

Indeed, as noted below, the more seamless the design of a *people finder* service, the closer the status of those participating in the service to equality, both technically and socio-culturally.

Seamful Design for People Finder Services

Greenfield (2006) offers five guidelines for experience design in ubiquitous computing applications. We apply the guidelines below to compare *people finder* services. Greenfield (2006) presents them as “ethical” guidelines. However, as our previous discussion of embodied interaction indicates, when it comes to location-based services, the guidelines offered by Greenfield (2006) involve more than merely ethical considerations. At least four of them are in fact practical guidelines for defaults for the interface to location-based services, which provide good experiences to the people using them.

1. Default to harmlessness
2. Default to self-disclosure
3. Default to conservation of face
4. Default to conservation of time
5. Default to deniability

We compare four location-based services using four of the guidelines (2 - 5) offered by Greenfield (2006). Specifically, the analysis covers Sprint's *Family Locator* service²⁰, Verizon's *Chaperone Service*, The Walt Disney Company's (Disney) *Family Phone*, and *Dodgeball*. The analysis below doesn't discuss the *default to harmlessness* guideline since we agree with Greenfield (2006) that it involves primarily ethical considerations. However, the discussion contends the other four guidelines offered by Greenfield (2006) are relevant to designing for experience when people use a location-based service to engage social networks, whether those are at home, work, or play. The closer a people finder, location-based service approximates equal participative status, the more Greenfield's (2006) guidelines apply to the defaults designed into the feature-set of the service (see Figure 1).

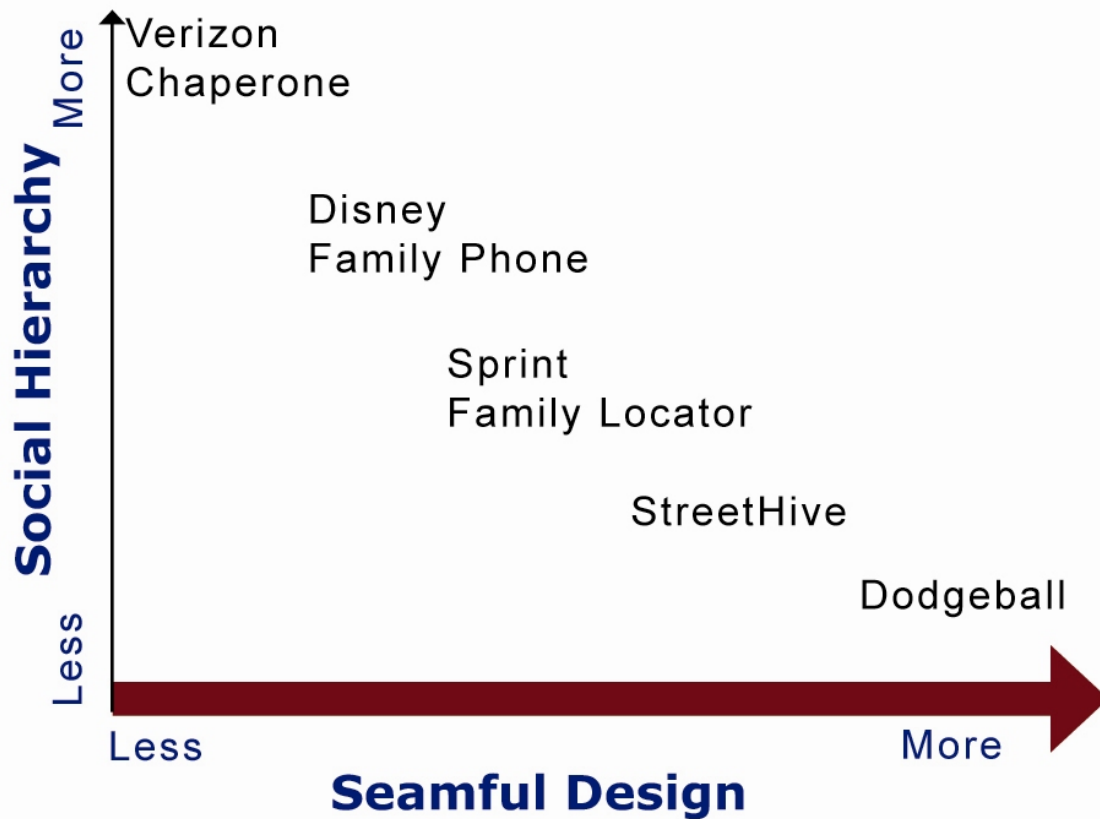


Figure 1

As Chalmers and MacColl (2003) point out, seamless interfaces work best where consistent interaction is necessary whether legal, medical, educational, organizational, or familial in nature. However, seamful interfaces work best when personalization, adaptation, or exploration are needed in the relationship. In other words, the more people using a location-based service are equal participants the more seamful the service design. Consequently, the more hierarchical social distinctions exist between participants the more seamless the service design. The insight is basic when technology incorporates cultural practices into design.

Default to self-disclosure: “Ubiquitous systems must contain provisions for immediate transparent querying of their ownership, use, and capabilities” (Greenfield 2006, p. 237). A range of research is emerging that deals with how to visually indicate the presence of RFID sensors on objects (Arnail 2006) as well as how people perceive the interaction requirements of such near field

communication technologies (Belt, Greenblatt, Häkkinen, and Mäkelä 2006). In a *people finder* service, the self-disclosure default essentially means that the person being located receives notice when it occurs.

Sprint's *Family Locator* service implements this default in two steps. It requires the person using any cell phone that it *locates* to give permission in order for the location service to begin. Before the Family Locator service begins locating a person for a Sprint subscriber, that person must agree to participate in the location service. To do so, the person enters a "safe" word that the subscriber created with Sprint and shared. Once a person gives permission to be located, they receive notification by text message each time the network *locates* them for someone else. Sprint's service allows a subscriber to locate up to five other people, including people outside the family members. However, any of those people wanting to locate the subscriber must themselves subscribe to another account.

Neither Verizon's *Chaperone* service, nor Disney's *Family Phone*, notify people when they are located by the service. Dodgeball's service, an explicitly social networking application, requires people registered to the service to tell it where they are currently located. The Dodgeball service provides a list of friends, or friends of friends, or crushes, whose current location is within a ten-block area based on their own self-disclosure, and all are notified that others are available for engagement.

Interestingly, the discussion forum for Sprint FLS offers numerous instances of subscribers who don't want their children notified when they locate them. In fact, the discussion thread with the most replies (29), and the most views (1787) asks, "Is text MSG necessary to tracked phone?" Many of the comments relate to this question, with most contending the Sprint service needs to allow the parent to decide when to notify the child that they were located. The following comment by "Rod" is typical of that position.

"I think it is stupid, to have the kid have to accept the fact that the parent is keeping a eye on them. We as parents pay the phone bill, we

should be able to track all of our phones, no matter who is carrying them that day, and they should NOT be paged to tell the child the parent is checking in on them. We should be able to block the 9010 and then the child feels all grown up and the parent feel secure when we know where they are.

SPRINT WAKE UP.. IF I PAY THE BILL I SHOULD BE ABLE TO LOCATE ALL MY PHONES WITHOUT MY 12 YEAR OLDS APPROVAL. THAT IS CRAZY!!! If you want to keep customers you better, let the account owner, watch over all their own phones.”

However, one poster, with the User ID “Parent of a troubled teen” offered a different take on the feature.

“To be completely honest, when I initially heard about this service I was interested because I am the parent of a teenager that has a few "problems" and wanted to use it to keep tabs on her without her knowing it.

I was disappointed when I found out that I couldn't use the service in this way. I didn't want my daughter to know when I was checking up on her. Now, though, after using the service, I realize it actually works better this way.

Now she knows that I can know where she is (and she knows that I can know when her phone is off, too). So, instead of going on about as she might have normally done, and possibly getting into trouble or, even worse, hurt, she avoids going to places she shouldn't with the knowledge that I will be able to know.

This actually works better than how I had originally wanted it to. So, just a message to other parents out there who might be in a similar situation: **the product works better if it's used to build a relationship of trust rather than suspicion.** I think it's better to try and build a solid relationship with your children rather than one based on snooping and spying... and this product helps.”

Yet another poster pointed to the fact that the Sprint FLS, regardless of its name and marketing, can locate friends as well as family members with compatible mobile phones.

“I think the text messages are an extra safety precaution. For example, if someone gets a hold of your parent phone, they could be able to find out where child is. So, its helpful for the contact to know that they are being located.

Also, not everone is using this for their children. Some people plan to use it for their friends, whom they may not be the legal guardian of. So, in this case it lets that person know each time; if not, it could be a serious violation of privacy.”

The middle comment by “Parent of a troubled teen” points to a key issue in differentiating the Sprint service from that of Verizon and Disney, on the one hand, and Dodgeball on the other. The Sprint service’s “feature set” positions it in the middle of location-based services designed to support hierarchical social relationships (Verizon and Disney) and location-based services designed to support horizontal relationships (Dodgeball). In other words, Sprint FLS incorporates self-disclosure because the service caters to families as well as friends. Yet, the service is hierarchical to the extent that only subscribers can locate others.

Verizon’s Chaperone service is available on mobile phones explicitly designed with children in mind. The Verizon LG Migo mobile phone is designed specifically for small children with four buttons to pre-program numbers, and a 911 button for emergencies. Disney mobile phones are designed for adults and teens, offering standard functionality with the ability to send out scripted messages to one or more members of a family as well as allow parents to manage the use of the phone by children. In the Disney Family Phone service, one or both parents can track the children on the account, but neither parent can track the other.

Default to conservation of face: *“Ubiquitous systems must not act in such a manner as would unduly embarrass or humiliate users, or expose them to ridicule or social opprobrium, in the course of normal operations”* (Greenfield 2006, 240). The guideline seems vague until you look at the design and precision of location-based services. Location-based services can help you locate friends or find places, and provide wayfinding instructions to get you from here to there (Moreville 2005). Of the four location-based services reviewed here, only Dodgeball permits a person using it to choose invisibility in response to efforts by others to locate them. Yet, short of turning their cell phone off, people who agree to use the Sprint, Disney, or Verizon services are unable to turn off their findability (Moreville 2005). Discussant “kenh” on the Sprint forums offered the following observation on the topic.

I can think of lots of reasons for the SMS notification. The main one is so that everyone knows what is going on with this service. If my kid doesn't want me to know where he is, he'll turn off his phone! I want him to know that I know where he is!

If a jealous boyfriend bought your daughter a phone for a "gift" and set it up on SFL before he gave it to her, she would never know he was stalking her until it was TOO LATE. There are too many creeps out there that would abuse this service.

Indeed, several additional members of the Sprint forums noted that their children did in fact turn off their phones periodically, or claim their batteries ran low of power. Disney's LBS does not allow one adult in the family to locate another adult, but either adult can locate the children. On the other hand, Sprint's LBS allows a subscriber to locate any friend or family member with a compatible mobile phone who agrees to it, but incorporates a safeguard so that people who the service locates know about it.

Unlike Dodgeball, the location-based services that use tracking to establish location do not incorporate ambiguity into their design to preserve face, meaning that people using the service "can only convey their precise location or – when permitted – nothing at all" (Lederer, Hong, Dey, and Landay 2004, p. 449). Incorporating ambiguity into the design features allows those located to control the granularity of information they share with the person locating them. The capability becomes increasingly important as the relationships of the people the location-based service *finds* approach equality, i.e. as friends or associates.

Most location-based services are accurate only under optimal conditions. The inaccuracy of GPS sensors deserves consideration in the user interface, especially when people are accountable for where the locator service indicates they are found (Rehman, Stajano, and Coulouris 2002, p. 19). Greenfield (2006) suggests that experience design take advantage of the imprecision in the network by making it possible for people being located to give "anyone looking for you most of the information they need about where you are, but not a pinpoint granular location that might lend itself to unwelcome inference" (2006, p. 241). As an example, when I first started using the Sprint FLS my son was on a mid-afternoon workout schedule. I set up a "Safety Check" in the Sprint FLS to locate him on the 2:00pm schedule, with his agreement that when he arrived at the gym he would send a text message to me. He changed his schedule one day to exercise in the early

evening and, when my “Safety Check” located him at 2:00pm, I received a phone call from him a few minutes later incredulously wanting to know why I located him before he indicated being at the gym. It turned out he was at a park with a girlfriend. It took reassurance from me that I really didn’t care where he was at the time, which I didn’t. As a result, I eliminated the “Safety Check” schedule and only located him when he indicated being at the gym via text message.

Location-based services can conserve *face* by incorporating a level of granular control over information precision that is unheard of in the present services. The Boise prototype design at Intel Research offers one useful way of thinking about the relationship between precision of sharing in location-based services and face saving activity. Boise offered three modes for managing findability.

1. Boise offered a “Normal” mode in which a subscriber could respond to a request for their location at a time and place of their choosing. In the prototype form, Boise was designed only to support person-to-person communication, with no buddy or friend lists.
2. Boise offered a “Tracking” mode in which a subscriber could proactively let others know their location and track their movement. Tracking mode was most useful for coordinated activity where two or more people are meeting, or where a status is needed throughout the day. In Boise, tracking turns off automatically after a predetermined amount of time, or once the sender comes into close proximity to a designated receiver.
3. Boise offered an “Away” mode in which someone attempting to locate a subscriber is provided an automatic message that the person is unavailable.

Indeed, one of the posters on the Sprint FLS community forum named Snippet suggested something similar:

I don't mind that my kids know when I'm checking on them. I believe like 'parent of a trouble teen' said - I think it has helped them make smarter choices of where they should be. They know I will check on them and their phones better be nearby (and on) so I can call if I need to.

I don't like the SMS messages though. I don't want others knowing I'm locating my kids. I don't want to disrupt their activities/school/functions. We could set the sound notifications to off, but there are times when I do need to disrupt their activities. Besides, I can imagine the 'pain and agony' of the other kids knowing I'm tracking them.

I'd like to send a silent message with a configurable message. Or a Locate is ON symbol for the tracked phone.

In other words, Snippet is saying the phone needs an “on/off” setting for the location service that the owner can use to show they are available to locate.

Still others assert that the person people are attempting to locate needs to control the granularity of information as the requests for their location occur, rather than a simple “on” or “off” mode for the phone’s locator service. A recent survey of cell phone users in the United States indicated that 22 percent reported they have lied about their location in conversations (AP-AOL-Pew 2006). Thus, Lederer, Hong, Dey, and Landa (2004) suggest using a *precision dial* for findability. Specifically, they propose a dial, or rocker switch, on the mobile communication device that lets the person receiving a request for their location determine how precisely to respond, if at all. They propose using a four point scale of < *undisclosed* < *vague* < *approximate* < *precise*. The precise location could provide the specific location address, with the approximate location providing the zip code of the address, and the vague location providing the name of the city or neighborhood. A subscriber would use a default setting for each contact, or list of contacts, with the ability to change the setting on the fly. The scale could be as few as three, but would always be more than two. In other words, access policies need to distinguish between different requestors. For example, work colleagues could be restricted to locating individuals during work hours on the one hand, while you allow your family to locate you at anytime (Li and Jonsson 2006).

The number of points on the scale is arbitrary, meaning the number could just as easily be three. However, anything less than three would revert to a binary choice that negates the granularity control. Consider the following scenario: Anna is leaving her office downtown fifteen minutes later than she told John to expect her. John uses a location-based service to check her location since they plan to meet across town in ten minutes. Rather than give John a precise location, Anna gives him an approximate location telling him she is in the downtown area heading his way. As Moreville (2005) noted of the now defunct AT&T *Find People Nearby* service,

“Participants are learning to manage the intricacies of their own privacy. How much detail should we divulge? Will we store and share our location history...? And when do we choose to be totally unfindable?” (2005, p. 85).

Yet, participants in location-based services are only able to manage their findability if service providers employ seamless design.

Default to conservation of time: “*Ubiquitous systems must not introduce undue complications into ordinary operations*” (Greenfield 2006, p. 244).²¹ All the location-based services compared here provide people with the ability to see where friends or family members are located. In that respect, they offer the benefit of saving time when the finder doesn’t want, or have the time for, a conversation but wants to inquire about the location of others participating in the service, i.e. an *okayness* check. However, to the degree that the location services are not accurate, instances in which a friend or parent locates another friend or family member provide opportunities for misunderstandings, or require reverting to making a phone call to establish their real location. Consider the answer to the following question from Verizon’s FAQ for their Chaperone service. **“How is it possible that the level of accuracy can differ (address, intersection, or city) when locating the child device multiple times, even though the location of the device has not changed?”**

“Even though the child device has not changed locations, it is possible for the location results to differ when multiple searches are performed. For example, you may get back location results that display an address, intersection, or possibly just the city. The location information presented may differ due to many factors such as atmospheric, environmental, and geographic conditions, satellite location or other factors associated with the use of satellites and satellite data, cell site location and information, or other network conditions. If you try to locate the device again, it should provide the same or a similar location to one of the earlier attempts. ***If you are unsure or concerned about your child’s specific location, you should place a voice call directly to the device to contact your child***’ ([Chaperone website](#), emphasis added).

As a result of the imprecision of the physical infrastructure, i.e. GPS and cell towers, it is unclear whether location-based services that automatically find where people are located actually save time or make the activity of generally knowing where one or more people are located a more convenient thing to do than just calling them. Those using a locator service who expect precision and receive imprecise results, are likely to misunderstand the results. By depending on the subscriber to declare their location, Dodgeball avoids these potential shortfalls.

Default to deniability: “Ubiquitous systems must offer users the ability to opt out, always and at any point” (Greenfield 2006, p. 246). Sprint’s Family Locator service does not provide the person who agrees to participate in the service the ability to opt out as people attempt to locate them. Neither do the services offered by Verizon or Disney. In other words, none of the services except Dodgeball allows the person located with the ability to manage their findability. For location-based services offered to help friends keep track of one another, a control such as the “Away” mode in the Boise prototype by Intel Research would provide an opt out capability. In an equivalent feature, Dodgeball permits individuals to remain invisible to specific people or lists of friends who are in the same vicinity.

Conclusions

The interaction approach to ubiquitous computing offers insights into seamful design for location-based services that the representation approach’s emphasis on seamlessness and invisibility misses. Hierarchical relations among those participating in a location-based service point to seams in the space of experience for those participating in the service. Design defaults for seamful design can point out granular control opportunities that provide people participating in a *people finder* service with capabilities to manage the cultural infrastructure involve in the social relationships.

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Endnotes

¹ Dourish, for example, notes that, “Probably the most significant transition, in terms of the development of the user interface models that are familiar to us today, was the transition from textual to graphical interaction,” (2002, p. 11).

² McCullough noted, “This breakthrough was quite simply the beginnings of hand-eye coordination in computer usage: for the first time, the computer placed all procedures and data in plain view and in reach of the hand. This advance proved to be exactly what was necessary to make computing acceptable to most people, and it has done more than anything else to support the proliferation of computing,” (1996, pp.116-17).

³ As Grudin recalls, “The term ‘user interface’ was not needed in the beginning, when most users were engineers and programmers; it may again become inappropriate when more applications are written for groups than for individuals,” (1990, p. 261).

⁴ Hallnas and Redstrom summarize this transition nicely saying, “When computer systems change from being tools for specific use to everyday things present in our lives, we have to change focus from design for efficient use to design for meaningful presence” (2002, p. 108).

⁵ As McCullough observes, “The idea of context has been growing all along. The graphical user interface was conceived as a context for processing symbols, for instance. Later, the information flow through an enterprise was a context in which new software has to be introduced appropriately. Next that flow moved out onto mobile devices. Those devices meet up in arbitrary locations; others are embedded into relatively permanent local configurations; and sensors and effectors are added to the built environments that house them,” (2004, p. 21).

⁶ Some observers, such as Nardi (1996), contend that there are three basic approaches to context, namely, situation action, activity theory, and distributed cognition. Our point is simply that the most basic distinction in approaches to context depends on whether the research depends on the notion that locations provide maps for acting in them that people carry around as mental representations of how to use technologies and, further, that those maps are determinative for the way people use those technologies. In that sense, activity theory and distributed cognition are simply two research programs within the same basic approach.

⁷ Norman (2005b) aptly describes the extreme instance of this approach by taking note of the problem of overautomation in automobile design. Referring to the range of automated capabilities now available to auto design Norman observes that, “Put them together, and oops, we are training drivers to be inattentive. In other words, the driver is no longer ‘in the loop’” (2005b, p. 45).

⁸ The FCC provides the following explanation of the enhanced 911 service requirement: “The wireless E911 program is divided into two parts - Phase I and Phase II. Phase I requires carriers, upon valid request by a local Public Safety Answering Point (PSAP), to report the telephone number of a wireless 911 caller and the location of the antenna that received the call. Phase II requires wireless carriers to provide far more precise location information, within 50 to 300 meters in most cases. The deployment of E911 requires the development of new technologies and upgrades to local 911 PSAPs, as well as coordination among public safety agencies, wireless carriers, technology vendors, equipment manufacturers, and local wireline carriers.” See <http://www.fcc.gov/911/enhanced/>, last accessed on October 4, 2006.

⁹ Even though Sprint calls the service a Family Locator Service, any group of subscribers with compatible cell phones can subscribe to the service. However, the service's design is best suited to coordinating group activities and providing *okayness* indicators.

¹⁰ Marek Pawlowski (2006) recently put the point in the following manner, "User interface designers often talk about metrics such as the 'number of clicks' or 'time to complete'. They are ways of measuring the effectiveness of an interface: i.e. how quickly can a user reach what they want? The goal is always to reduce these figures: less clicks and less time equals a more satisfied user. So what happens if we extrapolate the principle? Is the most effective interface one which requires no clicks and has zero latency?" Available online at <http://mobileuserexperience.com/?p=233>. Last accessed on July 29, 2006.

¹¹ Gaver, Beaver, and Benford (2003) point to seamless design noting that, ambiguity can "make a virtue out of technical limitations by providing the grounds for people's interpretations to supplement them" (p.233).

¹² As Hong, Chiu, and Shen (2005) stipulate, "Context is not only used in an application but is also shared among different applications. In order that contextual information is accessible among different applications, the context needs to be represented in a common format and properly categorized. In addition to being able to obtain context information, applications need to have some 'intelligent' component which functions as a predictor of user's intentions," (p. 591).

¹³ Pawlowski (2005) puts the point as follows: "User interface designers often talk about metrics such as the 'number of clicks' or 'time to complete'. They are ways of measuring the effectiveness of an interface: i.e. how quickly can a user reach what they want? The goal is always to reduce these figures: less clicks and less time equals a more satisfied user. So what happens if we extrapolate that principle? Is the most effective interface one which requires no clicks and has zero latency. You want to see a video clip of the World Cup final, so you simply imagine it in your head and it is transmitted over a wireless network, through a brain receiver and replayed in your mind's eye" (pp. 2-3).

¹⁴ Referring to the challenge of building context-aware homes, Meyer and Rakotonirainy note, "A very challenging topic is the development of smart applications which will likely require some sort of artificial intelligence systems to enable them to derive meaningful responses, as desired by the occupants of context-aware homes, from the context information" (2003, p. 8)

¹⁵ A Wired Magazine story from a few years ago put the challenges facing artificial intelligence (AI) into perspective in an interview with Marvin Minsky, an AI pioneer. "Unfortunately, the strategies most popular among AI researchers in the 1980s have come to a dead end. Minsky said. So-called 'expert systems,' which emulated human expertise within tightly defined subject areas like law and medicine, could match users' queries to relevant diagnoses, papers and abstracts, yet they could not learn concepts that most children know by the time they are 3 years old. 'For each different kind of problem,' said Minsky, 'the construction of expert systems had to start all over again, because they didn't accumulate common-sense knowledge" (Baard 2003).

¹⁶ As Ward and Pering (2005) note, "The shift from single devices with well-known names and easy to discern network connections to a multiplicity of semi-autonomous objects arbitrarily connected to other nearby objects, presents a significant challenge for both software engineering and the basic supporting technologies. Systems will need to be made intelligent and adaptable, automatically figuring out which devices are appropriate for any given set of interactions, and which devices 'belong' in a particular space" (p. 12).

¹⁷ Erickson (2002) notes further that, "We want the car to safely lock us inside...We want our systems to monitor the context, and then act appropriately, so we don't have to be in the control

loop. Context-awareness is ultimately about action...the ability to recognize the context and determine the appropriate action requires intelligence. Why is it a problem to lock the car doors when the car is running?...Although the answers are evident to anyone over eight years old, they are not easy to build into a system,” (p. 103).

¹⁸ As Greenfield (2006) notes: “Kowing when a loved one’s feelings have been hurt, when a baby is hungry, when confrontation may prove a better strategy than conciliation: These are things that we know in an instant, but that not even the most sensitive pattern-detection engine can determine with any consistency at all” (p. 231).

¹⁹ Suchman (2007) adds to this point by noting that, “Software agents, ‘smart’ environments, and ‘wearables’ together are figured within a discourse that makes service the imperative for a global economic infrastructure. We need to keep our eye, accordingly, on the ways in which autonomous machine agency, however subserviently constructed, might be consistent with regulatory practices aimed at foregrounding certain kinds of humans (employers, workers, consumers) and erasing others. The relations of upstairs and downstairs, front stage and back, that the service economy presupposes are constituted within a closed world that simultaneously presumes and regenerates the needs, desires, identities, and inequalities that those relations comprise” (2007, p. 224).

²⁰ Even though Sprint calls the service a Family Locator Service, any group of subscribers with compatible cell phones can subscribe to the service. However, the service’s design is best suited to coordinating group activities and providing *okayness* indicators.

²¹ Jones and Marsden (2006) provide an insightful example of when a context aware service should depend on the person using it rather than automate. They note, “One of our colleagues...was asked to create a computer vision system which could recognize the tracks of animals in a game reserve. The thinking was that the computer could process the image and infer the context from the cues such as GPS location, time of day, type of foliage nearby, shape of print, etc. – a solution known as ‘context awareness.’ Not only is this a mammoth piece of computation, but it ignores the fact that the park employs very skilled trackers who are able to read the context instantaneously. So, rather than build an application which would never be as good as a human at reading context, he did some ethnography of the situation and discovered that he could use computers to aid the trackers with recording their insights into context. The result was a GPS-enabled PDA which allowed the trackers to log their observations more accurately than before and upload these to a center park management system. By seeing context as an artifact of technology, it is unlikely this system would ever have been built” (2006, pp. 217 – 218).