Putting Systems into Place: A Qualitative Study of Design Requirements for Location-Aware Community Systems

Quentin Jones[1], Sukeshini A. Grandhi[1], Steve Whittaker[2], Keerti Chivakula[1], and Loren Terveen[3]

[1]New Jersey Institute of Technology   [3]University of Sheffield   [2]University of Minnesota

{qjones,sg49,kkc2216}@njit.edu   s.whittaker@sheffield.ac.uk   terveen@cs.umn.edu

ABSTRACT

We present a conceptual framework for location-aware community systems and results from two studies of how *socially-defined places* influence people's information sharing and communication needs.

The first study identified a relationship between people's familiarity with a place and their desire for either stable or dynamic place-related information. The second study explored the utility of various system features highlighted by our conceptual framework. It clarified the role of place information in informal social interaction; it also showed that people valued, and were willing to provide information such as ratings, comments, and event records relevant to a place.

These preliminary findings have important implications for the design of location-aware community systems. In particular, they suggest that such systems must integrate information about places with data about users' personal routines and social relationships.

Categories and Subject Descriptors

H.5.3 [**Group and Organization Interfaces**]: Computer-Supported Cooperative Work.

General Terms

Design, Experimentation, Human Factors.

Keywords

Ubiquitous/Pervasive Computing, Virtual Communities, Location Based Services, Context Aware Computing, Diary studies, Semi-Structured Interviews, P3-Systems.

THE WEASLEY'S CLOCK

Harry liked this clock. It was completely useless if you wanted to know the time, but otherwise very informative. It had nine golden hands, and each of them was engraved with one of the Weasley family's names. There were no numerals around the face, but descriptions of where each family member might be. "Home," "school," and "work" were there, but there was also "traveling," "lost," "hospital," "prison," and, in the position where the number twelve would be on a normal clock, "mortal peril"(Harry Potter and the Goble of Fire, P. 151) [26].

1. INTRODUCTION

People, acting individually and collectively, actively structure their environments. They create specialized types of *places* – the office, home, coffee shop, museum, school, etc. – to support a variety of activities [10] and constrain possibilities for action and communication. Several observations about how places structure activities are relevant:

- A shared physical environment promotes informal social communication [19][32]. Physical proximity increases the likelihood of impromptu social conversations; many organizations exploit this in the design of their workplaces, e.g., by designing shared public spaces where people can "bump into each other."

- The design of a place simultaneously encourages certain activities and discourages others [2][11].

- Places act as "social" filters. That is, different types of places attract certain people, making these places feel familiar and safe for some people but not others. A place thus serves as a setting both for friends to meet opportunistically and for like-minded strangers to have opportunities to get to know one another [30]. Milgram's [22] notion of the "familiar stranger" shows that recurring co-presence in a place has consequences even when people never meet.

- Harrison and Dourish [13] imported the notion of a place ("a space, which is *invested with understandings* of behavioral appropriateness, cultural expectations") into CSCW research. They drew analogies from work in architecture and urban planning for the design of collaborative virtual environments.

However, until recently, the ability of designers to incorporate the concept of physical places into systems was quite limited. Purely online communities could be restricted – either formally or by social convention – to form "community networks" [28][8] that deal only with information relevant to a particular locality – e.g., a university – and restrict access to people associated with that locality – e.g. students and faculty of a university.

New technological developments have changed this picture. Widespread adoption of technologies such as the Global Positioning System (GPS), 802.11, Bluetooth, and RFID enable the design of systems that link information and communication to the actual physical locations of people and places. A number of systems have explored this possibility since the Active Badge [31] was first prototyped. For example, various systems have enabled individuals and groups to associate text notes with locations [20] [7]. Use scenarios include indexing items from one's personal to-do list to physical locations – e.g., grocery items to purchase at a grocery store – and tagging places such as restaurants and museums with ratings and recommendations that can be shared by multiple users. Other systems have extended the status information to awareness, through the display of the location of

multiple users. Other systems have extended the status information to awareness, through the display of the location of "buddies" [12]. This may enable new types of informal, opportunistic communication – "oh, I see that Susan is in the lab now – I'll stop by to talk about the Jenkins project." Collectively, these systems illustrate the potential of positioning technology to enable new classes of collaborative location-aware systems.

However, the system building efforts in location-based community information systems have lacked a firm foundation – there is little empirical knowledge of user requirements, a general conceptual framework does not exist, and the efficacy of systems design has not been empirically established. Thus, each system is a singular exploration of a point in a design space whose overall characteristics remain unknown. Our research program aims to remedy this problem.

The remainder of this paper reports on our first efforts. We begin by presenting a conceptual framework for analyzing the design space of location-based community information systems. By analyzing a broad range of prior work, we have developed the **P**eople-to-**P**eople-to-Geographical-**P**lace – or *P3-Systems* – framework. We next describe two diary studies that investigated:

1. What types of information do people want about a place? Do people want different types of information for places they visit routinely as compared to those they only visit occasionally?

2. How do place-types influence people's desire for place-related awareness of and communication with others? What information are people willing to provide about themselves to enable place-related communication and awareness?

Finally, we conclude by discussing the limitations and implications of our findings for the design of P3-Systems.

2. THE P3-SYSTEMS CONCEPTUAL FRAMEWORK

The P3-Systems conceptual framework [15] organizes the design space of location-aware 'community' systems into a 2 x 2 matrix. The rows characterize the user interface, which we divide into **People-Centered** and **Place-Centered** techniques[1]. People-Centered techniques use location information to support interpersonal awareness, enable informal communication, and identify previously unknown affinities between users. Place-Centered techniques link virtual spaces to physical locations, using social information to aid place-based navigation and decision making. The columns characterize the synchronicity of the design space by use of the traditional CSCW distinction between **synchronous** and **asynchronous** systems. We extend this distinction, however, beyond communication to include user-location information. Thus, we also refer to synchronous and asynchronous "location awareness". This distinguishes techniques that provide information about *current* user location or activity within a place from those that provide *historical* information.

People-Centered systems are further subcategorized into those that represent absolute user location and those that operate in terms of user proximity or co-location. The distinction here is between systems that can tell you where all your buddies are vs. those that can only tell you which buddies are close to you now. Place-

Centered systems are further subcategorized by the representation type. Some Place-Centered systems represent current or past user activity relative to a location, e.g., showing something about who is on a university campus now. Others associate virtual spaces with a physical location. Both *GeoNotes* [9] / *digital graffiti* [7] systems and most traditional community network systems fall into this category.

The P3-Systems framework is expressive enough to describe relevant previous work. Space does not permit a full discussion of relevant commercial systems and research prototypes; instead we briefly discuss a few key systems to illustrate the framework. Want and Hopper's Active Badges [31]uses infrared signals to track wearers within a building. The software supports several uses, including finding the current location of a named user and looking up the badges currently at a specified location. This illustrates the point that many implemented systems include features that span multiple parts of the design space (Active Badge's FIND is People-Centered/absolute location/synchronous, while LOOK is Place-Centered/user activity/synchronous). Ulocate supports tracking the current location or location history for a specified cell-phone user (http://www.Ulocate.com/).

Meme Tags [5] let users share "memes" – short ideas or opinions – when they are close to one another, thus facilitating social interaction. *LoveGety* [24] uses a similar notion; simple profile information is swapped to match co-located people with similar interests. Building on these ideas, Social Net [29] infers affinity of people from patterns of co-location that recur over time.

Several systems provide representations of user activities relevant to a particular location; these include ActiveMap [21]*,* and ActiveCampus [12]. ActiveCampus overlays an interactive map of a campus with avatars that represent the current location of a user's buddies and enables synchronous communication between users. Wiberg's proposed FolkMusic system [34] will use GPS receivers to record locations where users play audio files. This will result in labeling a physical space with the musical preferences of people who use that space.

Finally, several systems link virtual spaces to physical locations. Some systems let users associate "digital notes" with specific locations; these notes can then be accessed by certain users when they are at or near a location. These often are used for rating, e.g., of restaurants. Examples include E-Graffiti [7], GeoNotes [9], and the 'graffiti' function of the ActiveCampus Explorer [12].

Table 1 summarizes the P3-Systems framework. For each system feature category, it provides a brief definition, a question that illustrates the feature, and one or more representative systems.

The framework raises some pressing empirical questions. For example, while it illustrates services provided by each category (e.g. remote awareness of current user location), we have little evidence if these services meet real user needs. Further, since systems built to date largely have not used a notion of *place*, the framework leaves open the role of place in location-aware systems; for example, are certain design features more valuable in certain place-types? Would comments and recommendations be of more use in certain types of places than others? We carried out two studies to explore these issues. The first study examines the relationship between place and information needs. The second study looks at the relationship between place-types and informal social communication, specifically the information that users desire about others' locations and would be willing to provide about themselves.

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[1] A single system may implement different types of techniques; however, for ease of exposition we refer to systems, rather than techniques when the context makes the meaning clear.

Table 1. The P3-Systems Framework: Definitions, Utility, and Previous Work

P3-System Design Approaches		Synchronous Communication or Synchronous Location Awareness		Asynchronous Communication or Asynchronous Location Awareness	
People-Centered	Absolute User Location	Provides remote awareness of current user location	*Where are my buddies now?*	Provides people's location histories	*Where have my buddies been?*
		Active Badge – FIND Ulocate – current location		Ulocate – location history	
	Co-location / Proximity	Provides real-time inter-user co-location for the exchange of social information	*Who's close to me now? Is there anybody like me here?*	Provides co-location history to enable future interactions	*Who uses physical space/ has routines like me?*
		Meme Tags, LoveGety		Social Net	
Place-Centered	Use of Physical Spaces by People	Provides online representation of user's current use of physical spaces.	*Who is in this place now?*	Provides history of people's use of a particular space	*How much do people use this place?*
		Active Badge – LOOK ActiveMap, ActiveCampus Maps		FolkMusic (Location-based music history)	
	Interactions in Matching Virtual Places	Provides synchronous online interactions spaces related to physical location	*Who can I talk to in this place?* *What are people here now thinking?*	Provides asynchronous online interactions related to physical location	*What did people have to say about things that happen here?*
		ActiveCampus Map messaging		GeoNotes, E-Graffiti, ActiveCampus Graffiti	

3. STUDY 1 - EXPLORING THE RELATIONSHIP BETWEEN PLACE-TYPES AND PLACE-INFORMATION

Our first study built on ideas from the environmental psychology literature and took them in the direction of system design. Specifically, we wanted to probe the extent to which certain types of 'places' foster specific activities and to what extent this leads to consistent place-related information needs. For example, do people consistently need up-to-date information about train arrival times at train stations? Are there many examples like this, or only a few? Answers to these sorts of questions are useful for the design of location-aware systems. We also used them to inform the design of our second study, which focused on 'community' issues arising directly from the P3-Framework.

3.1 Method

We wanted to explore people's actual personal experiences of place, everyday activities, and associated information needs. Since we were attempting to probe the mundane details of people's everyday place-type activities, we had informants keep a *diary* and then further probed and elaborated the descriptions they generated through semi-structured interviews. This method has been used successfully to study many activities, ranging from "eureka" incidents of copier use [25] to the process of reading documents [1] to methods for capturing information [6].

We instructed study informants to record where they were (which we utilized to infer 'place') and the activity they were engaged in

for 30 minute intervals. In this study (and in the second study present in this paper), informants kept a diary for a single day. This allowed us to collect data on a large number of 'place-types' and associated information needs[2]. Table 2 shows an excerpt from the diary kept by one of the informants.

Time	Where were you?	Main Activities
11.30 am	*Work*	*Meeting with project manager*
12.00 pm	*Gym*	*Work out*
12.30 pm	*Cafeteria*	*Picked up lunch to go*

Table 2: Excerpt of the form used to log informant activities

The interviews were organized around a set of questions for each unique place visited. Questions included:
- What is this place?
- How often are you there?
- Why did you go there?
- Are there other places where you do this activity? Could you have done this activity somewhere else?
- Is there any information that would have made this activity easier to do?

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[2] The studies reported here are limited in several ways, including covering only a single day. We discuss these limitations, the potential consequences, and our plans for future work to overcome these limitations at the end of the paper.

Note that these questions probed the conceptual structure (such as activities and resources) that constitutes meaningful *places*, thus moving beyond the physical notion of a location.

Ten people participated in this study; interviews averaged 50 minutes ranging from 30 to 90 minutes. The informants included three University professors, three students, and four professionals and salespeople. All the informants visited a variety of places on the day they kept their diary, including their office, train and ferry stations, car service centers, the opera, dormitories, customer sites, and retail stores.

3.2 Results

As we expected on the basis of environmental psychology literature discussed above, people identified distinct place-types (distinguished by activities in the place and their relationship to the place) and place-related information. Additionally, the study deepened our understanding of place-related information needs by identifying several important considerations:

- While informants did identify information needs based on place-types, place was not the sole factor; rather, needs were primarily based on the *activity* being done in a place.
- A key factor in determining whether and what type of information people needed was how *frequently* they performed a particular activity in a place.
- Whether information was relatively *stable* or *dynamic* also influenced people's needs. Stable information includes things like train schedules and restaurant menus; dynamic information includes things such as whether a particular train is running late and the waiting time to be seated at a restaurant.
- There were interactions between these factors: for example, if people engaged in a particular activity in a place frequently, they had little need in obtaining stable information, but judged dynamic information to be useful.

Activity in place is done:	*Stable Information*	*Dynamic Information*
Frequently	**Need: Low** Commuter: What is the train schedule?	**Need: Moderate/High** Commuter: Is the 10.17 train on time today?
Infrequently	**Need: Moderate/High** Anyone: How do I get to a restaurant (that I have never been to before)?	**Need: High** Anyone: What movies are playing this afternoon (at a theater I don't go to often)?

Table 3. Relationship between Places, Activities, and Information Stability

Table 3 provides a framework for these findings. It shows the interaction between the frequency of doing an activity in a place and information type. It shows the need for information in each situation and provides examples.

Stable Information / Frequent Activity

When people do a particular activity in a place frequently, they tend to know the stable information relevant to that activity in place. A classic example is the commuter who knows that rush hour trains leave every 10 minutes starting at 5:37 a.m. The train schedule changes infrequently, so once you've learned it, you

don't need to consult it again (or at least not often). This point was made by several of our informants[3].

Connie regularly takes the subway to work, and thus knows the train schedule for the times she typically commutes

Interviewer: you used the subway; did you need the timetable?
Connie: no, it is regular; I just go there and take the next one that comes.

Connie also goes to a yoga class at a health club. She knows the class schedule, so doesn't need to be reminded of it every time she goes to her class.

Interviewer: Do you regularly go to this yoga place?
Connie: yes, every Monday at 6 and Thursday at 7.30....I know there is class at that hour and I know it because I have a schedule on paper that's on my refrigerator.

Stable Information / Infrequent Activity

In contrast to the previous situation, when one does not do a particular activity in a place frequently, even stable information is useful. An obvious example is the tourist who constantly is stopping to look at a map. The streets don't change – but this person hasn't been there (often) before. Informants in our study gave examples of this in their everyday routines.

Anupra takes the train to work only when her car is being serviced or needs repairs. So, unlike Connie, who knows the train schedule due to her commuting routine, Anupra does find schedule information useful.

Interviewer: How often do you catch the train from Summit?
Anupra: 10 times a year.
Interviewer: Is there any information you would have liked to have known [before you went to the station]?
Anupra: I would have liked train schedule information ... I didn't know when the train out of Summit was…

Dynamic Information / Frequent Activities

When information relevant to an activity and place changes often, people need regular updates even if they do the activity frequently. A classic example is: is my train on-time? Our informants gave various examples of this.

Anupra attends musical performances and wanted current information for each performance.

Anupra: All of us wanted more information about the opera (like conductor information) that we could not remember.

Dynamic Information / Infrequent Activities

As we mentioned earlier, Connie regularly takes the subway to work. However, she does not use the subway after business hours very often. Therefore, when she did, she found herself wanting information about both the schedule and the dynamic status of the train she was waiting for.

Connie: I then left to the subway; there I had to wait a long time for the train; I wished I had known why it was late.
Interviewer: Earlier in the evening you said you didn't want any information for the subway but now you do.
Connie: yes, that was regular hours. Also, this was not a train I take often. The earlier one was one I take often.

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[3] Names of the informants have been changed to maintain privacy.

In summary, the basic result of this study was that while there is a general match between the kind of information needed and place-type (e.g. menu at restaurant), it is impossible to state the need for information relative to place-types alone (e.g. individual knows what is on the menu and just wants to place an order). Rather, information needs relative to a place depend on the activity individuals are doing there (sitting at a café / managing a café), how frequently they do those activities, and the nature of the information in question. We expect such relationships will also apply to the social information needs associated with P3-Systems.

4. STUDY 2 - EXPLORING THE RELATION BETWEEN PLACES, INTERACTION, AND INFORMATION

Our second study elaborated the results of study 1 and explored the utility of potential P3-System features. As noted previously, the framework raises issues about the value of various potential services to users, such as "who is in a place now", "who can I talk to there", and "what do others have to say about this place"?

We examine these issues by addressing two main, complementary questions, each of which has two more specific sub-questions:

1. What are people's specific needs for place-related communication and information awareness?
   a. Under what circumstances do people want to know about other people in a place?
   b. Under what circumstances do people want to access other's comments and ratings about a place and associated activities?
2. What data are people willing to provide – about themselves or a place and associated activities – to enable place-related communication and information awareness?
   a. Under what circumstances will people share information about their location? Will they share this information anonymously or by name? With whom will they share it?
   b. Under what circumstances will people provide comments and ratings about a place and associated activities? Anonymously or by name? For whom?

4.1 Method

As in the first study, informants logged their activities for one day, again specifying their location and main activities at 30 minute intervals (see Table 2). Twenty people participated in the study, including engineers, professionals, managers, consultants, students, salespeople, administrators, and homemakers. All the informants visited a variety of places on the day they kept their diary such as: their office; student dormitories; supermarkets; malls; restaurants; pubs; customer offices; the airport; and their children's schools. After filling out their diaries, informants were interviewed by the experimenters; interviews averaged 40 minutes and ranged from 15 to 80 minutes.

Since the questions we focused on in this study differed from the first study, the structure of the interviews also differed. Generally speaking, this study probed much more into the social structure of places. For each place listed in the informants' diaries we probed for information about other people at the place in question that the informant was interested in, and information about themselves they would be willing to share. We explored the utility of current and historical information and the temporal aspects of information utility. Tables 4 and 5 detail the question structure for each place listed.

Main questions:

A. **Would you like to know who was currently in or near this place?**
B. **Would you have liked to know who has been to this place?**
C. **Would you have liked to view comments that other people have left about this place?**

For each of the main questions, we asked sub-questions to get informants to detail **who** they wanted to be aware of and **when** they wanted this information:

i. *When:* Before you got to the place and while you are in the place:
   a. *Who*: friends, family, colleagues, people with common interests, anybody.
   b. *Aggregate/Demographics*: Number of people, ages, genders, etc.

Table 4: Interview Structure Probing Information Needs

Main questions:

D. **Would you have liked others to know that you were currently at this place?**
E. **Would you have liked others to know that you were at this place?**
F. **Would you have liked to leave comments at this place for others to read?**

For the first two questions, we asked sub-questions to learn which other people – in the current place or elsewhere – that study informants were willing to share information with, and whether they would identify themselves or wished to remain anonymous:

i *People in the place / People not in the place: (*Friends, family, colleagues, people with common interests, those present near you, anybody).

For the third question, in addition to these sub-questions, we also asked what type of comments informants would leave and how long they wanted the comments to last.

Table 5: Interview Structure Probing Willingness to Share/Provide Information

4.2 Results

The semi-structured interviews were recorded and transcribed. We then analyzed the transcripts and identified responses to the broad questions outline in the introduction to section 4. Analysis of the data showed only a weak relationship between place-types and social-information needs. With an individual's relationship to a place (e.g. regular visitor, owner, tourist) playing a stronger role. Individuals associate places with typical activities and people they are likely to meet there (i.e., who play various roles in the activities). It is these place-activity-people aggregates that influence information needs and people's willingness to share information.

Consider an example. A restaurant is a common place-type. Most of us think of restaurants from the point of view of a diner. Consider, however, the contrast between an intimate dinner with a romantic partner and a loud after-hours get-together with 10 or 20 work friends. Alternatively, we could take the perspective of a restaurant owner, a cook or waiter. With this in mind, it's clear that we can't say that a particular piece of information (eg. the menu, daily special, wait time, customer comments, who else is or has been at the restaurant) is relevant just because one is at (or is going to) a restaurant. Assessing relevance requires knowing the

user's activity: what they are doing there and who they're doing it with.

Note that we're not arguing against operationalizing the notion of 'place' and utilizing it as a key component of location aware community system computing. Rather, as we elaborate below, it should be used in conjunction with knowledge of:

- Personal properties of the people, including general attitudes and interests, current activities and disposition.
- Properties of the place, e.g., roles and social norms concerning expected behaviors.
- The relationship between the people, including whether they already know each other, whether they have mutual acquaintances, whether they belong to the same organization, etc.
- The relationship between the people and the place, including things such as whether they have a distinct role (a student vs. a teacher in a classroom, a customer vs. a waiter in a restaurant) and their familiarity with the place.

4.2.1 Under what circumstances do people want to know about other people in a place?

Study informants described six situations in which they would like to know who is in or near a place they are in or intending to visit: 1) to support ad-hoc interactions with friends, family, and colleagues; 2) to support ad-hoc interactions with strangers; 3) to determine if a place is busy and the resources it provides are in use; 4) for better task coordination; 5) to avoid people; and 6) for management purposes. We describe these situations in more detail and explain how they relate to place-types and people's routines and social relationships.

1) To support ad-hoc interaction with friends, family, and colleagues. Nearly every informant was interested in using location information to support informal communication with their friends and acquaintances. They identified a number of public places – such as campuses, airports, train stations, restaurants, and dormitories – where knowing that their "buddies" (friends, family) were in the vicinity would have been useful. The quotes from Ingrid, Sam, and Sue are representative.

- Ingrid – discussing her visit to the supermarket:
  Interviewer: So in that instance would you have been interested in knowing if anybody you knew was around?
  Ingrid: Yes. I don't know if I would have done anything to meet them but I would have been interested.
- Sam – discussing his time at the airport
  Interviewer: So would you have liked to see if any other friends were at the Airport while you were waiting to pick up-?
  Sam: I think that would be one interesting option because airports usually get delays and get cancellations so you would want to know if there's someone you know so you can waste time with them.
- Sue – talking about catching a ferry
  Sue: The ferry people are friends of mine, my sailing club is right there, I would like to know who the dock master is so that I can say hello on my way.

However people are not always receptive to ad hoc interactions, e.g., if they are rushed or feeling antisocial.

- Ted – discussing catching the train at 6am.
  Interviewer: Would you have been interested to know who was currently around at the train station? Like maybe if anyone you knew was there, your friends, or your family was there?
  Ted: Absolutely not. No, not at all, in fact I probably would avoid them. I mean at that time of day I am in a total fog.
- Contrast to Ted – now talking about getting the train at 6pm
  Interviewer: Then you went to the train station again. Any difference this time? Would you want to know who is around? Lets say before you got to the train station. What if your friend was there for example?
  Ted: Yeah, at this time of the day, yeah that would be useful.
- Ingrid – talking about taking children to school in the morning
  Interviewer: Would you have been interested to know who was currently around?
  Ingrid: Not really, because all I'm doing is dropping them off and run. I'm not interested in talking at that time in the morning because it's a bit rushed.

These comments refer to people's receptiveness to ad hoc interactions in public places. In private places, people typically are not interested in ad-hoc informal communication. It is important to note, too, however, that even in public places, people are unreceptive if they are engaged in an activity that they view as being private, e.g. having a romantic dinner at a restaurant.

2) To support ad-hoc interactions with strangers. Informants also expressed an interest in striking up conversations with strangers in public places. The places where individuals expressed an interest in this included airports, train stations, pubs, and a diner. All these places either were designed for socializing or are places where people have long waiting periods with large numbers of other people whom they don't know.

- *Interviewer: Well while you were waiting in the airport would you have liked to know if any of your colleagues or friends were around?*
  Edward: No, but it would have been nice to know if there was a person that had visited or had flown into the destination airport. It's always nice to find someone who has been there. Sometimes you can't with a formal approach.

Again, the desire for such information appears to relate to people's plans and the expected behaviors for a place; social matching appears to be useful primarily in situations when people are hoping to make new acquaintances or need to pass the time.

3) To determine if a public resource is being used. Informants also wanted to know whether a public place was currently crowded or a resource such as a meeting room was available. They wanted this information to decide whether or when they should go to the place. The places for which informants wanted this sort of information were train stations, pubs, restaurants, corporate meeting rooms, auditoriums, and shared work rooms.

- *Tom: Yeah it would be nice to know if it was crowded on the platform.*
- *Paul: Yeah, it would be good to know if the place was packed or how the bar is. If it were too packed we'd go to some other place. A little bit more quiet.*

4) For better task coordination. Informants also noted problems in coordinating meetings or ad hoc collaborative work activities. Being able to track specific 'buddies' on collaborative projects was thought to be very useful. This extended to tracking the location of individuals who were late to an agreed meeting.

- *Paul: Sometimes if I'm looking for the manager I will either call his cell phone but it would be easier if I knew exactly where he was. If I looked at my PDA and I saw that my manager was there it would be easier for me.*
- *Joe: Well it would be nice to know if Mike …. was there so we didn't go to the building in vain. We would like to know that our trip was worth while. Since we were going to the building to find him anyway that information would have been extremely helpful and useful.*

5) To avoid people. We were surprised that five informants expressed a desire to know who was in a place *in order to avoid specific coworkers.* In each situation they had to navigate a place but hoped to do it at a time that would enable them to avoid bumping into individuals they did not like.

- *Interviewer: So you [mean] want to know if he (boss) is around in the building so that he might just pop up to see if you are there?*
- *Christi: Correct, and we try to use IM to do that too. The people that work downstairs … They will warn you he is coming up to see you. Or my boss will do the opposite, he will call people upstairs to say "have you seen this person yet this morning" "have you seen this person yet this morning" until we finally say "we are not your secretary" and then …*

6) For management purposes. Individuals with responsibilities associated with a place such as a home, or an office or research lab, expressed a desire for information about people in the place in question. This ranged from checking on loved ones, to workplace monitoring:

- *Christi: [I'd like to know] where my husband is, because if he's home then the dog is out if not then the dog is caged. That would be good. Or if the dog got out of the cage that would not be good; she would be eating the house – it's a puppy.*
- *Victor: Yeah, my boss would love that [information about his direct reports]. He does it in the parking lot because he knows which car everyone drives. Every morning he scans the parking lot to see who is in or not. But, yea, I would like to know who is there.*

These observations illustrate people's desire for synchronous location based communication and awareness features (the first column in Table 1). Such features are used primarily to improve management of existing social relationships and the use of place-based resources.

4.2.2   Under what circumstances do people want to access others' comments and ratings about a place and associated activities?

Nearly all informants expressed a desire to read place-related perceptions. These related to: 1) choosing which place to visit (e.g. restaurant, shopping mall); 2) making an informed choice in a particular place (e.g. menu item); 3) gathering information prior to a visit to a particular place (client's office); 4) enhancing social interactions in a social place (office coffee area, student dormitories, university cafeteria, dinning area); 5) helping manage place-based resources (e.g. "what did clientele say here yesterday?"); and 6) reading place-based notifications (e.g. "we will be using this room at 6pm").

Comments by Robert and Mary were typical.
- Mary – describing shopping at a mall:
Mary: I would like to know what kind of things are on sale. We usually get the brochures sent home, but I would have liked to have had access to that information once I got there. So, I want to know what things that were on sale are still there, so I don't have to go to the store and search for them.
Interviewer: So you are looking for comments on specific things you want to shop for?
Mary: Yes, and any general comments about the stores.
Interviewer: Is it ok if anybody posts these comments?
Mary: Anybody.
- Robert – referring to eating at a restaurant:
Interviewer: Would you be interested in comments that people left in the eatery place you went to? What type of comments would they be?
Robert: Quality of food, um, what experiences they had, restaurant review things.

To summarize, nearly all informants expressed a desire for the types of features provided by place-centered P3-Systems that provide a virtual space linked to a physical place.

4.2.3   Under what circumstances will people share information about their location? Anonymously or by name? With whom?

Informants made it quite clear that they were wary of being "tracked", i.e., their location at any time being (potentially) available to anyone. Nevertheless, they were willing to let their location data be used in certain constrained ways. One key factor that seemed to make this acceptable was by basing location information sharing around particular places, instead of being universal.

Informants' willingness to share depended on how public a place was. In most public places (malls, cafeterias, etc.), they were willing to provide anonymous location data, e.g., to enable others to see how busy a place (like a restaurant) was. A few people were also willing to provide identifiable location data when they were in public places doing public things like shopping or dining. In private places (like their homes) informants were only willing to provide personal location data to select individuals (family or friends).

All our informants were willing to provide identifiable location data to enable either: 1) *ad hoc* social interactions; or 2) improved task coordination, provided that such information was filtered. The filtering criteria were: (a) if the people had some strong connection to the place (i.e. only people on or associated with the university campus, in the pub, or in the business establishment in question); (b) the major social category to which an individual belonged - friends, family or coworkers; and (c) individualized relationships such as my ex-girlfriend should not know that I am here.

- Neil – a university student working late into the night:
Neil: Well sometimes you don't want all your friends to know where you are. Sometimes you don't want all your family to know where you are. Right? I don't want my family to know because they would get mad because I was up really early. I didn't sleep all night, I was actually there at the kilt café earlier than 6 am, … If my friends want to know where I was it doesn't really matter because I can tell them that. As far as colleagues are concerned one of my colleagues knew I was there.
- Ted – a college lecturer discussing his office:
Interviewer: And would you like others around your working environment [to know] …
Ted: Yeah, like if my student had an emergency, and had to speak to me, I would want them to know I was in my office.
Interviewer: So just students, colleagues?

Ted: Yeah, students, colleagues, that sort of thing. I mean it's important for my students to know where I am if they need me.
Interviewer: What about that you have been there, that information?
Ted: Yeah, that could be useful, so they could say where is he, and then well he was here but he isn't here right now. Or he wasn't here so he is either in route to the classroom or I don't know where he went.

To summarize these observations, people were uncomfortable with the "open" people-centered P3-Systems. By "open", we mean that any user can determine another user's location or identify other users co-located at anytime. Individuals saw this as "tracking", and said that was not acceptable. However, it was acceptable for their friends to know when they were in a specific type of place (e.g., a restaurant) engaged in a specific activity (eating with friends or alone). In other words, people were fairly comfortable with place-centered location awareness, but less so with person-centered location awareness. People seemed willing to accept person-centered awareness if appropriate filters were used.

4.2.4 *Under what circumstances will people provide comments and ratings about a place and associated activities? Anonymously or by name? For whom?*

Leaving comments about a place seemed to raise fewer privacy concerns, but informants still wanted to have significant control over distribution of the content they generate.

- *Interviewer: And would you be interested in leaving comments that identify you?*
  Natalie: Definitely, I'd be leaving my address and everything - where I'm coming from; if I have a comment it's a very serious comment or a suggestion and I want that to be acted upon. If anyone wanted to get back to me on that one, you know, I would be more than happy to give them information on what the situation was and how I want them to help or even a customer for that matter. I would leave my contact information.
  Interviewer: Who would you be willing to allow anyone to view these comments?
  Natalie: Probably customers, customers of the bank... I would leave just enough information, just the comment, I wouldn't leave any mail address or any phone number or any such thing. An email address is not [the same].. if I don't want to respond I have to block them not to respond, but if I feel it will help the individual then I would respond.

Indeed, several informants only wanted to leave comments on the condition that their anonymity would be preserved, e.g. leaving an anonymous message in a shared dormitory about keeping the place clean. And when informants did feel that they were prepared to go on record, they only wanted their comments to be readable by their buddies or by people with a strong association with the place, or people with rights to know.

- *Mark: ... for friends and colleagues, I wouldn't mind if they knew I was there as long as I could leave a comment saying do not disturb. But for anyone else, I would rather be anonymous so that they know at least someone is there in case of a fire or something. As far as I am concerned, everyone else is a statistic to me.*

To summarize, people were interested in posting place-based messages, but wanted to control access rights, from being fully open to all to being readable by only a particular individual or group.

5. DISCUSSION

5.1 Limitations

Our studies have several methodological limitations. First, our informants kept diaries for a single day. Although with this approach we were able to examine a very large number of place-type and information need relationships, which was our focus, we were not able to effectively compare multiple-visits to the same the place/place-types. In future studies we intend to collect data for longer periods of at least a week. Since there are rhythms to people's activities – e.g. weekday vs. weekend – this may give us insight into a broader range of situations and attitudes.

Second, our findings are based on a relatively small number (30) of informants. Further, the informants were fairly homogenous – largely highly-educated professionals, academics, and students. Therefore, future studies that look at larger, more diverse populations are necessary to determine the generality of our findings.

Third, we recognize that even though we asked informants about attitudes in particular places, and at particular times, interview responses were made "out of context" and "after the fact." Thus, we plan future studies that use methods such as experience sampling to capture people's attitudes and needs *in situ*.

Fourth, there is a difference between what people *say* they will do (e.g., that they will be willing to share certain information) and what they actually *will do* in a particular situation. For example, Spiekermann [27] found this with respect to user willingness to provide personal data in e-commerce interactions. Scenarios or *technology probes* [14] are ways to overcome this limit.

Finally, privacy concerns may have limited informants diary entries as well as responses to semi-structured interviews regarding various "places" they have been to.

In spite of these limitations, our findings offer improved insight into our research question namely "How do place-types relate to people's information sharing and communication needs" and suggest directions for future research.

5.2 Implications for P3 Systems

The results of our studies have a number of implications for P3 systems. They both offer evidence on which features of previous system designs that users are most interested in and suggest new requirements that successful designs need to meet. We organize this discussion around two general implications.

1. Place-type in isolation does not determine information needs; user routines and social relationships (e.g., buddy lists) must be integrated.

Both our studies showed that the information people want in a place depends not just on the place, but also on their disposition and the activity they're engaged in, frequency of that activity in that place, and their relationship to others in that place. From a design point of view, this is unfortunate – it makes the knowledge acquisition task for a system much harder.

How can a system obtain knowledge of users routines and relationships? Recall that our studies showed that a key aspect of

people's activity was how frequently they did an activity in a certain place. There is relevant prior work, based on systems that log and analyze user location histories. Marmasse & Schmandt [20] showed that significant places could be identified by finding patterns in location history logs. Ashbrook & Starner [3] and Patterson et al [23] present algorithms that not only extract places but also attempt to predict transitions between places. Begole et al [4] demonstrated some success in analyzing computer usage patterns and online calendar entries to recognize people's work routines. Therefore, there is a body of work to draw on when building a system that needs knowledge of people's routines.

Regarding social relationships, there are several options. First, there is evidence that people will manually enter information when they are sufficiently motivated. The buddy lists of IM systems show this, as do social mapping systems like Friendster (www.friendster.com) and Orkut (www.orkut.com). Second, many users have built up electronic records from which social relationships can be mined automatically. These include email archives [33] and (in more limited cases) co-authorship or other professional relationships (e.g. www.spoke.com).

2. While people are willing to share their location information with others, they demand fine control over this process. In particular, they want to be able to: (a) specify particular individuals and groups who may or may not access information, (b) use basic categories – friends, families, colleagues, etc. – in their specification, and (c) filter information based on people's relationship to the place in question.

We note that several of our informants already are finding ways to use existing tools to share their location information. For example, when we asked Paul whether he would like other people to know when he's in the office, he responded:

> *Paul: I already do that… I use MSN Messenger, and what we do is we put down our locations – whether I'm at the FEI Office which is in Somerville or at the Metuchen office - which is my home, or whether I'm on site with the customers.*
> *Interviewer: so you already keep a track of who is where?*
> *Paul: yeah, but it's a pain because we have to manually change it each time we log in and you forget to change it and say you're at home when you're really in the office.*

However, as Paul's comments show, entering and updating locations manually is tedious and error-prone. Therefore, systems that infer user's places automatically are desirable. Note that this reinforces the need to use *places* – not just locations – in systems. It's not useful to see that one's buddy is at "latitude 44 ° 57', longitude: 93 ° 15". Instead, the system must be able to translate physical locations into socially meaningful place labels. The work cited above on place identification also suggests interactive methods to acquire labels from individuals and groups of users. Another approach is to make use of existing information about people's locations, e.g., calendar entries [4].

As we discussed earlier, data such as IM buddy lists can be used to learn people's social relationships. However, significant challenges remain in using social relationship data related to a particular place. One issue is reciprocity – e.g. Am I on the buddy list of everyone who appears on my list? A number of our informants did not want to be "tracked" by authority figures (such as managers or parents) but were willing to reveal there presence information in various places in a reciprocal fashion and to trusted service providers [17]. Our study also showed that people want to

use location information to avoid others – a face to face analogue of spam filtering. This too raises interesting issues such as; can users become aware that their location information is being used to minimize (rather than facilitate) casual contact? Should they become aware?

We also saw that people wanted to segment their social contacts based on the activity they were carrying out in a place: e.g., work buddies in work locations and social buddies in social and other non-work settings. There are interesting technical possibilities here: e.g. it might be possible to calendar information ("9:00 meeting with boss") and location information to provide a location/place label (e.g. "departmental meeting room" as opposed "training room") - which then can then be used to manage the presentation of awareness data such as availability to others.

Our informants also spoke of wanting to share information only with individuals who were "associated with" a place. Techniques that analyze location history data may be useful in determining person-place associations. However, various subtleties here may require user verification is required. For example - every night my office is visited by cleaning staff, they therefore have a strong association with my office, but I would not want them to have access to all my work related movements. Incorporating temporal factors into the analysis and matching of location histories may help handle such nuances.

Finally, while an association with a place was seen to be a strong factor in determining whether another person should have access to one's personal data, there was no particular desire expressed for people to be able to access that data only while in that place. This is in contrast to systems like E-Graffiti [7] and GeoNotes [9].

6. SUMMARY AND FUTURE WORK

This paper describes our efforts to strengthen the theoretical, conceptual and empirical foundations of location-aware systems. First, based on a rich body of prior work largely from the environmental psychology field, we argued for using *place* as a first-class object in location-aware systems. Second, we presented the P3-Systems framework. We showed how it structured the design space of location-aware systems and suggested a number of important empirical questions. Finally, we conducted two empirical studies that built on prior work and explored some of these questions. Our initial findings show that while places play an important role in people's information and communication needs, they do not stand alone. Rather, factors such as the activities people are engaged in, their general geo-temporal routines, and their social relationships, also play key roles.

Our ongoing efforts build upon the preliminary findings reported here in two ways. First, we are working on new studies to complement the ones we have presented here. We will conduct a longitudinal study that uses the experience sampling method and a larger, more diverse sample. This will let us learn more about larger-scale patterns in user's place-related routines and gather this data with a greater degree of reliability. We also are exploring the comparative information needs of users of various Wi-Fi hotspots. Second, we are developing a general technical infrastructure based on the lessons we report here. For example, allowing for representation and acquisition of place information and setting up interfaces that define access policies for personal

information, notes and comments, and information about places and other people in place.

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