

## Geographic ‘Place’ and ‘Community Information’ Preferences

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**Abstract.** People dynamically structure social interactions and activities at various locations in their environments in specialized types of *places* such as the office, home, coffee shop, museum and school. They also imbue various locations with personal meaning, creating group ‘hangouts’ and personally meaningful ‘places’. Mobile location-aware community systems can potentially utilize the existence of such ‘places’ to support the management of social information and interaction. However, acting effectively on this potential requires an understanding of how: (1) places and place-types relate to people’s desire for place-related awareness of and communication with others; and (2) what information people are willing to provide about themselves to enable place-related communication and awareness. We present here the findings from two qualitative studies, a survey of 509 individuals in New York, and a study of how mobility traces can be used to find people’s important places in an exploration of these questions. These studies highlight how people value and are willing to routinely provide information such as ratings, comments, event records relevant to a place, and when appropriate their location to enable services. They also suggest how place and place-type data could be used in conjunction with other information regarding people and places so that systems can be deployed that respect users’ **People-to-People-to-Places** data sharing preferences. We conclude with a discussion on how ‘place’ data can best be utilized to enable services when the systems in question are supported by a sophisticated computerized user-community social-geographical model.

**Key words:** locomotive media, place, pervasive computing, P3-Systems, social computing

### 1. Introduction

People, acting individually and collectively, actively structure their environments. They create ‘places’, locations imbued with social meaning. Sometimes ‘places’ are fairly personal, others are understood by communities in terms of ‘place-types’ – homes, coffee shop, museum, school, etc. The extent to which places and place-types act as environmental signals that inform individuals as to the range of appropriate social communication and activities is now well

recognized by environmental psychologists (Genereux et al., 1983), sociologists (Franck et al., 1994) and more recently computer scientists (Harrison and Dourish, 1996).

Despite explorations of how place shapes behavior, little work has been conducted on the extent to which 'place' can be utilized to manage the delivery of social information. This is not surprising considering the fact that until recently, our ability to identify a user's physical location was limited. This in turn, limited the likelihood of inferring correctly the 'place' within which a user was physically situated. However, this situation is changing with the availability of a range of technologies for systematically locating individuals as they go about their daily activities. A prominent example is the increasing use of the cell phone as a locating device, encouraged by commercial opportunities and legislation (such as the FCC E911 mandate requiring the deployment of location-based services infrastructure). As we will discuss, with a small amount of additional user input, it is possible to derive 'places' from location data. One key implication of these changes in the technological environment and software mechanisms for the identification of places, is that it is becoming increasingly important that we understand the extent to which we can utilize 'place data' to increase the usability of location-based community systems. This requires a deeper understanding of the relationship between place, place-type and social information needs and sharing preferences.

This paper reports on our initial efforts to address this gap in the literature. We begin by presenting a diary study that investigates the types of information that people want about a place they frequent. Do people want different types of information for places they visit routinely from those they only occasionally visit? Following on from our first study, we briefly describe our **People-to-People-to-Place**, or **P3-Systems** framework, guided by an analysis of the design space of location-aware community-systems, which we used to structure the second and third studies presented. We then detail our second qualitative diary study that more directly explores how place-types influence people's desire for, and willingness for place-related awareness of and communication with others. This is followed by a presentation of a survey study aimed at providing empirical evidence for the conclusions derived from our qualitative studies in regards to people's information sharing preferences in open public places. This survey swaps the emphasis in the first two studies from 'people' and the places they visit, to place-types and associated P3-information sharing preferences. The final study we present explores how mobility traces can be used to identify personally meaningful places. We conclude with a discussion of how the lessons learned from these studies can be used to guide the development of the infrastructure necessary to support the next generation of location-aware community systems.

## 2. Study 1 – Exploring the Relationship Between Place-Types and Place-Information

Location-based services (LBS), which provide mobile-device users with personalized location services, are becoming increasingly important to the telecommunications industry. The development of such services has highlighted the importance of identifying geographically localized information. Table I based on Goodman (2000) provides binary classifications of time and space resolution and suggests one type of information that fits into each of four categories. However, we do not know how this sort of geographic information division relates to place and individuals' routine information needs. Our first study aimed to address this concern. Building on ideas from the environmental psychology literature we aimed 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 in general.

### 2.1. STUDY 1 METHOD

As we wanted to explore the mundane details of people's personal everyday experiences of place, associated activities and information needs, 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 (Rieman, 1993) to the process of reading documents (Adler et al., 1998) to methods for capturing information (Brown et al., 2000).

We instructed study informants to record where they were (which we utilized to infer 'place') and the activity they were engaged in at 30-min intervals. In this study (and in the second study presented 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. Table II shows an excerpt from the diary kept by one of the informants.

Table I. Binary classification of time and space resolution for information

	Geographically localized	Geographically independent
Localized in time	Traffic reports	Share prices
Time independent	Restaurant locations	Music recordings

Table II. Excerpt of the form used to log informant activities

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

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?
- What resources did you use to do this activity?
- Is there any information that would have made this activity easier to do?

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.

While we had initially planned to use 20 informants for our first study, we ended the study after ten individuals' participation because, as discussed in our results section, we felt that we had derived the likely value to be gained from this general line of questioning. Interviews averaged 50 min ranging from 30 to 90 min. 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. All interviews were audio taped and transcribed. In total, the data consisted of over 10 hours of recordings, which, when transcribed resulted in 250 pages of text (about 90,000 words) along with hand written interview notes.

## 2.2. STUDY 1 RESULTS

As we expected based on 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:

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- While informants did identify ‘information needs’ based on place-types, their in situ real world information 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.

This deepened understanding, represented by the four points above and outlined in greater detail below, replaced our naïve expectation that we could observe a consistent general relationship between place-type and information needs. Table III 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.

2.2.1. *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 min 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.<sup>1</sup>

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

Table III. *Frequency of activities in places and the stability of geographically localized information*

	Stable information (e.g., route from home to work)	Dynamic information (e.g., traffic conditions)
Activity done in a place frequently	Need: low	Need: moderate/high
Activity done in a place infrequently	Need: moderate/high	Need: high

*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.*

#### 2.2.2. *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...*

#### 2.2.3. *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.*

#### 2.2.4. *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.*

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*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.*

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., an individual might know 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. These findings can usefully guide the design of mobile CSCW service delivery.

### **3. Study 2 – People-to-People-to-Place (P3) Information Preferences**

Our second study elaborated on the results of study 1 using a similar method but focused more narrowly on the value of various potential services offered by computer systems that link people-to-people-to-place, or P3-System, 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? (People-Centered)
  - (b) Under what circumstances do people want to access other's comments and ratings about a place and associated activities? (Place-Centered)
- (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? (People-centered)
  - (b) Under what circumstances will people provide comments and ratings about a place and associated activities? Anonymously or by name? For whom? (Place-centered)

The interview questions were generated from an analysis of deployed systems that link people-to-people-to-place or P3-systems. Associated research on the P3-System Framework is described in detail in an earlier

volume of this journal (Jones et al., 2004) and is briefly summarized in the section below.

### 3.1. THE P3-SYSTEMS CONCEPTUAL FRAMEWORK

After conducting study 1, and to provide the area with a firmer foundation, we developed the P3-systems conceptual framework from an analysis of deployed P3-systems and associated research. As shown in Tables IV and V, the framework organizes the design space of location-aware ‘community’ systems into a 2×2 matrix of different type of system techniques. The rows of the framework distinguish between four different approaches to ‘situating’ the interaction environment with regards to physical space (spatial foci). We divide these into two:

Table IV. P3-System framework techniques summary

Design techniques		Synchronous communication or location awareness	Asynchronous communication or location awareness
People-centered	Absolute user location	1. Uses remote awareness of current user locations	2. Uses people’s location histories
	Colocation/proximity	3. Uses real-time user colocation	4. Uses colocation history to exchange social information.
Place-centered	Use of physical places	5. Uses online representation of user’s current use of physical spaces	6. Uses history of people’s use of a particular space
	Matching virtual places	7. Uses synchronous online interaction spaces related to physical location	8. Uses asynchronous online places interactions related to physical location

Table V. Representative deployed P3-Systems and techniques

Design techniques		Synchronous communication or location awareness	Asynchronous communication or location awareness
People-centered	Absolute user location	Ulocate: user real-time tracking	Ulocate: user location histories
	Colocation/proximity	LoveGety: proximity match alerts	Social net: social match alerts inferred from colocation histories
Place-centered	Use of physical places	ActiveCampus: maps showing location of users on campus	FolkMusic: maps overlaid with <i>in situ</i> user music listening histories
	Matching virtual places	MOOsburg: chat for real-time discourse in matching virtual places	ActiveCampus: graffiti system for digitally annotating physical locations

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- *People-centered* techniques where the focal point is either (a) the users geographic location, or (b) the users relative location to other people and objects in the environment.
- *Place-centered* techniques where the focal point is either (a) on user activities in a particular physical location, or (b) online interpersonal interaction in spaces that match/represent physical location.

The columns in the framework divide communication and location aware design techniques into synchronous and asynchronous approaches. This distinguishes techniques that provide information about current user location or activity within a place from those that provide historical information.

To more clearly illustrate the framework some representative systems and associated techniques are provided in Table V. People centered techniques are typified by the features of Ulocate ([www.Ulocate.com](http://www.Ulocate.com)) which represents absolute user location by tracking the current location or location history for a specified cell phone user, and LoveGety (*Wired News*, 1998) uses physically colocated individuals' profiles for social matching. Social Net (Terry et al., 2002) uses proximity to infer people's affinity from recurring colocation patterns.

An example of a synchronous use of physical places technique is the ActiveCampus Explorer's (Griswold et al., 2003) Maps interface, which overlays campus maps with avatars that represent the current location of buddies and other users. In this way, system users can see how crowded a location is. An example of asynchronous use of the use of physical places technique is provided by the FolkMusic (Wiberg, 2004) system, which represents the music associated with various locations through an analysis of users geotemporal music listening histories. MOOsburg (Carroll and Rosson, 2003), a community network system for Blacksburg, Virginia, provides various tools including an interactive map that users can pan or zoom to locate and navigate to virtual representations of geographical places and a related chat area for various locations that are representative of synchronous use of the matching virtual places technique. ActiveCampus Explorer also uses the matching virtual places design technique through its place-linked digital graffiti interface that lets users annotate the physical world by creating location-linked electronic notes on campus maps.

### 3.2. STUDY 2 METHOD

As in the first study, this second study informants logged their activities for one day. They again specified their locations and main activities at 30-min intervals (see Table III). The twenty participants included 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 min.

Since the questions we focused on in this study differed from the first study, the structure of the interviews also differed. This study probed more deeply 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 temporal aspects of their information utility. Tables VI and VII detail the question structure for each place listed.

The 20 semi-structured interviews were recorded and transcribed. We then analyzed the transcripts and identified responses to the broad questions outlined.

*Table VI.* Interview structure probing information needs

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Main questions:

- A. Would you like to know who was currently in or near this place?
- B. Would you like to know who has been at this place?
- C. Would you like 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.

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*Table VII.* Interview structure probing willingness to share/provide information

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*Main questions:*

- D. While you were there, would you have liked others to know that you are at this place?
- E. Would you like others to know that you were at this place?
- F. Would you like 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.

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### 3.3. STUDY 2 RESULTS

Our interviews provided us with a wealth of information about the situations in which people wish to know about or share place linked social information. Like the first study, analysis of the data showed only a weak relationship between place-types and information needs, in this case though it was more specifically social-information needs. Here, an individual's relationship to a place (e.g., regular visitor, owner, tourist) played a stronger role. Our informants associated 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. In the next four subsections, we will discuss our findings in relationship to our four main questions regarding utilizing "place" to customize the delivery of social information.

#### 3.3.1. *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 based on identification of shared affinities (social matching); (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 6 am.

*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.*

- Ted – now talking about getting the train at 6 pm

*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 based on identification of shared affinities/social matching.* Informants also expressed an interest in striking up conversations with strangers in public places, based on social matching. 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.

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*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 of our 20 informants expressed a strong 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 want to meet.

*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, yeah, 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 I). Such features are used primarily to improve management of existing social relationships and the use of place-based resources.

#### 3.4. 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, dining 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 6 pm”).

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 like to have access to that information once I get 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.*

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- 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.

### 3.5. UNDER WHAT CIRCUMSTANCES WILL PEOPLE SHARE INFORMATION ABOUT THEIR LOCATION? ANONYMOUSLY OR BY NAME? WITH WHOM?

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, such as enabling others to see how busy a place (like a restaurant) is. 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 who 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 support social matching our informants felt the need for a process of gradual user-approved revelation of their identity.

*Ted: Well, I would want it to be anonymous at first. I would walk in and be notified that someone here has common interests, then I would want a[n] option to be identified and so would they, so I would want both to identify.*

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 any-time. 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 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.

### 3.6. 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.*

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*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.*

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.

### **4. Study 3 – Survey of P3-System Service Preferences in Open Public Places**

The qualitative studies described above suggested a general desire for P3-System services and willingness, in the right circumstances, to share personal geotemporal data so as to enable such services. However, these findings were limited in a number of ways, three of which are particularly relevant to the design of our third study. First, they were based on a 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 were thought necessary, if we were to determine the generality of our findings. Second, 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.” Finally, the studies were focused on individuals, ‘people’ rather than particular ‘places’. To partially address these limitations we decided to conduct an *in situ* survey with a large sample size (over 500 respondents) of P3 attitudes of the general population in a range of urban open public places.

#### 4.1. METHOD

*Places/Locations* – The survey was conducted in Manhattan, New York, during the last three weeks of November 2004. We considered surveying at other locations in the New York Tri-State Area, including small towns, shopping malls, strip malls and residential areas. However, we felt that limiting our study to one urban center would increase the value of any observed differences between place-types. Further, Manhattan was preferred for pragmatic reasons such as a wide range of potential survey sites within walking distance of each other. That said, we believe that the findings of this survey could be enhanced by comparisons with studies of places situated in areas with different levels of urbanity, settlement density, and cultures.

The places for the survey were chosen to fit into the place-types set forth by Kramer in the “Classification of Generic Places” (1995) produced by rigorously exploring how people distinguish and cluster locations together into place-types, and then, in turn into larger groupings. The generic places he derived were services (e.g., train stations), institutions (e.g., banks), daily necessities (e.g., supermarkets), socializing (e.g., café), entertainment (e.g., cinema), leisure (e.g., park), cultural (e.g., museum), physical (e.g., gym), residential (e.g., apartment units). We aimed to survey in two of each of these generic place types. From an initial list of 16 place-types we were able to gain permission in conducting our survey at a Gas Station, Train Station, Post Office, Public Library, Supermarket, Restaurant, Café, Cinema, Central Park, Rockefeller Center plaza, and a Museum. Except for the Café where the survey was conducted indoors, subjects were approached as they went in or out of the survey site.

*Survey instrument* – The survey consists of 24 questions in a paper format, and took an average of 8 min to complete. The questionnaire was organized into three parts. The first section, related to the subject’s demographic information: age, gender, home zip, and occupation. The second section asked questions about people’s relation to the place in which the survey was conducted, such as frequency of visits and their reason for their current visit. The third section consisted of questions related to their interest in location related social information and willingness to share their personal location data. Each question in this third section was guided by the P3-Systems framework.

It was not possible to ask questions pertaining to each cell of the P3-Framework because: (1) of limitations to the survey length; and (2) because of perceived difficulties associated with describing hypothetical future services. This resulted in questions being derived primarily from cells 2, 3, 5, and 8 of Table IV. We also asked one question from cell 1 about knowing the current location of others.

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Where appropriate, respondents when describing their willingness to share personal location data, or desire for social-location data were asked to specify relationship types. Nine relationship types were specified: people you don't know/stranger; friend, boy-girlfriend/spouse; your child; colleague; superior/your boss; subordinate/employee; customer; and other (with the option to specify what "other" referred to). We used this data to create three categories of relationship types (i) family and friends; (ii) work / service related; and (iii) strangers/unknown others.

*Ethnographic data* – Apart from the survey data, in order to obtain a better understanding of the place-types where this survey was conducted, the researchers carrying out the survey took photos and, notes every half hour. These notes described occupancy and activity levels and the number of non-respondents per half hour.

*Respondents* – Survey respondents were recruited through a random stratified sampling technique. Stratification was based on: (1) place-type; and (2) sampling time at each location, either weekdays/weekends, or at peak/off-peak times of occupancy. In the end, 509 individuals completed the survey of which 19 provided spurious information or were unable/unwilling to complete the full survey. Gender was fairly evenly distributed (52.9% males). Most respondents (64.1%) fell into two main age brackets, 18–25 and 26–35, years of age. The majority of the remaining respondents were greater than 35 years of age, with only 4.9% of the total under 18 years of age.

Respondents relationship to survey sites – The majority of respondents, 74.7%, were New York Tri-State area residents (New York, New Jersey, Connecticut). Another 13.3% lived in the United States but outside of the Tri-State area and 7% of respondents lived outside of the United States. Twenty-three respondents or 4.7% of the sample did not provide details of their place of residence.

While the majority of respondents (57%) came to the location with the expectation of meeting somebody, only 28.6% of respondents came to the location in question for a scheduled activity. Furthermore, the greater part of respondents stated that they had come to the survey location for reasons of entertainment (37.8%), with only 25.9% having come for either work (17.1%) or study (8.8%). This emphasis on entertainment and unscheduled activity is obviously related to the types of places at which the surveys were conducted.

Respondents were asked how frequently they visited the survey location. The responses were fairly evenly distributed between our categories. Interestingly, 22.9% were visiting the location for the first time, which could be attributed to the types of places surveyed and the touristy nature of New York City.

#### 4.2. STUDY 3 RESULTS

This section is divided into six parts: (1) descriptive statistics of respondents' desires for people-to-place awareness information; (2) descriptive statistics of respondents' willingness to share their personal location data; (3) descriptive statistics of respondents' attitudes towards reading and writing location linked comments; (4) descriptive statistics of age and gender relationship to P3-System services; (5) descriptive statistics of subjects relationship to the survey site and interest in P3-System services; and (6) Regression modeling of interest in location awareness and sharing of personal location data. The first five of these sections contain the tables of simple percentages of relationships that were found to be statistically significant and can be presented in simple table format in terms of percentages. Of course for the more complex regression modeling statistics test outcomes are presented.

##### 4.2.1. *Desire for People-To-Place Awareness Information*

Two yes/no questions regarding desire for occupancy information were asked: (1) "Would you like to know how many people are nearby now?" (21.7%) and (2) "Would you like to have known how many people were in this place before you came here?" (29.0%) (Table VIII).

The majority of respondents (57.5%) listed the desire to know one or more types of information about the people that came to the survey sites in question. These included: Age 18.8%; Income 11%; Hobbies 22%; Music 12.2%; Religion 5.3%; Ethnicity 9.8%; Political opinions 12%; and Other 4.5% (such as tastes in art, dating availability, job).

Table VIII. Desire to for people-to-place awareness information

Question	Yes to any category	Family and friends	Work/Service related	Strangers
(a) Before you came here, would you have liked to know if any of these people were here or not?	42.0	31.0	12.7	10.0
(b) Would you like to know where a person/s from any of the following categories is/are right now?	44.5	33.5	14.3	9.2
(c) Would you like to know if a person/s from any of these categories is/are nearby now?	56.3	48.6	20.2	8.0

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Table IX describes respondents’ interest in people-to-people-awareness information in terms of relationship types. A high proportion of respondents were interested in having P3 awareness information. In general the respondents were more interested in knowing the location of family and friends, although this is not surprising considering the finding that only 17.1% of respondents were at the survey sites for work purposes.

4.2.2. *Willingness to Share Personal Location Data*

The vast majority of respondent said “they would let themselves be counted” as being at the survey location (84.3%). Table X describes two key questions about respondents’ willingness to share personal location data with others. In our fairly public locations a large percentages of respondents were willing to have their personal location used to provide information for others and to inform family and friends of their location.

4.2.3. *Attitudes Towards Reading And Writing Location Linked Comments*

As expected from the analysis of the P3-Framework in terms of privacy (Jones et al., 2004), respondents were less concerned about sharing location-linked comments than personal location data with strangers. They were also

Table IX. Sharing personal location awareness with others

Question	Yes to any category	Family and friends	Work/service related	Strangers
(a) Who would you allow to know that you are in this place now?	77.1	68.6	32.0	16.5
(b) Who of these people would you let know that you are nearby now?	71.4	64.3	22.9	9.2

Table X. Reading and writing location linked comments

Question	Yes to any category	Family and friends	Work/service related	Strangers
(a) Would you like to be able to READ comments about this place or events that happen here from the following people?	54.3	42.2	23.7	21.4
(b) Would you like to be able to LEAVE comments about this place or events that happen here for the following people?	65.9	63.7	22.4	18.6

Table XI. Age group and percentage interested in various P3-Information

	18–25	26–35	36–50	51–65
Would you like to know where a person from any of the following categories is/are right now?	52.7%	47.6%	32.6%	23.6%
Would you like to know if a person/s from any of these categories is/are nearby now?	64.7%	60.4%	50.0%	32.7%
Who would you allow to know that you are in this place now?	84.7%	75.6%	77.9%	56.4%
Who of these people would you let know that you are nearby now?	80.7%	72.6%	67.4%	47.3%
Would you like to be able to READ comments about this place or events that happen here from the following people?	61.3%	56.1%	52.3%	29.1%
Would you like to be able to LEAVE comments about this place or events that happen here for the following people?	53.3%	49.4%	51.2%	21.8%

more interested in reading the comments of strangers than knowing about their location.

#### 4.2.4. Demographics and P3-System Preferences

As found in our regression modeling of the importance of place described in Sec. 4.2.7 below age strongly related to both desire for, and willingness to provide P3-System data (Table XI).

Similarly gender strongly related to P3-System preferences with males being much more likely to suggest a desire for and willingness to provide P3-data (Table XII).

Table XII. Gender and percentage interested in various P3-Information

	Female	Male
Would you like to know where a person from any of the following categories is/are right now?	39.4%	49.0%
Would you like to know if a person/s from any of these categories is/are nearby now?	51.1%	61.0%
Who would you allow to know that you are in this place now?	75.3%	78.8%
Who of these people would you let know that you are nearby now?	69.7%	73.0%
Would you like to be able to READ comments about this place or events that happen here from the following people?	48.1%	59.8%
Would you like to be able to LEAVE comments about this place or events that happen here for the following people?	43.3%	52.1%

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4.2.5. *Personal Relationship to Survey Site and Interest in P3-Information*

We tried to gain a general feeling as to the relationship between an individual and the survey site and basic P3-System preferences, although the interaction effects were examined through regression modeling which are partially described in Sec. 4.2.7 below. The survey asked individuals if they were on a schedule or unscheduled visit to the survey site. As can be seen from Table XIII when individuals were in the location for a planned activity they were consistently more interested in sharing and utilizing P3 information.

An examination of proximity of respondents to the survey site also gave clear cut results but they are more difficult to interpret. Respondents from

Table XIII. Scheduled visit and percentage interested in P3-Information

	Scheduled	Unscheduled
Would you like to know where a person from any of the following categories is/are right now?	53.6%	40.9%
Would you like to know if a person/s from any of these categories is/are nearby now?	69.3%	51.1%
Who would you allow to know that you are in this place now?	84.3%	74.3%
Who of these people would you let know that you are nearby now?	82.9%	66.9%
Would you like to be able to READ comments about this place or events that happen here from the following people?	61.4%	51.4%
Would you like to be able to LEAVE comments about this place or events that happen here for the following people?	50.7%	46.9%

Table XIV. Home location and percentage interested in various P3-System services

	Within tri-state	US not from tri-state	Outside US
Would you like to know where a person from any of the following categories is/are right now?	44.5%	55.4%	27.8%
Would you like to know if a person/s from any of these categories is/are nearby now?	56.6%	66.2%	41.7%
Who would you allow to know that you are in this place now?	78.7%	86.2%	52.8%
Who of these people would you let know that you are nearby now?	73.0%	83.1%	38.9%
Would you like to be able to READ comments about this place or events that happen here from the following people?	53.0%	61.5%	47.2%
Would you like to be able to LEAVE comments about this place or events that happen here for the following people?	47.3%	56.9%	38.9%

inside the United States that did not live in the region (within the New York, New Jersey, Connecticut Tri-State area) were more likely on all questions to be more interested P3-System services than Tri-State residents. Yet paradoxically those coming from outside of the United States were much less likely to be interested in such services. This find is perhaps also best explained through regression modeling (Table XIV).

Finally, we examined both ‘frequency of visit to the survey site’ and ‘reason for visiting the survey site’ (work, social/entertainment, errand, other). In both cases simple analysis which did not take into account various interactions did not produce significant differences and so the percentage table is not presented here.

#### 4.2.6. *Regression Modeling of Place and interest in P3-System Services*

Logistic regression modeling was carried out on answers to each of the three questions in Tables VIII–X to determine the key predictors of desire for P3-System services. The primary approach used for regression modeling was backward elimination. Independent variables examined included: age; gender; place (Kramer’s place-type categories or survey sites); how frequently subjects visited the location; if the visit was scheduled; if their place of residence was in the tri-state or elsewhere in the United States (the analysis reported here excludes respondents that did not provide a united states residential zip code), and reasons for their visiting the survey site (work, social, errand, other). This required the conducting of 24 logistic regression models. The binary dependent variable for each of these models being interest in one of the 6 P3-System services listed in Tables VIII–X and a positive or negative response to the people categories (‘yes to any category’, ‘family and friends’, ‘work/service related’ and ‘strangers’).

Unfortunately, although the categorical independent variables ‘survey site’ or ‘Kramer’s place type’ were associated with different patterns of P3-System preferences even when other independent variables (age, gender, etc.) were taken into account, this could not be interpreted in any simple fashion that would inform us as to how services provision could be linked to place. In addition, Kramer’s place-type categories were weaker predictors than the full fine grained approach of considering each survey site a unique place-type, suggesting that in terms of P3-Service delivery such categorizations are of limited value. Moreover, the variable “survey site” only became significant for the regression models where the dependent variables were P3-System preferences for sharing or utilizing data pertaining to “family/friends” or “work/service related”, as opposed to a composite measure that combined together desire of P3-System services in relationship to any individual. In other words, “survey site” mattered only when social relationship was taken into account at a most basic level. This can be illustrated by an examination of modeling of question (a) Table IX, where “going to the location for a

scheduled activity” was the best predictor of the ‘any category’ ( $\chi^2 = 6.14$ ,  $df = 1$ ,  $p = 0.013$ ), while the ‘survey site’ was the primary predictor when ‘family and friends’ was the dependent variable in the logistic regression ( $\chi^2 = 24.91$ ,  $df = 10$ ,  $p = 0.006$ ). Another important example results from the modeling of answers to Question (a) Table X – where ‘any category’ was best modeled by age and schedule ( $\chi^2 = 18.26$ ,  $df = 6$ ,  $p = .006$ ) and ‘friends and family’ was best modeled by combining “survey site” and “age” ( $\chi^2 = 43.54$ ,  $df = 15$ ,  $p = .000$ ).

### 5. Personally Important Places

The survey described above addressed a significant shortcoming of the qualitative studies by collecting data from a large number of respondents *in situ*, and in so doing, even with its necessary focus on attitudes in fairly public places, highlighted just how important knowledge of users’ personal connections to places is for effective service delivery. Thus, developing systems that are able to acquire knowledge of user’s relationship to places, particularly those that users consider personally meaningful, is fundamental, if we are to deploy truly place-sensitive P3-Systems. With such knowledge of ‘places’, descriptions of locations in socially meaningful ways such as “I’m home” (see Wilenmann and Leuchovius, 2004 for a discussion of this notion) becomes possible, as does service delivery tuned to social understandings of place (e.g., “this is where the Indian students hangout”).

Various prototypes and groups have explored computer-aided discovery of place. ComMotion (Marmasse and Schmandt, 2000) allowed users to mark up their GPS traces to enable alert deliveries (e.g., a reminder at the supermarket to buy milk). Ashbrook and Starner (2002) applied a clustering algorithm to group GPS readings into “significant locations”. A number of other location-aware applications have also begun to do this. DeDe, a location-aware mobile messaging application, allows messages to be delivered to places like “Anne’s home”, “school forest path”, “railway station”, etc, that are meaningful to the sender and recipients (Jung et al., 2005). Place-Its, a location-based reminder system, lets users create brief personal reminder messages (“talk to my lab mate”) for delivery at a place (“lab”) that is defined for a specified group of users (Sohn et al., 2005). A major challenge faced by these applications is to understand what constitute a user’s personally important places, and establish the mapping from the physical locations to personal places.

The full extent of our explorations of these issues is beyond the scope of this paper (see fuller discussions in Zhou et al., 2004, 2005a, 2005b). Here we aimed to highlight two key points through the description of a place identification study. First, that people during their everyday routine activities operate in only a small number of places that they see as personally relevant,

and second, that the majority of these places can be fairly well identified through data mining of user's mobility traces. In the discussion at the end of this paper we tie these findings to the potential for future of P3-Systems and outstanding issues that the research community need to address.

## 5.1. METHOD

### 5.1.1. *Subjects*

Our subjects were 28 individuals from the Minneapolis/St. Paul metropolitan area of the United States. Some lived in the inner city, some in the suburbs. They used a variety of travel modes, including walking, biking, public transportation, and personal cars. Their ages ranged from the early 20s to late 60s, with an average in the early 30s. Twenty were male, eight female. Three subjects had preschool children, four had school-aged children, and two had adult children not living with them. They were highly educated, with 2/3 having college or advanced degrees. They included six college students, four engineers, four information technology professionals, four teachers, a range of other professional and service jobs, as well as several retired people.

### 5.1.2. *Data Collection*

All subjects were provided with GPS-enabled Motorola i88s cell phone and Nextel service that ran the Accutracking software ([www.accutracking.com](http://www.accutracking.com)). The software was configured to take a GPS reading every minute and send it to our server. Subjects were asked to carry these phones for 3 weeks, and were instructed to keep it with them and turned on at all times unless they specifically felt a need for increased privacy. In addition, subjects kept a diary of the places they visited each day. At the end of the mobility trace data collection period the trace-data was analyzed using our place discovery algorithm (Zhou et al., 2005a). This algorithm leveraged a number of features including:

- *Readings*: Intuitively, the more time a person spends at a place, the more important that place would likely be to the person.
- *Reading Days*: Number of unique days on which a reading in the cluster occurred.
- *Visits*: A visit represents a contiguous amount of time spent at a place.
- *Visit Days*: Number of unique days on which a visit in the cluster occurred.

We then conducted semi-structured interviews where we led subjects through the process of matching their diary-logged places to algorithm discovered places. Subjects were also asked to list the importance of the place visited on a five-point scale from important (5 and 4) to unimportant (1, 2 and 3).

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Table XV. Number of places visited

	Average no. places visited	Maximum no. places visited	Minimum no. places visited	Weekly average no. places visited	Weekly maximum no. places visited	Weekly minimum no. places visited
Important	2.3	12	0	0.77	4.00	0.00
Unimportant	20.75	46	3	6.92	15.33	1.00

Table XVI. Place prediction accuracy metrics

Class (count)	Precision	Recall	F-measure
Important and frequent places (64)	0.713	0.891	0.792
Unimportant and frequent places (42)	0.731	0.452	0.559
Important and infrequent places (49)	0.111	0.02	0.034
Unimportant and infrequent places (127)	0.713	0.937	0.81

## 5.2. RESULTS

Table XV below describes the small number of places individuals describe as important during a routine week and Table XVI provides the precision and recall associated with the identification algorithm. As the recall of important and frequent places is very good (89%), we can confidently say that individuals do not routinely visit during a typical week a large number of personally important places. Further, it is apparent from the results that systems could easily be developed that leverage knowledge of users' personally important places through a combination of computer generated place discoveries and moderate user input.

## 6. Summary and Discussion

Collectively the four studies presented in this paper present a clear picture of both the value and complexities involved in utilizing 'place' data to create valuable social computing services.

The first qualitative dairy study highlighted that while there is a general match between the kind of geographically localized 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., an individual might know 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.

The second qualitative diary study demonstrated the utility of the P3-Systems framework for deriving service features, suggested that such services would be of general interest to the public, and provided us with a long list of ways in which individuals perceive potential benefits of various People-to-People-to-Place services. This study also highlighted how individuals' relationship to places moderates their desire for various services.

The third study, where we surveyed over 500 people in Manhattan highlighted a number of key points. Firstly, interest in various people-to-people-to-place services appears to be high. Examples of supportive findings include over 40% of respondents expressing an interest in locating others at the various survey sites, 54% wanting to read place linked community generated comments, and an even higher percentage (56%) wanting to know about who is nearby. This was influenced by age, with younger survey respondents and interviewees expressing a stronger desire for such services. Second, people are willing to share personal location information with others to enable P3-System services. However, our findings also suggest that individuals demand finer control over this process. Combining the findings from this and the first two studies suggests that individuals 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. Again the survey highlights this point, with the majority of respondents in all of the 11 survey place-types being willing to share aspects of their personal location data (e.g., 84.3% of respondents were willing to have their location data used to provide information about occupancy/crowding). Thirdly, geo-temporal routines and demographics help define desire for P3-System services. Finally, while place-type in isolation does not determine information needs (user routines and social relationships must be integrated), it does relate to desire for P3-System services. Illustrative of this point, the logistic regression modeling of our survey data consistently found survey site place-type impacted on when individuals wanted to obtain or share personal location data, however social relationships were always found to be a stronger predictor.

Collectively the first three studies paint a picture of how 'place' data for P3-System ideally needs to be contextualized through 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.

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- 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.

Fortunately, the fourth study presented here highlights just how few places that are considered important to an individual are visited in a typical week, and how places that individuals describe as important, are relatively easy to identify using a mix of user input and algorithmic discovery. While places that are important but infrequently visited are harder to identify, they are by definition rarer and therefore less likely to overly burden a user with frequent user-input requests. This finding is in line with the work of Sandy Pentland's social dynamics group (e.g., Eagle and Pentland, 2006) who have consistently found that gross aspects of human behavior can be modeled from analysis of sensor data. To achieve this end, location aware community systems are going to have to be designed so that over time a sophisticated 'user-community world model' is generated that can be leveraged to enable P3-services that meet user privacy concerns and information desires.

While the four studies presented suggest that there is a great potential for P3-System services and that to make these systems truly place-based is feasible, numerous fundamental questions remain unanswered. One key question is how the interconnectedness of places both physically and socially relates to P3-System preferences and more importantly how such knowledge can be leveraged to improve service delivery. For example, some subjects in study 4 on occasions said that "university" was an important place; yet university itself is composed of many places. While individuals in such large "places", might have broad preferences related to the sharing of their personal location data that differentiates between those in the same place and those in different places (e.g., off campus), they are also likely to have fine-grained P3-sharing and utilization preferences that differentiate between different people/social relationships within the campus environment. If we understood better how places are connected and categorized by individuals, could we produce mechanisms for context aware management of P3-System privacy/interruptibility preferences? A second key question that needs to be explored, is how to move beyond identifying and leveraging knowledge of an individual's places and place preferences, to notions of 'group hangouts' or 'community places'. A single location can have multiple uses and occupancy patterns resulting in different groups understanding the location in quite different terms. Such understandings may mean that time has to be taken into account to understand how a place's social context/place-type is understood.

Collecting and utilizing such geotemporal social knowledge may require innovative approaches that analyze community behavior in ways that cannot be extrapolated through scaling the analysis of single users.

We navigate our everyday environments through an understanding of place and place-types gained through a lifetime of experience. 'Place' is a critical part of our context that we understand intuitively and as a result extracting its core elements to enable software applications is not straightforward. The studies described in this paper while clearly highlight that our understanding of how to turn 'place' into a fundamental computational object is still in its infancy, make important contribution in terms of identifying and empirically confirming the role of people and place properties and various relationships between the two. They further show how knowledge of place can be used to support the delivery of location-aware community system services. With technologies such as increasing number of sensors in the environment, and carried by individuals raises the opportunities for great advances in our understanding of society and communities. We hope future work in this area will leverage and extend on this foundation to build place-based systems.

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### **Note**

1. Names of the informants have been changed to maintain privacy.

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