“WHERE WE MET LAST TIME”: A STUDY
OF SOCIALITY IN THE CITY

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ABSTRACT

Understanding the context of use of a computing system is an important part of designing human-centred interaction especially where that computing pervades the places and activities of daily life. The aim of this paper is to introduce two ontologies that represent understanding of 1) human perception of architectural place and 2) sociality in an urban space, gained through field studies of the physical and social layers of an urban environment. This paper demonstrates how these ontologies are used to provide an understanding of context of use of an urban space, and how to identify design opportunities for informing design of a digital layer of pervasive computing.

KEYWORDS: sociality, user studies, context-aware interaction, ubiquitous computing, built environment.

1. INTRODUCTION

Facilitating sociality is a new area of exploration in the use of technology (Crabtree & Hemmings, 2001; Jensen & Lenskjold, 2004; Willson, 2003). Context-awareness and pervasive computing provides opportunities for interaction designers to make a positive contribution to our experience of urban environments in complementing and augmenting the way that people interact in these places (McCullough, 2004; Paulos & Goodman, 2004; Ciolfi, 2004; Galloway, 2004). To identify these opportunities we need to understand those aspects of the existing environment that impact people's experience of place and how people interact with their environment and with each other.

Understanding the context of use of a computing system is an important part of designing human-centred interaction especially in the situation where computing pervades the places and activities of daily life (Agre, 2001; Dourish, 2004). If we want a system to adapt to its context, we need to have a workable understanding of what to adapt to. Early context-aware systems used the user's spatial location as sufficient approximation of context (Schmidt et al., 1999) provided through positioning technologies such as the Global Positioning System (GPS) or locally embedded technology such as Wireless LAN, Bluetooth, or infra-red beacons. Recently the concept of context-awareness has been extended to include a richer collection of contextual factors such as physical and social aspects of an environment (Agre, 2001; Bell & Dourish, 2004; Bradley & Dunlop, 2002; Dourish, 2004; Goodman & Gray, 2003; McCullough, 2004; Tamminen et al., 2003) creating a challenge for researchers trying to qualify what physical and social context means in terms of designing context-aware pervasive systems.

Physical context as characterised by both Agre (2001) and McCullough (2004) includes architectural structures and elements of the built environment that people use in every day life to orient themselves and to operate in that environment. This includes the use of landmarks as reference points, identifying legible pathways in the landscape as an indication of the way to go, and reading the design of doorways as places to enter. Social context includes the social processes and human activities that surround everyday interactions (Dourish, 2001). For example, Buscher and Hughes (1999) established that people are
attracted by other people and that people desire an overview of the activities and movement of others in places around them.

To understand physical and social context, we need to study the relationship of interactions between people and technology and the social settings and places in which they occur. This includes mutual understandings based on shared experience of past events such as meeting "where we met last time", interpreting flows of people as indicating a way to go, choosing to sit in an elevated position to watch others, and reading the presence of others as a recommendation of places to go.

This study proposes a way to gain an understanding of physical and social context, using an empirical user-centred approach. This knowledge has been used to design, implement and evaluate a context-aware pervasive computing system called Just-for-Us (detailed elsewhere in Kjeldskov and Paay, 2005, and Paay and Kjeldskov, 2005). This paper does not reiterate that process nor describe the prototype design, but instead gives a detailed account of the fieldwork and analysis phases that preceded the design process. The paper finishes off by listing the outcomes from the empirical work in the form of the identified design opportunities that constituted the foundation for the design phase of the project.

The paper is structured in the following way. Section 2 reviews pervasive computing in relationship to sociality in the city, describing both physical and social aspects of urban context. Section 3 presents a case study, including two field studies: the first analysing the physical environment and the second, the social environment of a civic space. Section 4 presents the outcomes from these field studies in the form of ontologies of physical and social context. Section 5 presents specific design opportunities derived from the outcomes of both field studies. Section 6 concludes on the work presented in this paper, and describes further work associated with this research.

2. PERVASIVE COMPUTING AND SOCIALITY IN THE CITY

Sociality exists in cities (Canter & Kenny, 1975; Goffman, 1963; Whyte, 1980). This study explores how a pervasive computing system might augment that sociality by using awareness of people’s context to extend their potential for social interaction. In the past the physical environment has provided the structural resources and constraints for the socialization process (Agre, 2001; McCullough, 2001). McCullough (2004) states that the built environment has traditionally organised the flow of people, resources and ideas, but that architecture has recently acquired a digital layer augmenting this traditional role. In this way pervasive computing is extending architectures reach in enhancing the lives of people.

Pervasive computing can create a space for new kinds of everyday social interactions and experiences. Digital technologies are increasingly mediating relationships between people, and their experience of the world and others in it. By extending what the built environment offers its inhabitants, pervasive computing provides new opportunities for sociality in urban space (Jensen & Lenskjold, 2004). Galloway (2004) provides an overview of research investigations studying operational systems that augment people's experience of the city in order to investigate the notions of sociality and spatialisation and their relevance to the design of pervasive computing. Examples presented include Amble Time and Urban Tapestries both of which augment social experience of the city.

Field studies are an important part of understanding the context of use of pervasive computing systems. Paulos and Goodman (2004) created Jabberwocky to identify the location of familiar strangers in the user’s environment using field studies to understand what constitutes a familiar stranger. Borntrager et al. (2003) used field studies with their context-aware city guide, GUIDE, to systematically study user interface preferences, addressing a shortcoming of previous tour-guide design work. After using extensive field studies to understand the context of use of mobile devices, Tamminen, et al (2003) state that the only way to answer the challenge presented by urban environments for context-aware computing is to use an empirical, user centred approach to study how people operated while situated in the context of use.

My approach to this study was inspired by these studies and by McCullough (2004, p.97) who says “The representation of contexts now becomes an essential challenge to designers of information technology”.

2
2.1. Understanding Physical Context

The HCI literature stresses the importance of understanding physical context, yet no established method for gaining this understanding exists. Bell and Dourish (2004) indicate that thinking architecturally about mobile and wireless technologies that are developed and deployed in the built environment could be used to support the intersection of the built form with people and their social interactions. It seems reasonable to base a study of physical context on architectural methods since both McCullough (2001) and Agre (2001) refer to architectural elements of an environment as important aspects of physical context.

City Planner, Kevin Lynch (1960) developed a method for the visual analysis of a city through descriptions of key characteristics of the space held by people as they navigate and orient themselves within city precincts. To understand the role of environmental images of cities in the lives of those who inhabit them, Lynch carried out two basic analyses. Firstly, interviews were conducted with people who either lived or worked in an area, eliciting their image of the city using interview techniques. Secondly, a field reconnaissance was done by an architecturally trained observer, who mapped the presence of various elements of the physical environment, using the categories: districts, landmarks, nodes, edges and paths. The observer made subjective judgments about the visible contribution of these elements to the image of the city. The outcome was a map representing the visual form of a city. The method proved successful in the analysis of types of elements of a city and as a method for describing and understanding key aspects of the environmental image of space held by people as they navigate and orient within city precincts.

Architect, Christopher Alexander et al. (1977) empirically investigated the interplay between architectural space and its inhabitants, identifying a "checklist" of plausible solutions for design. He created "A Pattern Language", a series of patterns drawn from observations of historical solutions to common design problems, as a method of analyzing aspects of the built environment and advising design. This collection of 253 patterns was ordered hierarchically, and identified architectural design problems in context and their impact on inhabitants of that environment. These patterns in themselves are a form of composite pictures including: photographs, sketches, descriptive explanations detailing the context for the pattern, its relationship to parent patterns, a description of the problem, the empirical background of the pattern, evidence for its validity, and the design solution.

While these methods have proved valuable within architecture, they have also proven useful for analysing the interplay between architectural, informational and social space for the purpose of context-aware pervasive system design (for a more detailed review see Paay & Kjeldskov, 2005). The methods of both Lynch and Alexander were chosen for this study because they both model built environments, specifically cities, with regard to the people that inhabit those places.

2.2. Understanding Social Context

The literature also stresses the importance of understanding social context, and like physical context, there is not yet an established method for gaining this understanding. Sociological studies of human behaviour provide a basis for our understanding of human interactions, and therefore sociological methods are being explored as a way to gain insight into what might constitute an understanding of social context (Buscher & Hughes, 1999; Dourish, 2004; Galloway, 2004; McCullough, 2004). Agre (2001) in establishing a framework for analysis of context includes activity and the social relationships as part of social context.

In reviewing current theoretical approaches to defining social context McCullough (2004) endorses the move toward understanding how people act out situations. He suggests that this could be gained through modelling people in context and finding a method of representation to capture the situational and social aspects of a space that influence people’s ability to achieve their intended activities within built environments. McCullough’s (2001) typology of every day situations provides a starting point for a study of situated interactions in place. This is a preliminary list of everyday situations that could be transformed by technologies, grouped to reflect the usual categories of place: at work, at home, on the town, and on the road. The category of “on the town” is the most relevant when studying sociality in the city, and has the following situated interactions associated with it: 1) eating, drinking, talking (places for socializing); 2) gathering (places to meet); 3) cruising (places for seeing and being seen); 4) belonging (places for insiders); 5) shopping (places for recreational retailing); 6) sporting (places for embodied play); 7) attending (places for cultural productions); and 8) commemorating (places for ritual).
3. CASE STUDY: FEDERATION SQUARE

With the aim of understanding physical and social contexts in urban environments field studies were conducted at Federation Square, Melbourne, Australia. Federation Square is a new civic structure, opened to the public in October 2002, to provide the people of Melbourne with a ‘unifying square, a landmark, a civic focus’ (official brochure), by bringing together a creative mix of attractions and public spaces. The design intention for the space was to incorporate digital technologies into the building fabric creating a meeting of virtual information space and physical building space for people to experience. Federation Square was chosen for this study because it is a multi-modal public space with a mixture of distinct architectural features and embedded digital elements that provide a variety of activities to visitors, including restaurants, cafes, bars, a museum, galleries, cinemas, retail shops and several public forums.

3.1. Field Study One: Analysing the Built Environment

The aim of Field Study One was to inquire into architectural elements of an urban environment that contribute to visitor experience of a urban space and how this could subsequently be modelled. It was designed to identify important characteristics of the inhabited built environment and create an analytical abstraction of this. There were three significant outcomes from this study: 1) a map identifying districts and landmarks, 2) an ontology of physical context and 3) a quantified visualisation of physical context at Federation Square. This group of analytical outcomes is called MIRANDA (Multilayer Info Related to Arch aNalysis Data Abstraction) and represents the human experience of the architectural properties of an urban environment.

The study started with a field inspection that consisted of an observational expert audit of architectural space at Federation Square. This expert audit was inspired by the method outlined by Lynch (1960). In this adapted method the trained observer recorded, through photographs and field notes, the elements of the physical environment in a visit to the site, resulting in a collection of 125 digital photographs of physical elements of the urban environment. Observations of the relationship between the elements being photographed and the environment, including human interaction, were recorded in the form of field notes.

Coding this data was a two-pass process. In the first pass, the architectural elements were classified by the auditor using a visual inspection technique to classify the key element of each image using Lynch’s (1960) defined categories of: district, landmark, node, path. An additional classification of the image data was then conducted on the architectural elements using Alexander's (1977) pattern language as an encoding schema. Sketches and notes showing the applicability of each pattern were appended to the existing field notes. Each image was associated with one or many Alexandrian patterns. In the second pass, content analysis (Patton, 2002) was applied to the text associated with each architectural photograph. They were read through several times to identify key concepts and repeating phrases in the loosely structured data. Key themes were highlighted in the textual descriptions and then extracted from the data and further analysed using affinity diagramming from the contextual design method (Beyer & Holtzblatt, 1998). After several iterations of grouping and regrouping, sets of words emerged and were refined to a concise set of representative terms. To ensure that the key element of each image could be comprehensively described using MIRANDA, the detailed prose description associated with each photograph was equated with one or many signed word pairs. A tally of these word pairs was made from the entire dataset and pairs were associated diagrammatically providing a visualisation showing variations and frequencies of word pairs.

This process resulted in an analytical ‘language’ which described the physical environment using a concise set of words and clarified and identified the essence of the characteristics of the space, providing a preliminary ontology of human perception of urban space (see Table 1 in Section 4)

3.2. Field Study Two: Studying Situated Social Interaction

Exploring the categories of McCullough’s (2001) typology of “on the town” everyday situations a field study of social interaction at Federation Square was conducted. Field Study Two consisted of a series of contextual interviews (Beyer & Holtzblatt, 1998) and ethnographic field observations on location at Federation Square. Three different established social groups participated in the study. Each group consisted of three young urban people, mixed gender, between the ages of 20 and 35, who had a shared
history of socializing at Federation Square. One of the members of the group was taken to Federation Square and asked to contact the other members of the group and arrange to meet them at Federation Square. When the group had met up, they were asked to undertake the same activities they would usually do as a group when socialising at Federation Square. The participants were asked to “think aloud” as they moved around the space and advised that the interviewer might interject with questions and on points of clarification about interactions that were not explained. The contextual interviews and observations lasted approximately three hours for each visit. These visits were recorded on digital video, in field notes and in diary reflections about each visit written immediately after.

Shortly after the field visits all video recordings were reviewed, transcribed and analysed. Spoken interactions between participants and also with the interviewer including gestures and actions (such as pointing and the group forming a closed circle) were transcribed. The analysis of the transcript involved open coding adapted from the grounded theory analysis method (Strauss & Corbin, 1990) and affinity diagramming. During coding, category-property-dimension triplets were assigned, describing situated interactions and actions. Higher-level themes were then extracted from the data using axial coding and by looking at relationships across the data and between occurrences of composite descriptive categories. Themes were then transferred to individual pieces of paper for the process of affinity diagramming, which was used to draw successively higher levels of abstraction from the data until a small set of high-level concepts emerged, representing the essence of the data and encompassing all lower level themes. The assigned category-property-dimension triplets recorded in the transcript were then tallied using a spreadsheet. These tallies provided a list of most frequently occurring categories in the data, giving a weighting to each high-level concept.

The conceptual framework that emerged from the analysis of situated interactions at Federation Square is called SOPHIA (SOcial PHysical Interaction Analysis). SOPHIA encapsulates a formalized understanding of every day social interaction in the situation of an urban environment, and provides a preliminary ontology of sociality in urban spaces (see Table 2 in Section 4).

4. ONTOLOGIES OF PHYSICAL AND SOCIAL CONTEXT

Outcomes from the analysis of the field data can be represented on two levels: firstly a general representation of contextual factors for physical and social layers of an urban environment, and secondly a specific representation of those key contextual factors that characterise the environment at Federation Square. This section presents the general findings from the field studies in the form of ontologies of physical and social context and Section 5 then presents the aspects of these ontologies that specifically characterise Federation Square and the implications of this for the design of context-aware computing.

The ontologies presented in this section can be used to analyse any urban environment and provide an analytical representation of an urban space in respect to those elements of physical and social context that are most strongly represented there. This can be done at any level of granularity, either by a traditional ethnographic study using the ontology as encoding schema for grounded theory analysis, or in rapid ethnography (Millen, 2000) where these terms can provide observational triggers or checklists for analysts.

4.1. Ontology of Human Perception of Urban Space

The ontology of human perception of urban space that emerged from analysis of Study One field data provides an overview of the physical context of civic space, judiciously extracted from historical understanding of human experience of architectural space. The MIRANDA ontology (Table 1) makes available an analytical language for describing inhabited space that can then be used for identifying the key physical characteristics of any built environment, and to describe the user's surroundings in a way that is grounded in human observation of that place, and formed with reference to collected knowledge about human understanding of architectural form. MIRANDA is unique, in so far as it provides syntax and a vocabulary that can be used to analyse and describe a built environment, and thereby provides a widely sought representation of physical context for that place, which did not exist in the literature surveyed. The aim of creating MIRANDA is to provide pervasive system designers with a way to gather knowledge
about elements in the user’s physical context, so that the system can index to information that already exists in the world.

MIRANDA is interpreted in the following way. A language statement is composed of a sign, followed by a word from the set of descriptors paired with a word from the set of places. The best way to explain this is by example. An available MIRANDA statement would be "+activity.edge". This would be read as “the space has activity around the edges”. Another statement might be "~bright.entrance" indicating that an entrance is not brightly lit but is semi-bright. Alternatively a statement used to describe a place might be "~clear.path" meaning that a place does not have clearly defined paths. All descriptor words are not necessarily pair-able with each place word, as the concept of a bright goal might seem a bit odd but it is conceivable that there may be a situation where brightness (a display of lights) is used to draw attention to the location of an event.

Table 1: MIRANDA: Ontology of Human Perception of Urban Space

| Syntax: | [+ , ~ , -]<descriptor>.<place> |
| Set of descriptors: | activity, bright, clear, connected, decorative, focal, functional, general, high, human-scale, inviting, natural, sheltering, visible |
| Set of places: | goal, edge, entrance, floor, node, path, roof, structure, surrounds, transition, wall |

4.2. Ontology of Sociality in Urban Space

The ontology of sociality in urban space that emerged from the analysis of Study Two field data provides a hierarchical summary of key social characteristics affecting social interaction in urban space. In this way, it provides a set of concepts for studying a space in respect to gaining an understanding of its social context. The SOPHIA ontology (Table 2) makes available a set of concepts about sociality in urban space that can be used as an encoding schema for understanding the key social characteristics of any built environment, and to describe the user's social situation in a way that is grounded in human observation of people in that place, and collected through ethnographic study of situated social interaction. SOPHIA is unique, in so far as it represents a grounded approach to providing a widely sought representation of social context. The aim of creating SOPHIA is to provide pervasive system designers with a way to gather knowledge about key aspects of the user’s social context, so that the system can index people’s social environment.

SOPHIA is interpreted in the following way. Knowledge, one of the primary aspects of the ontology, is an important part of how we operate in a social world. People socially interacting in urban space draw on their knowledge using their understanding of the world around them. They use physical affordances to operate in the world recognizing places for entering or places for gathering. People also operate in public places using a set of social affordances. They look to what other people are doing to find cues about what to do in a place. Following crowds or people queuing is a way for people to work out where they are supposed to go. Physical familiarity with a place means that they approach specific places using familiar paths, the way that they “usually come”. They use social experience of places as a basis for selecting places to socialize in with friends and use their shared past experience to index to past social events, for example "lets meet where we met last time". Context is another primary aspect of the ontology. The context, or current situation of a space, is an important aspect of sociality in urban space. When socializing the presence of people, both friends and strangers, influences the way that people behave and move through urban space. Friends maintain their sense of “group” by the way that they physically locate themselves as they move through a public place, they like to be near others but not necessarily interacting directly with them, they also like to watch others. The setting in which a particular activity takes place matters. The presence of others and environmental comfort influences the choice of location to socialize. Surroundings also play an important role, and are often used as reference points. The final aspect of the ontology addresses what motivates social interaction in a place. People like to size up situations by standing on the outside to understand what is happening before entering into them. People require different levels of information for different activities. While wayfinding in a place people direct their movement by familiar paths and looking ahead for familiar objects. As a social activity they spend time
exploring, both physical space and shared knowledge, just for the sake of it. Friends spend time negotiating while socialising in a place deciding what to do and where to go next.

<table>
<thead>
<tr>
<th>Knowledge</th>
<th>physical affordances, social affordances, physical familiarity, social experience</th>
</tr>
</thead>
<tbody>
<tr>
<td>Context</td>
<td>us and them, setting matters, indexing to surroundings</td>
</tr>
<tr>
<td>Motivation</td>
<td>sizing up situation, seeking information, directed movement, exploring, making decisions</td>
</tr>
</tbody>
</table>

**Table 2: SOPHIA: Ontology of Sociality in Urban Space**

5. **DESIGN OPPORTUNITIES AT FEDERATION SQUARE**

This section presents outcomes from the field studies that represent key contextual factors that characterise the environment at Federation Square. These factors can then be used to identify design opportunities that can be used to inform the design of context-aware pervasive computing for Federation Square.

The analytical process that led to the set of high-level concepts that became the MIRANDA and SOPHIA ontologies also provided a quantification of those concepts. From this quantification it was possible to systematically identify the key characteristics of Federation Square and to derive from this a set of design opportunities that incorporate understanding of both the physical and social context of that place.

5.1. **Understanding Physical Context at Federation Square**

The key characteristics of physical context at Federation Square were identified from analysis of the tallied word-pairs of the analytical ‘language’ and are listed in Table 3.

From this list, it can be seen that activity in Federation Square occurs primarily around the edges inferring that spaces generally have little activity in the middle. This was represented on the positive layers of the diagram as a strong link between ‘activity’ and ‘edge’ meaning that the statement "+activity.edge" occurred frequently in the dataset. Other information provided by the tally was that the space looks out at views of its surroundings. The space has general paths, and general entrances, indicating that Federation Square does not provide specific paths and entrances to individual places. In amongst these general paths and entrances are nodes, or places, designed to accommodate specific activities. Similarly, there are distinct structures in the space acting as focal points or landmarks. The negation of the word pairs provided the following summaries of the space. Locating a specific place within Federation Square is difficult because the destination place is often not visible from the main plaza. Paths between places are not inviting, and it is often unclear what is intended as a path, which path to take or where a path leads. Entrances are also difficult to identify and are not clearly distinguishable from building facades. These facades in themselves are monolithic and do not relate to the scale of a person walking beside them.

<table>
<thead>
<tr>
<th>positive characteristics</th>
<th>negative characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>activity edges</td>
<td>no visible goals</td>
</tr>
<tr>
<td>visible surrounds</td>
<td>inviting paths</td>
</tr>
<tr>
<td>general paths</td>
<td>unclear paths</td>
</tr>
<tr>
<td>general entrances</td>
<td>unclear entrances</td>
</tr>
<tr>
<td>activity nodes</td>
<td>non-humanscale walls</td>
</tr>
<tr>
<td>focal structures</td>
<td></td>
</tr>
</tbody>
</table>

This catalogue of the MIRANDA ontology was used to derive the following set of design opportunities from the understanding of physical context at Federation Square:

1. Federation Square has activity edges, focal structures, and no visible goals, so it is not clear from the middle of spaces what is around, and how to find where you want to go; and
2. Federation Square has visible surrounds, general paths and entrances, focal structures and no clear paths, so people need to use the structures and surrounds in finding their way around the space. These two design opportunities derived from understanding physical context at Federation Square contributed directly to the design of a functional prototype (see Paay & Kjeldskov, 2005).

5.2. Understanding Social Context at Federation Square

The key characteristics of social context at Federation Square were identified from analysis of the tallied category-property-dimension triplets of the coding process and are listed in Table 4.

From this list, it can be seen that at Federation Square, the presence of others is important, and being a place with many outdoor spaces, environmental conditions also plays a big part. The choice of activity and place to socialize are mostly based on the experience that the group has shared in the past, they like to go to familiar places or places that they know they like, and new places require recommendations from reliable sources. As Federation Square has open spaces and can attract large crowds the group usually defines themselves as a group by staying close together. People enjoy proximity to others but not necessarily interaction with them. They like to watch others, especially when they are on their own. A group of friends spend a lot of time negotiating decisions about different options. In making choices at Federation Square people want the opportunity to size up a situation and get an overview before committing to a course of action. They also like to make sense of things that are happening around them, and like to know where the busy places are. In giving directions or orienting people use the surroundings in terms of visible elements, or even aspects of shared knowledge that they have, for example "it's where that book launch was held". In moving about the space they rely heavily on the use of familiar paths to familiar places and despite a more efficient route to a place, they prefer to go "the way I usually go".

<table>
<thead>
<tr>
<th>Table 4: Social context at Federation Square</th>
</tr>
</thead>
<tbody>
<tr>
<td>setting matters</td>
</tr>
<tr>
<td>- environment and others</td>
</tr>
<tr>
<td>social experience</td>
</tr>
<tr>
<td>- past/shared experience, recommendations, preferences</td>
</tr>
<tr>
<td>us and them</td>
</tr>
<tr>
<td>- maintaining group, proximity, watching others</td>
</tr>
<tr>
<td>making decisions</td>
</tr>
<tr>
<td>sizing up the situation</td>
</tr>
<tr>
<td>- getting an overview, making sense of what's happening</td>
</tr>
<tr>
<td>indexing to surroundings</td>
</tr>
<tr>
<td>- shared knowledge, visible elements</td>
</tr>
<tr>
<td>physical familiarity</td>
</tr>
<tr>
<td>- familiar paths and places</td>
</tr>
</tbody>
</table>

This catalogue of the SOPHIA ontology was used to derive the following set of design opportunities from the understanding of social context at Federation Square:

1. At Federation Square peoples past experience with places and people (familiar places and shared experiences) and the situation of these experiences are important in choosing places and activities;
2. At Federation Square people typically coordinate meeting up with friends in an ad-hoc manner, depending on activity and shared history with those friends;
3. At Federation Square people give directions by referencing to shared experiences and visible elements, and use their history and physical familiarity with a place to find their way around using familiar paths;
4. At Federation Square people like get an overview of what is happening and want to know about the existence of other people in places and what they are doing.
These four design opportunities derived from understanding social context at Federation Square contributed directly to the design of a functional prototype (see Kjeldskov & Paay, 2005).

6. CONCLUSIONS AND FURTHER WORK

Sociality in the city is complex. This study has provided a way of understanding physical and social context better. Through empirical fieldwork, using a user-centred approach and observational methods, high-level understanding of both physical and social context of urban space has been formalised into ontologies, and these representations have also been quantified to identify design opportunities for a digital layer of pervasive computing that facilitates sociality in a particular urban environment.

To realise the validity of the process of studying physical and social context in this way, the design opportunities presented in section 5 have been used to inform the design of functional prototype context-aware pervasive system called Just-for-Us. This system was designed specifically for groups of people socialising at Federation Square and runs on a mobile device using embedded sensors in the environment to provide spatial, physical and social contextual information to the system. The system also uses indexical references to key physical and social aspects of its context of use, as identified through MIRANDA and SOPHIA to minimize the amount of information displayed in the interface. At present, field studies are being conducted in Federation Square with the Just-for-Us system to provide more field data. This contributes to answering the challenge presented by urban environments for context-aware computing of using an empirical, user centred approach to studying how people operate them while situated in the context of use.

7. REFERENCES


8. **ACKNOWLEDGEMENTS**

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