

2006

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Recommended Citation

Kjeldskov, Jesper and Paay, Jeni, "e-Spective: pervasive computing presenting a new perspective of the city" (2006). *ACIS 2006 Proceedings*. 47.
<http://aisel.aisnet.org/acis2006/47>

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e-Spective: pervasive computing presenting a new perspective of the city

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Abstract

As urban environments become increasingly hybrid physical and digital spaces, designing for public computing in city contexts requires researchers and practitioners to explore the intersections between spatial and physical context, sociality and pervasive computing technologies. This paper presents the e-Spective research project bringing together expertise from the fields of architecture, sociology, human-computer interaction, and computer science to explore inner city socialising and to design and evaluate in situ a public pervasive computer system prototype facilitating sociality by adding to a city precinct a digital layer of information about people, places and activities adapted to each individual user's own physical and social context. Making invisible dimensions of the inhabited physical space around you visible, the prototype system augments the city and contributes to the ongoing reshaping of urban life by facilitating new kinds of behaviour and situated social interactions in public spaces.

Keywords

Location-Based Services, Pervasive and Mobile Computing, Sociality, Built Environment, Field Studies

INTRODUCTION

As public urban environments become increasingly hybrid physical and digital spaces the intersections between spatial and physical context, sociality, and pervasive computing technologies need to be better understood when designing for people's public interactions in these hybrid spaces (Graham & Marvin 1996, Mitchell 1995). Pervasive computing has "radically refashioned the relationships of individuals to their constructed environments and to one another" (Mitchell 2003) and the boundary between virtual and physical space is dissolving. Our physical, virtual and social worlds are colliding, merging and coordinating (Rheingold 2003). This motivates rethinking the relationship between the environment and the technology pervading it (McCullough 2001, Mitchell 1995).

Pervasive computing and particularly mobile devices are increasingly being appropriated and used outside the work domain to facilitate urban people's social life in public. Mobile phones, and especially SMS texting, have changed the way people communicate, interact in the city, and coordinate their social activities (Grinter & Eldridge 2001, McCullough 2001). Smart Phones and Personal Digital Assistants (PDAs) connected to the Internet bring access to Internet communities and blogging to the mobile user (Beale 2005) and extend the potentials of SMS through Internet chat capabilities and facilities for video-based communication. By embedding networked sensors into the built environment, adding advanced positioning technology and short range network capabilities (i.e., Bluetooth, RFID tags, etc.), public mobile services are emerging that adapt their content to the user's location. For example, mobile dating services exist which alert people when they are in the proximity of a potential partner matching their own pattern of attributes. As another example, in some Danish cities swiping electronic membership cards at the entrances and exits of cafés, discotheques, music clubs, etc. makes it possible for members of a social group to identify the whereabouts of their friends and other people through the mobile Internet, and to see which places in the city are currently popular – and which are not. In the more experimental domain, location-based mobile services show the location of friends in vicinity (Fithian et al. 2003), take into consideration the user's social context when presenting event and tourist information (Cheverst et al. 2000), and create intersections between physical and virtual spaces by enabling people to attach virtual text and media content to physical locations for others to find (Persson et al. 2003).

The emergence of public pervasive and mobile location-based services like these represents a new trend of huge interest not only to researchers and practitioners within the human-computer interaction community but also to architects, urban planners and designers: reshaping urban life by adding to our inhabited built environments a digital layer of information and communication – a digital layer which is not only created, maintained and owned by commercial information providers such as vendors, large businesses etc., but which is generated and continuously refined by the public itself through its very use. The new challenges imposed on us by this new

trend are not trivial and further research is needed into the design and use of mobile technologies in urban environments.

In response to the trends outlined above, the aim of the *e-Spective* project presented in this paper has been to inquire further into some of the challenges of designing for public computing in city contexts through a design case study of public pervasive and mobile computing facilitating sociality in a specific city precinct. The e-Spective project has currently spanned over two years and is still ongoing. It has combined expertise from the fields of architecture, sociology, interaction design, information systems and computer science in a collaborative effort to carry out architectural analysis of a public city precinct, sociological analysis of people socialising there, design and implementation of a functional prototype of a public pervasive information system, and to study people's use of this prototype system in situ. Currently, we are in the phase of refining our initial design ideas and extending their scope to a larger city area. Below, we briefly outline the case site for the initial e-Spective research study, Federation Square in Melbourne, Australia. We then describe how architectural methods were applied to the analysis of this particular city precinct and how this in combination with the sociological study informed the design of a public pervasive computer system prototype accessible through personal mobile devices augmenting the city by making invisible elements of urban life visible. Finally, we describe how we took our prototype location-based service back into the public city precinct and studied its use in situ, and discuss highlight findings from this study.

DESIGN CASE: FEDERATION SQUARE, MELBOURNE, AUSTRALIA

For the purpose of understanding urban socialising behaviour within the built environment of inner cities and informing the design of public pervasive information systems facilitating this kind of "situated sociality", the e-Spective project took its offset in a newly opened and geographically delimited civic space in the city centre of Melbourne, Australia called Federation Square (Figure 1).



Figure 1: Federation Square, Melbourne, Australia

Federation Square is a new civic structure, opened to the public in October 2002, covering an entire city block, providing 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 for socialising including restaurants, cafes, bars, a museum, galleries, cinemas, retail shops and several public forums. In just a few years, Federation Square has become a highly popular place to socialise for urban people living in inner city Melbourne. It is open early until late, every day of the week, and there are almost always some events taking place there. Located right in the centre of the city, on a major tram line, and across from the main train station, Federation Square is easily accessible for people, is considered a landmark in itself, and is a convenient place for people to arrange to meet up in the beginning of a night out on the town. From the very beginning, one of the design intentions for the public space of Federation Square was to incorporate public digital technologies into the building fabric, creating a mix of virtual information space and physical building space for people to experience. Thus, this particular place provided a unique setting for the e-Spective project studying people's situated social interactions in a "hybrid" digital and architectural space and inquiring into the user experience of pervasive technologies augmenting such a physical space with digital information.

Field study of the physicality of an inhabited public space

Designing information systems for public use in city contexts differs fundamentally from designing for private use in the workplace or in the home, and requires system developers and interaction designers to obtain a basic understanding of how the architecture of a physical space works, how it contribute to our experience of a place, and how it interplays with the situated social interactions taking place there. As a starting point for the e-Spective project, expertise was thus brought in from the fields of architecture and sociology, firstly turning attention to the seminal works of urban planner Kevin Lynch and architect Christopher Alexander. Although originating from the field of architecture, the works of Lynch (1960) and Alexander et al. (1977) have recently been taken up by a range of researchers within the field of human-computer interaction, indicating a compatibility of thinking between these two otherwise very different areas of research. For example, Erickson and Kellogg (2002) use Alexander and Lynch for exploring the relationship between physical spaces and social interaction and informing the design of web systems supporting social interaction. In relation to mobile interaction design, Lynch has inspired several experimental guide systems (Goodman & Gray 2003, Kulju & Kaasinen 2002). Alexander and Lynch also inspired the study of “familiar strangers” in urban settings and the subsequent design of the “Jabberwocky” personal mobile device facilitating social interaction in public places (Paulos & Goodman 2004). While this research has mostly adapted Lynch and Alexander’s work on either a conceptual level or by applying their methods to challenges of computing similar to those of architecture, our aim with applying the works of Lynch and Alexander lay closer to their original purposes as methods and techniques for analysing and understanding a physical space, from the level of a whole city precinct down to each individual architecturally designed element, not informing further physical design in this case but further digital design. Guided by Lynch’s (1960) and Alexander’s (1977) methods for city precinct and built environment analysis, the architectural study consisted of a series of field visits to Federation Square by an architecturally trained researcher. This researcher systematically observed the architectural and informational properties of the space by mapping the presence of architectural elements through photos and field notes for later classification. The field visits resulted in a collection of 250 digital photographs of physical elements in the built environment of Federation Square annotated with written notes of observations of the relationship between architectural elements and the environment (including interaction with people inhabiting the space) and a map of the identified elements of the space. Using rapid ethnography content analysis (Millen 2000) and affinity diagramming (Beyer & Holtzblatt 1998), Lynchian and Alexandrian concepts and themes were then extracted from the photographic data and notes, and repeating phrases and concepts were grouped and refined until a concise set of terms describing the space emerged. These were then overlaid onto a map of Federation Square to produce a colour-coded annotated Lynchian map of the space indicating the physical location of the source of the different categories (Figure 2 left) and grouped with representative digital photographs to produce a series of Alexandrian “patterns” describing the specific features of the architectural space (Figure 2 right).

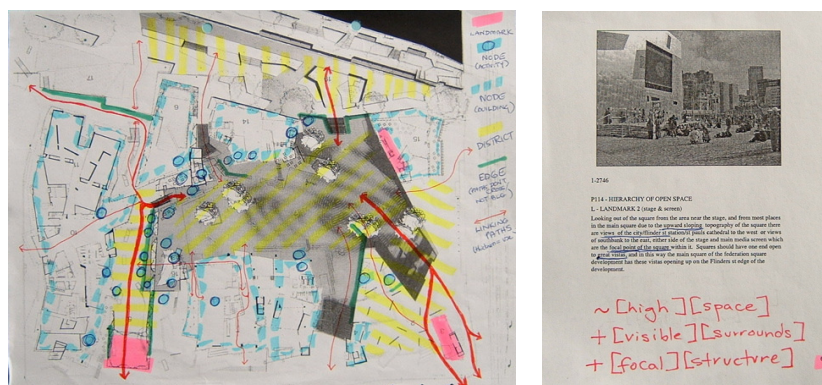


Figure 2: Map of Federation Square precinct with annotated codes for districts, landmarks and other significant architectural features inspired by Lynch (1960) (left), and Alexandrian coding of significant architectural features inspired by the Pattern Language approach described in Alexander et al. (1977) (right)

The architectural field study provided the project team with a shared baseline understanding of the physical space we were going to design for on several levels of abstraction from the properties of the overall city precinct (primarily informed by Lynch) to the more specific architectural properties of the space (primarily informed by Alexander).

While the complete set of findings is too comprehensive for reporting here in its totality, we outline, as an example, some of the highlight insights gained about the architectural space studied.

From our analysis of the comprehensive data material about the architectural space of Federation Square, it was clear that this space is physically complex with a series of significant features both enabling, challenging, and sometimes hindering the social interactions taking place there. From the Lynchian map of the precinct (Figure 2) it was apparent that Federation Square is divided into four key “districts” with clear corresponding landmarks: 1) the transit zone - connecting Federation Square with the rest of the city, centred on the information centre, 2) the main plaza - an earthy, sloping open space with outdoor activities facing the stage and media screen, 3) the atrium - noisy, sheltered, constructed of machine-made materials, with a huge opening towards the city, and 4) the river precinct - at the back, flat, damp, lower than the rest of the spaces facing towards the river itself. In addition to this, the Alexandrian coding of the data revealed a series of key architectural characteristics of the space. Places at Federation Square were found to be primarily located on the edges and consequently there is very little activity in the middle of the space. Due to its openness, however, the space has clear views of the surrounding city skyline from almost anywhere. The space has a lot of general paths and entrances, in amongst which there are distinct nodes, or places, designed to accommodate specific activities. Paths between places are not inviting, and it is often unclear what is intended as a path, which path to take or exactly where a path leads. Locating a specific place within Federation Square can be difficult because places are often not immediately visible. Also, it is difficult to identify entrances, as they are often not clearly distinguishable from the facades. These facades in themselves are monolithic and do not relate to the scale of a person walking beside them. On the other hand, the facades constitute distinct structures in the space and act as focal points or landmarks.

Field study of situated social interactions in a public space

Although the works of Lynch and Alexander explicitly consider the inhabitants of architectural space and the interplay between human activities and cities, buildings and constructions, applying these architectural methods to the study of public computing in city contexts tells us little about people’s experience of an urban environment, how they operate within the complexities of the city and how they shape their lives around public architectural and technological infrastructures. Complementing the architectural field study, the second phase of the e-Spective project thus inquired into people’s situated social interactions at Federation Square guided by a subset of McCullough’s typology of everyday situations (McCullough 2001) for classifying peoples’ social activities when out on the town: eating, drinking, talking, gathering, cruising, belonging, shopping, and attending. This sociological field study consisted of a series of contextual interviews (Beyer & Holtzblatt 1998) and ethnographic field observations (Figure 3) with three different established social groups of three young urban people during normal outings to Federation Square. Prior to the field visits, each group was interviewed for 20 minutes about their socialising experiences and preferences out on the town. The interviewer and a cameraperson then followed the group to the nearby Federation Square where the group had arranged to spend time together. Throughout the visit, the group was asked to verbalise their actions as they moved around the space and respond to questions from the observing interviewer. Each contextual interview and field observation lasted approximately three hours amounting to eight hours of video and 30 pages of written notes. The video data was first transcribed and then analysed using open coding (Strauss & Corbin 1990) and affinity diagramming.



Figure 3: Contextual interviews at Federation Square

From analysing our video data it was clear to us that people’s situated social interactions in a public city space are not simple and random but highly complex. We outline here some highlights about people’s situated social interactions in the city extracted from our sociological field study.

When interacting socially in public, people draw extensively on cues embedded in the world around them. They use physical affordances of the built environment for recognising places for entering, places for gathering etc., and they make wide use of landmarks as focal points. People also use social affordances when operating in public

places. They observe what other people are doing and often work out where to go and what to do in a public place simply by following the crowd or queuing up with other people. People also make extensive use of their experience from similar public places and situations to determine how they are supposed to act and behave.

The presence of other people, including friends and strangers, highly influence the way people behave when socialising in public places. People like to “socialise by proximity”, that is, be near other people but without having to interact directly with them. People also like to watch others, especially if they feel unobserved themselves or if they are waiting on their own. Setting is also an important contextual factor for socialising. Factors such as presence and types of other people, physical comfort, convenience of location, and whether a place is sunny or sheltered highly influences people’s choice to socialise there or not. As an example, people often describe places in terms of their physical appearance, spatial location in relation to other places or landmarks, typical types of patrons and activities rather than by their official names.

Reflecting on what is going on around you is also a central aspect of socialising in a place. People are continuously trying to size up the situation and like to get an overview of what is happening in the places around them. As a part of this, people spent a lot of effort on making sense of things and places often based on very little and fragmented information such as the presence and activities of others. Before committing to entering a place or event, people tend to pause, stand back, and familiarise with the situation. As a part of this, people want to know what is new at a place, and are generally hungry for information. Lack of appropriate information, especially in unknown places, leads to uncertainty and to reluctance of entering.

MAKING THE INVISIBLE VISIBLE: A PROTOTYPE SYSTEM

Insight generated through architectural and sociological field studies as exemplified above is highly valuable when designing a public information system facilitating sociality in the city. Based on findings from our field studies and inspired by related literature we have designed and implemented prototype system called *Just-for-Us*. *Just-for-Us* is a publicly available mobile web location-based service using a pervasive network of context-sensors embedded into the built environment to generate a digital layer of information about people, places and activities adapted to each individual user’s own physical and social context and to their history of social interactions in the city. Presenting a new perspective of the city by making invisible (or obscured) dimensions of the physical space around you visible, *Just-for-Us* augments the city and contributes to the ongoing reshaping urban life by facilitating new kinds of behaviour and situated social interactions in public spaces.

The *Just-for-Us* system was implemented as a server-side web application that can be accessed through a mobile web browser facilitating content delivery over HTTP (Figure 4). For the first prototype, we used a series of HP iPAQ h5550’s connected to the Internet through WLAN or a GPRS connection. The content of *Just-for-Us* is powered by a MySQL database containing information about the physical layout of Federation Square (derived from the architectural field study), descriptions and photographs of landmarks and transition points, and information about the different establishments and businesses in the precinct including their spatial location, accessibility, descriptions of special events, menus, programmes, photos etc. Additionally, the database is continuously updated with information about peoples’ current context (location, activity, social group, etc.) and keeps a history of their interactions in the city.

Just-for-Us works very similarly to a dynamic web site delivering dynamic information to the user generated on the basis of database queries. PHP is used to generate web pages on the basis of the information in the database and client-side interaction and handling of information pushed to the browser is done using JavaScript. Supporting the web site, a number of server-side programs perform specific sub-tasks such as pushing information to the user when appropriate and dynamically generating maps and annotated photographs. However, *Just-for-Us* differs from a traditional web site by delivering its content in response the physical and social context of the users location and by a large proportion of this content being accumulated public information about the physical space and people currently situated there, their physical location, what they are doing, popular events, friends nearby, etc., relayed anonymously back to the *Just-for-Us* server in real time from pervasive computing technology embedded in the environment (e.g., network infrastructure) or carried by other people (e.g., cell phones). Thus, *Just-for-Us* system generates content about the public for the public by the public.

Just-for-Us is able to acquire the location of people by means of several positioning technologies including GPS, WLAN or Bluetooth beacons. Using Bluetooth beacons for positioning, the system does not know peoples’ exact coordinates but has a rough idea of his or her position (e.g., if he or she is in a specific café or in the main square). The presence of friends in vicinity is resolved by scanning for other Bluetooth devices matching the user’s list of friends. The *Just-for-Us* system provides the user with a range of location-based functionalities designed to facilitate social urban life. Below, we describe how it presents you with a new perspective of the city by annotating buildings and places and by showing people and activities around you.



Figure 4: The general system architecture of the Just-for-Us prototype

Augmenting physical context: annotating buildings and places

One of the key findings from the field studies was that the physical space of Federation Square is divided into four districts each with distinct features and landmarks. Like many other places, the space has significant focal structures but it is difficult to find out what is going on behind the facades. Because the space is very open, however, the city skyline surrounding the precinct is highly visible. This informed the design of the “home” screen of Just-for-Us, augmenting the users immediate physical surroundings by annotating buildings and places and in this way “indexing” information to the built environment (Figure 5). When entering Federation Square, a home screen is pushed to the device with information corresponding to the district where the user is located. The home screen consists of four elements; 1) the name of the district, 2) textual descriptions of places in that district, 3) a 360° annotated panoramic view of the district and surrounding city, and 4) an activity meter showing the current patronage and primary activity at a selected place. The annotations on the panoramic photograph show what is located behind the physical structures surrounding the user, thus making the invisible visible through a form of indirect augmented reality. Clicking on an annotation, a short description of that place and a list of what’s currently happening there, such as specials or upcoming events, movies etc., are displayed, and the activity meter indicates how busy the place currently is and what people are primarily doing there. Using the arrow icons below the photograph, one can explore the surrounding by panning the panoramic photo left or right. By default, the panoramic photograph is focused on the most prominent landmark in that district. When the user enters a new district the corresponding panoramic photograph is automatically pushed to the device.



Figure 5: Home screen: augmenting the user’s immediate built surroundings

Augmenting social context: displaying people and activities in proximity

Another key finding from the architectural and sociological field studies was that while the physical space of Federation Square is highly complex, people were surprisingly good at making sense of it. They do this through the social affordances provided by other people: where they are and what they are doing there. People often use this information as important cues for where to go and what to do themselves, and it also accommodates their desire for interaction by proximity between their own social group and others. These findings informed the design of the “now” screen of Just-for-Us, augmenting the social context by displaying people and activities in proximity (Figure 6). When the user clicks on the “now” icon on the main menu, a small map of their immediate surroundings appears superimposed with dynamically updated coloured circles indicating the current clustering and activities of people within proximity. The radius of the circle indicates the number of people at a place while

the colour represents their prevalent activity (e.g., “having coffee”, “having drinks”, “eating” or “attending a cultural event”) using the system’s general colour coding of these activities. The map also shows the user’s (approximate) location. Clicking on a circle takes the user to more information about that place or group of people such as menus, programmes, descriptions, images, and to wayfinding directions. The information on the “now” map is public in the sense that it is not authored or “owned” by anyone but is generated collectively by the public anonymously relaying fragments of information about themselves, their whereabouts and their history of socialising in the city in return for access to the shared resource of cumulative information.



Figure 6: Now screen: showing clustering and activities of people nearby

STUDYING JUST-FOR-US IN USE

Due to the real world nature of the public pervasive information system presented above we wanted to study the use of it by people socialising in situ at Federation Square. For this purpose, we developed a “field laboratory”, which we could take with us into the city (Figure 7). The use study included 20 established social pairs of people familiar with Federation Square using the system for approximately 1 hour. Prior to the study, the database was populated with data about people’s history of socialising in the city gathered through a questionnaire. Because we were not interested in whether or not people were able to operate the system as much as we were interested in how they would perceive and make use of its location-based and city augmenting functionalities, people were given a 10-minute introduction to the system and were allowed to familiarise themselves with it for another 5-10 minutes. Inspired by the method of rapid ethnography (Millen 2000) we gave the users a number of overall scenarios for socialising, prompting them to explore different parts of the system. Inspired by the constructive interaction approach to thinking-aloud studies with more than one user (Kahler 2000), the groups were asked to talk among themselves about their perception of and interaction with the system interrupted only with questions for clarification.



Figure 7: Studying the use of Just-for-U in the field: researcher operating mobile AV recording studio (left) and researcher doing contextual interview (right)

The use studies were recorded by means of a miniature wireless camera attached to the mobile device transmitting a close-up image of the screen to a bag carried by the test monitor where it was mixed on the fly with a third-person view of the users allowing high-quality data collection as well as unobstructed user interaction (Figure 8). Ensuring high-quality sound, users and interviewer wore directional wireless microphones. Mixed

video and sound was recorded digitally on a 100GB AV recorder. For testing purposes, the users' position, people and friends in vicinity etc. were entered manually on another PDA in a "Wizard of Oz" fashion (Dahlback et al. 1993) without the users' knowledge.



Figure 8: The mobile field laboratory (left), wireless micro camera mounted on mobile device (middle) and the video recording of participants, interviewer and physical surroundings with inserted close-up of mobile device interface (right)

USER RESPONSES

The user study provided rich data on the use of a public pervasive information system within a city context. On a general level, the study showed that people could easily operate the system; find what they were looking for and understand the presented information and functionality. They found the design of the system attractive, streamlined and professional looking, and trusted its content to be true. On a more specific level, most users reported that providing a public digital layer of information augmenting the city on their mobile device was "very cool", "useful" and "fun". In particular, people were fascinated that the system knew their current physical location, who they were with, and where other people in the civic space were currently gathering. They were also fascinated by the ability to access information about the places around them from both businesses and from other people, and they perceived the service as a credible source of information augmenting their surroundings.

Visually augmenting the users' physical surroundings was generally found to be an interesting, flexible and easy way to explore what's around you. In relation to this, users generally found it very easy to match up objects (i.e., huge satellite dishes), structures (i.e., significant buildings) and outlines (i.e., the city skyline) in their physical surroundings to the images on the screen. As a direct consequence they also found it straightforward to "reverse-match" information in the system to corresponding places in the real world.

Representing other people and their activities was found to be of huge interest and value for people getting an overview of a public space and for informing discussions among the group about what to do and where to go. Observing the use of this functionality we were amazed with the extent of conclusions that people would sometimes draw about the presence and activities of others based on a relatively simple graphical representation.

In relation to public pervasive computing augmenting the city, we found that people are generally both willing to and highly capable of making sense of sometimes very reduced and fragmented information, depending on the contextual factors adapted to and provided that the right clues for the interpretation of information are given. For example, we found that adapting information to the user's physical location was typically understood right away while adapting information to their current social group was often found to be unclear when the underlying premises for this behaviour was not explained. In relation to information push, we found that while people were generally happy about the home screen subtly adapting to their current district, they did not like receiving a lot of pushed information that they had not explicitly requested.

On the problem side, the user responses also revealed some limitations of our prototype design for making the invisible visible. First of all, people were surprised when the system adapted information to their social context. They were not used to web sites operating in this way and were at times uncertain about how to control it. As part of this, people generally expressed that for privacy purposes they would like to have more control over their profile in the system and be able to review and modify the information they were making publicly available. In relation to matching up information in the system with places in the physical world, images on the screen were sometimes difficult to see in bright daylight and using line drawings rather than photographs was suggested as an alternative. In relation to the labelling of places in the system, we found that formal place names (i.e., "St. Paul's Court"), or indexing to transient activities (i.e., "the sitting steps"), was found problematic by many users, while objectively descriptive labels (i.e., "the black building") were generally easily understood. A final limitation of the current design was related to the accuracy of information presented in the system. While the design team had tried hard to make sure that the system was populated with correct and updated information, most users noted promptly when this was not the case, for example when places had shut down or temporary constructions had

been put up, which was not reflected in the system. While most people were able to distract from this lack of accuracy, it was perceived as confusing and weakened the system's credibility.

CONCLUSIONS

This paper has addressed the challenge of facilitating sociality in the city through public pervasive location-based services. Based on findings from field studies of an architecturally designed urban public space and people socialising there, we have presented a mobile prototype system, Just-for-Us, which facilitates socialising in public city contexts by adding to a city precinct a digital layer of information about people, places and activities – making invisible dimensions of the inhabited physical space around you visible, thereby expanding people's current perspective on their situation.

Applying architectural methods to the study and analysis of a city precinct enabled us to gain a deeper understanding of the physical space we were designing for by identifying a series of significant features both enabling, challenging, and sometimes hindering the social interactions taking place there. Investigating people's situated interactions when socialising out on the town expanded the architectural analysis with a human-centred perspective on people's experience of an urban environment, how they operate within the complexities of the city and how they shape their lives around public architectural and technological infrastructures. Bringing expertise about architecture and sociology into the design team allowed us to explore properties of the physical space of a specific city precinct and situated social interactions taking place there, which are typically not brought to mind in interaction design for mobile and pervasive information systems.

Studying the prototype system in use, we learned that people are fascinated by the concept of a digital layer of public information overlaying the city and making invisible (or obscured) dimensions of the urban environment around them visible and providing content about the public for the public. They like the augmented "e-Spective" of the city, and they are highly capable of "connecting the dots" when linking information from physical, social and digital layers of an urban environment. Extending pervasive public computing functionalities such as the ones presented in this paper may provoke new and unforeseen technology supported behaviour within the city and contribute to the ongoing reshaping of urban life enforced by mobile and pervasive technologies that we are already witnessing.

Informed by the findings from our use studies, we are currently working with further iterations of design. While the fundamental idea of augmenting the city by a public pervasive computer system proved to be feasible and intriguing, our first prototype system left us with many possible avenues for further work to explore. Of special interest, we are investigating further opportunities for allowing the users to contribute more with their own content in ways similar to mobile blogging, and hence create a more organic and richer layer of public digital media overlaying the city. It would also be interesting to explore the creation of virtual entities of social groups and to blur the boundary between physical and virtual urban life by allowing for socialising by virtual proximity.

On the interface design level, our present design work is focusing on indicating more clearly to the user what the system knows about their context, and how it is adapting to it, and to facilitate more flexibility and user control. Also, we are exploring ways of merging the benefits of the photographic representation with interactive 2D and 3D map representations.

On the technical side, we are developing a more flexible platform for extending the system to cover a much wider physical area, making the interface adaptable to even smaller mobile devices such as mobile phones, and extending the mobile, location-based interface with omnipresent, web-based access.

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ACKNOWLEDGEMENTS

This research is supported by the Danish Technical Research Council's talent project "Indexical Interaction Design for Context-Aware Mobile Computer Systems" (project reference 26-04-0026) and The University of Melbourne's PORES program. The authors thank everyone participating in the field study and in the evaluations of the prototype system. We also thank Steve Howard and Bharat Dave for valuable input throughout the project.

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