Urban Space and Pervasive Systems

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ABSTRACT
In this paper we present an early approach for developing a theoretical framework and understanding for designing pervasive systems as an integral part of the urban landscape. The research will be conducted in the city of Bath as part of the CityWare project, in a heritage environment with tourist attractions.

Here we propose to investigate the application of research methods based on Space Syntax, which encompasses a set of theories and techniques for the analysis of space and spatial patterns, as a framework for understanding the complex relationship between pervasive systems, urban space and society in general; and the impact of the deployment of pervasive systems on people's relationships to heritage, and to each other in particular.

Keywords
Urban space, pervasive systems, Space Syntax

INTRODUCTION
Building pervasive systems as an embedded part in the public space, allowing information and communication devices to sense changes in their environment and automatically react based on user needs and preferences in relation to these changes requires a new way of thinking about the design and use of these systems and how they interweave with the built environment. From the human factors perspective, developing successful city-scale systems requires significant advances in areas such as interface design, context awareness and service discovery, to help people manage the demands on their attention and make the best use of their limited ability to describe what they want or need from this new combination of the built environment and the digital services.

Recent research has addressed some aspects of pervasive systems in urban contexts but without taking into consideration the design of pervasive systems as an integrated facet of urban design. Previous studies have explored people's social behavior and relationships with urban space and pervasive technologies and provided useful findings on which we can build (For instance: eGraffiti, Guide, Equator IRC, Mobile Bristol, Urban Tapestries and Intel's Urban Atmospheres).

Although some of them have investigated some of the technical issues, these studies have not solved the technical and engineering challenges of implementing city-scale pervasive systems. Research to date has been mainly conducted through 'experiences' or 'performances' that cover a small area and in almost all cases are held over short timescales [1].

In our research we seek, within the Space Syntax group and as part of the CityWare project, to extend and adapt our understanding and practice of urban design by looking at the urban environment as an integrated system mediating both the built environment and pervasive information and communication systems.

SPACE SYNTAX AND PERVASIVE COMPUTING
The urban built environment plays a critical role in the construction and reflection of society and social behaviors. It does not only reflect and express social patterns, but can also generate these patterns by shaping patterns of movement and co-presence between people [2, 3, 4]. However, there have been a number of technologies that have influenced the form and dynamics of cities to a great extent. The skyscrapers, for example, were made possible not only through the constructional innovations, but also by the invention of the elevator and the telephone [5].

We argue that a systematic approach to designing the urban environment as an integrated system of physical architecture and pervasive technologies demands a coming together of the disciplines of Urban Design and Computer Science. Key to this interdisciplinary integration is the concept of space. In order to address and understand social issues raised by using pervasive systems as an integral part of the public space we propose an early approach based on the implementation of Space Syntax theories and methods for the analysis of the spatial morphology of the city of Bath. Space syntax, first developed by Hillier & Hanson 1984, analyses cities as systems of space created by the physical artefacts of architecture and urban design in order to understand how the spatial structure of the city is related to its function [4, 6, 7]. Space Syntax is distinct from other forms of spatial analysis in that it characterizes spatial elements (rooms, streets segments etc) first and foremost in terms of their relations (e.g their topological distance) to other elements in the system. The resulting patterns of values for elements have been shown to correlate with many functional phenomena, such as movement and land use patterns. This allows us to integrate a range of social,

cultural and economic factors within a single study methodology.

RESEARCH METHODS

In the research various emerging issues will be addressed. These include understanding the following: 1) the complex relationship between pervasive computing technologies, urban space and society, 2) the nature of the city and its relationship with society, 3) the role of heritage in the construction of society and social structures, 4) the impact of the deployment of pervasive systems on our understanding of the city, the heritage and on our sense of belonging to the physical and social space, and 5) the different usage patterns of physical and digital artifacts.

These issues will be investigated through a Space Syntax analysis of the City of Bath. This will involve identifying social practices in Bath as a heritage based tourist attraction and as a place of work and study; identifying existing social protocols and the emergent ones that result from the deployment of pervasive technologies; and identifying existing sub-cultures.

We will use five methods to capture data:

- **empirical observation**, survey and analysis of the urban space and the way it is used by different groups;

- **social mapping** of existing groups and social practices;

- **pervasive technologies mapping** of existing pervasive technologies and ICT services;

- **spatial analysis** of the urban space in terms of visibility and accessibility;

- **agent simulations** of interactions between different groups, as constrained by the city's form.

All the data obtained will be analyzed using software specifically developed by the Space Syntax group to understand the relationship between space and society. In order to map and analyse the social construction of heritage in the city of Bath visitors with phone cams will be encouraged to send their pictures or video clips, together with a small amount of text, to their friends as 'digital postcards'. In doing so, we will capture information on both their heritage interests and values, and the social from their phone cams. This record will be coded and analysed to generate an understanding of those aspects of Bath and its cultural heritage networks of participants. The public will be

encouraged to leave traces of their visit through text messages and images that people find of interest and for indications of possible usages of pervasive technologies and in particular contextual cues that sensitive service delivery should address. Finally the experience of pervasive computing will be analyzed through artistic experiments involving the city, the technologies and the people who happen to be using the space at that time. Key issues here are attitudes and reactions towards the use of technology and the experience of space. This objective will also be achieved through observations of new practices in the public space as a result of using new pervasive technologies (e.g. devices with Bluetooth) The most important objective of these activities is that people understand and are familiar with the possibilities of the technology and its use in space.

CONCLUSION

Urban space has not featured strongly in pervasive systems research. Here we suggest an early approach using research methods based on Space Syntax theory for developing a theoretical frame work and understanding for designing pervasive computing technologies as integral elements of the urban landscape in the city of Bath. We believe that the results of these analyses will contribute to fundamental theory and knowledge.

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CityWare: http//www.cs.bath.ac.uk/~vk/cityware/wps.html