Please reference this paper as
Kostakos, V. and O'Neill, E. (2003) Introducing Pervasive Computing to Society,
1st UK-UbiNet Workshop, 25-26th September 2003, Imperial Collene, London, UK.

Introducing Pervasive Computing to Society

Vassilis Kostakos & Eamonn O'Neill

Department of Computer Science

University of Bath

Pervasive computing is a relatively new area of interest within computer science. Most challenges that have been faced so far in our attempts at designing pervasive systems have been technical, as the focus of much of the research has been on implementation aspects, such as the enabling technologies and techniques for combining and integrating various technologies in a system [Hightower & Borriello, 2001]. Although such issues are of crucial importance, they do not address a vitally important issue of truly pervasive computing: integration and interaction with society. We argue that this is in large part due to the physical and conceptual limitations of current attempts at implementing pervasive systems.

Pervasive computing was supposed to be part of our everyday life and promised to assist us in all our activities regardless of our location [Weiser, 1991]. This vision of pervasive computing is that, ultimately, our whole society will benefit from such systems, and not just a few people doing very constrained tasks within physical "islands" of computing support. A pervasive system cannot reach its full potential – and cannot really be described as pervasive – when it is limited to, say, a "smart house" or a "smart car". If the whole of society is to benefit from such systems, then the whole of society must be part of such a system. Thus, the social issues that arise are not just side effects or problems that can be dealt with ad hoc, but are at the heart of the challenge – and the solution.

Much research to date in pervasive computing systems has focused primarily on small-scale, geographically constrained systems and the technical challenges that they entail. We argue that for the vision of truly pervasive systems to be realised, we must develop better understandings of and design methodologies for large-scale pervasive systems and the societal challenges that they will entail. Rather than moving towards large-scale pervasive systems in a bottom-up way from today's small-scale systems, and their associated challenges and ad hoc solutions, we argue for following a top-down approach, drawing on the human-computer interaction (HCI) lessons that have already been learned in the development of more traditional computer systems.

In our work, we revisit and extend the established HCI design foci of user, task and domain so that they are more relevant to designing for a social setting, proposing three analogous foci of citizen, sphere, and space respectively. The concept of a citizen can be more meaningful than the concept of a user in the social realm. Arguably, we may know little or nothing about the users of a publicly available, large-scale pervasive system, but there are a number of things we can know about citizens in general. Such information includes citizenship rights, how citizens view public systems (e.g. TV, public transport etc), what sort of legislation regulates the design and implementation of such systems, and what type of access to public systems users prefer or require.

The second concept used in our approach is that of information spheres: public, social and private. These concepts describe how information and services may be classified according to the kind of access they offer, while at the same time taking into account those issues that play a vital role in public and private life. This concept is used in conjunction with the other two as a means of validating or generating a mapping between the physical and digital environments.

Finally, we have introduced into our model the notion of spaces, classified as public, social and private spaces. These describe the physical as well as non-physical characteristics of a location, such as norms, expectancies and values that people attach to them. Public spaces, unlike private and social spaces, have not been adequately addressed by research in pervasive and ubiquitous computing, despite being of vital importance. Pervasive systems may facilitate public spaces in becoming more useful and usable by utilising guidelines and rules from architecture and urban design [Brebner, 1983]. But at the same time, our systems should reflect these guidelines themselves, since we envision our systems as invisible parts or extensions to the physical environment.

In order for pervasive computing to succeed in its vision, we must try to identify the strengths of the designs we propose, and how they should be integrated into our physical and social environments. Humans and computers can work together, feeding each other's strengths: computers are good at storing and retrieving information, constant monitoring and other monotonous tasks, and performing complex calculations, while humans are good at identifying patterns, spotting changes, responding to new situations, and extrapolating from knowledge and experience. We have identified an analogous situation in the case of the built physical environment and pervasive computing technology. One of the goals of architecture and urban design is to manipulate physical spaces in such a way as to provide greater functionality to people, and to allow them to do things quickly, effectively and with minimal obstacles. We could therefore say that space constraints are minimized in order to overcome time constraints. The situation with computer systems is complementary: performing complex calculations and data manipulation and exchange in order to overcome spatial constraints, i.e. minimizing time constraints in order to overcome space constraints. It would seem, therefore, that these two complex systems, the build environment and computer systems, could potentially benefit from each other by tackling each other's weaknesses and feeding off each other's strengths.

The concepts presented above represent scaffolding to assist us in the design and implementation of truly pervasive systems. Combining and using these ideas, we can address important issues such as privacy, delivery, mapping functionality to physical location, and interaction methods in a generalised top-down approach, always keeping in mind the social issues and requirements that may arise.

References

Brebner, J. 1982. Environmental Psychology in Building Design. Applied Science Publishers Ltd, London.

Hightower, J. and Borriello, G. 2002. Location systems for ubiquitous computing. *IEE Computer* 34(8), 57-66.

Weiser, M. 1991. The Computer for the Twenty-First Century. *Scientific American*, 265(3), pp.94-104.