Please reference this paper as
O'Neill, E., Woodgate, D., and Kostakos, V. (2004).
Easing the Wait in the Emergency Room: Building a Theory of Public Information Systems.
In Designing Interactive Systems. Cambridge, Massachusetts.

Easing the Wait in the Emergency Room: Building a Theory of Public Information Systems

Eamonn O'Neill, Dawn Woodgate and Vassilis Kostakos

HCI Group
Department of Computer Science
University of Bath
Bath BA2 7AY
UK
{eamonn, daw, vk}@cs.bath.ac.uk

Abstract

In this paper we discuss a real world problem encountered during recent fieldwork: that of providing information in public settings when the information has both public and private components. We draw on our ethnographic studies in the waiting area of a busy hospital Emergency department. Despite evidence that lack of information can lead to stress, problem behaviours and poor levels of satisfaction with treatment, little information was made available to patients. We review the types of information needed and propose how the theoretical concepts of public, social and private information spheres relate to public spaces such as the Emergency department waiting area. We argue how the further theoretical concept of interaction spaces may be used in conjunction with these information spheres to inform interaction design for public settings.

Categories and Subject Descriptors: H.5.2 **Information interfaces and presentation**: User Interfaces – Theory and methods; H.1.2 **Information Systems**: User/Machine Systems – Human factors.

General Terms: Design, Security, Human Factors, Theory.

Keywords: Social Computing and Social Navigation; Computer Supported Cooperative Work (CSCW); Handheld Devices and Mobile Computing; Ethnography; Health Care; Social and Legal issues; User Interface Design.

INTRODUCTION

There have been many empirical studies of groupware and computer-supported collaborative activities and large *vs* small display devices. What we hope to do is to build on previous empirical work to reach the stage of theory development and testing. In an idealized progression, we would move from empirical observations to tentative explanations, to testable theories, to empirical testing. HCI as a discipline remains pre-theoretical and is, at best, at the theory generation stage. We want theory in order that we can develop design principles. In contrast to guidelines or heuristics, we consider design principles to be theoretically well-founded, empirically tested and operationalized in unambiguous terms that designers can use. In this paper, we draw on empirical studies by ourselves and others and propose some first-cut theory in the hope that it may stimulate the theory generation, critique and testing cycle that ultimately may result in the development of reliable design principles for public information systems.

Our own most recent empirical work, on which we draw, involved field studies in the Accident and Emergency (A&E) department of a busy hospital. The use of information displays by staff in healthcare settings has been shown to provide important support for patient care [11, 48], for example in organizing and locating clinical information, and coordinating and managing patient care. Our fieldwork in the A&E department has also raised the need for the use of information displays by the patients themselves. In this paper, we discuss two important contemporary problems for healthcare which we argue may be linked, and which undeniably cause high levels of stress to both patients and staff in A&E: unexplained long waiting times, and problem behaviours on the part of some patients and visitors. We argue that lack of information, for instance information about *why* there are long waits, may exacerbate such behaviours.

We go on to argue that the type of information likely to be salient in this context typically has both *public* and *private* aspects, and this has impact upon the design of systems to provide such information. We propose how the theoretical concepts of public, social and private information spheres relate to public spaces, such as the A&E waiting area. We argue how the concept of interaction spaces may be used in conjunction with information spheres to inform the design

Permission to make digital or hard copies of all or part of this work for personal or classroom use is granted without fee provided that copies are not made or distributed for profit or commercial advantage and that copies bear this notice and the full citation on the first page. To copy otherwise, or republish, to post on servers or to redistribute to lists, requires prior specific permission and/or a fee.
DIS2004, August 1–4, 2004, Cambridge, Massachusetts, USA.
Copyright 2004 ACM 1-58113-787-7/04/0008...$5.00

of systems in these kinds of public settings. The main contribution of this paper is the presentation of a developing theory that may contribute to our understanding of the design of systems providing a combination of public and private information in public places.

PATIENT INFORMATION SEEKING IN A&E

Violence and abuse towards hospital staff are perceived to be sufficiently widespread and serious to necessitate the recent announcement by the UK Government of new national guidelines to help make hospitals safer environments for both staff and patients. Hospitals are now permitted first to warn and then to exclude without treatment patients or visitors who are violent or abusive. Despite such measures, the problem is reportedly still on the increase [33], and seems to be particularly prevalent in A&E departments. Several incidents were observed or reported during our fieldwork. The majority of these incidents involved rudeness or verbal abuse of staff and other patients. However, even patients whose behaviour did not descend to these levels were frequently observed to show signs of annoyance, stress and exasperation, and these reactions tended to coincide with long waiting times.

As well as stress for the patients, continual requests for information about waiting times, even polite requests, also seemed to cause stress to the staff. The frequent need to respond to these requests was often distracting, interrupting their ongoing work. Such interruptions at times had the unfortunate effect of increasing the patients' waiting times still further. Hospital staff and managers are concerned that people have to wait so long for treatment, and are constantly reviewing the organization of their work to try to reduce the problem. One consultant's comment was quoted in the press recently: 'There are times when I walk into the department and it is a total heartsink. Every cubicle is full, the corridors are full of people on trolleys, there is nowhere to sit and write up your notes, and you are trying to find space in the resus room …' [4]. This concern is linked not only to the clinicians' obvious anxiety about the welfare of their patients, but also to negative reports in the media, and government directives which impose limits on waiting times but offer few suggestions for how to accomplish this in an aging facility with ever-increasing patient numbers.

Previous work has shown that certain characteristics of queues, such as uncertainty of waiting times and lack of information, can cause stress and antagonism [45] and, more specifically, that urgent care patients who were told the expected waiting time for treatment and were kept busy while waiting, had higher satisfaction perceptions of their treatment [35]. Maister [30] suggested that customers who were given information about how long they would have to wait are less likely to be anxious about the wait. Dansky and Miles [10] found that telling patients in an urgent care department how long they would have to wait was positively related to their satisfaction with the treatment.

This research suggests that the provision of information of this type might be a useful tool not only for reducing stress and averting some violent or abusive incidents, but also in influencing patients' perceptions of satisfaction with their visit. In the A&E waiting area under study, there was some information on display, though nothing that related to likely waiting times, or the reasons why long waits occur for some patients. The only way patients could get this information was to ask a member of staff, usually a nurse or a receptionist. Some patients were observed to become angry when told that they faced a very long wait, especially if they had been waiting for some time already, and when other patients seemed to have been given priority over them. They were unaware of the reasons for this type of occurrence. The significance of the assessments of staff of the relative seriousness of a particular individual's condition, and the intricacies of triage categories for example, were not obvious to patients, and the prioritizing of some patients over others with little or no explanation was often observed to initiate negative remarks from patients who felt that they had been less favourably treated. It seems then that there are potential benefits to be had from making aspects of this information available to the patients. However, some of this information is private, and this must have a major impact upon the design of systems to provide such information.

INFORMATION PROVISION IN THE A&E WAITING AREA

It is useful first to summarize the existing types of information available to patients and visitors in the waiting area of the A&E department. At the time of our study, this took the form of posters and signs displayed on the walls, and also leaflets that could be taken up and read by interested parties and taken away should they wish for future reference. Typically, the posters and leaflets related to health information or health promotion advice, alerting people for example to the symptoms and dangers of particular serious diseases and conditions, or drawing attention to various charities and facilities offering help and advice to individuals and groups. The posters were designed to be eye-catching, featuring small quantities of information in large print, often in conjunction with photographs or other illustrations, whereas the leaflets were in small format, offering more detailed information. Many of the posters were somewhat faded and tired-looking, and some of the leaflet holders were empty. Leaflets in one area had become scattered over a tabletop and the floor. It was a further drain on precious staff time to keep displays featuring posters and leaflets in public areas in good order.

As well as healthcare and health promotion information, there were also directional signs, and notices warning of the consequences of violent or abusive behaviour towards

staff and other patients, and about the procedures to follow should anyone wish to make a complaint. There was also a plan of the hospital. Many of these items were juxtaposed with signs and notices directed mainly at staff, such as lists of names and extension numbers, which tended to overflow from the area behind the reception counter.

There was no information at all about waiting times for treatment. There was clearly a requirement for this information since staff were continually asked by patients both for general information about the average waiting times that day and for specific information about their personal waiting time. This kind of information would enable patients to make transport arrangements, and to let anxious family members know roughly how long they would be at the hospital. It would also help reassure them that they had not been forgotten. Information about average waiting times could be freely available by means of a public display. Linked to this, information about the routine activities of staff may also be of value, since many of the negative comments observed by the authors related to the perceived (by patients) non-activity of the staff. It was not obvious to patients or visitors who were unfamiliar with the way in which the department worked that, for example, the nurses who were 'just standing around talking' by the whiteboard were engaged in important planning and management work vital to the scheduling and continuity of patient care, nor that doctors who were 'sitting down writing' were not only recording case notes, an important activity in itself, but also using the time provided by this activity to 'develop their thinking' (as the doctors put it) about what was wrong with a patient, and how best to treat her condition. Therefore, a strategy that informed patients why clinicians engaged in these activities, which undeniably took up a lot of their time, may help to avert patients' negative perceptions. Still other information about the hospital could be provided via such a public route, similar for example to the information available on the hospital website.

In addition to this general 'public' information, there is a need also for more specific 'private' information directed at individuals. For example, a waiting patient typically wants to know where she is in the queue, and how long she can expect to wait. It could also be useful to provide a summary of any treatment or tests she has had so far, and to inform her if there is a necessary waiting period for the results of such tests, which may contribute to any delay. However, tension exists between the advantages of providing individuals with adequate and timely information about their treatment while at the same time avoiding overburdening the staff with requests for information, and the need to preserve privacy, which is backed by force of legislation such as the UK's Data Protection Act. A public display is therefore unsuitable for conveying some aspects of patient information, and an alternative solution is necessary.

PUBLIC AND PRIVATE INFORMATION

Much of the HCI and CSCW research on information displays has concentrated upon the provision and exchange of information among work groups. One strand of this research features systems which combine ambient 'public' or 'semi-public' displays, providing general information, or information at a low level of detail, augmented by PDAs which are used to access more detailed, or more personal aspects of this information, e.g [7, 18, 21, 34, 41]. This model reflects to some extent the existing provision in the hospital, of posters and signs displayed on the walls, and leaflets available for closer scrutiny or for later reference. Indeed, such an arrangement is commonplace in all sorts of environments. However, it is unlikely, for reasons of access and expense, that PDAs would be suitable for areas such as this, which are genuinely 'public' in that anyone may enter them at any time, as opposed to work contexts to which only co-workers have access. Theft of equipment, from doctors' personal mobile phones to portable hospital equipment, was a recurring problem in the A&E department we studied.

Building on single-display groupware approaches that utilize conventional large shared displays, work by Shoemaker and Inkpen [44] on single-display privacyware, defined as systems that allow private information to be shown within the context of a shared display, seems promising. However, their system requires that pairs of users wear specially adapted glasses to view private aspects of the information shown on a shared display, and although the system was successful in the context of allowing shared and individual work activities to take place side by side, it too, is unlikely to be suitable in this form for use in a public space such as the A&E waiting area.

Apart from the unsuitability for this domain of the equipment required for these approaches, it is likely that the issues of privacy involved within a work context would differ in important ways from those involved in supporting patients and visitors in the truly public domain of a hospital waiting area. 'Public' and 'private' are not absolute qualities [6]. Privacy, for example, can be taken to mean a person's ability to manage what information about herself is made public, to whom it is made available and for what purpose it is used [22], and this will be heavily dependent upon the context in which it occurs.

Palen and Dourish [39] note that 'as a dynamic process, privacy is understood to be under continuous negotiation and management, with the boundary that distinguishes privacy and publicity refined according to circumstance'. Therefore, any essentialist public/private dichotomy is over-simplistic. Greenberg et al [21] suggested that these terms do not represent watertight categories but merely

indicate the extremes in a spectrum. As they also noted, people constantly shift their attention seamlessly between the private and the public, and gradations in between, and what is more, people's actions when shifting objects or information between the private and the public are straightforward and easily read by others, and this is reflected in the language we use to describe such actions. Luff and Heath [29], in their work on paper-based medical records, noted that there should be mechanisms in a work environment for supporting the movement of data from 'the individual and private' to the 'collaborative and public'. Greenberg et al [21], however, described the difficulties of designing systems that reflect the flexibility of real-life private/public distinctions. However, a successful system to support and inform patients in the manner we propose would necessarily reflect such aspects of people's everyday behaviour.

Greenberg [19] drew attention to the ways in which the behaviour of his children and their friends when playing action games on his office PC differed from their behaviour when playing the same games on a Nintendo set connected to a TV located in the lounge. Interactions around the PC were constrained by the difficulties involved in accessing the controls and seeing the display, while their play on the Nintendo afforded more successful group involvement, allowing the children to scatter themselves around the TV in positions relative to the degree of their involvement in the play. Greenberg [19] described how there is no 'public' face to a desktop PC, and how when it is in use by one individual, other people tend not to look at what is displayed on its monitor unless invited to do so by the user, as it is somehow considered to be a 'private space', a thing that isolates. Greenberg and Rounding [20] further showed how users of their Notification Collage system used it differently when it appeared on a public display from when it was accessed via their desktop computers. For instance, people would draw the attention of others to items on the public display, and would converse around them. This did not happen with desktop machines. Rogers and Rodden [43] discussed the sub-optimal nature of single-user PCs for collaborative work involving two or more participants, and stressed the importance of designing 'shared information spaces' to show participants, on first entering the space, where and how to position themselves vis à vis the information resources and the other participants to enable sharing and comfortable interaction. Such characteristics of different types of displays, and also their location and position in the world can afford or inhibit public interaction. They may therefore also afford or inhibit the possibility of providing different types of information to individuals and to groups within the same context.

CITIZENS, SPHERES AND SPACES: A FRAMEWORK FOR PUBLIC INFORMATION SYSTEMS DESIGN

A perennial problem in systems development with gathering data on users, their activities and their environment is how we move from the data collected to system designs. In this instance, how do we move from ethnographic field notes, photographs and questionnaire results to designs for information provision in the A&E department? In our work, we have consistently emphasised the need for a principled approach to systems development, with traceability of requirements right through from field work to system implementation [36]. In this research, we have revisited and extended the established HCI design foci of user, task and domain, so that they are more relevant to designing for a social setting. We propose the analogous foci of citizen, sphere and space respectively. These foci help us to structure – or focus – the results of our field studies and identify requirements [27].

The User as Citizen

The intended users of information systems in public settings may be viewed as 'the public' of the societies in which these systems will be embedded. Designing a highly usable system is difficult, even if we know the specific users, tasks and domains that the system will support. The problem becomes much more difficult if the specific users are not known in advance, such as when we are designing a system for the public. Designing a system without studying its users is anathema to many in the HCI community, yet many systems are used by the public, and thus were designed without knowing in advance the specific users. Such systems include the subway, trains, buses, electricity, highway management (signs, lights etc), telephone and television, and any system that supports or imposes social rules and regulations, such as voting [5]. These systems were designed without having specific users in mind, but by targeting citizens. So if we are to follow established HCI design wisdom in designing pervasive systems for the public, then we need to study our potential users: citizens.

The concept of a citizen can be more meaningful than the concept of a user in the social realm. 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. Such information includes citizenship rights, how citizens view public systems (e.g. TV, public transport etc), and what type of access to public systems citizens prefer or require.

Citizenship has a long and chequered history, though throughout this history it has retained certain common attributes. For example, citizenship comprises certain rights against, and obligations towards a community, and invariably implies membership of that community [26]. However, it has often been used to *ex*clude, as well as to *in*clude, and there have been numerous attempts to restrict

citizenship to certain categories of people, thereby excluding other categories. Such restrictions have tended to favour more powerful groups within a society, and disadvantage the less powerful. In the UK, for instance, citizenship rights have been withheld at certain times, on the basis of factors such as gender, race, age and social class. In our adoption of the concept within the HCI community, therefore, this aspect of citizenship must be taken on board, and our practices scrutinized. A useful question to ask ourselves about our designs is: are they truly inclusive, or do they, however unintentionally, effectively exclude some potential users? How usable are they, and for whom?

Marshall's classic [32] account viewed citizenship as comprising three distinct components, which were achieved at different times. The first part was a civil element, which encapsulated those rights necessary for the freedom of the individual, such as liberty of the person, freedom of speech, thought and faith, the right to own property and to conclude valid contracts, and the right to justice. The second part was a political element, which Marshall characterized as the right to participate in the exercise of power, whether as a representative, or a voter. The third part comprised a social element, which was itself composed of a wide range of rights, from the right to a degree of welfare and security, to the right to play a full part in social life, living the life of a civilized being according to the standards currently prevailing in that society. It is this social element which is of primary interest here, although it is not always easy, or useful, to consider these elements in isolation from each other.

Marshall's ideas have not gone uncriticised. For example, Giddens [15], Mann [31] and Turner [47] have variously criticised the apparent evolutionary character of Marshall's account of the historical and social processes involved in the development of citizenship. Giddens [15] pointed out that additionally, citizenship rights, as described by Marshall, are not necessarily as unified and homogeneous in character as Marshall seems to indicate. On the contrary, they may have been achieved as a result of very different types of political struggles, and furthermore, once achieved, they are not necessarily irreversible. Mann [31] took issue also with what he termed the 'anglocentricity' of Marshall's approach, and others have argued that his preoccupation with social class has ignored, or at least obscured, important issues of gender and ethnicity, even within the framework of exclusively British society [40].

Nevertheless, Marshall's conceptualization remains an influential one, and one that has proved to be useful in respect of thinking about such things as social rights, and access to services, and it is in this sense that it is of value in thinking about system design and usability. More recently, social citizenship has been linked with issues of usability for particular groups such as the elderly [24, 46] and disabled people [13], with the provision of government information to the general public [8, 12], and with issues of privacy [1, 42]. Meanwhile, Dearden and Walker [11] have begun to examine issues of citizenship in respect of what they call 'civil society' (p.157) but which, according to Marshall's model, merges the civil with the political elements of citizenship.

Information Spheres

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 kinds of access to them that are required. The spheres concept may be used in conjunction with the other two concepts of our framework, citizens and spaces, as a means of validating or generating a mapping between physical location – such as an A&E waiting area – and the information and services that are provided, as well as addressing privacy and ownership issues [25, 27].

The term *public sphere* was introduced by Habermas [23]. He analysed the development of media from the early eighteenth century up to today, tracing the emergence of the public sphere. The public sphere is a conceptual area of public debate in which issues of general concern can be discussed and opinions formed. It has also been defined as the space in which citizens deliberate about their common affairs, and a site where social meanings are generated, circulated, contested and reconstructed [14].

Acknowledging that public and private merely indicate the extremes in a spectrum, we consider the 'non-public' sphere in two categories. The first is the *private sphere*, which deals with completely private issues, services and information, access to which must be tightly controlled. The second category, covering the spectrum between the two extremes of public and private, is the *social sphere*. Social spheres contain information relevant to a group of people. Social dynamics and constraints prohibit information in a social sphere from being made completely public. Hence, the public sphere is not simply a collection of social spheres. In recent generations, the telephone has been the technology most associated with the development and maintenance of the social sphere. For some people the phone is a way of extending private boundaries beyond their home to family and friends who are welcome to call at any time. The phone is used to capture a friend or household and bring them into an elastic, psychological domain of social space. A private call has the effect of relocating the other psychologically within the social sphere. In the A&E setting, the fact that a doctor may ask friends and visitors to leave the room is an example of the kind of social norm that dictates the creation of social spheres. The patient-doctor relationship may require that other people leave both the physical space and the social sphere in which the activities of that relationship are

conducted and the associated information is made available within the shelter of doctor-patient confidentiality.

The categories of public, social and private spheres describe how the information that we deal with may be categorised in social terms. These categories, along with their respective chunks of information, can help us in understanding how we can categorise a specific task, service or information offered by a computing system in a public setting. For example, the task of sending a message to a friend, and the respective digital service that allows us to do so, fall in the category of the social sphere. On the other hand, a task such as looking up the train timetables would be included in the public sphere. This 'assignment' of services to specific spheres can help us in the design process, as we discuss below.

Public, Social and Private Spaces

In trying to identify the social dimensions of domain, we start by noting the difference between space (physical location) and place (social dimensions) [25]. A place has embedded understandings and protocols of what is regarded as appropriate behaviour. Places have values attached to them. Places tend to convey cultural meaning and frame our behaviour. In addition, the presence of others within a place has an effect on how we behave and perceive the place.

Building on, for example, Green [17], we propose a top-down approach that categorizes all possible spaces in three main groups: *public spaces, social spaces* and *private spaces*. (Note that although they are called *spaces*, they are *places* in the sense used by [25].) These notions carry with them a great number of characteristics and understandings that are peculiar to each society or social group.

Public spaces are open to everyone, mainly because they usually belong to the community itself, e.g. a town square is a public space. On the other hand, private spaces are spaces controlled by an individual, which can be used in whatever way the owner sees fit. Private spaces promote a sense of security and privacy, such as a bedroom or a toilet. Again covering the range between the extremes of the public-private spectrum, we describe social spaces are those spaces that are neither private nor public. Examples of such spaces include homes, cars, hospital treatment cubicles etc.

It is important to stress that public, social and private spaces are not simply defined by their geographical coordinates. Therefore, it is not helpful to try to categorize 'pure' locations, i.e. is a house a social space?; is a park a public space? etc. The criteria for categorizing a location need to address the values attached to the location and the things that are happening there. Similarly to the boundaries between information spheres described earlier, the boundaries between the three types of spaces we propose are also quite dynamic and fluid. A good example is 'the park', which can be seen as a public space or a social space (e.g. a group of friends playing a board game in the park).

In the A&E department, there is a large public space, the waiting area, with a number of contiguous social spaces such as the resuscitation room ('resus'), treatment cubicles, reception desk and administration area. The only private spaces, either for patients or staff, are the toilets.

Interaction Spaces

Interaction spaces describe volumes of space that are created by artefacts such as computers or physical objects. These volumes of space define the boundaries within which the device or artefact is usable [37]. Goffman [16] described 'participation frameworks' through which participants in interaction use bodily alignment vis à vis other participants, eye contact, tone of voice and other resources provided by the situation to maintain and to display shared task orientation and attentional focus. Our previous work [37] suggests that collaborative activities that rely upon a shared artefact break down predictably whenever a participation framework extends beyond the boundaries of the interaction space defined by the shared artefact.

If we take the example of the A&E waiting area as a public space, an interaction design that included everyone present in the waiting area would generate a public interaction space. For example, a large display showing waiting times could create a public interaction space. On the other hand, waiting time information presented via audio headsets would create a private interaction space despite the person wearing them being in a public space. Finally, groups of people interacting collaboratively with artefacts are acting within a social interaction space. Consider a group of relatives sharing a crossword puzzle in the waiting area. The interaction space that is created by the puzzle is a social interaction space, since the relatives are included in it but not everyone in the waiting area is.

The characteristics and boundaries of the interaction space are defined by the characteristics of the artefact, the users and the environment. Interaction spaces may, for example, be visual, such as the interaction space defined by a computer's display. In this case, characteristics such as size and orientation of the display, ambient lighting etc are crucial to the definition of the interaction space within which the display is usable.

Interaction spaces may also be auditory. Once again, the characteristics of the users, the sound sources and the environment define the characteristics and boundaries of the interaction space. Aoki et al [2] describe a study in which visitors to a historic house used a tourist guide application with audio information presented via a single ear headset. They noted that 'this configuration leaves one ear available to hear sounds from the external environment' (p.432). They ruled out playing the audio content into the

open air, via loudspeakers, because 'this approach is problematic in a public space with a large number of visitors' (p.433). They ruled out the use of two-ear headsets because 'two-ear headsets had a strong isolating effect and inhibited the ability to converse. By contrast, all single-ear headsets enabled participants to converse easily' (p.433).

We argue that the effects observed are explainable and predictable as the effects of creating differing auditory interaction spaces. Open air broadcast of audio content via loudspeakers creates a *public* interaction space within which groups of people can interact with respect to the audio content. However, because of the characteristics of this type of interaction space, conflicts will arise when different people attempt to participate in separate interaction spaces within the same (physical) public space at the same time. The characteristics of audio will result in a distracting cacophony rather than a set of usable colocated interaction spaces.

Two-ear headsets, whereby only the wearer has access to the audio content delivered by the device, create a *private* interaction space whose boundaries include just the person wearing the headset. This has a doubly isolating effect. Other people are excluded from the interaction space defined by the headset, while the wearer is excluded from other auditory interaction spaces that may be copresent in the same (physical) space.

The standard effect of a single-ear headset is to create a private interaction space for the wearer (from which others are excluded) while allowing the wearer, using her free ear, to engage in participation frameworks within surrounding public and social interaction spaces. This removes one of the isolating effects of two-ear headsets. The effect of Aoki et al's work was to create a new *social* interaction space by allowing a participant to eavesdrop on what her partner could hear in his single-ear headset. This enabled participation frameworks to develop within the boundaries of this social interaction space, thereby enabling collaborative activities that otherwise would not have been possible.

DESIGNING PUBLIC INFORMATION SYSTEMS

Together, the concepts of interaction spaces and information spheres – public, social and private – aid us in mapping from physical spaces to the technological artefacts that are available to us as developers and the forms of interaction we wish to support. Through the design of artefacts (display hardware, audio output, software interfaces etc), we define the interaction spaces within which people may interact with the information presented and, in some cases (i.e. public and social interaction spaces), with other participants. Through the identification of the information sphere into which a particular service falls, we can determine what kind(s) of interaction space – and, from there, what artefact designs – we require in order to provide that service in different settings, such as public, private or social spaces.

For example, a person wants to access a particular service or information that is in the private sphere. Within a private (physical) space, she may be happy to access that service or information in a public interaction space, whereas in a public (physical) space, she would want it presented in a private interaction space. So, to determine how to deliver the same service to her, the system needs to take account of the information sphere and the physical space, in order to know what kind of interaction space to create.

In the A&E department, we have a situation with various stakeholders; to simplify, there are patients and healthcare staff. We have a range of information and services that we wish to provide to these stakeholders. We have a large public space, with a number of contiguous social spaces such as the resuscitation room ('resus'), treatment cubicles, reception desk and administration area. There are few private spaces.

Some information or services that we wish to deliver in this setting may fall in the private sphere, e.g. her blood test results are available to a particular patient. Some information or services that we wish to deliver may fall in the social sphere, e.g. all patients with a particular ailment are invited to a clinic on Thursday. Some information or services that we wish to deliver may fall in the public sphere, e.g. average waiting times today are 4 hours.

In designing systems for the delivery of these services or information, we have available a range of artefacts, such as devices from PDAs to wall-sized displays. We can use these artefacts to define interaction spaces that map the appropriate information sphere – appropriate, that is, to the citizen's current activity and information requirements – to the current space in which the citizen is located.

Our framework will not design systems for us but it will support us in making design decisions. For example, we might consider using PDAs and headsets to create private interaction spaces for patients to access their hospital records and communicate via a video link with a doctor while they are in the public space of the A&E waiting area. The private interaction space thereby maps the social information sphere of the patient's record and conversation with the doctor safely to the public space of the waiting area. However, in proposing this design solution, our identification of the A&E waiting area as a public space with particular characteristics of its own should raise issues associated with that physical space, such as the issue of thefts of mobile equipment. Indeed, our identification of the relevant information sphere as social may raise ethical or legal questions about the nature of patient records as private or social information.

CONCLUSION AND FUTURE WORK

This paper argues the need for developing a theoretical base on which to found design principles for information systems. An example of such a theory is presented that addresses the provision of public and private information and services in public settings. The theory helps to map the interaction spaces created by particular designs to the public, private and social information spheres required by citizens in public, private and social spaces. Of particular concern is how to design interaction spaces to support the private information sphere in public (physical) spaces. Palen and Dourish (p.130) note that 'our most familiar ways of managing privacy depend fundamentally on features of the spatial world and of the built environment, whether that be the inaudibility of conversation at a distance, or our inability to see through closed doors. With information technology, our ability to rely on these same physical, psychological and social mechanisms for regulating privacy is changed and often reduced'. Our ongoing work must include testing our theoretical developments in systems development practice. In turn, the production and evaluation of such systems will serve to refine our theoretical understandings that enable explanation and prediction for the design of public information systems.

ACKNOWLEDGMENTS

The research reported here is part of a UK EPSRC-funded research project 'Designing for common ground in mobile distributed collaborative systems', award number GR/R24562/01.

REFERENCES

[1] Ackerman, M.S., Cranor, L.F., Reagle, J. Privacy in e-commerce: examining user scenarios and privacy preferences. In *Proc. 1st ACM Conference on Electronic Commerce*. Denver, Colorado (1999), 1-8.

[2] Aoki, P.M., Grinter, R.E., Hurst, A., Szymanski, M.H., Thornton, J.D. and Woodruff, A. *Sotto voce*: exploring the interplay of conversation and mobile audio spaces. In *Proc. CHI 2002*, CHI Letters 4(1), 431-438.

[3] Aoki, P.M., Romaine, M., Szymanski, M.H., Thornton, J.D., Wilson, D. and Woodruff, A. The Mad Hatter's cocktail party: a social mobile audio space supporting multiple simultaneous conversations. In *Proc. CHI 2003*, CHI Letters 5(1), 425-432.

[4] Arlidge, J. Quick fix revolution. *Evening Standard*, 12 November 2002.

[5] Bederson, B.B., Lee, B., Sherman, R.M., Herrnson, P.S. and Niemi, R.G. Electronic voting system usability issues. In *Proc. CHI 2003*, CHI Letters 5(1), 145-152.

[6] Boyle, M. and Greenberg, S. Balancing awareness and privacy in a video media space using distortion filtration. In *Proc. Western Graphics Symposium 2000*.

[7] Carter, S., Mankoff, J. and Goddi, P. Representing and supporting action on buried relationships in smart environments. In *Proc. CSCW 2002*.

[8] Catarci, T., Matarazzo, G., and Raiss, G. Usability and public administration: experiences of a difficult marriage. In *Proc. 2000 ACM Conference on Universal Usability*, 24-31.

[9] Clarke, K., Hughes, J. and Rouncefield, M. When a bed is not a bed: the situated display of knowledge on a hospital ward. In Pro*c. CSCW 2002*.

[10] Dansky, K.H. and Miles, J.A. Patient satisfaction with ambulatory healthcare services: waiting time and filling time. In *Hospital and Health Services Administration*, 42 (1997), 165-177.

[11] Dearden, A. and Walker, S. Designing for Civil Society. In *Proc. HCI 2003: Designing for Society, Vol. 2*, 157-158.

[12] Donnelly, V. and Merrick, R. Community portals through communitization. *In Proc. 2003 ACM Conference on Universal Usability*, 9-14.

[13] Edwards, W.K., Mynatt, E.D. and Stockton, K. Access to graphical interfaces for blind users. In *Interactions Vol. 2, Issue 1* (1995), 55-67.

[14] Fraser, N. Politics, culture and the public sphere: towards a postmodern conception. In L. Nicholson and S. Seidman (eds) *Social postmodernism: beyond identity politics*. Cambridge University Press, Cambridge (1995).

[15] Giddens, A. *Profiles and Critiques in Social Theory*. London, Macmillan (1982).

[16] Goffman, E. *Forms of talk*. University of Pennsylvania Press, Philadelphia (1981).

[17] Green, L. *Communication, technology and society*. Sage (2001).

[18] Greenberg, S. and Boyle, M. Moving between personal devices and public displays. In *Proc. CSCW 1998*.

[19] Greenberg, S. Designing computers as public artefacts. In *Int'l J. Design Computing: Special Issue on Design Computing on the Net* (1999).

[20] Greenberg, S. and Rounding, M. The Notification Collage: posting information to public and personal displays. In *Proc. CHI 2001*, CHI Letters 3(1), 515-521.

[21] Greenberg, S., Boyle, M. and Laberge, J. PDAs and shared public displays: making personal information public and public information personal. In *Personal Technologies* 3(1) (1999).

[22] Gutwin, C. "Workspace awareness in real-time distributed groupware". PhD Thesis, University of Calgary (1998).

[23] Habermas, J. Strukturwandel der Offentlichkeit, 2nd ed., Suhrkamp, Frankfurt, 1989. Translated as *The structural transformation of the public sphere*, Polity, Cambridge (1989).

[24] Hanson, V.L. Web access for elderly citizens. In *Proc. 2001 EC/NSF Workshop on Universal Accessibility of Ubiquitous Computing: Providing for the elderly* (2001), 14-18.

[25] Harrison, H. and Dourish, P. Re-place-ing space: the roles of place and space in collaborative systems. In *Proc. CSCW 1996*, 67-76.

[26] Held, D. *Political Theory and the Modern State*. Cambridge, Polity Press (1989).

[27] Kostakos, V. and O'Neill, E. Pervasive computing in emergency situations. In *Proc. Thirty-Seventh Annual Hawaii International Conference on System Sciences*, (2004).

[28] Lister, R. *The Exclusive Society: Citizenship and the Poor*. London, Child Poverty Action Group (1990).

[29] Luff, P. and Heath, C. Mobility in collaboration. In *Proc. CSCW 1998*, 305-314.

[30] Maister, D.H. The psychology of waiting lines. In J. Lovelock (ed.) *Managing services: marketing, operations and human resources*. Prentice-Hall, NJ. (1988) 176-183.

[31] Mann, M. Ruling class strategies and citizenship. In *Sociology 21* (1987) 339-354.

[32] Marshall, T.H. *Citizenship and Social Class and Other Essays*. Cambridge, Cambridge University Press (1950).

[33] Miekle, J. Assaults rise despite crackdown. *The Guardian*, 27 March 2003.

[34] Myers, B.A., Stiehl, H. and Gargiulo, R. Collaboration using multiple PDAs connected to a PC. In *Proc. CSCW 1998*, 285-294.

[35] Naumann, S. and Miles, J.A. Managing waiting patients' perceptions: the role of process control. In *Journal of Management in Medicine*, 15(5) (2001), 376-386.

[36] O'Neill, E. *User-developer cooperation in software development: building common ground and usable systems*. Springer Verlag, London (2000).

[37] O'Neill, E., Johnson, P. and Johnson, H. Representations and user-developer interaction in cooperative analysis and design. *Human Computer Interaction* 14(1) (1999), 43-91.

[38] O'Neill, E., Woodgate, D., Johnson, P. and Johnson, H. Designing interaction spaces to support successful participation and collaboration. In *Proc. HCI 2002: memorable yet invisible, Vol. 2*, 158-161.

[39] Palen, L. and Dourish P. Unpacking "privacy" for a networked world. In *Proc. CHI 2003*, CHI Letters 5(1), 129-136.

[40] Pascall, G. *Social Policy: A Feminist Analysis*. London, Tavistock (1986).

[41] Rekimoto, J. A multiple device approach for supporting whiteboard-based interactions. In *Proc. CHI 1998*, 18-23.

[42] Rezgui, A., Ouzzani, M., Bouguettaya, A. and Medjahed, B. Preserving privacy in web services. In *Proc. 4th International Workshop on Web Information and Data Management* (2002) 56-62.

[43] Rogers, Y. and Rodden, T. Designing new workspaces to provide physical and social affordances for successful interaction. Workshop paper presented at *CSCW 2002*.

[44] Shoemaker, G.B.D. and Inkpen, K.M. Single display privacyware: augmenting public displays with private information. *Proc. CHI 2001*, CHI Letters 3(1), 522-529.

[45] Stewart-David, D. Taking the stress from the queue. *Focus* May 2002, 50-54.

[46] Tilley, S. Computer documentation for senior citizens. In *Proc. 21st Annual Int'l Conf. on Documentation* (2003) 143-46.

[47] Turner, B. Outline of a theory of citizenship. *Sociology 24:2* (1990) 189-217.

[48] Xiao, Y., Lasome, C., Moss, J., Mackenzie, C. and Faraj, S. Cognitive properties of a whiteboard: a case study in a trauma centre. *Proc. ECSCW 2001*.