When Geography Matters - Location Awareness and Community Care

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This paper presents some of the early design work of the 'Care in the Digital Community' research project - begun under the EPSRC IRC Network project EQUATOR. We outline some initial findings and designs from this interdisciplinary research project focusing on developing enabling technologies to assist care in the community for user groups with different support needs. While location-awareness may be regarded as an important, if not crucial, component for future mobile devices, and there are interesting arguments about what location-aware services can achieve, our impression is that much of the research has been technology led with technological 'solutions' being proffered for what may well be imaginary 'problems'. In the process the various 'real world' challenges faced when trying to meet the requirements of a real application domain - where geography really does matter - are avoided or invented and many of the 'real world, real time' issues - such as political factors, ethics, development and evaluation remain unexplored. Our early studies suggest that designing for care settings must not only take account of the usability of applications, but also how such technologies and their uses are integrated into a range of social contexts. Moving away from technology led applications and attempting to have a useful input into the development process requires an understanding of how technologies and their uses are integrated into a range of social contexts. As with other studies of domestic environments as sites for the introduction of new information technologies (Venkatesh 1995; 1996; Hughes et al. 2000; O'Brien et al 1999]) our interest lies in understanding the social context,

in the interaction between the social and the technological space, and considering when and in what circumstances location awareness becomes not just technically feasible but socially relevant.

Ubiquitous domestic technology and location awareness.

In earlier work the team (Dewsbury & Edge 2001) has focused on location aware devices within the home considering the design of 'smart' home systems to meet the needs of adults with learning disabilities. Here the safety of residents and staff was paramount and location awareness was an important aspect of design so that the residents could be protected from injuries such as falls and other accidents. The technology was required to be location aware, so that staff would be able to find out where possible incidents were occurring when an alert was triggered. In addition, with residents prone to outbursts of violence the system was designed to ensure assistance could be provided. The system arrived at used a series of wireless alerts which were predefined in a structured order. Hence the system could distinguish between a staff attack, a resident in trouble, staff requiring general assistance (e.g. an extra pair of hands to lift someone) and the resident requiring non-essential assistance (e.g. a staff member to talk with). The system was sensitive enough to allow location specific information about the given alert which was transferred through to staff pagers as well as a central control panel in the main office so the senior manger could determine the appropriate cause of action depending on the level of alert. The system also had the facility that staff members could let the system know that they would be responding to an alert, so staff activities could be tracked during alerts.

Residents were also monitored through passive infrared sensors in their rooms, providing staff with information concerning which room the resident was in at any time. The sensors would not invade the privacy of the resident by giving any more information apart from the room was occupied. In the double apartments this meant that it was impossible to track individuals as often they might be sharing common spaces and the sensors could not differentiate between different people. This was seen as acceptable as the main use of these sensors was to determine that the residents were not in inappropriate spaces (someone else's room). Bedroom doors and the front door of the flats were fitted with magnetic reed switches in order to produce alerts when residents were active during sleeping hours. These were configured individually based on the common activity patterns of the resident. The switches on the front door were designed to be triggered should a resident leave their accommodation during sleep periods. The resident would not be stopped from doing this, but staff were required to be notified that the resident is no longer in their flat in case the resident was in trouble. Each device had its own address and was configured into a hard-wired system which had a computer control panel in the main nursing station. This provided a central readout as well as a log of all alerts and actions that followed from the alerts allowing for accountability and traceability.

The key features of the design were to determine the appropriate level of location awareness of the system. Certain areas were required to be 'out of sight' from the system, such as staff sleep-over flats, and other staff-only areas. The system was also required to be functional in the areas of poor visibility. This meant that sensors were required to be used inside the flats and in the open spaces. The major difficulty with the open spaces was the location of the sensors so that only the most appropriate sensor was triggered and sent the alert. This was solved by the short range of the transmitted signal. Despite the opportunity to install a considerable amount of high-end technology, in the final design a minimum set of devices was arrived at and installed with each device providing a specific and necessary functional aspect to assist the quality of life of the residents.

Location Awareness and Community Care: Uncovering Requirements.

Our current interest, in the Equator and DIRC projects, is in the extension of location awareness to provide and extend support and security for community care and the use of devices to support staff in their everyday work where some form of location awareness may be useful in facilitating and coordinating care pathways. The setting for our project is a hostel and nearby and associated semi-independent living accommodation, managed by a charitable trust, for former psychiatric patients in a large town in the North of England. The hostel is the first step for patients leaving the psychiatric wards of local hospitals that are currently being closed down. In the hostel residents are provided with a room and are monitored and helped to develop independent living skills by a number of staff. Residents can then move on to the other, semi-independent living site of sheltered housing consisting of a number of flats and bed-sits, prior to moving out to flats in the local area, or, if they are deemed to need further and continuing support, back to the hostel. The overall aim of these facilities is to gradually introduce the patients back into the community and allow them to support themselves and any technology introduced into the setting should contribute to this or other identifiable care goals.

Developing an appreciation of the social context of community care, any comprehensive understanding of user needs and any requirements for location aware devices is extremely difficult. Gaining a comprehensive understanding of needs or a perspicuous view on user requirements in this domain poses a number of interesting methodological challenges. It is not just that many of the important ethical and deployment issues concerning the development, deployment and evaluation of real systems remain unexplored, but that methods for eliciting needs and translating them into a realistic, practical solution are relatively under-developed. Our own, long standing, preference for ethnographic approaches (Hughes et al 19994) , designed to bring out the socially organised character of settings and attuned to gathering relevant data in 'real world' environments, while appropriate for investigating workplace settings faces obvious problems in domestic environments, especially care settings.

At present, the project is guided by ethnographic study, user-centred design workshops and the use of 'cultural probes', carrying out observational studies of the work of the staff and conducting a series of informal, open-ended interviews with residents. The kinds of the research questions we are interested include general questions about the organisation and coordination of domestic space as well as more specific issues to do with the availability and use of technologies and their affordances. 'Cultural Probes' (Gaver et al 1999) have been utilised in a number of innovative design projects (e.g. the Presence project). We use a 'cultural probe pack' (consisting of Polaroid and disposable cameras, diaries, maps, dictaphones, photo-albums, postcards, maps of the area and so on) in the Digital Care project, as a way of uncovering information from a group that is difficult to research by other means and as a way of prompting responses to users emotional, aesthetic, and social values and habits. The purpose of the probes is both informational and inspirational, as Gaver notes - "..we were after "inspirational data" with the probes, to stimulate our imaginations rather than define a set of problems. ..a more impressionistic account of their beliefs and desires, their aesthetic preferences and cultural concerns." (Gaver et al 1999). They also provide an engaging and effective way to open an interesting dialogue with users who can be notoriously reticent.

The eclectic approach adopted by this project attempts to meet some of the ethical and moral dilemmas through careful involvement and acknowledgement of users in the design process. These challenges highlight some of the moral and ethical components of the design enterprise, in particular the need to carefully think through and balance issues of 'empowerment' and 'dependence'. As location aware technologies are developed the real problem becomes not so much the creation of devices as their effective integration with the everyday demands of any particular setting. The design challenge is to provide support for individuals in the move towards independent living, rather than create new, technological, forms of dependence. This requires a certain ethical awareness and recognition of the various ways that technology can impinge on individual care pathways and a sensitivity towards the social implications of any technological intervention. Embodying this philosophy of care into the design of artefacts necessitates considering philosophical issues of empowerment and dependence and their impact on design guidelines.

Early work - location awareness and physical security - panic alarms

Although our research is at an early stage, a number of requirements have already arisen, in the fieldwork and the design workshop, many of which focus on supporting various forms of 'awareness'. Paramount amongst these - as displayed in the interviews, the maps and everyday folk tales - is an absolutely overwhelming preoccupation with security and the need for various forms of location awareness. Situated on what is referred to as a 'difficult' council housing estate both residents and staff have been subjected to frequent physical and verbal attacks. The main locations for the attacks are the road between the hostel and the semi-independent living accommodation and the park next to the accommodation which is used either as the quickest way into town or to avoid the abuse and attacks associated with the other route. A number of meetings to address this issue have been held with the local community and the police and four CCTV cameras and nine foot iron railings have been installed to protect the semi-independent living accommodation. The house is also protected by burglar alarms and an entry control system. Paradoxically, these now mark out the residents as being somehow 'different' and make them the natural and unfortunate victims of occasional, ill-informed, media induced, moral panics. Attacks and verbal abuse by children has resulted in the gates being locked at four o'clock each day and some residents will only travel outside the accommodation by taxi and residents are increasingly cut-off from the outside community.

In these circumstances we have been investigating the design of location aware devices that would allow staff to monitor residents and increase the resident's sense of safety and reduce their anxiety. However, any devices need to meet some rather strange requirements dictated by the setting. In particular the device should not have any significant commercial value or appear attractive enough to be worth stealing because of fears of encouraging theft and therefore the assaults the devices are intended to prevent. In addition, any device needs to be highly dependable both in terms of location accuracy and the ability to communicate information in a timely manner for, as Banahan reminds us, when geography matters it is not just place but timeliness that is important. In order to encourage residents to feel safer while travelling between sites we have considered the potential for issuing personal panic alarms. When activated, such alarms would alert staff as to the identity and location of the person in distress. The alarm needs to be monitored by the staff rather than being directed to the police because it may be pressed, for example, when the resident is having a panic attack rather than a physical attack. In order to respect residents' rights to privacy, their location will not be tracked constantly, instead their location will only be communicated when the alarm is activated. In terms of location sensing, one approach that might be suitable in the future would be to use a system such as E-OTD (Enhanced Observed Time Difference location technology) (see http://press.nokia.com/PR/200102/809551_5.html). However, this solution is not currently viable because the modifications required to the base station infrastructure are not yet in place. The approach that we are currently considering is to deploy a device that incorporates a GPS (global positioning system) receiver and transmits the user's current coordinates via a GSM (global services mobile) connection whenever the alarm button is pressed. The GPS system is based on using satellites that transmit signals that can be received by special purpose GPS receivers. If a GPS receiver is able to receive the signal from three or four satellites then it is able to calculate its geographic position (to an accuracy of approximately 5 metres) by using highly accurate timing information which is coded into the signals transmitted by the satellites. In order to receive the signal from a satellite, the receiver must have visual contact with the satellite and this can make operation in high-rise city environments problematic.

Our original idea was to incorporate the device into a mobile phone - since most of the residents appear to own one. However, mobile phones are themselves valued and valuable devices (ie. worth stealing and sellable) and one of the most significant benefits of the proposed panic alarm device is that it need not be incorporated into a mobile phone and consequently is less likely to be perceived as worth stealing. The potential drawback of this device is that in areas of the town with high buildings the so called ‘canyon effect’ could prevent a GPS fix from being obtained. However, tests in the area between the two sites revealed that the view of satellites by the GPS receiver is very good. However, if residents did wander into an area where a GPS fix could not be obtained then this would clearly present a real problem. For these reasons, any device needs to provide its user with simple but immediate feedback if there is any problem with obtaining a location fix and/or communicating the distress call.

Location awareness and the coordination of work and social life.

Our other work in this location is also concerned with examples of 'when geography matters' particularly in its coincidence with issues of timeliness in the coordination of working life. Here are interest is in what Zerubavel (1985) would view as the 'temporal rhythms' of work; a notion that provides a method for us to think about work activities repeating themselves over time as they get absorbed into the routine of everyday working life in the domain. The notion helps us understand the work of the hostel by highlighting the intrinsically temporal and cyclic nature of the work. In the everyday work of the hostel a number of working rhythms can be perceived - shifts and shift handover, 'visiting' rounds, movement of residents into, around and out of the site, medication delivery, resident and staff meetings - and were the focus for many of our ethnographic observations. Such rhythms were not only important to the staff for coordinating work but also for the residents, serving both a communicative and a therapeutic function. That events should happen in some sort of regular and predictable order; knowing what people were doing and where they were from the orderliness of the days work was of value to both staff and residents. The rhythms of daily activity orient residents and staff to their present and future activities and requirements and such knowledge allows them to plan their activities accordingly. Current activities are crafted with an orientation towards expectations of future events - for example, a staff member and resident knowing that a visit and talk, or a trip to the shops or the dentist etc will take place at a particular time when another staff member comes on duty. Of course such patterns can be affected by unexpected occurrences - and it is here when location aware devices might prove useful. Such devices - and here we are thinking of some form of texting system - facilitate what Ling and Yttri (1999) call 'micro-coordination' - 'softening' time through the revision and modification of schedules and affording the negotiation and management of commitments in acceptable ways.

At present staff activity is coordinated through the use of a diary, notice-board a telephone answering system and an on-call pager system but observations revealed a number of instances when this proved less than satisfactory, where the manager would lose track of where workers were or staff be unable to alert their colleagues to relevant circumstances. This issue was raised at a design workshop with the staff where a number of possible scenarios were outlined - where residents or staff member needed to inform the site of their circumstances - and possible problems and solutions in terms of some form of visible display in the staff rooms discussed. The workshop also revealed a number of other circumstances where some form of messaging system might prove a useful addition to current facilities.

Location Awareness - the SMS Public display

Following the workshop we embarked on developing an SMS public display system. The system is designed to run a sms message public display application, allowing users to send a text message to a public display situated in the staff office, thereby quickly and easily allowing staff off-site to inform their colleagues of important information e.g. car broken down on way to work, or a hold up at dentist means patient will be returned late. The main requirements for the hardware was that is should be unobtrusive (both visually and aurally) and take up the minimal amount of space. Again another important requirement was that it should not present itself as valuable and an obvious target for criminals. Additional requirements were reasonable processing, storage capacity, and modest cost. Initially it was decided an LCD touchscreen would be ideal for input, eliminating the need for keyboard and mouse additionally being very compact in size, also the miniature PC104[3] form factor was chosen for the computer.

After investigation we found that PC104 computers are significantly more expensive than similar mass-produced hardware and did not give the level of performance we required. After considering various FlexATX[4] and MicroATX[5] solutions we settled on the Shuttle SV24 Barebones[2] figures 1.1 and 1.2 , a stylish miniature aluminium case (270mm x 190mm x 160mm) containing a FlexATX motherboard with all the functionality we required onboard; video, sound, networking, USB, IEEE 1394, TV out.

The SV24 case contains 2 x 3.5 inch bays and a single 5.25 inch – space for a CD/DVD drive, floppy disk drive and internal 3.5” disk drive. The computers would not need a floppy disk or CD/DVD drive, and leaving them out helps to disguise the case (as it looks far less like a fully functional PC) and removes any issues of users installing additional software. The 3.5” hard disk drive is mounted inside a SilentDrive™[6] enclosure, this drastically reduces the level of noise produced by disk drive - usually the primary cause of noise produced by computers. The SilentDrive™ enclosure fits out of the way in the 5.25” bay at the top of the case – see figure 1.3.

The Shuttle SV 24 contains a single type 370 processor socket, which limits the choice of processor to either Intel PIII/Celeron[11] or VIA C3[1] ranges. For our application VIAs C3 range of processors are ideal, compared to the offerings from Intel they are inexpensive, use very little power, produce very little heat, while still fully x86 compatible - the performance of the VIA C3 range is less than those of comparable clock speed in the Intel range, though we found this trade-off acceptable. We selected the 800 MHz C3 processor for our application; VIA maintain that this processor only requires passive cooling when used with an approved heatsink [1], due to space limitations use of a smaller than recommended heatsink was unavoidable. After investigation it was found that using a smaller heatsink with a fan running at 6v instead of the usual 12v would keep the temperature well below upper limits [1], even at sustained 100% CPU utilization, also dramatically reducing the noise produced. Following this finding the case fan is also run at 6v, while still providing adequate cooling.

To provide the facility for sending and receiving sms text messages GSM [9] connectivity is required. Following a survey of available solutions (the idea of a mobile phone with data cable was quickly discarded), the reasonably priced Siemens M20 Terminal [8] was chosen. This is effectively cellular mobile phone hardware in a box, minus keypad and display, requiring external power supply, aerial, and providing a 9 pin D-type serial interface. This device is similar in operation to the usual computer MODEM, accepting the standard Hayes AT compatible [10] command set over a serial connection, though an extended command set [8] is used to enable sending/receiving of SMS messages. The device is relatively compact and can easily fit inside the case, and with a specially made power cable can use the cases internal 12v power supply (figure 1.4). The M20 is situated in the SV24s spare 3.5” bay at the rear of the case, using adhesive tie wrap bases and tie wraps to securely hold it in place shown in figures 1.3 and 1.4.

To help reduce costs we selected the smallest, cheapest LCD touchscreen available, fortunately this was a high quality 12” resistive [7] touchscreen with a serial interface, available with a pedestal stand (320mm x 323mm x 146mm on stand). The standard the

Figure 1.1 -Backplane of SV24 showing serial port expansion card and GSM terminal aerial connector with aerial

Figure 1.2 – Front view of case with aerial

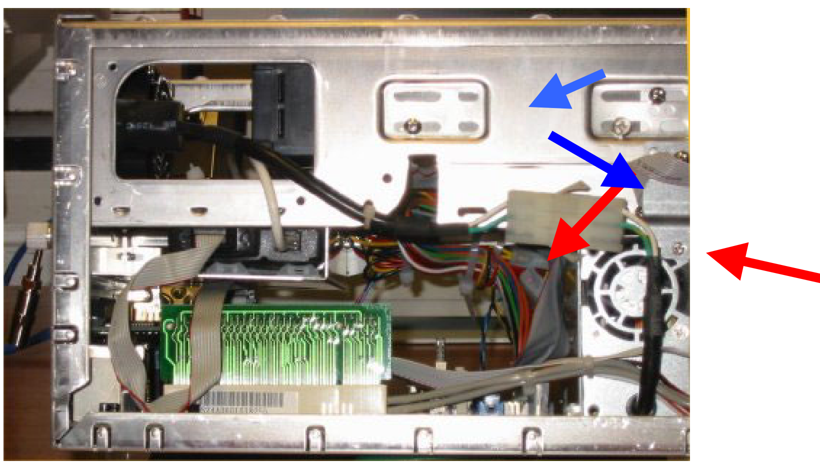

Figure 1.3 – Left hand side view internal showing mounting of M20 Terminal, serial and power connections, also SilentDrive enclosure.

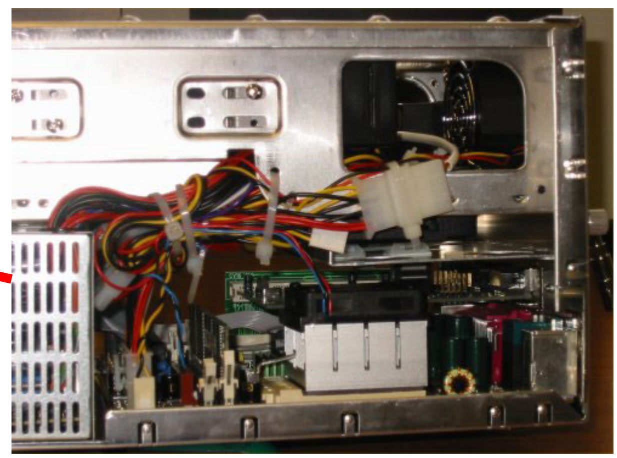

Figure 1.4 – Right hand side view internal showing mounting of M20 Terminal and custom power connector

Shuttle SV24 only incorporates a single serial port, and unfortunately both M20 Terminal and touchscreen each require one. Luckily the case provides a single PCI card slot, which was filled with a 4 serial port expansion card. Conveniently, the chosen serial port expansion card provides both internal and external connections for all 4 of its serial ports, allowing the M20 to be connected to a serial port completely internally as figure 1.3 shows.

The result of this work is a specialised miniature PC package, providing GSM connectivity and touchscreen. From the exterior it is hard to tell that the device is a fully functional PC, and even harder to tell that it contains an expensive GSM MODEM. This configuration needs no additional peripherals, and its size allows to be easily situated on a desk in an office (the SV24 case placed out of the way: on floor etc) with a mere footprint of 320mm x 146mm for the touchscreen. The SV24 is practically silent, very significantly quieter than a usual desktop computer; it should not be noticed by office inhabitants.

Although the device has yet to be deployed and training sessions organised for staff we anticipate further developments involving resident texting and the installation of these devices into the residents room where it is anticipated they may well perform a similar communicative and coordinating function - allowing the use of the system to display medication reminders, diary updates, rendezvous etc. There are, of course, issues of confidentiality and privacy to be considered and although the device has not yet been deployed many of these concerns have already been anticipated by hostel staff and the design team in the workshop. The issue of confidentiality for example, might arise because residents are generally assigned to a single staff member who visits them and coordinates many of their activities such as visits by their psychiatric social worker etc. Displaying messages on-screen and viewable by other staff members might be regarded as a possible breach of confidentiality. While we had some concern that messages sent by residents to an individual team member should only be readable by that member - suggesting a design solution in terms of the transfer of messages to individual staff mobiles - the staff argued forcefully that they worked as a team and the team overrode any such issues of confidentiality.

Concluding Remarks

Following deployment and training, a period of evaluation will commence which (in addition to raising further issues) will no doubt lead to refinements in our initial set of requirements and therefore modifications to our adopted approach as an aspect of both 'unanticipated use' and cooperative design whereby what Henderson and Kyng (1991) refer to as ‘design in use’ becomes achievable. Staff and residents require a period to explore fully the possibilities using and adapting to the new technologies, addressing the real problem which is not so much the creation of devices as their effective integration with the everyday demands of this particular care setting .

The approach adopted by this project attempts to meet some of the ethical and moral dilemmas of designing in and for care settings through careful involvement and acknowledgement of users in the design, deployment, use and evaluation process. It therefore incorporates possibilities for ‘innofusion’ (Fleck 1988; Williams et al 2000) where getting devices to work in particular user settings produces useful innovations and ‘domestication’ (Williams et al 2000),the integration of a device into everyday working practice. In amongst the technical challenges, central to the 'Digital Care' project and the technology development effort are issues concerning the moral and ethical components of the design enterprise, in particular the need to carefully think through and balance issues of ‘empowerment’ and ‘dependence’ and 'privacy' and surveillance'. The design challenge thereby involves an ethical awareness and recognition of the way that technology can impinge on individual care pathways, and a sensitivity towards the implications of any such intervention. This paper has sought to identify and address some of the complex design challenges faced when trying to investigate, understand and then meet the requirements of the ‘real life, real time’ concerns of this complex application domain.

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