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New technology in the human services

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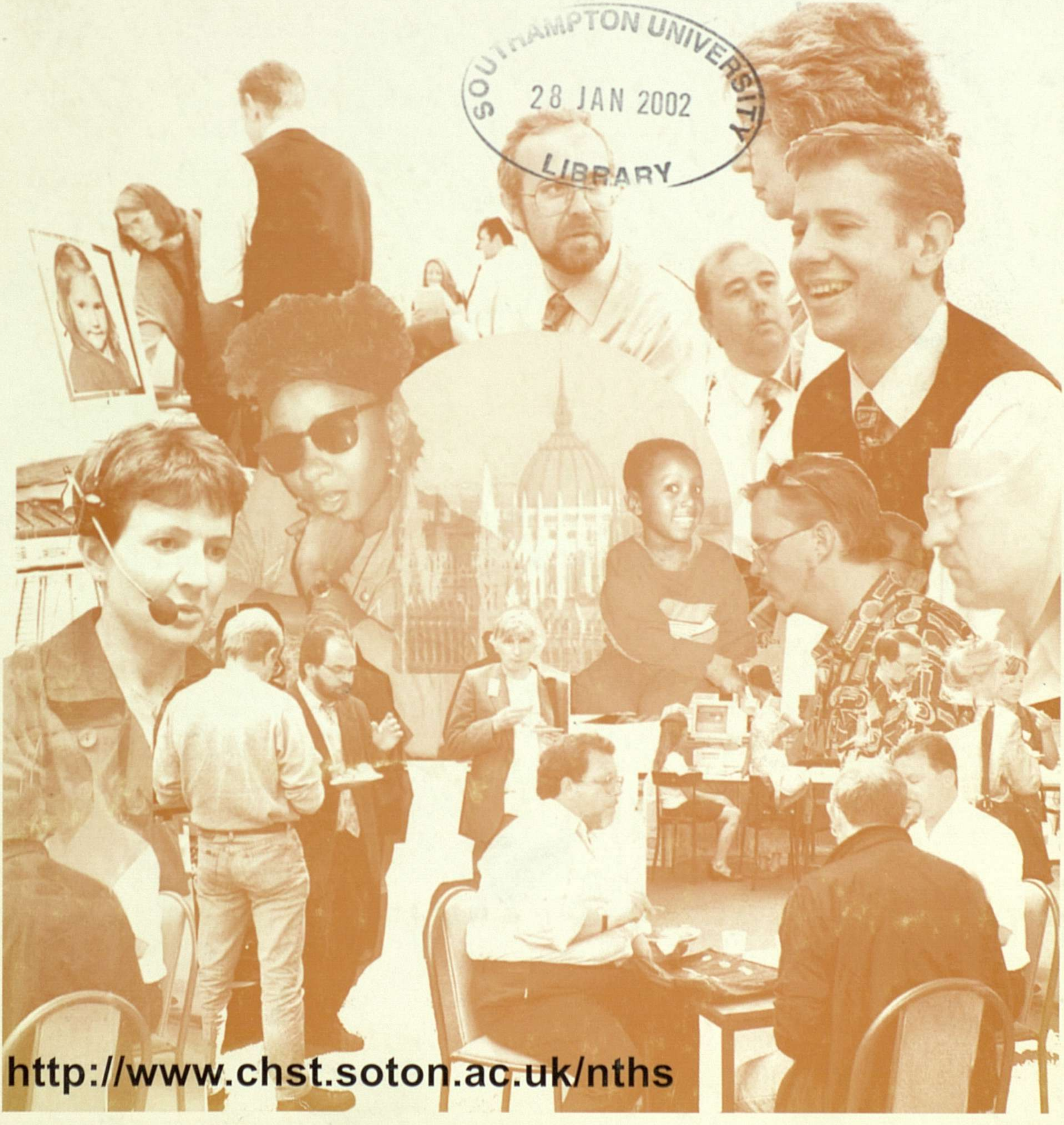

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New technology in the human services

Volume 14, Nos. 1 and 2

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New Technology in the Human Services is a journal devoted to the dissemination of information about the application of information and communication technology to social work and the broader human services. The journal publishes internationally refereed papers and from tme to time also publishes papers that are not refereed but reflect interesting developments - these are clearly shown as being 'Policy and Practice' papers. This is to encourage people to share their work but who do not wish to fulfil all the academic criteria normally applied to 'refereed' papers.

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Editor's introduction

Increasingly human service professionals and educators are working across boundaries. This is particularly true when working in the area of communication and information technologies. The subject of assistive technologies is a focus this journal has had before and members of the journal's editoral team have been involved in several research and development projects in this area. We are therefore particularly pleased to have worked in conjunction with the the Environmental Design Research Association (EDRA) to bring you a selection of papers, most closely related to the human services, from the 32nd Annual EDRA conference which took place this summer. The conference was in Edinburgh and was the first time this major international conference has been out of North America.

EDRA describes itself as "an international, interdisciplinary organisation founded in 1968 by design professionals, social scientists, educators, facility managers and students. The purpose of edra is the advancement and dissemination of environmental design research, thereby improving understanding of the interrelationships between people, their built and natural surroundings, and helping to create environments responsive to human needs."

For further information about the Association have a look at their website at http://www.telepath.com/edra/home.html

Over page we include details of the two courses we are aware of within the Health and Social Care Studies arena in the UK, one is sub-degree at HE level and the other is a Masters course.

Jackie Rafferty
Editor

MSc in Assistive Technology at Kings College, London

The Centre of Rehabilitation Engineering at Kings College, London has recently launched a new full-time and part-time Masters Programme in Assistive Technology. This programme offers a multidisciplinary educational experience that is both academic and vocational in nature. The main aim of the new programme is to produce AT specialists who are able to develop and apply assistive technologies with an understanding of the needs and desires of older and disabled people.

The multidisciplinary nature of the course means that the target student population for this Masters Programme are those who have a background in the fields of occupational therapy, physiotherapy, physical science, engineering, medicine, social work, therapy or education. In recognition of the need to increase the skills of those working in the field of asistive technology, the EPSRC (Enginnering and Pyhsical Sciences Research Council) has awarded the Centre of Rehabilitation Engineering a four year grant. Part of this grant will be used to offer bursaries for those who gain a place on the ocurse.

More information on the course, bursaries and application can be obtained from the CoRE web site www.kcl.ac.uk/core
Dr Jane K Seale, Co-ordinator of Masters in Assistive Technology jane.seale@kcl.ac.uk

HND Technology in Disability Studies at Bridgend College / University of Wales College Newport

The Higher National Diploma in Technology in Disability Studies is a two year course franchised from University of Wales Newport, but taught only at Bridgend College. It is the only course of its kind in the UK and as such is an exciting development and opportunity for individuals to make a meaningful and creative response to meeting the needs of people with disabilities. The course was developed in 1996 as a result of recognising the increasing need for workers with people with disabilities to have an understanding of both disability issues and information and assistive technologies, in order to be as empowering of disabled people as possible.

The course covers a wide range of subjects, including; Disability Issues, Policy and practice, Health Education, Organization and Management and Physiology and Ergonomics, together with a strong focus on information and assistive technologies, taught in a range of units including IT workshops, Computers in Caring, Computer Concepts, Computer Assisted Learning and Databases. Most of these units have a high emphasis on integrating theory with practice, which is why students undertake appropriate practice placements during the academic year. The academic year is divided into two semesters, with assessment of all units undertaken at the end of each semester.

Since its inception in 1996, the number of students undertaking the HND Technology in Disability Studies has steadily increased. The students who have so far successfully completed this HND have usually obtained jobs in the broad caring/education sector, both statutory and voluntary sector, and an increasing number are now going into business settings where their skills and knowledge are being put to good use. An increasing number of students are also going on to further academic and vocational studies, in line with interests they have developed on the course.

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How are we to grow old?

by Robin Burley

Introduction

In our society the phrase 'the elderly' conjures up a picture of passive recipients of care tended by nurses in a stone built Victorian mansion at the end of a long drive. None of us would want this for ourselves in later life and yet we seem to accept it as the inevitable consequence of ageing, at least when we think of the ageing of others.

For us, no doubt, things will be different, or will it? The Royal Commission on Long Term Care reminded us that in recent years it has become common for older people to go into residential or nursing home care after a crisis in their own home or on discharge from hospital. (Sutherland S, 1999)

Despite the evidence around us, most of us will assume we have some sort of immunity to the physical slowing down and dependence on others that goes with this image of ageing. But if we, as a society do not take action, many of us will be driven down that long one-way drive to the Victorian mansion.

Professor Tom Kirkwood, in the first of his Reith Lectures, drew attention to the prejudice that exists in relation to older people. "*On a regular basis we read, hear, or ourselves make flippant, jokey or negative remarks about the state of being old. 'Grumpy old', 'silly old', 'boring old', 'dirty old' - the linkages are so familiar that we fail to notice what we are doing.*" (Kirkwood T, 2001)

These are the underlying cultural prejudices that permeate the social environment in which our grandparents and parents have grown old. When we design services for them we seem to overlook their capacity to be contributors or their desire to be independent. If we do nothing to change the way we regard ageing, these will be the cultural influences that will shape the way we grow old.

Encouraging active ageing

The physical design of our home environment is one area where professional practice is unfriendly to infirmity. Our housing is full of physical impediments that make it difficult for us to maintain activity. Switches and power points require us to stretch. Taps and doorknobs are difficult to grip. And, if we have to resort to a wheelchair to move around, we discover that our doors are too narrow and there are steps at the front door. (Burley R, 1994)

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The problem is probably that most designers are in the active years of their life and the natural inclination is to create built environments that meet their own needs. There are well documented guidelines on barrier free design but still too little attention is given to creating environments that are accessible and usable for people of all abilities. We need to encourage a culture change in our schools of architecture so that the natural thought process in the profession comes to regard inclusive design as the overarching principle.

Some signs of change encourage the belief that progress is being made. Building legislation in the UK has been introduced that will widen the doors and remove the steps into our homes. Clients' briefing documents, particularly in the social housing sector, are adopting barrier free approaches under descriptions such as design for all, lifetime homes, and universal or inclusive design. All of these approaches will assist people to remain active in their home in later life.

Design that adopts an inclusive approach will be a necessary but not sufficient condition of a strategy that supports active ageing. The way that human services are provided will need to change. Take, for example, our health and social care practices. Older people tend to receive these services when there has been a break down in family care or the older person's health. This often results in their admission to institutional care which in turn increases the risk of dependency.

The alternative approach would be to redesign services according to policies that emphasise the importance of prevention of morbidity and the maintenance of quality of life. This would require health and social services to adopt a more holistic view of their support for older people – an approach that encourages healthy lifestyles and healthy ageing. (Kirkwood T, 1999)

Respecting the individual

For some decades, our service policies have treated older people as an homogeneous client group that was content to fit into the priorities and notions of economy and efficiency established by others. Even the commonly used term, 'the elderly', implies they are a separate group. This has the effect of reducing their needs and the service they receive to the lowest common denominator, detached from their personal experience.

Older people wish to preserve their individual identity as much as younger people and they will look for services that treat them as the unique individual customer. These services will focus on their particular interests and priorities. They will be designed to enhance individualism and independence. They will strive to keep people in touch with their usual haunts but where this is no longer possible, these services would help the older person to find new ways to stay in communication and alternative interests to pursue.

We will come to recognise that the socio-medical needs of the older person are best met when their ordinary needs are also being met in line with their personal priorities. This person centred approach will provide support for everyday activities because by doing so the older person's care needs will be better met. It will also give the highest priority to delivering the service in the older person's own home.

The ageing consumer pull

The demographic change that is sweeping through developed countries worldwide will generate innovation in products and services based on older people's agenda. In Europe, North America and East Asia, the balance of the population is changing. People are living longer and birth rates are lowering. These two – increasing longevity and fewer babies – will not only alter the population balance, it will also transform the power balance between the generations.

Tomorrow's older people are the generation that did not accept things the way they always were. In the 60's and 70's they created youth culture in Liverpool's Cavern Club and the pop festivals on the Isle of Wight. Through the 80's and 90's they remained forever young by moving effortlessly to consumer culture in the aisles of Tesco and Ikea. This is the baby boom generation that in the next two decades will make itself felt as a silver boom.

In the first two decades of this century this generation will bring into play the purchasing power of their index-linked pensions and their youthful attitude to living. (Underhill P, 1999) They will not find it difficult to persuade the commercial world to support their desire for home comforts and independent living. This will lead to a change in culture, not by waiting for legislative change but because customer pull acts on the commercial strategy.

If the newsprint is too difficult to read because the font size is small, the paper will be left on the newsagent's shelf. If the jam maker is incapable of providing a lid that is both airtight and easy to open, there will be another manufacturer that will identify the opening in the market. When we visit the supermarket we will pass by products out of reach. The more that consumer pull acts on the market place the more the market place will change to meet the requirements of the older customer.

We will not need to concern ourselves with these changes in culture becoming a reality. It will happen, in time. The question will be which companies will be in the vanguard of change and which will be left behind as the followers of silver haired fashion? The companies that will gain the commercial advantage will be those that see it coming and steal a march on their competitors by changing their product range to suit the emerging silver generation's choices.

A smart infrastructure for care

We are now at the start of an era that can turn the emerging person centred services into mainstream services that benefit everyone, everyone that is who chooses to live at home and receive care tailored to their personal requirements. Can new technologies provide a smart infrastructure that will render the bricks and mortar of the twentieth century care institutions redundant? That is a vitally important question for all of us since all but a few can expect to grow old and many will need support and care in later life.

Demonstration projects are already identifying the important role for new technologies in the emerging person centred services for older people. As an older person with reduced strength and mobility we can use new technologies to help us control appliances within the home and there are devices that will improve our safety and security. (Gann D, 1999) Telecom and wireless devices will provide new ways to communicate with retailers, services, friends and family. (Tang P, 2000)

Of course, the interfaces with these new technologies do not require control to be initiated from within the home. Telecommunications can place controls as readily in the hands of remote carers who may have parallel or complementary systems that operate devices in our homes. This facility has the potential to be an important source of support for a vulnerable older person. However, if it is used inappropriately it also has the potential to be an invasion of our rights. (Marshall M 1997)

Avoiding the virtual institution

This development of smart homes and telecare creates the potential to regard the masonry care institution as a thing of the past, except in exceptional situations. It also creates the potential for the institution to re-emerge in a new dimension that is not defined by the built environment. Smart systems can either be liberating for the older person or they can become a virtual institution that will be more insidious in the way it removes our liberties than institutionalisation.

This choice of institution or independence will be conditioned by the context within which digital care services develop. Will they be installed as stand-alone aids brought into the home in clinically designed white boxes especially for a separate client group of 'the elderly'? Alternatively, will these services develop as incremental extensions of the already familiar array of digital home helps that have found a valued place in our homes?

We need to encourage the development of new technologies for care within a context that maximises the benefits to the older person and, as far as possible, places control at their hands. Such a context might have the following parts:

- it should extend the functionality of already familiar appliances and controls;
- it should exploit the capability of new technologies to be tailored to individual preferences; and
- it should use principles of inclusive design to ensure that new technologies are accessible and comprehensible to the widest range of people.

Extending familiar technologies

Around the home there are plenty of home helps that are already part of our daily activities to provide an entry point for operating more sophisticated new technology devices. The TV remote controller is probably the most frequently used and the cordless phone has become a familiar device in many homes, including those of older people. We can add to these: the microwave oven, the hi-fi, the intruder alarm and the washing machine. These devices already provide us with a skills bank that can be built on to operate the new digital devices that will help us to maintain our independence, as we get older.

By making use of existing skills, older people already have the ability to operate a wide range of new technologies if only the interfaces were designed to be friendlier. Too often we write off the abilities of older people to use new technologies because there is little attention given by the designers to developing user-friendly interfaces and operating procedures. We seem to accept as a given that our children should be able to operate the latest piece of high tech that we have introduced to our home rather than demand that the manufacturers make it comprehensible to a wider audience.

Tomorrow's demographic realities will not allow manufacturers of new technology to get away with this laziness. We are not many years off the time when there will be as many people over 50 as under 50. What is more, over 80% of the nation's wealth is controlled by the over 50's. This fact is beginning to wake the commercial world up to both the scale and the power of our ageing population. (HOPE, 2000)

Responding to the individual

The second factor in the context of telecare's development is to focus on the capacity of new technologies to respond to individual preferences. We know that our computer screen can not only be arranged so that the programmes we most regularly use are most conveniently to hand but also the symbol size, colour and contrast can be adjusted to aid us if we have a visual impairment. It is now commonplace for mobile phones to allow us to choose the ringing tone with some being capable of having a ringing tone implanted that we have recorded and when connected to our car being operated by voice commands.

Older people will wish to stamp their individuality on the appliances they use. Why not have differently styled clip-on fascias for the telecare hub to fit in with the house décor? After all, we can buy a variety of fronts for our mobile phones. But, more importantly, we will want to choose the way an interface device is controlled or which type of interface we use. One person may use buttons, another may prefer a menu, a third might use a touchscreen while a fourth would make use of voice control. Our choice of interface might be the infrared remote controller, the cordless or mobile phone or a computer or personal digital assistant. A manufacturer in Japan has even developed a user-friendly interface in the form of a cuddly toy pet, which acts as a memory jogger for older people. (Gann D, 2000)

Whatever we use as our digital home help as we grow old we will want convenience, familiarity and that they should be an extension of the ordinary activities of our day. We will also expect good design. Fitness for purpose and reliability are rarely the factors that differentiate the products of one manufacturer from those of another today. We expect design that reflects our lifestyle both in an aesthetic sense and in the sense that the device can be tailored to our personal preferences.

Adopting inclusive design

The unique selling point for so many new devices when they are brought to market is their capacity to be tailored to individual choice. However, in this world of choice we are also frequently reminded of the impossibility of grasping the technique of operating the video. This black box mounted two inches off the ground with an array of confusing controls has become the butt of anyone who wishes to poke fun at the intelligence of home appliances.

Even if we arm ourselves with a remote controller to operate the record and playback functions of a video there is no getting away from having to get down on hands and knees to change the cassette. It is a rarity to find a manufacturer of televisions that has thought through the design of the stand to mount the video at a convenient level.

The difficulties in operating videos do not stop there. The development of user-friendly graphical interfaces seems to have passed most of these appliances by. Videos that are full of microchip technology should be capable of being configured to give high priority to ease of use. However, they have the reputation of being one of the least comprehensible appliances found in most homes.

The video serves as a lesson that inclusive design should be the third contextual layer for the development of smart home and telecare services. Products and services designed according to the concept of inclusive design should improve the opportunities for people to live on equal terms regardless of their ability, circumstances or stage in life. The key principles would be:

- Designs (hardware and software) that are flexible enough to be used without modification by people of the widest range of abilities
- Designs (hardware and software) that are capable of adaptation to suit people's varying needs,
- Assistive technologies that enable people with complex needs to make more efficient and effective use of their operating environment.

Someone old with something new

The silver boomer generation will not be content to grow old as passive recipients of care. Neither will older people be content to settle for products and services that mark them out as a different group in society.

The way forward for smart home and telecare products and services is to become an extension of ordinary and familiar technology in the home. In this way they will complement the things older people choose as important to their everyday life and they will avoid the stigma of ageism.

We will grow old with our strongly imbued sense of independence and a desire to shape a silver culture that is as potent as the pop and consumer cultures of our former years.

New technology industries need to develop their product lines and services to support active ageing and be relevant, accessible and comprehensible to all ages.

Our expectation today is to buy what we want, when we want it. We regard reliability as the basic standard and we differentiate on the basis of style. These things will not change as we grow old, although our priorities and tastes may. The challenge for services and industry is to identify older people's emerging care priorities and to seamlessly integrate the related services with familiar home products and services.

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The social and psychological aspects of smart home technology within the care sector

by Guy Dewsbury

Introduction

Everything has become an operation, everything has to have a function and a use. (Fromm 1995, 24)

Technological innovations within the home are nothing new. The introduction of the radio, through to the current rise of computer technology have affected the way in which people interact with their environment and between each other. The advent of 'smart' technology for the home has been welcomed by the minority and shunned by the majority, being perceived as unreliable and too 'sci-fi'. Orwelian conceptions of the home as a locus of extended social control, no doubt, also affect the acceptance of technology into the fabric of the house. Alienation from this form of technology might have also arisen as a by-product of the way it has been introduced and marketed (Edge, et al. 2000). Many people with disabilities and older persons might feel that they are not included in discussions on technology, as it is perceived as irrelevant to their needs. There is little doubt in the mind of the author that this pessimistic view will decrease and acceptance will occur when the technology no longer holds the associations and values associated with the sci-fi label and is used within the care field appropriately. This paper considers how the technology can be used in the provision of extending care for people with disabilities or older people. It considers the efficacy of approach and its potential consequences.

The observations within this paper stem from undertaking a number of workshops and consultations on the use of smart home technology within the social care field. Within these consultations, certain common themes evolved from the discussions that the author attempts to address here. Most frequently, the issues centred on the relationship between technology and the person with disabilities.

Assistive technology and the care setting

> *The use of technology appears to present dramatic compromises in social activities, role definition, and identity. (Gitlin, 1995)*

Many authors have considered the individual in relation to the effects of disability on quality of life. Clearly, there

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is a necessity for the person to be perceived as being real and not *'in relation to'* things such as technology. Technology is often also considered from the scientific communities' dispassionate stance where its efficacy is judged against whether it performs operationally, according to set rules that can be quantified and judged. This quantifying of operations belies the fact that technology affects the individual who encounters it in a number of ways. We are all affected by technology every day, from the cars on the road through to the television or radio programmes we consume (Burley 2000, Dewsbury, et al 2001). By perceiving technology from an operational position, it is easy to neglect the person consuming or using the technology.

Assistive technology connotes adaptions to enable people to lead a better quality of life. As Story et al (1998, 10) suggest:

> *The label, "assistive technology," was applied to devices for personal use created specifically to enhance the physical, sensory, and cognitive abilities of people with disabilities and to help them function more independently in environments oblivious to their needs.*

Sutherland *(1999, Vol 2, 6-7)* extends the definition, whilst offering a note of caution:

> *...Assistive technology... ...includes communications equipment such as telephones and alarms, equipment to aid mobility, personal and domestic care, 'smart homes' and telemedicine/telecare. They can answer problems of communications, mobility, manipulation, orientation and cognition. Some will answer more than one problem, e.g. an alarm for both communication and security, and may greatly enhance the quality of life. However, they cannot take the place of social interaction.*

Hence, the purpose of Assistive technology (AT) is to provide assistance, without being a replacement for personal care and attention. It is unsurprising that in the age of greater cost benefit analysis, and greater strains on limited resources that health authorities tend to heed this advice seeing personal qualities as outweighing the logistics of financial considerations. Often preference is given to options that enable the quality of life of a person to be increased whilst retaining a regular care worker whose visits provide social communication and interaction. Isolation is a major problem for any person who is older or has a debilitating disability (Marshall 2000). People who are incapacitated in some way are at the mercy of others to provide the simple basic needs that Maslow (1943) so poignantly observed over one half of a century ago. People who do not have disabilities should not need to be concerned with food, shelter or human contact, as they are part of everyday life. It is therefore essential that people with disabilities are not given substandard care packages that do not meet their needs in all areas: social, psychological, physical, social and emotional. Similarly, care packages should not be over technologised so that the person is reduced to being the slave of technology.

The technologisation of needs

> *Visions of what technology can do for the elderly are rarely based on any comprehensive understanding of needs and in some cases are blatant technology push.(Quigley and Tweed 2000)*

Can technology meet human needs? Can the technology act as a method of reducing the levels of a person's dependency? The marketing of the technology has traditionally ignored the care sector. Therefore, the answer is not trouble-free. As Baum (1997, 138) suggests:

> *If AT were viewed at the disability and societal limitations level, it would be more obvious that the application of technology overrides barriers by*

supporting independence and self-reliance and provides opportunity for self-sufficiency ... Is community independence not the ultimate purpose of AT?

Baum perceives that AT can meet needs and act as a method of increasing community independence of which there is little doubt, but how does the person interact and perceive the technology? Lupton and Seymour (2000, 1852-1853) suggest that the interplay between technology and the individual is far from straightforward:

Any human body using any form of technology may be interpreted as in some way adopting prostheses to enhance its capacities. Nearly everyone in contemporary western societies has developed a close dependency on technologies to function in everyday life, such as using spectacles to see clearly or a car to achieve greater mobility. As this suggests, the category of 'disability' is not fixed, but rather is fluid and shifting, a continuum rather than a dichotomy...

In the process, it has implications for the ways in which people with disabilities construct selfhood and interact with others. By augmenting or substituting particular bodily functions and transcending time and place, new technologies offer people with disabilities the possibility of facilitating entry and participation into previously inaccessible activities and domains. Computer technologies, for example, may lessen the importance placed on physical prowess and allow greater entree into the workplace for people with disabilities. As such, they may go some way towards redressing the disabling features of many work environments.

Therefore, technology augments bodily functions and facilitates entry and participation into previously inaccessible domains, the technology itself enables the person to interact with their surrounding in a new sense. Technology can enable the person to engage and participate in activities that would have been previously impossible. The dichotomous 'disability' might indeed be a shifting concept, but the evidence from Seymour (1998, 184) is that:

People with disabilities have the potential to be amongst the major beneficiaries of the technological revolution.

Because

The positive attributes of technology...contributed to an integral aspect of selfhood and bodily experience: the opportunity to engage more easily in social relationships...technologies were valued for allowing them to tame the disorderly aspects of their bodies and thus to facilitate social integration. They [the people in her study] drew an important distinction, however, between the technologies they considered more 'normalising' and others, which they saw as marginalising or stigmatising (Lupton and Seymour, 2000, 1857)

Technology can play an important part in assisting people in their daily lives. The possible problem that arises from the technologist approach is that needs can be obviated by its use unless undertaken by professionals who have expertise in the technology and in assessing need. With the future unification of the community care assessment procedure, it is a concern whether the technology will be misplaced or overused. In either of these cases, the person who has been assessed will not have their needs appropriately met by the imposition of technology.

Technology that does not function properly is extremely confusing and distressing to everybody, but exceptionally so for people with dementia and their carers.(Bjorneby 2000, 37)

It is essential that training in needs assessment include the use of new technology within its remit in order to allay any misunderstandings or misplaced technology.

Too often, the knowledge and experience of the consumer is neglected, resulting in needlessly complicated or even useless devices. As always, time, budget constraints and medical factors must be integrated into the formula for success. (Bazinet, 1995, 329)

Smart homes and social care

Smart technology is not the Holy Grail of the system of care for older people in the new millennium. But used sensitively alongside person centred care it can be a vital and valuable companion in a journey that will bring a happier, more fulfilling life to those of us about to join the silver generation. (Burley, 1999)

Although AT can be seen as extending the options that are provided to people, where do smart homes fit into the equation? Smart homes (automated homes, networked homes, intelligent homes) are homes that contain devices that are able to operate complex tasks that are pre-programmed either into the devices themselves (via a bus line) or through a computerised operating system (X10). A bus line is a small cable that runs through the house in addition to the conventional mains wiring. Its function is to send messages to and from the devices so that they can communicate with each other (bi-directional protocol). Allen & Dillon (1997) and Gann, et al (1999) demonstrate that the ability of two-way communication between devices within the bus line is more effective that the one-way computer driven system and is therefore essential to be used for people with disabilities who rely on robust and reliable systems.

A smart home can enable the person by assisting in daily routines and enabling the individual to achieve tasks, they might not have previously been able to achieve. Tasks can range in levels of complexity from simple tasks such as turning on or off lights through to fully automating the majority of electrical systems within the house. Although the last '*extreme*' example might only ever be considered for severely cognitively impaired people who are likely to endanger themselves within the domestic setting if left unattended for any time.

Smart homes for people with disabilities and older people can provide empowerment, independence and most importantly, choice. Smart homes can be offered as an alternative to residential care, allowing the person to choose to stay at home, which for some individuals is essential for their happiness and well being. (Dewsbury and Edge 2001)

Through the CUSTODIAN[1] project (DE4004) the design and development of smart homes were able to be analysed and developed to meet specified needs of people with a wide and diverse range of needs. Translating the needs into devices proved to be relatively simple for a person with a basic knowledge of the hardware. The complexity of the derived solutions lay not in the selection of devices but in determining how the devices were to behave in relation to each other. The software developed within this project attempts to facilitate this process by the fact that a number of different scenarios are available to the user with preconfigured devices that can be modified to the specific

[1] For more information on CUSTODIAN see: http://www.custodian.org.uk or http://www.rgu.ac.uk/subj/search

needs of the person for whom the design is being undertaken. Through the design of the smart homes that were undertaken as a result of this project the technology was put to the ultimate test with a specified design for real people that were built and lived in as their home. It was through this experience that the conclusion was arrived at that AT and smart homes exist on the same continuum and smart homes extend the range of services and domestic support that is offered to the person with disabilities.

> *The reality is that the home, even without intelligence is not so much bricks and mortar, but increasingly a series of personal care services. With the advent of the smart home the range of services that the home provides may be about to undergo a radical change.*
> *(Edge, et al, 2000, 7).*

The technological costs and the benefits

The cost of smart home technology is consistently the question that appears to be the stumbling block in the introduction of the technology. There does not appear to be clear and concise data from which to extrapolate cost information (Sutherland 1999). The manufacturers of devices can give a quotation for a selection of devices, but this is not all that is required. Each installation can cost differing amounts if the building is retrofitted as the installation costs will differ by a number of variables such as the ease of installation, the type of walls, whether the rooms are prefabricated etc. In new build houses, the ability to cost is easier and if all the houses are the same, within a project, then a baseline cost can be derived. Due to the fact that smart home technology has been marketed and used predominantly in larger buildings such as office blocks, shops and for the rich and famous, prices have not been calculated for one off smaller installations of the type that occur in the social care settings. It is only when the technology becomes used regularly over a number of years within the social care sector that a picture of the real cost of the technology will become clear.

The smart home installations that the CUSTODIAN project designed and had installed cost between £13,000 and £15,000, but this may not be truly representative of other installations, but can act as a ball park figure for future guesstimates to be drawn. Through the work carried out on the project, a baseline minimum for an installation could be perceived to be around £5,000 for the basic bus line installation with a minimum of devices. As Bazinet (op cit) suggests, often the protocols of the institutional environment outweigh the efficacy of the system design. Other issues such as acceptability of the use of smart home technology and lack of outcome studies in relation to the technology impede its general acceptance. As Sutherland S (1999, Vol 2 p6-7) observes:

> *Issues of feasibility are around those of cost and production on a large scale, the degree of subsidy and the contribution of the public sector, the fact that some equipment is bulky and expensive, and the lack of accessibility. On acceptability much depends on the perception of the person – for example mobile phones are very acceptable and do not have a stigma. In general, there is satisfaction with some types of AT such as alarms but sometimes a reluctance to use them.*
>
> *However this may change in the future, with a new generation of older people who are more accustomed to electronic devices. There is little evidence about acceptability to carers or service providers. On outcomes, one cannot generalise but some have the potential to restore mobility, give greater independence and save lives as well as improve the quality of life. There is not a great deal of data on costs but the development of a market in the EU would undoubtedly bring prices down.(Sutherland, 1999)*

Acceptability of carers and service providers can only come as a result of a technological push into the area of social care. Clearly, the rigidity in evidence-based approaches is impeding the acceptance of the technology as the rationale for acceptance is too rigid to allow for the benefits to be demonstrated. The manufacturers of the technology are also to blame as they have not seen the social care market as realistic previously and therefore have not undertaken the necessary research and development into the area (Gann, et al, 1999, Marshall, 2000). The Joseph Rowntree Foundation (JRF) commissioned a survey on attitudes to smart homes after the development of the Gann, et al (1999) study. The JRF findings were not too surprising and offer a small amount of hope to the reader.

> *With the infant Smart Homes and other associated high-technology markets changing so rapidly, any predictions for their future are highly uncertain. Nevertheless, this research does identify reasons to be optimistic that a mass consumer market for Smart Homes type technology could develop if the market grows and prices fall appropriately. There appears to be significant consumer interest in the concept, which could be unlocked at the right price.*
>
> *Unsurprisingly, the Smart Homes idea is most attractive to more pro-technology consumers, including the so-called 'early-adopters' vital to the early development of high-technology markets. But, in addition, the Smart Home also could appeal to a broader range of consumers because of its potential safety and security benefits. If a market does develop, it seems less likely to come from impetus in the building, construction or property sectors. The greater opportunity for growth in the use of Smart Homes technology appears to be from its addition to the burgeoning array of consumer electronics - especially home entertainment and personal communication systems - and initial demand from the more technology-literate early-adopter households.*
> *(Pragnell, Spence, & Moore, 2000)*

The most important study on costs and benefits of technology was undertaken by Quigley and Tweed. Their findings, although generalist and predominantly qualitative, demonstrate that the technology is of significant value and should not be tested in terms of cost/benefit from a monetary position, but rather should be seen in qualitative terms. They concede that savings are likely, but see this as a side issue to the more important enhancements to the quality of life and quality of care provided with this form of assistive technology.

> *The costs and benefits to a person's quality of life are more important than the financial cost. Any system, no matter how costly that improves quality of life is probably worthwhile. The financial benefits of such a system will be recuperated in due time as the costs of care and hospital expenditure drop. Any system that does not improve quality of life will in the long run prove costly financially because not only is there the expense of the installation but there will be a continued need for high level of care for the individual.*
>
> *It is in the interest of care providers and housing authorities to install and maintain such systems. It would be unreasonable to expect an old age pensioner to purchase assistive technology, as this would prove a financial strain. It may be possible for the users to contribute in some way e.g. deduction from their pension or deductions in benefits.*
> *(Quigley G, Tweed C, 1999, 5)*

Through the new unified assessment procedure, there is the faint hope that smart homes could be put on the agenda and used regularly when appropriate. The concern relating to who is to pay could no longer be a significant issue with a centralised budget. Maybe there is light at the end of the tunnel. Resources alone cannot get smart home technology introduced into the social care arena, education must play an important part. The assessors must be trained in the use and appropriateness of the technology and the purchasers should be made aware of the value in real terms of its use. Moreover, the installers and commissioners of the equipment need training in understanding and translating needs into device configurations.

The Future

The Orwellian vision that began this paper is required to be reassessed. Technology does not have to be something that *de facto* controls people but can and should be used by people to control their own lives. There are no easy answers concerning how to achieve a shift in attitude and perceptions towards technology. Possibly, by the fact that the technology exists, and is being used by some forward thinking health authorities will impact on those who have not considered it to date, trickling down. Most importantly, the technology is required to be used correctly. There is no point in providing substandard technological solutions if it possibly will endanger or debilitate potential users.

Through CUSTODIAN, the technology has been given the opportunity of being used in the 'real world' and has had some very encouraging results. One home that was designed for a person with severe disabilities whose prognosis was poor, has achieved a remarkable change[2]. As a disabled person who lives with the technology, she feels she has been empowered, and she retains a quality of life that she would not have otherwise have had. Smart home technology allowed this person to make a choice whether to remain at home with her loved ones or whether to have other arrangements made. The technology has also helped her husband to cope with his wife's disabilities. It is difficult to suggest that all the rehabilitative effects are technologically derived as being at home must play an important factor in itself, but there are significant psychological and social changes for the best.

Smart homes are not something to be scared of, just as computers and televisions are no longer to be feared. Over time, technology becomes accepted as the norm and is taken up by the majority of society. Like all technology, if it does not work it is not taken up, but smart homes clearly do work. If you travel to Sweden it is likely that the majority of buildings you visit will contain a 'bus' line, as Sweden has embraced this technology directly. You might not be aware that the technology is present, because the ideal technological solution is in the background, it does not make itself overt. How many times do you look at a light switch and consider its qualities? It is taken for granted. When you enter a room, the lights will gradually come on and will turn themselves off once you have exited. It is subtle. Maybe if the technology were more obvious it would stand a better chance of being accepted? It is difficult to know.

Some tentative gudelines for smart home technology implementation within the socail care sector

Below is a list of guidelines, which have been developed not as an exhaustive list of do's and don'ts, in attempting to facilitate the introduction of smart home technologies, but rather as a few ideas to consider. In undertaking a list of guidelines, it is noted that any list should not be a static prescription. Guidelines need to evolve just as the needs of people modify daily. The following guidelines have been developed by the author through working in the area of smart home technology within the social care field and are designed to be judicious in nature.

[2] For more information on this person see: http://www.smartthinking.ukideas.com/Sigma.htm

1. A long-term view of a person's condition should be undertaken in the assessment. If a person's condition is to degenerate slowly then the technology will be useful for longer.
2. Assessments and judgements should consider how the person is to interact with the technology from a psychological, emotional, physical and social perspective.
3. Assessments should not just consider what the technology can do for the person but what it can do for all stakeholders.
4. Seeing technology as enabling and empowering is essential to the design process, whilst it is important to recognise that inappropriate design is disabling and unempowering.
5. Specifying devices to meet the needs of stakeholders must also include specifying how the devices will interact with each other.
6. Technology requires regular maintenance and it is essential that the system is regularly checked to ensure it still meets the needs it was designed to meet and the costs for this are put into any designs.
7. Technology should not be considered predominantly in terms of being cost saving or a labour saving intervention; social exclusion should not result from the design.
8. Technology should not be seen as the panacea for all ills in the world, whilst it should be considered in all assessments.
9. The implementation of the user needs assessment by professionals requires that appropriate technology be used in the correct manner, with the correct devices undertaking the correct functions when and if they are supposed to do so.
10. The long-term efficacy of the technological design should reflect the needs of all stakeholders, the person(s) with disabilities, carers, and others.
11. Undertaking a full user needs assessment is critical to determine if technology as appropriate to meet the needs of the person.
12. Training is essential for assessors and for installers and maintenance personnel. Everyone who encounters the technology should understand what it is supposed to be doing and be able to assess if it is not performing appropriately.

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From caring home to smart house – a needs led evolution

by D A Bradley, S Levy and S J Brownsell

Abstract

A persons' home provides them with a sense of security, familiarity and belonging, all of which contribute to the extent to which they feel that they have control over their life. In recent years technology has established an increased presence in this environment enabling (older) people to benefit from the use of systems, including community alarms, to make their lives more manageable. The Smart House concept is seen by some technology champions as an obvious progression of home healthcare technology, enabling the house to facilitate the support necessary to enable individuals to remain in their own home rather than being forced into a sheltered or institutional setting. Yet it may be argued that care provision through the medium of a Smart House transforms what is essentially an individually crafted environment into a fully operational extension of a clinical environment while losing crucial elements associated with an individual's personal space.

Home care technology that 'grows with you' rather than a Smart House that must 'grow on you' should therefore be the goal for work to find a technical solution to bridging the gap between available resources and demands on healthcare providers. This paper considers the need for home healthcare technologies and the ways in which they may evolve while introducing the concept of a '*Technology Prescription*'. This mode of future 'smart' care provision is suggested as a means of matching user need to appropriate technology, as part of a needs led approach which would allow for the gradual introduction of specific care technologies into a familiar home environment.

Introduction

The traditional low-tech living space - the 'Dumb House' - could be defined as a layer of bricks and mortar, encapsulating a lifetime of personal experiences interwoven into the inner fabric of a home. Such a structure serves to enhance a sense of security, familiarity and belonging and contributes to the feeling of control over ones life. Indeed, studies in the UK and North America have confirmed that the majority of older people value their independence and would wish to continue to live in their own home environment for as long as it is possible and safe for them to do so. (UK

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Department of Health, 1992; Abbott & Fisk 1997) However, people would require reassurance about their ability to live independently, expressed through the provision of appropriate support for care, assistance/enablement and advice as suggested by Fig 1, which together support their wish to 'stay put' rather than 'move out' of their home.

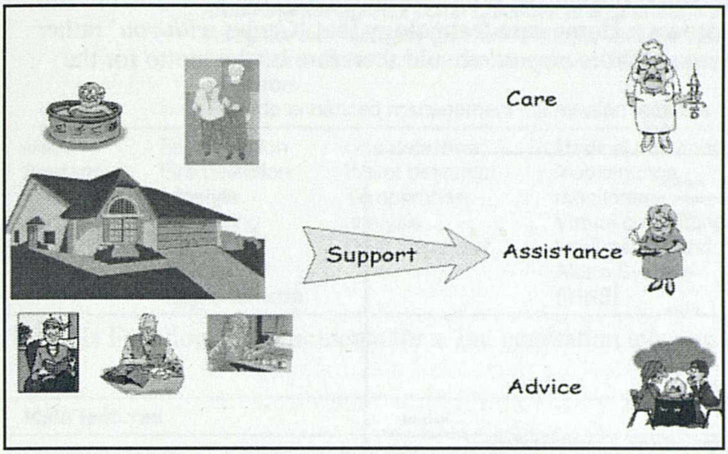


Figure 1: Requirements for independent living

In recent years technology has developed an increasing presence within the home, enabling (older) people to benefit from a number of support systems such as 'first-generation' community alarms which help to make their lives more 'manageable and comfortable - the 'Semi-Clever House' environment. The idea of transforming a personally crafted home environment into a fully operational 'Smart House' is seen by some technology champions as an obvious progression in the pursuit of domestic technical advancement. Moreover, the incorporation of the Smart Home concept into the care provision infrastructure is held out as the means by which individuals are to be provided with the necessary support to enable them to remain in their home rather than being forced into a sheltered or institutional setting.

While the use of a wide range of home-based telecare and telehealth technologies aimed at supporting independence is believed to make sound economic sense in relation to integrated and seamless care provision; (Brownsell et al., 2001), the use of the Smart House concept as an extension of a clinical environment does not always serve to reassure prospective recipients that it is a needs led solution. Indeed, the vocabulary that is often associated with the transformation of a *home* into a *Smart House* often brings to the forefront images such as surveillance, lack of control and dependence. It may also be misleading to presume that by simply placing a full range of consumer orientated products and devices in the home, patient care and self-care routines will be dramatically improved. In the great majority of cases what is needed is not a technology driven solution such as may be perceived as being provided by a Smart House, but a simpler and integrating approach which draws together user needs with a responsive care provision through the application of appropriate technologies. Matching the devices or resources appropriately with and to specific user needs and abilities, through a consultative healthcare orientated process, will help to revoke the belief that Telecare is based on the application of technologies looking for a problem rather then a problem seeking to use appropriate technologies.

The adoption of an approach which would allow for the gradual introduction of specific care technologies into a familiar home environment through the use of familiar and trusted advisors such as a GP or health visitor is more likely to be perceived as matching user need to technology provision. Such a strategy may well ultimately result in the deployment of a full range of Smart House technologies, but these will be implemented in a gradual manner in response to identified healthcare changes and needs occurring over time. Such modular Telecare technologies and solutions will result in the progressive transformation of the home environment from a dumb but caring home to a state of the art, smart responsive home while leaving the individual in full control of the transition process. Home care technology that '*Grows with you*' rather than a Smart House that must '*Grow on you*' should therefore be the motto for the future of care provision.

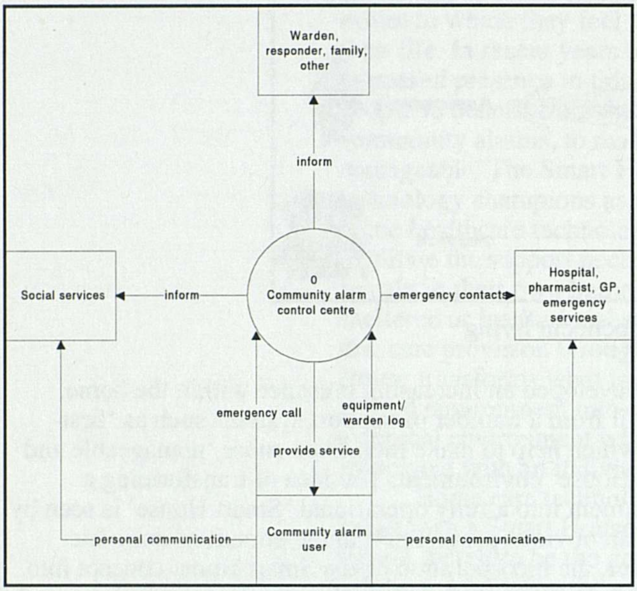


Figure 2: Context diagram for a conventional current community alarm system

The evolution of TeleCare technologies

Figure 2 shows the context diagram for a conventional community alarm system from which it can be seen that the control centre acts as the primary interface between the user and a range of service providers. Such a system, while providing significant levels of reassurance, relies on the user initiating an action requiring a response from the control centre which in some circumstances, for instance following a fall, may not be immediately possible. While much effort has gone into improving the 'wearability' of alarms, they still rely on the user taking appropriate action in case of an emergency. The evolution of the community alarm to provide increased capability and functionality represents a developmental path which would be capable of growing with user needs while integrating with the overall requirement for a needs led approach to telecare. Based on the evaluation of the progression of need and related technical requirements, functional requirements for 2nd, 3rd and 4th generation telecare systems based around the community alarm concept can be developed and these are set out in Tables 1, 2 and 3 respectively.

Function	▪ Support independent living ▪ Support next-generation community healthcare systems ▪ Support the deployment of enhanced sensors ▪ Support the use of machine based intelligence in the provision of community healthcare services ▪ Support inter-agency communication and data transfer ▪ Integrate automatically generated alarms with the operation of control centres ▪ Prioritise calls and provide enhanced decision support for control centre operators ▪ Provide enhanced management information features			
Major System Elements	Fall detection Fire detection Lifestyle monitoring Security Virtual neighbourhood	Gas detection Water detection Temperature analysis Drug dispenser	Medical monitoring Incontinence monitoring Virtual consultations Intelligent Home Alarm System (IHAS)	GP surgery Electronic Patient Record (EPR) Control centre Hospital health services Social services

Table 1: Functional requirements for a 2nd generation telecare system

Main features
Components of 2nd generation system: the previous modules are available in the 3rd generation system. **Lifestyle monitoring**: identify the movements of users without having to use tagging. **Security**: more developed burglar alarm, central locking and automatic user recognition. Access to appropriate sections of EPR for all professionals. **Drug dispenser**: enables repeat prescription reminders and analysis of the medication held within the dispenser. Enables remote adjustment of medication regime, prevents overdosing. **Medical band**: provide 24-hour continuous medical monitoring for users wearing a medical bracelet or vest. **Distance support**: communicate with the medical band and allow the user to call for assistance when away from the home. Could be based on a mobile phone. **Intelligent Home Alarm System (IHAS)**: the ability to track the user if they fail to return home at a specified time. **User control**: provide verbal communication with the home based system. **Virtual GP/neighbourhood**: provide remote physiotherapy and tailored exercise schemes. **GP surgery**: expert system to suggest to the GP what medication may be prescribed, identify contra-indications and cost. Record unmet needs for further development **Pharmacist**: enable paperless prescription linked to the home drug dispenser. **EPR**: store the users data. **Control centre**: support for foreign languages and analysis of users EPR's to ensure that correct medication is being used.

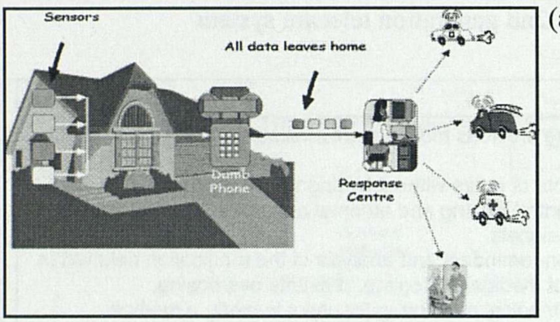
Table 2: Functional requirements for a 3rd generation telecare system

Main features
Components of 2nd and 3rd generation system: the previous modules are available in the 4th generation system. **Water detection**: monitor the washing habits of the user. **Incontinence detection**: detect the onset of incontinence. **Robotic assistance**: provide mechanical assistance with vacuum cleaning, retrieving items from the floor and dressing. **Virtual GP/neighbourhood**: the scanning of letters and forms that cause distress. Assistance being provided from friends or relatives, and ultimately the control centre or social services. **Implanted medical monitoring**: implanted sensors measuring vital signs 24-hours a day. **Intelligent Home Alarm System (IHAS)**: route emergency fire calls directly to the fire brigade. **User control**: the use of the mind to control electronic devices around the home. **Control centre**: each user's EPR is analysed under the automatic Activities of Daily Living (ADL) assessment.

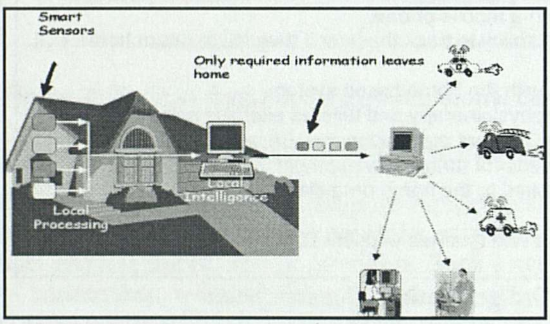
Table 3: Functional requirements for a 4th generation telecare system

As the technology content of home telecare systems increases, the need to manage and interpret the resulting data similarly increases. There are essentially two basic strategies for the management of the generated data as illustrated in Fig 3. In the first of these strategies, shown by Fig 3(a), all the data collected will leave the home to a remote location where it will be processed and analysed. This was the strategy adopted by the recent BT/Anchor project (Porteous & Brownsell 2000).

Such a strategy presents two major problems for the user. Firstly, all data **must** leave the home in order to be processed which means that the user has little or no control over the nature of the data transfer and subsequent processing. Secondly, because the system scans the users installation at fixed times to download the data, there is the possibility of an emergency situation being left unanswered for a significant length of time. While this latter aspect can be alleviated to some degree by incorporating a conventional alarm within the overall system, this still requires the user to initiate a response with the same limitations as a current community alarm installation.



(a) Remote



(b) Local processing

Figure 3: Information processing options for telecare

If however the local processing strategy of Fig 3(b) is adopted incorporating local intelligence at the sensor level together with local processing of the data prior to transmission, it becomes much easier for the user to be involved in and be a part of the decision making process which establishes the conditions under which data is to leave the home environment. In addition, because the processing and decision making is carried out locally, with only agreed data being transmitted as required, the load on the communications network will be significantly reduced. Further, the introduction of local intelligence makes the system more responsive to emergencies as it no longer has to wait to be interrogated by the external system.

System costs

One argument for an increased use of telecare is that it would result in savings which could then be used to extend care provision. Consider a system offering the features set out in Table 4, in order to be justifiable a system with this level of functionality must as a minimum recover its initial costs and pay for its replacement over its lifetime by generating savings in areas such as: time spent in hospital, entry into care and levels of support required within the home environment. In order to understand the changes that would be required in each of these areas to achieve the required balance of cost and performance consider the requirements for a city such as Birmingham where there are currently some 11,500 community alarm users supported by the local authority through its *Careline* service (Brownsell et al., 2001).

Element	**Description**
Lifestyle monitoring	Automatic detection of situations where assistance is required and the user is unable to raise the alarm themselves.
Security	Linked to the lifestyle monitoring component, the in-house equipment automatically activates/deactivates a home security system, it also indicates if occupant(s) are in the home.
Automatic fall detection	This could be part of the lifestyle monitoring system or a stand-alone device..
Emergency monitoring	This should automatically detect if a cooker has been left on by mistake and turn the cooker off if necessary, this element should also automatically detect fire and gas appliances left on by mistake, responding as necessary to maintain safety.
Medical monitoring	A basic set of medical parameters are measured and if outside of GP defined boundaries, the GP can be contacted.
Virtual GP consultations	Some GP consultations are performed remotely through video conferencing and the medical monitoring equipment in the home, rather than physically in the home or surgery.
Virtual nurse visits	Nurse visits that do not require 'hands on' care can be performed remotely through video conferencing and the medical monitoring element.
Improved communication	Data gathered from the home is stored locally and at defined times sent to the control centre for predictive analysis and accurate information for hospitals, social services via the Electronic Patient Record (EPR).
Automatic drug dispenser	Dispensing the correct medication when required, as defined and updated by the GP when necessary.

Table 4: Possible system elements

Assuming average system costs of £500, £700 and £1,000 respectively, Table 5 shows the related expenditures required to put a system in place. The major areas of expenditure, and hence those areas where the most savings are to be obtained, are in the duration of the average annual time spent in hospital for the target group, currently of the order of 9.5 days in the UK (UK Department of Health Statistical Division 1998) at an average cost per day (UK Department of Health 1997) of £148 for an acute bed and £135 for a geriatric bed. The model therefore uses an average cost of £142 per day as the relative numbers of patients in acute beds and geriatric beds was not available. Using these values, Table 6 indicates the changes that would need to take place in relation to the current situation if cost recovery is to take place while Fig 4 shows the associated cash flows (Brownsell et al 2001).

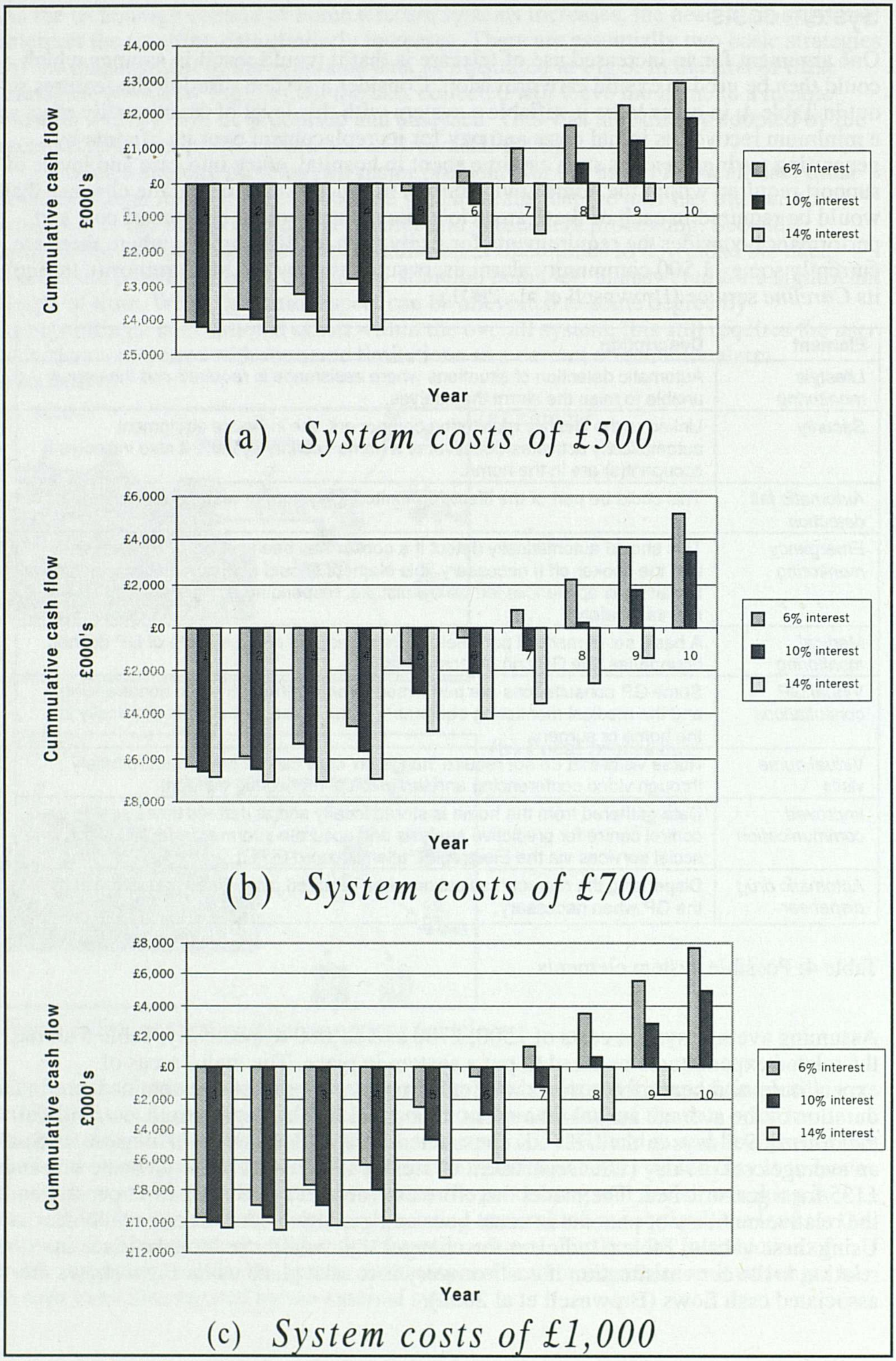


Figure 4: Cash flows for varying system costs

	Cost (£)			
Technology costs	Present system	Proposed telecare system		
Technology cost of home based equipment	£175	£500	£700	£1,000
Home based equipment cost	1,909,000	5,362,000	7,487,000	10,675,000
Warden schemes		141,000	141,000	141,000
Control centre		50,000	50,000	50,000
GP and nurse equipment		241,000	337,000	482,000
Installation and training	279,000	531,000	550,000	579,000
Total Initial expenditure	**4,097,000**	**6,325,000**	**8,565,000**	**11,927,000**

Table 5: Prosepective system costs for different average installation costs

	Present system	System Costs	Proposed telecare system (Year)									
Variables			1	2	3	4	5	6	7	8	9	10
		£500	9.35	9.2	9.2	9.2	9.2	9.2	9.2	9.2	9.2	9.2
Average duration of a hospital stay for client base.	9.5	£700	9	8.75	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.5
		£1,000	9	8.75	8.5	8.25	8	7.75	7.75	7.75	7.75	7.75
		£500	19	18	18	18	18	18	18	18	18	18
Percentage of people in hospital delayed in discharge	20	£700	18	16	14	12	10	10	10	10	10	10

Table 6: Possible changes to care provision resulting in system cost repayment (Represents one possible scenario, other combinations are possible.)

Matching technology to need - the technology prescription

While Tables 5 & 6 and Fig 4 together suggest that the introduction of a technology based telecare system can provide a cost effective solution to enabling individuals to continue to live independently in their own home for longer, the question of how to ensure that the technology grows with and adapts to user needs has not been addressed by this analysis. The move towards the use of the Electronic Patient Record (EPR) (NHS Executive 1998) provides the basis for a strategy which integrates a needs led approach to the introduction of telecare technology while allowing for the integration and sharing of the relevant information among and between the relevant healthcare professionals.

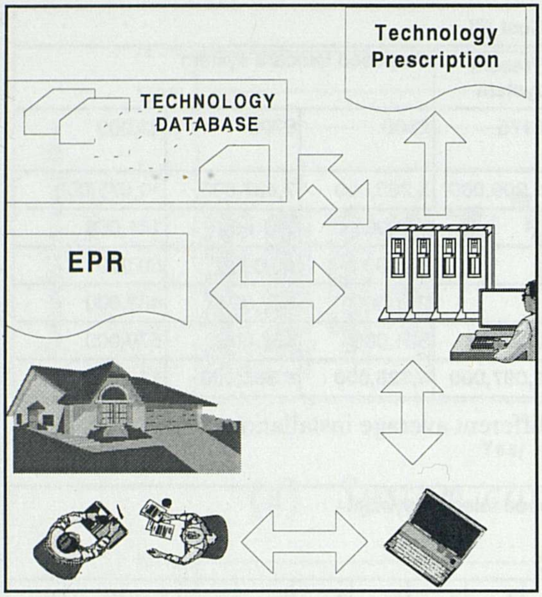


Figure 5: Generation of the technology prescription

In a needs led strategy to the provision and use of technology in telecare and telehealth, the involvement of the user in the decision making process that leads to the introduction of the technology is essential while they must also have confidence in the sources of information relating to that technology. Current studies indicated that, as might be anticipated, individuals would turn to established healthcare professionals such as their GP or community nurse for advice rather than a 'Technology Professional' and perceive that by doing so they are receiving advice appropriate to their healthcare needs rather than having a technological imposed upon them.

However, for such a strategy to be effective it means that the relevant healthcare professional must also be aware of the ways in which specific technologies can impact upon individual needs which in turn means that there must be some training provision for those professionals to enable them to act in that role while assessment procedures need to be put in place to allow needs to be mapped to technology. Because of the diversity of technologies likely to become available, there will be a requirement both for the updating of the healthcare professional acting in the role of assessor/advisor and some direct support for them in those roles. Referring to Fig 5, a possible approach to the provision of this support within a framework with which the user is comfortable, i.e. their own home, is suggested.

Following an initial decision by a GP or other health professional involving the client that there may be a possible advantage from the introduction of telecare and telehealth technologies to their home environment this is entered onto the EPR. A search would then be initiated between the EPR and the *Technology Database* to establish any possible fits between available technologies and the user needs as defined by the EPR. The results of this search would then be transferred to the local system of the relevant healthcare professional acting as the *Technology Assessor* for the individual in question.

The assessor would then arrange to meet with the individual in their own home environment where, working from the base of the initial search and evaluation together with appropriate assessment and evaluation tests, again defined initially by the EPR but taking into account the assessors own personal skills and knowledge of the individual, they would seek to map need onto technology provision. At the end of the assessment the result, after reference back to any other healthcare professionals as appropriate - for instance the GP who nominated the individual for assessment initially - would be the *Technology Prescription* for that individual.

Developed in consultation with the user, the *Technology Prescription* would set out the technology to be provided and would include details of the nature of the information to be passed between the local, home, system and any remote systems. The technology prescription would then be taken by the user to an authorised installer, for instance their local authority, who would then arrange for the installation of the indicated technologies into the user's home environment. Cost of the installation would be assessed in relation to need and provision and, based on the earlier analysis, would be structured around a base level of provision. For higher levels of provision it would then be necessary either to make the appropriate case on behalf of the user or for them to assume responsibility for the cost of higher levels of system performance. In this context, Table 7 (Brownsell 2001) suggests that at least one group of prospective users would be willing to pay for additional levels of confidence and security.

Amount	£5	£10	£35	£50	£75	£1,000	£1,500	£2,500	£3,000
Frequency	2	1	1	3	1	5	1	1	1

Table 7: Willingness of prospective users to pay for a telecare system

Conclusions

Given the increasing demands on the National Health Service resulting from an ageing population there is a need to investigate the prospective use of technology as a means by which individuals can be provided with the necessary levels of support to enable them to remain independent in their own home environment for as long as possible. In order to achieve this in as cost effective a manner while maintaining a '*needs led*', as opposed to a '*technology driven*', approach to technology provision the concept of a *Technology Prescription* generated in consultation with the user by an appropriately trained healthcare professional and mapping need to technology provision is suggested as providing the means by which the two can be brought together.

By this means it is believed that the requirement set out in the introduction that home care technology '*Grows with you*' rather than '*Growing on you*' can be achieved.

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Frankenstein homes: would you want to live in one?

by Bruce J Taylor

Abstract

The media have, in some instances, portrayed smart houses as Frankenstein homes that could potentially run amok with ruinous if not necessarily fatal consequences. Smart homes turn a simple robust system, a house, into a complex tightly coupled system, which means that the potential for failure is increased beyond that predicted by conventional risk analysis. There is some justification in these sensational media stories about smart homes. Furthermore, the lay persons perception of risk is based, not on the absolute risk assessments of experts, but on three more or less independent factors: dread risk, unknown risk, societal and personal exposure.

Introduction

'The idea of a house full of 'smart' gizmos connected to the Internet and controlled by the touch of a telephone button is more nightmare than fantasy"' (Kirwan-Taylor, 2000). She then goes on to describe the scenario whereby you miss-key the code to make the coffee with the result that the so-called Smart home sets off the fire sprinklers, turns on the hi-fi and opens the front door. Far-fetched? What about the real problems with a 'smart' car – the Ford Galaxy. Owners would leave their cars parked in the station or office car park in the morning to return later to find the windows had spontaneously wound down, the doors unlocked and the horn blaring. ('Watchdog', BBC1, 2000).

Smart houses, like smart cars, like many other systems in common use today are inherently complex systems which increases the risk of failure. This paper looks at the nature of complex tightly coupled systems, the difficulties they lead to and the human attitude to risk and failure. The objective is to set out the background to the problem, to inform discussion and debate about smart homes for vulnerable people. No technical solution is proposed since it is up to society to decide what is acceptable. In other words social research should be carried out before providing definitive technical solutions.

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System accidents

Nothing is perfect: every part of every system, industrial or social is liable to failure (Perrow, 1999). Common, run of the mill industrial plants have a steady run of unremarked failures. The more complicated or tightly coupled the plant, the more attention is paid to reducing the occasion for failures. In a smart home, especially a smart home for vulnerable people, how far do you go to reduce failure? Failure cannot be entirely eliminated so what degree of probability (risk) is deemed acceptable for the unacceptable failure? In a smart home an example of unacceptable failure would be for the door to fail to unlock in the event of a fire. However, even in the best engineered systems such a failure could happen albeit with a very low probability. Nuclear power stations in the UK are designed so that a catastrophic failure will happen no more frequently than once in 10,000 years. For many people this is not an acceptable level of risk.

Many failures and their consequences arising from failure of a components or subsystems or systems can be predicted using techniques such as risk analysis and reliability engineering. However, there is a category of failure or accident for which the above techniques are useless. This is the system accident, which arises for the **unanticipated interaction** of multiple failures or events. The kind of systems that are prone to system accidents are characterised by having:

- Complex interactions which are those in which one component can interact (by design or unintentionally) with one or more components outside of the normal production sequence. Complex systems have branching paths, feedback loops and jumps from one sequence to another. (Fig 1)
- Tight coupling (see below for explanation of coupling)

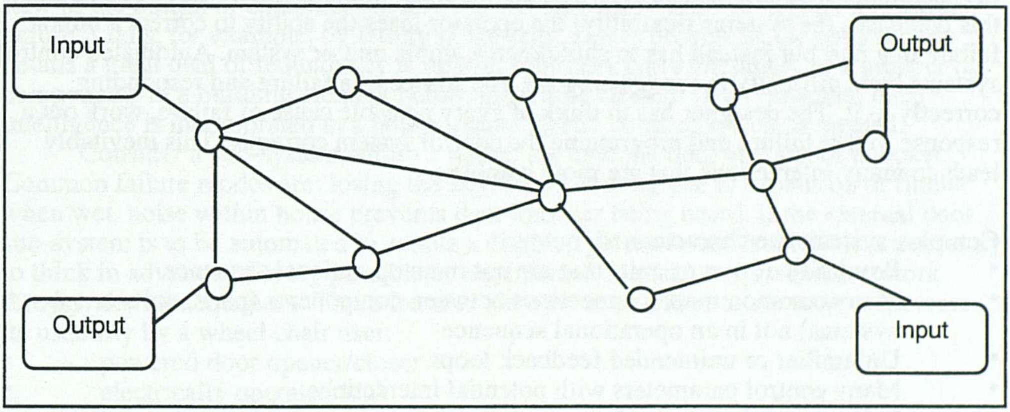

Figure 1: Complex system

In linear interactions, a component will interact with only the preceding and the following component (Fig 2). Most systems will have some form of feedback loop (Fig 3). Whilst this increases the complexity of the system, the system behaviour can be determined accurately. Even the most linear of systems will have at least one source of complex interactions, the environment, since it impinges on many parts of the system.

The environment can thus cause failure in different parts of the system at the same time – common mode failure. The problem with the Ford Mondeo was a box of electronics that, when it got wet, admitted water and short-circuited three different circuits at the same time. The problem was solved by relocating the box so that it did not get wet.

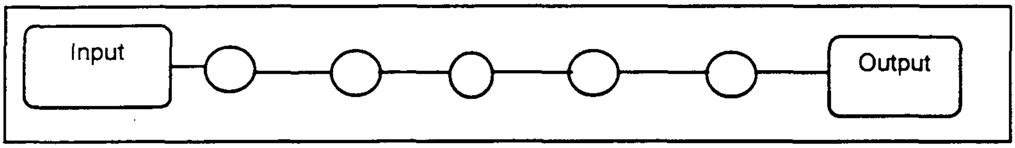

Figure 2: Linear system

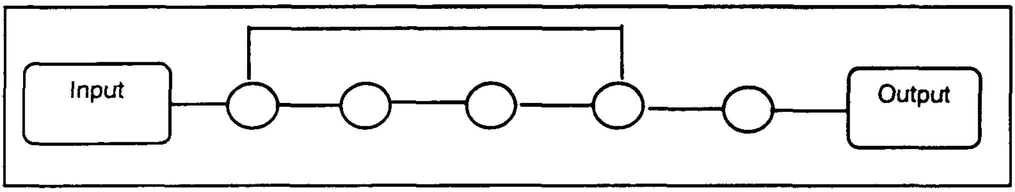

Figure 3: Linear system with feedback

Coping with hidden interactions

Linear and complex systems both have hidden interactions, but in linear systems they occur within well-defined and segregated segments of the operational sequence. In systems with a fair degree of complex interactions, however, well-defined and segregated segments do not necessarily exist. Instead jiggling unit D may well affect not only the next unit E but also A and H. Complex interactions increase the number of controls that have to be installed and monitored.

Attempts are continually made to reduce the number of controls by automating the subsidiary interactions and leaving only the main interactions to worry about. But this decreases the systems flexibility: the operator loses the ability to correct a minor failure in a part but instead has to shut down a whole unit or system. Automated control systems have difficulty in recognising the true source of a failure and responding correctly to it. The designer has to think of every possible cause of failure, work out a response to that failure and programme the control system correctly. This inevitably leads to many interactions that are more complex.

Complex systems are characterised by:

- Proximity of part or units that are not in an operational sequence
- Many common mode connections between components (parts, units or sub-systems) not in an operational sequence
- Unfamiliar or unintended feedback loops
- Many control parameters with potential interactions
- Indirect or inferential information sources
- Limited understanding of some processes

Complex systems tend to be more efficient (in the narrow terms of production and operating efficiency, which neglects accident hazards) than linear systems. From the point of view of design and hardware efficiency, complexity is desirable: less slack, less space used, less tolerance of low-quality performance and components that are more multifunction. However, where possible complex systems should be transformed into linear systems. It is especially important to reduce the complexity in a system where system failure has catastrophic consequences.

Tight and loose coupling

Systems may have many interacting components but there may be sloppiness or flexibility in the way components in system interact. This is a loosely coupled system.

These tend to have ambiguous or perhaps flexible performance standards, there may be a lack of monitoring so that any unintended consequences are either not reported or not acted upon. Higher educational institutions are a good example of a complex but loosely coupled system. Loose coupling allows certain parts of the system to express themselves according to their own logic or interests. Loose coupling is not the same as disorganisation.

Tightly coupled systems do not have this flexibility in the way they respond to perturbations. They will respond more quickly but the response may be disastrous. Tightly coupled systems have more time-dependent processes: they cannot wait or stand by until attended to. In loosely coupled systems, delays are possible; processes can remain in stand-by mode; partially finished products will not change much while waiting. Tightly coupled systems have little slack: quantities must be precise, resources cannot be substituted for on another (device failure causes a system shut-down because no other device can substitute for it).

Coupling is particularly germane to recovery from the inevitable component failures that occur. In tightly coupled systems, the buffers, redundancies, and substitutions must be designed in: they must be thought of in advance. In loosely coupled systems there is a better chance that expedient, spur of the moment buffers and redundancies and substitutions can be found, even though they were not planned ahead of time. This does not mean that loosely coupled systems have sufficient designed-in safety devices. Even in loosely coupled systems, there is still room for engineered safety features as opposed to ad hoc arrangements.

Smart house design

Conventional houses are essentially loosely coupled systems. Unless there is a serious flaw in the design or construction, a house can take many years of neglect and abuse before it fails, for example, by letting in the rain. This is because in the construction details a great deal of redundancy is built it. It usually takes the failure of a number of components in a building element before the whole element fails. However, once intelligence is incorporated in a house a more tightly coupled system is created.

Consider a sub-system within a house: the external door and a door knocker. Common failure modes are: losing the key, door jamming due to expansion of timber when wet, noise within house prevents door knocker being heard. If the external door sub-system is to be automated to enable a disabled person to use it safely, it is necessary to think in advance of every possible event, interaction with door system and work through the consequences. Three features are now to be added to the door to increase its usability by a wheel chair user:

- powered door opener/closer
- electrically operated lock
- intercom system

A systematic way of designing such a system is to make use of some of the techniques for software development. A particularly useful tool is use-case analysis in object-oriented programme design. Use cases provide a way of identifying and enumerating every possible interaction between an actor and a system including incorrect interactions and fault operations of the system. Appendix 1 shows a use case analysis for an external door sub-system. It can be seen that just adding these three elements considerable increases the complexity of the external door sub-system. When the smart home is intended to compensate for diminished cognitive abilities such as in dementia, brain injury, learning disabilities it is essential that a detailed use case analysis is carried out.

It should be noted that the use cases in Appendix 1 are incomplete since sources of common mode failure, such as fire and power failure have not yet been considered.

Nor has three-way interactions between the actor(s), building fabric and the Smart home system been considered. The following case study illustrates the problems that can arise when this is not done.

Modifications were carried out to the home of a middle-aged couple as a consequence of the female partner having a viral infection which left her severely immobilised and able to get about her home only by using a powered wheelchair. Her husband was her primary carer. Wheelchair access to their house was created at the rear via a ramp to the kitchen door. However, the combination of the ramp design and automatic door implementation meant that the woman was afraid to use it. Her husband instead carries her out of the front door to the car.

The problems were:

1 The door closed too quickly not giving the woman enough time to get through it: she was in constant fear of the door closing on her, propelling her out through the door.

2 A ridge on the floor at the door required a certain amount of momentum to get over it. If she did not get enough momentum, she risked being hit by door. Too much momentum and she was afraid of being tipped out of the chair by the ridge in the floor and trapped in the doorway.

3 The platform outside was not wide enough to turn comfortably through 90- to go down the ramp. To get through the door the woman must travel at speed, then do a sharp 90 degree turn. This frightened her as she felt in danger of falling out of the chair.

If designing a smart home for one individual (the frail elderly person living on their own) is not complicated enough, multiple-occupancy homes create numerous opportunities for interfering interactions between different occupants and the smart home. A simple analogy is a PC being used by different people with no means of identifying who is using the machine at any one time. Someone who is working on a document leaves it to answer the door and someone else comes along to use the PC and accidentally deletes the document. A simple technical solution to this problem is for people to have some means of identifying themselves to the PC by use of an identification number/name and a password. In the context of smart homes for vulnerable people, this would involve tagging people. Tags would inform the smart house where every one is at any given time and who is interacting with the system. Visitors to Bill Gate's smart house are given an electronic pin to wear which identifies the visitor to the smart house system and enables them to enjoy all its features (Hotline 2001). Tagging may be fine for people who are giving informed consent but is very questionable when applied to vulnerable people.

Risk assessment

Risk assessment is a very sophisticated field. Mathematical models predominate; extensive research is conducted; and the esoteric matters of Bayesian probabilities, ALARA (as low as reasonably achievable) and ALARP (as low as reasonably practicable) principles, discounted future probabilities etc are debated in courtrooms and academic conferences. The methodology is based on the moneterisation of social good. Everything has a price: if a price cannot be put on it then it does not enter the calculations. A life is evaluated largely on the basis of its residual earning capacity. Therefore, for people over retirement age their life is worth, in risk assessment science, very little.

Furthermore, risk assessment cannot handle the difference between imposition of risk on individuals or a population by others (e.g. siting of mobile phone masts) and acceptance of risk by individuals (e.g. using mobile phones). Another comparison is the difference between active and passive smoking. When providing smart homes for vulnerable people it is precisely this lack of the client being able to give meaningful acceptance of risk that often means that others have to make a risk/benefit analysis for them. The risks and benefits may not all be shared equitably among the stakeholders. A risk imposed by others and a risk willingly accepted by an individual are not the same. However, risk assessment cannot distinguish between them.

People accept risks where they believe their skill will play some part in avoiding the hazard (car driving, playing the stock market) however illusory this may be. People fear and reject risks where they are potentially the passive recipients of harm (e.g. travelling in a train). The relevance to Smart houses is that whilst people may interact with a Smart houses they are passive recipients of a design, with all its benefits, foibles and faults, created and installed by others. Who has never been infuriated by a piece of software that refuses to do, what ought to be a very simple task? Can a smart house be designed any better than a piece of software?[1] The only power the occupier has, is to switch those subsystems off that are causing a nuisance and in some cases the designer might not even have provided that option. Research is required into the willingness of people to accept the passive risk of living in a Smart home.

Three ways of assessing risk (rationalities) have been identified (Slovic, Fischoff and Lichenstein, 1981, reported by Perrow, 1999), absolute rationality, beloved by economists and engineers in their risk assessments, 'bounded' or limited rationality and social or cultural rationality. In bounded rationality, lay people adopt heuristics or intuitions for assessing risk rather than the mathematical rigorous tools of absolute rationality. The public pursues an informal, possibly messy, 'logic' that the experts do not share. The accident at Three Mile Island (TMI) nuclear power plant was a one in three hundred year event according to risk assessment calculations. The fact that it occurred a few months after start up would neither alarm nor change the view of an absolute rationalist - it is still a one in three hundred year event. A bounded rational analysis would come to a different conclusion and would go something like this. This significant event (TMI) is a signal that these nuclear plants can have severe troubles even though the experts say these events will happen only rarely. If experts are wrong, and the frequently are, then the event at TMI may not be the one in three hundred year event, but the first one of many such events over the next three hundred years.

Furthermore, even if there is a remote chance of a catastrophe, why risk it? Bounded rationality is an efficient logic because:

- experts are immediately put on the defensive
- it requires little effort
- authorities are faced with a popular demand to remove the risk.

Social or cultural rationality is even more concerned about the wider social impact of accidents than bounded rationality. The public appears to emphasise social rationality when considering new technologies (GM foods, cloning, to name a few recent scares). The public is uninformed in many respects, and certainly can make errors in reasoning, but for matters of catastrophic risk these errors seem less disabling than the alternative of neglecting the rationality embedded in social and cultural values.

The public's assessment of risks may be biased by

- sensational reporting in the media
- catastrophic accidents (e.g. many fatalities in one rail accident, will alter people's perception of risk although the daily attrition on the roads has very little impact)

[1] Robust, reliable software can be written if it is subject to either a rigorous formal quality assurance procedure (Minasi, 2000) or the code is made available to anybody to test it, debug it and develop it (ie the way in which the GNU/Linux operating system was developed) (Platt, 2001).

Dread and the unknown, uncontrollable aspects are recognized by the experts but not thought relevant in judging riskiness. But not so for the public. One can almost predict the lay publics assessment of risk, based upon their assessment of how much dread is involved and the likelihood of a mishap being fatal.

Researchers (Slovic, Fischoff and Lichenstein, 1981, reported by Perrow, 1999) also conducted a study of 90 hazards and found that the 18 risk characteristics could be grouped into three more or less independent factors: dread risk, unknown risk, societal and personal exposure.

The most important of the three, 'dread risk' is associated with

- lack of control over the activity
- fatal consequences if there was a mishap of some sort
- high catastrophic potential
- reactions of dread
- inequitable distribution of risks and benefits (including transfer of risks to future generations)
- belief that risks are increasing and not easily reducible

'Unknown risks' included risks that are:

- unknown
- unobservable
- new
- delayed in their manifestation

Less information is given by the original researchers about the third cluster 'societal and personal exposure'. It would appear to involve the number of people exposed and the rater's personal exposure. The dimension of dread was the best predictor of perceived risk.

The relevance of gaining a better understanding of the perception of risk to smart homes is that whilst the absolute rationality of risk assessment is necessary for an engineer to compare the safety of one design of smart home with another, this will not be sufficient to ensure the public acceptability of the risk of Smart homes. One needs to go further and investigate people's responses to the characteristics in the 'dread factor'. Many people fear and dread spending the last years of their life in a residential home, especially if they have seen older relatives or friends being neglected or even ill treated in a residential or nursing home. When presented with the choice would they like to spend their last years in a residential home or in their own home, most people will prefer the later. What would people's responses be if the following third choice were included as an option: stay in a smart home? Would people prefer to stay in their own smart home or their current un-smart home?

Smart homes provide a new option for the care of the older or disabled person. It would be unethical to withhold such an option if it were beneficial and acceptable. However, care providers and smart home designers must listen to any fears or concerns expressed by their clients in order to see if there is a significant dread factor before a smart house is provided for them. Similarly, when people have moved into a smart home and have had a chance to get to learn how to use it, post-occupancy evaluations should be carried out to find out their fears and concerns, which should be addressed.

Conclusions

The media have in some instances portrayed smart houses as Frankenstein homes that could potentially run amok with ruinous if not necessarily fatal consequences. If these homes are for vulnerable people then the 'dread factor' is increased. Smart homes turn a simple robust system, a house, into a complex tightly coupled system, which means that the potential for failure is increased beyond that predicted by conventional risk analysis. There is some justification in these sensational media stories about smart homes. Furthermore, the lay persons perception of risk is based not on absolute risk assessment of the experts but on three more or less independent factors: dread risk, unknown risk, societal and personal exposure. The dread factor is the best indicator of perceived risk.

In addition to carrying out absolute risk assessments using the conventional engineering and economic tools, in order to compare one design of smart house with another, it is necessary to conduct research into people's perception of the risks attached to Smart houses.

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Appendix 1

Use cases for front door and entryphone

Occupant has high physical dependency and lives alone in a house, which has ground level access by main entry door. It is also assumed that the occupant does not keep a pet such as a dog, which might escape when door is opened.

Use case #1:	**Occupant leaves house**
Actors:	Occupant
Overview:	Occupant prepares to leave house by main entry door. Checks no appliances have been left on and that the windows and other doors are secure. Occupant unlocks door, opens it goes through. Door closes behind. Occupant locks door.
Type:	Primary and Essential
Cross References:	

Typical course of events in ordinary house

Actor action	**System response**
• This use case begins when Occupant prepares to leave the house.	
• Occupant checks hazardous appliances are switched off, windows and any other doors are shut and locked.	
• Occupant unlocks and opens door	
• Occupant passes through door	
• Occupant closes and locks doors	

Notes

Line 2. The main hazards are fire and flood. Therefore heat producing appliances (eg iron, cooker, toaster etc) and taps should be checked. Other appliances such as lights may be left on as a security measure. Appliances such as fridge, freezer, dishwasher, washing machine, water heaters, central heating may be safely left on.

Proposed course of events in smart house

Actor action	System response
• This use case begins when Occupant prepares to leave the house.	
• Occupant presses button by main entry door to tell system that he is preparing to leave the house.	1. Informs occupant (visually or orally) that all other doors and windows are shut and locked and that everything that should be off is off.
• Occupant unlocks door	2. Door powers open
• Occupant passes through door	3. Door powers closed
• Occupant locks door	

Notes

Line 2. The main hazards are fire and flood. Therefore, heat producing appliances (eg iron, cooker, toaster etc) and taps should be checked. Other appliances such as lights may be left on as a security measure. However, it would be wasteful to leave too many lights on. Appliances such as fridge, freezer, dishwasher, washing machine, water heaters, central heating may be safely left on.

Alternative courses

Line 3 If appliances are not shut-off or windows and doors are unlocked then occupant has to make them safe otherwise the door will not unlock. If the occupant fails to make house safe the system will repeat the message. If occupant still does not make house safe then system dials the call centre opening up a channel of communication to find out what particular difficulty occupant has. Call centre can see status of house and if necessary unlock and open door. If there is a fire alert or other emergency alert (eg being attacked by family or "trusted" visitor) this will initiate unlocking of doors. Battery backup or uninterruptible power supply (UPS) is required to ensure doors unlock in the event of power failure.

Line 6 Occupant does not pass through door so that door closes on occupant. If it encounters resistance door will open again. Occupant will then have to request door to close. Occupant can at any time contact call centre to advise of problem and request assistance.

Use Case #2:	Occupant returns to house
Actors:	Occupant
Overview:	Occupant arrives at house. If dark the security light by door will be on. Occupant unlocks door, opens it and goes through. Door closes behind. Occupant locks door.
Type:	Primary and Essential
Cross References:	

Typical course of events in ordinary house

Actor Action	System response
• This use case begins when Occupant arrives at the house.	
• Occupant unlocks and opens door	
• Occupant passes through door	
• Occupant switches on hall light and exterior light if dark.	
• Occupant closes and locks doors	

Proposed course of events in smart house

Actor Action	System response
• This use case begins when Occupant arrives at the house.	1. If it is dark the security light by door will be on.
• Occupant unlocks and opens door	2. Hall light switches on and provides any other required welcome.
• Occupant passes through door	
• Occupant closes and locks doors	

Alternative courses

Line 3 If an intruder is waiting by door then occupant should be able to call for help by using a personal attack alarm

What if occupant has lost means of unlocking door?

Line 5 Occupant does not pass through door so that door closes on occupant. If it encounters resistance door will open again. Occupant will then have to request door to close. Occupant can at any time contact call centre to advise of problem and request assistance.

Use Case #3:	**Visitor calls to house**
Actors:	Occupant, Visitor
Overview:	Visitor arrives at house. If dark the security light by door will be on. Visitor presses "door bell" that can be heard outside. Occupant opens up communication channel (sound and vision or sound only) with visitor at door. If satisfied that Visitor is a "friend" then Occupant unlocks and opens door. Visitor goes through. Door closes behind.
Type:	Primary and Essential
Cross References:	

Typical course of events in ordinary house with door entry system

Actor Action	System response
• This use case begins when Visitor arrives at the house and rings door bell.	
• Occupant checks who is at door	
• Occupant unlocks and opens door	
• Visitor passes through door	
• Occupant closes door	

Proposed course of events in smart house

Actor Action	System response
• This use case begins when Visitor arrives at the house and rings door bell.	1. If it is dark the security light by door will be on.
• Occupant opens up communication channel (sound and vision or sound only) with visitor at door.	2. Displays image of visitor or relays the voice of visitor
• Occupant unlocks and opens door	
• Visitor passes through door	
• Occupant closes doors	

Alternative courses

Line 5-If the visitor is unknown to Occupant then Occupant can contact Call Centre. Call Centre can take control of entry phone, make enquiries of visitor, and check identification. If satisfied Call Centre explains situation to Occupant asking them to admit Visitor.

Line 3 -Where is the occupant in relationship to the entryphone when Visitor calls? If in living room, the Occupant can switch image of visitor through to TV if it is on. The entryphone needs to be located where it is convenient for the Occupier. If the Occupier is mobile it could be located in some central location eg in hall. If the Occupant is confined to one room (they shouldn't be) then entryphone needs to be located there.

If the Occupant fails to answer the "door bell". The Visitor either admits him/her self if they have a key (eg Warden or family or neighbour) or the system contacts Call Centre. Call Centre can take control of entry phone, make enquiries of visitor, and check identification. If satisfied Call Centre can try to contact Occupant and explain situation to Occupant asking them to admit Visitor. If Call Centre gets no response from Occupant then Call Centre unlocks and opens door to Visitor asking them to check on Occupant and advise them of situation.

Design with care

by Keith Cheverst, Karen Clarke, Sue Cobb, Terry Hemmings, Stewart Kember, Keith Mitchell, Peter Phillips, Rob Procter, Tom Rodden and Mark Rouncefield

Abstract

This paper is primarily about design and some of the difficulties of 'appropriate' design in care settings: about the interaction between technologies, application domains, design methodologies and about some of the challenges of informing design. This is hardly a novel concern, but this particular focus arises as a consequence of digital technologies maturing and transferring to the everyday domain; as the convergence of interactive digital systems, networks and mobile devices potentially transforms the ways that we carry out mundane, everyday activities. In recent years, the increasing presence of computing technology in the domestic environment has emerged as an important new arena of study. Domestic environments are becoming key sites for the consumption of information and communication technologies - embracing, in the 'care' domain, various forms of 'assistive' technologies and the design and provision of 'smart' homes. This paper reports on a recently initiated research project 'Care in the Digital Community' - begun under the Engineering and Physical Sciences Research Council (EPSRC) Dependability Interdisciplinary Research Collaboration (DIRC) Network project EQUATOR. The project aims to use a multidisciplinary research team to facilitate the development of enabling technologies to assist care in the community for particular user groups with different support needs. The general objective is to examine how digital technology can be used to support sheltered housing residents and their staff. Although only recently started, the project anticipates exploring the affordances of a variety of technological configurations, including the use of virtual environments replicating real world situations, and the use of handheld and wearable digital technology to provide support.

Design and methodological challenges

Much of the work in the care domain has been technology rather than 'needs' led - indeed 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

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not just that many of the important ethical and deployment issues concerning the development and evaluation of real systems remain unexplored, but that methods for eliciting needs in such a complex setting are relatively under-developed. The extent to which the relatively well tried and tested ideas and methods used to understand work environments can be transposed to investigation of domestic environments is an open question. Domestic environments in general and 'care' settings in particular are very different spaces from working environments and represent a very different set of challenges for those involved in the design of systems. This paper therefore considers some of the implications of the methodological options open to those working in the domestic domain, in particular, the translation of research into design recommendations and the attempt to uncover, elicit or validate 'requirements'. 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 in a range of social contexts. The problem is that research in certain contexts is often regarded as difficult, if not inappropriate. The deeply personal nature of many social activities limits just what can be investigated and reporting the interactional elements in a range of activities and contexts is difficult. Ethnographic studies (Hughes et al 1994) claim to provide a 'sensitising' to the 'real world', 'real time' character and context of everyday life and the facilitation of what Anderson (1994) calls 'the play of possibilities for design'. Much of our understanding of designing computer systems has been the product of ethnographic investigation of the workplace and we require significant shifts in our investigative techniques, as well as in our understanding of design, to consider how technology relates to and supports everyday living rather than productivity.

These and other delicate issues represent potentially obdurate problems and methodological responses have taken a number of forms. At present, the project research method for technology development includes ethnographic study, user-centred design and evaluation and the use of 'cultural probes'. 'Cultural Probes' (Gaver 1999), originating in the traditions of artist–designers rather than science and engineering, are a way of supplementing ethnographic investigations, prompting responses to users' emotional, aesthetic, and social values and habits, as well as providing an engaging and effective way to open a dialogue with users.

> Thus we were after "inspirational data" with the probes, to stimulate our imaginations rather than define a set of problems. We weren't trying to reach an objective view of ... needs through the probes, but instead a more impressionistic account of their beliefs and desires, their aesthetic preferences and cultural concerns. (Gaver 1999)

Our use of 'cultural probes' currently involves the distribution of cameras, dictaphones, postcards, maps and notepads to staff and residents in a semi-independent living environment in order to acquire both information and inspiration for the design of assistive technologies. 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. 'Process' here encapsulates rather more than the requirements elicitation stage to include deployment, use and evaluation. 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 practice). In amongst the technical challenges, central to the project and the technology development effort are issues concerning generalisability, the transfer of skills to real world situations, and support for independent living in the community. This challenge highlights 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'. The design challenge is to provide support for individuals in the move towards independent living, rather than create new, technological, forms of dependence. It 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. It further involves a recognition and understanding that the project, and any associated technical development, takes place within a particular political and moral framework (of deinstitutionalisation), and inevitably becomes embroiled in the various social science debates that surround this issue (Eyles 1988; Dear and Wolch 1987; Martin 1984). Of particular relevance is Gleeson and Kearns' (2001) comment that; 'De-institutionalisation has been constituted through moral-ethical discourses about places, about good and bad places - about moral landscapes'. The challenge for design in these settings, therefore, is not just to recognise this dilemma, but to steer a careful path through this moral landscape. Embodying a philosophy of care into design necessitates considering issues of empowerment and dependence and then thinking how these might usefully become incorporated into design guidelines.

Background and setting: hostel and semi-independent living

The setting for the project is a hostel and nearby and associated semi-independent living accommodation (see Fig 1 below), managed by a charitable trust, for former psychiatric patients in a large northern town. The hostel is the first step for patients leaving the psychiatric wards of local hospitals the hospital environment. Here they 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, which is 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. Emphasis is on the learning of daily living routine and skills and any technology introduced should contribute to this goal. A technology that merely completes a task for residents does little in producing independence but merely shifts reliance onto the technology.

Figure 1: The hostel

Supporting various forms of awareness: security and medication

Although our research is at an early stage, a number of issues/requirements have already arisen. Initial introductory and debriefing meetings at the hostel and the semi-independent living accommodation, and the early ethnographic fieldwork currently indicate some major preoccupations of both residents and care workers - all of which centre on supporting various forms of 'awareness'.

Firstly, there is an absolutely overwhelming preoccupation with security. Situated on what is acknowledged to be a 'difficult' council housing estate, both residents and staff have been subjected to frequent physical and verbal attacks. 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 ill-informed, media induced, moral panics about 'paedophiles' or 'community care'. 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.

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 (see Fig 2 below). In these circumstances, a security/monitoring system that would allow staff to monitor residents travelling between sites in order to increase the sense of safety, reduce anxiety and reassure residents. Such a system may also contribute to greater community awareness amongst both residents and staff.

Figure 2: The road between the hostel and the semi-independent living accommodation (left), and the neighbouring park (right).

In order to encourage residents to feel safer while traveling between sites we are investigating 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 lightweight (possibly wearable) and should not have any significant commercial value because of fears of encouraging theft and possible assaults. In addition, the device needs to be highly dependable both in terms of location accuracy and the ability to communicate the distress call in a timely manner. 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). 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 a collection of 24 satellites that orbit the earth. These satellites 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 (see Fig 3a) then it is able to calculate its geographic position (to an accuracy of approximately 10 metres) by using highly accurate timing information which is coded into the signals transmitted by the satellites (see Fig 3b). 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.

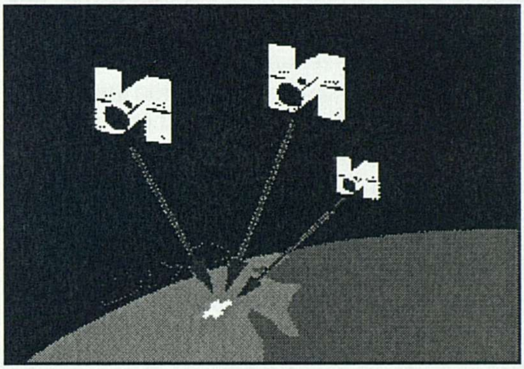

Fig 3.a

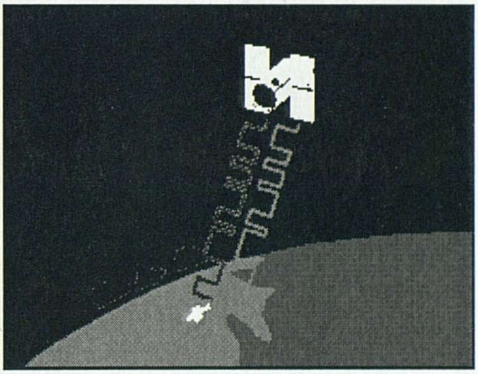

Fig 3.b

We had considered using SMS (simple messaging service) as the transport for sending the GPS information, however, we discounted this approach because of its lack of dependability. In more detail, SMS traffic is only sent when the network is under a low loading and so, if the GSM network happened to be under a high loading at the time then the successful transmission of the panic call could be delayed by a significant, and potentially critical, period of time.

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 certain areas of the town 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, we are designing the unit in order 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.

A second concern of both residents and staff focuses on issues surrounding the routine taking of daily medication. At the initial project meetings a number of residents expressed their concerns about the possible consequences of them forgetting to take their medication. In both informal interviews and via the postcards issued as part of the cultural probes residents expressed an almost overwhelming interest and concern with issues of medication, its importance, availability and effectiveness. Medication issues - dosage, delivery of 'medi-pacs', reminders, re-assuring residents about delivery and so on also feature heavily in the everyday work of the staff. At the hostel medication is kept in a locked drug cabinet, distributed by the staff when required with records kept in a written log. At the semi-independent living site patients must manage their own medication and it is a source of continuing anxiety for the residents. Although provided with a week's supply of packaged daily doses by the pharmacy - medi-pacs - there is some concern that they may either forget to take their medication or accidentally overdose. Technical devices that may prove useful in these circumstances are various medication reminders that help patients manage their own medication, i.e., when to take it, record acknowledgements of reminders, and so on, allied with a system to automate the recording of drug information. The functionality of any technology provided must be carefully considered and sensitively deployed. The devices are intended to act as 'reminders' to residents to take their medication and are not indicators that any medication has been taken. Obviously such devices must be dependable as failure of the technology could have potentially disastrous consequences.

Where residents are responsible for taking their own medication, this fact has significant implications for the way in which medication is monitored and tracked. For example, the use of a bar-code scanning approach would place an inappropriate burden on the resident. One possible approach is to use RFID-based smart labels in order to ascertain whether a resident has taken their medication from the medication store - as used in the 'Magic Medicine Cabinet' system (Dadong Wan, 1999). Another possibility worth exploring is to build certain reminder and recording features into the 'medi-pacs' themselves. Again, this will not control the medication regime to prevent deliberate overdosing, but it may contribute to the prevention of accidental overdosing. Some instances from the early fieldwork - coincidentally occurring on the same day - illustrate this point. In one case the care worker, following a phone call from the resident's doctor, was concerned to intercept the delivery of a medi-pac' in order to replace one dosage of tablets with another. In another incident there was some concern that an elderly resident was accidentally overdosing as a consequence of the design and delivery system for the 'medi-pacs'. As the 'medi-pacs' are delivered from the pharmacy at about 6:30pm, the resident was required to take only the evening dose for that day, leaving the two earlier doses to be taken the next week. Problems were arising both because the resident, used to emptying each daily dose, was accidentally overdosing by taking all the medication for the delivery day, but also was being left with no morning or afternoon medication for the same day on the following week.

The 'medi-pac' used by the residents at the semi-independent living hostel is a blue vinyl folder with seven plastic containers, each with four compartments. Each container is used to hold a day's medication and the whole pack is issued to the residents every week with medication for the next seven days. Our interest is in how to augment the medi-pac in order to aid the residents' management of their medication. Any device must help the residents manage their own medication rather than managing it for them. The main problem is establishing the dosage and timing of any medication. Such a device may also offer a level of reassurance to residents, by providing indications that they are following their medication regime correctly. As the residents rarely carry the containers or pack with them, and are rarely away from the site for lengthy periods of time, the device is not required to be mobile, and any device constructed can be installed in a resident's flat. Size of the device is therefore not a constraint. However, the device must hold a week's supply of drugs and it would be useful to make it simple to restock. Within these constraints, a prototype device is currently under discussion. This would consist of a 'lightbox' frame, into which a transparent box with internal compartments could be placed. The base of the frame would contain LEDs (light emitting diodes) to indicate the correct dosage for the time of day. It may also be useful to construct the frame with sensors to that would allow the controlling software to monitor when a dose has been removed.

One final issue about control of medication arose when one of the residents deliberately overdosed by taking all the medication in the newly delivered medi-pac. This incident highlighted other issues to do with medication and the recording of, access to and integration of information, as the care worker sought to give information on the resident and the medication regime to the ambulance service. Such information has four possible locations, a whiteboard that has details of each resident, their key worker, consultant, social worker and community psychiatric nurse; a noticeboard that details who is living in each flat or bedsit; the computer and the filing cabinet that contains the resident's records (see Fig 4 below). Ways of integrating, up-dating and displaying this information are currently being investigated.

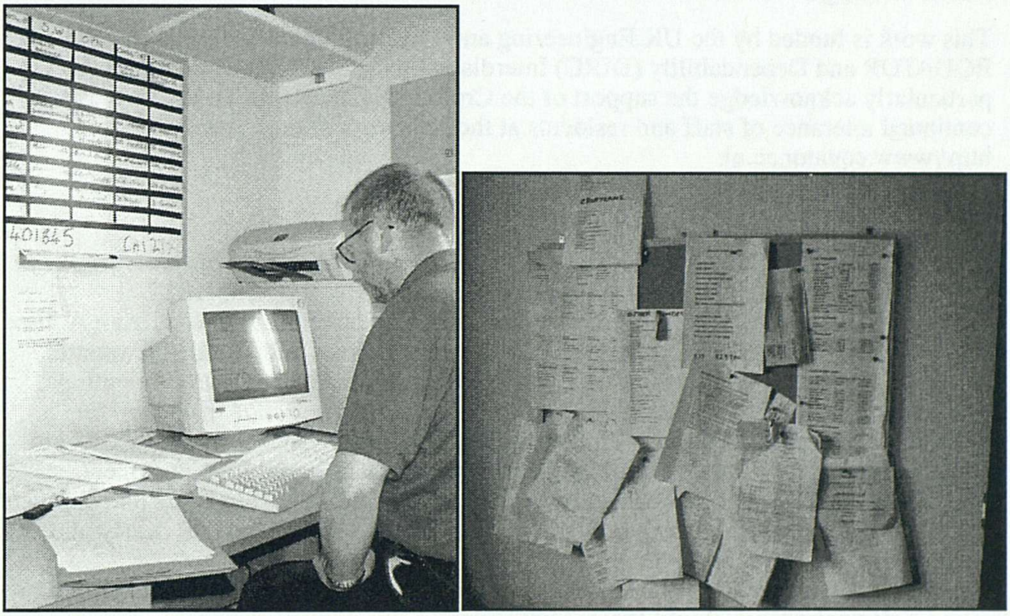

Figure 4: Locations of resident information. The computer and whiteboard (left) and the noticeboard (right).

Summary and concluding remarks

The main aim of our project is to explore the extent to which the requirements of a community care trust can be met by technology whilst staying within the political and ethical boundaries imposed by this setting.

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. With regard to the first of these concerns, we can report some measure of success in the use of cultural probes as a means of going beyond the limitations of ethnographic investigations. The extent to which we have then translated the results that these investigative devices have delivered into useful technological interventions will be tested over the coming months, when we begin deploying the chosen solutions within the trust itself.

This deployment process will itself raise a whole series of important and necessary issues including tailorability, mobility, and the trade-off between generic and specific devices. Following deployment, 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 cooperative design; 'an approach to the creation of more useful and useable computer artifacts ... the combination of envisioning, building and use ... as we work our way through successive rounds of trial and discovery regarding all of the ways in which the world is different than we had imagined it to be.' (Trigg et al, 1999)

Users need the opportunity to explore fully the possibilities for adopting, and adapting to the new technologies. As assistive technologies are developed and penetrate more and more into this domain, the real problem becomes not so much the creation of devices as their effective integration with the everyday demands of the particular setting and what Henderson and Kyng refer to as 'design in use' becomes achievable.

Acknowledgements

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Hospital managers closely observed: some features of new technology and everyday managerial work

by Karen Clarke, Mark Hartswood, Rob Procter and Mark Rouncefield

Abstract

The UK National Health Service is experiencing enormous growth in the deployment of information and communications technologies (ICTs). Extensive use of technology serves to 'reconfigure the organisation' through its application in data analysis, communication and decision support. This paper reports some preliminary findings from an ethnographic study of hospital information systems in everyday use, documenting precisely how people, systems and enterprises interact and collaborate. Our paper reports on some of the complexities involved in the use of ICTs in everyday managerial work and documents the articulation in practice of the cultural, organisational and technical arrangements through the investigation of the 'hands on' work of Hospital Trust management.

Introduction: new technology and organisational life in the NHS

This paper presents some preliminary findings from our ongoing ethnomethodologically informed ethnographic studies (Hughes et al 1994) into managerial work and hospital information systems in everyday use. Our focus is the everyday work of various managers - Clinical Directors, Nurse Managers, Service Managers and Information Managers, and how people, systems and enterprises interact and collaborate. This involves shadowing various hospital managers - usually for a week at a time-documenting and tape - recording their everyday, practical activities moment - by - moment as they occurred (Clarke et al 2001). Our paper reports on some of the complexities involved in the use of Information and Communication Technologies (ICTs) *in the provision of information*, the production and utilisation of that information in everyday managerial work, and the variegated skill and trust factors relevant to information use in managerial working practices. It documents the articulation in practice of the cultural, organisational and technical arrangements for the use of ICTs in managerial working across organisational boundaries.

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concern with the 'future of work' and its relationship with technological change. This interest has developed against the background of major transformations in the social and economic environment. (Lash & Urry, 1994) and the emergence of an 'Information Society' or 'Informational Economy' (Castells, 1996) where a particular emphasis has been accorded the role of IT in supporting skill and knowledge and facilitating the coordination and control of work (Zuboff, 1988) as collaborative work becomes increasingly electronically supported (Grudin, 1990).

In common with other large-scale, distributed, organisations the NHS is experiencing enormous growth in ICT deployment, intended to 'reconfigure the organisation' through its application in data analysis and processing, communication and decision support (Scott Morton (1991). This is recognised within the NHS itself: *'We certainly use IT as an explicit catalyst for organisational change, especially the design of working practices'* (in Doherty *et al*,1999)) and recent reports, such as 'Building the Core,' continue to argue the importance of IT as an intrinsic part of the agenda for change. Healthcare institutions are particularly information intensive and IT increasingly plays an important role in healthcare delivery and management, providing major benefits in reporting, organising and locating clinical information; in coordinating and managing patient healthcare; in cost reduction; and in organisational integration. Such presumptions have been at the heart of NHS design and policy-making processes.

> *Technological advances offer improved access to services, rapid access to assessment and treatment and to health information when and where patients need it ... The investment in new technology will mean that the equipment in the NHS will, for the first time, start to match the commitment and excellence of staff.' (NHS Press release, 2000)*

The challenge for the NHS lies in using information systems to organise, store and present health information for effective health-related decision-making.

Despite this emphasis on the importance of technology attempts to analyse organisational and managerial change have often tended to treat IT simplistically, assuming that IT contributes unproblematically to productivity, monitoring and accountability. Many analyses of IT and managerial work tend to be strongly theoretical, failing to examine the details of technology in use. Similarly, whilst much of the research on the future of work has necessarily focused on the immediate impact of IT systems on working practise, some studies (Casey, 1995) suggest that:

> *'. . . it was the social effects that these technologies had on the organisation of work that mattered most to people.These organisational constructs and cultural practices, at once made possible and required by advanced technology, represented the most significant shift in organisational life' . Amidst the proliferation of theoretical diagnoses of organisational change, then, there is an evident need for close empirical examination: 'We would expect communications innovations such as computer networks to affect organisational relationships. However, the changes caused by computer network communication will be hard to predict beforehand. Any changes will be as much a reflection of organisational culture as a product of the technology in itself ... The absence of an a priori direction in which the technology will take organisations makes the empirical investigation of how computer network technology is being implemented of the utmost importance and urgency.'*
> (Ducatel, 1992,166)

NHS managerial work and new technology: fieldwork observations.

In this section we present some empirical examples from our fieldwork observations to illustrate different aspects of the relationship between managerial work, new technology and organisational change. One common observation is that, despite the increasing investment and emphasis on 'new' technology, managerial work with IT often involves working with various kinds of 'legacy' system. A legacy system is one which, having been introduced with the best of intentions as an 'all singing, all dancing' solution has not been maintained, modified or developed to accommodate organisational or technological change. In consequence the system is unlikely to do all that is required or even 'talk' to more recent applications. So, for example, the Trust Pharmacy system, crucial for the costing of drugs and treatment, was unable to 'talk' to any of the other databases or management information systems, necessitating 'workarounds' in the form of the printing of documents and the double, and sometimes treble, entry of data. Such 'legacy' issues, of which this is but one obvious example, can arise relatively rapidly due to the fast changing nature of organisational priorities and organisational life, such as, for example, the move to GP fund-holding. This illustrates some of the difficulties of introducing and deploying technologies in organisations undergoing continuing and often significant change. In documenting the various workarounds required of legacy systems our observations point to a continuing and important facet of managerial work. The observations highlight how legacy concerns are not merely technological but also organisational in the sense of being intimately wrapped up in the everyday accomplishment of work and thus responsive to changes in working circumstances and priorities. Consequently, an appreciation of legacy needs to move away from a purely technological stance - with its emphasis on ageing systems and outdated code - to admit the importance and impact of organisational issues. Any attempt to resolve legacy issues will depend for its success on understanding that organisational change will necessarily have to confront legacies as the practical issues of daily work; understanding how technologies become embedded and are oriented to within everyday working practice. The paradox of such legacy systems is that such systems are adhered to long after their usefulness has become limited, precisely because of the way in which they are embedded within longstanding social and organisational processes.

The management information system

The many legacy issues stemming from the local organisational history impinge on the day to day practical organisation of work for the NHS managers we observed. The three hospital sites are not networked and there are numerous problems with the current Management Information System (MIS). The information section, which inputs all MIS data, can directly access data from departments, but must use the telephone for information from the other hospitals and it is often impossible to get an accurate, up-to-date picture of any given situation, e.g., waiting lists.

An example of the effect of this kind of organisational problem comes from the Directorate Manager of Orthopaedics (DMO). The DMO has developed 'process maps' for each possible type of patient seen by her directorate, e.g., referrals via GP, referrals from the Accident & Emergency department. This is central to one of her key roles, the monitoring of how efficiently patients are treated. She focuses on how much 'activity' is taking place in her directorate, i.e., how many patients are being treated. The idea behind these process maps is to identify what the DMO refers to as 'bottlenecks' in the medical process. For example, on the process map for 'new fracture clinic patients' there is a problem with patients' case notes not being collected prior to their appointment. As stated on the process map 'this often causes delays as the process does not happen. Patient arrives in clinic but no records.' The direct effect of this is that the patient's appointment may be cancelled if records are not found in time, thus leaving that patient on the waiting list for longer than necessary. The DMO thus cannot access up to date information about waiting lists from the MIS. Furthermore, the information available does not really identify 'bottlenecks'- the MIS information shows numbers of patients waiting but does not tell what the DMO calls 'the whole story'. Thus with a target maximum waiting list time of thirteen weeks the MIS data shows the percentage of patients for each consultant who have been waiting in excess of that time. This may be misleading, as in the case of spinal patients where the MIS information showed that an apparently alarming 100% were waiting over thirteen weeks for one particular consultant. This was accounted for by the fact that only one patient was on the waiting list and the consultant in question had left and his replacement was not yet in post. To get a more accurate picture the DMO must resort to other forms of record and recall. The DMO 'uses' the MIS information but does not trust it to 'tell the whole story'. These instances from the MIS system highlight the importance of understanding organisational settings as a precursor to systems design.

Everyday managerial work: bed management

Observation of the management of waiting lists and bed management illustrates the value of IT in coordinating work across different sites and different organisational units. In particular it illuminates the sheer complexity of managerial work with the figures produced by the technology requiring interpretive work that carries organisational implications. Hospital waiting lists and the availability of hospital beds is inevitably a highly charged political issue. At the time of the observations a great deal of concern was given to 'Winter planning' which was, in turn, related to previous national press reports, of hospitals being closed to new patients or patients waiting on trolleys. This concern was reflected not just in a daily managerial focus on bed numbers but also related statistics connected to waiting time on trolleys and the 'escalation policy'. The 'escalation policy' was linked to a government requirement that no patient should be kept on a trolley for more than 12 hours. Trolley waiting times were closely monitored and the Trust had contingency plans to open up a day-case theatre to accommodate more beds and patients. The 'bed availability' data is available on the MIS but is inaccurate for a number of reasons. Bed management was associated with a system of alerts that instigated various managerial responses: ' *to go to red (alert) the Directorate Manager has to go and count.. if the position is that we (the Hospital) are ..closed to admissions the Directorate Manager has to come in and physically count the beds ... Ward Sisters can be naughty .. if they know they have five admissions coming in tomorrow ... you can understand where they're coming from ..*'. The managerial focus on bed management was supported by the collation of a weekly site report circulated by email, for example:

> *'Weekly sitrep (site report) attached for your information. Large volume of medical sleepouts at both main sites. Current position:*
> *XXX: no available beds now although position will change. Some elective admissions for today being cancelled and admissions for next 2 days under review with relevant clinical directorates..*
> *ZZZ contacted by GGG last night to take medicine emergencies from south of GGG area... some patients at ZZZ still waiting for beds at DDD to become available'*

The availability of hospital beds across the two sites is co-ordinated by the Bed Manager (BM). The role of the BM is to constantly monitor and maintain the process of bed management in such a way as to avoid a situation where no beds are available. This is best explicated by reference to events that took place during the fieldwork.

On arrival one morning at one hospital (in the three hospital trust) the Directorate Manager of Orthopaedic's (DMO) first words were 'We're minus nine beds'. It became apparent that there was some kind of 'bed crisis' happening-assumed by the staff present to be caused by a road traffic accident-and that the DMO would be taking some action to determine the position of her directorate. The reference to 'minus nine beds' was to the state of play across all three sites, not only within the orthopaedic directorate, and this information had come from the BM. Although the 'minus nine' was referred to as being the 'state of play', it actually referred to the situation if all patients were admitted as expected for that day. The DMO said that she needed to go to the orthopaedic wards to assess the situation, adding, 'we go through our usual rituals for situations like these'. The DMO argued that it was essential to physically survey the wards rather than trying to get information another way e.g. by telephone; that establishing the availability of beds is *'a very physical thing'*. Establishing availability was represented as a process of 'chivvying people up'. Exactly what this meant became apparent once we arrived on the wards. First, the DMO walked around the floor of orthopaedic wards and did a count of seemingly empty beds. She then went to the nurses' station where there is a noticeboard that represents the bed situation. The noticeboard represented the total ward area, with each ward 'bay' (usually comprising six beds) marked separately. A metal slot where a card, with the patient's details, could be placed represents each bed. Cards that had been placed straight into the slots represented existing in-patients. Cards placed diagonally in the slots represented patients due to be discharged, pending a visit by social services, a consultant, the physiotherapist etc.

The presence of diagonally-placed cards forced an immediate re-count for the DMO, as her count was based on a 'head-count' of patients present. The DMO then discussed available beds with the ward sister, who explained the expected time/date of discharge for the 'diagonals'. The ward sister also pointed to two cards for existing in-patients and explained that they were terminally ill but that she *'couldn't guarantee a day or time for them'*. The DMO then left the nurses' station and went to speak to the physiotherapist to ascertain whether there were any 'walking wounded' patients who were fit for discharge or who were likely to become so that day. Through these processes, the DMO established that there were enough beds to see them through the 'crisis'. On leaving the ward area, the DMO said that establishing the availability of beds is *'a very physical thing'*.

The apparent solidity and objectivity of managerial information can thus continually be challenged as new data come to the fore, in bed management, for example, where supposedly 'occupied' beds become available. Understanding of the data is facilitated through reconstructing the available information that Ward Sisters were 'being naughty' or that some beds are occupied by 'walking wounded'. Thus readings of the bed management data are 'defeasible', capable of being re-interpreted to fit with new items of information and presented to different audiences. The Bed Manager actively orients to the data in order to accomplish the practical task at hand.

Bed management and the bed management figures impact on other aspects of managerial activity and reporting-most notably in managerial calculations of activity, bed occupancy and patient turnover, all of which are relevant in national calculations and audit of performance. A great deal of managerial work is consequently devoted to untangling, interpreting and re-calculating the statistics on activity and patient turnover to take into account the process of bed management. Its not that the statistics are not trusted, they are not regarded as 'just any old numbers' but that their limitations are recognised and related to how there are collected and collated. So, for example, although activity figures are provided on a Ward basis this is affected by such things as 'sleep-outs'-where patients from another Ward are moved into any unoccupied beds. The Unit Manager needs to extract 'her patients' and 'her doctors' from the figures in order to gain an accurate account of occupancy and length of stay to generate any performance indicators. Managerial work in these circumstances is not then subverted or simplified by the widespread use of new technology.

Managerial issues of implementation

Our observations of everyday managerial work provide some insight into the ways in which the defects and deficiencies of the new technologies that have been put in place arise from trying to use the system in the context of doing managerial work. When a manager needs a piece of information 'to hand' it is precisely then, when the options are highlighted that consideration will be given to the means of solving *this* problem, using *these* available resources. Particular artefacts and methods then become relevant that were previously part of the unconsidered background of the work setting.

Working within a highly distributed service that aims to provide 'seamless care' requires that managers need knowledge, or an 'awareness', of numerous separate and formally independent organisations. What clearly emerges from our observations of managerial work is its complexity. Much of the 'organisational knowledge' regularly utilised in the managerial work of coordination and decision making is not of a kind that is transparently visible in procedures or simply facilitated by reference to the record. Providing IT support for such contingent work requires that systems necessarily pay attention to the occasioned character of activities. If the aim is to embed knowledge properties in management information systems then it needs to be captured and managed in a way that will make it accurate, available, accessible, effective and usable. Such a task is hardly a matter of simply automating existing records or procedures, but raises complex conceptual and empirical issues:*'For shared databases and the like to be more than repositories or archives, and for contributions to be appropriate for some practical purpose .. the entries have to be tailored for the demands, or 'designed' for their recipients and sensitive to their circumstances.'* (Heath and Luff 1996: p. 362)

The challenges for the implementation of managerial systems in the NHS are then numerous and significant. For example, there are a large number of configuration issues concerning the detailed design of interaction with the system. There are issues too concerning the extent to which record-keeping practices may be standardised. Further, many of the implications of greater information integration, i.e., more rapid information flows, novel information representation and record keeping practices, will only become fully understood and exploited through experience. For example, integration may change existing, or create new, work dependencies between e.g., clinical and administrative departments in unexpected ways. Another problem may appear through the loss of important data because staff violate procedures, short-cut or ignore the system. This results in high implementation and maintenance costs, and loss of effectiveness of the system over time. A major risk then is a degraded level of service through staff avoiding use of the system and subsequent failure to achieve operational and strategic goals.

Routine managerial work

Our interest in carrying out ethnographic observations of everyday managerial work is in how such work gets organised. That is, how the orderliness of managerial work can be seen as arising from within the activities carried out by managers as part of their everyday work, work that incorporates technology use in various forms. Despite the grand claims for the empowering and liberating features of new technology, managerial work with IT is generally routine, everyday work consisting of using email, and routine data collection and collation. In the extract from the fieldwork observations below the Manager of Oncology is using a spreadsheet to update their database. Entering the data into spreadsheet took a large part of a morning interrupted by interviews, phone-calls and so on.

1. Working on spreadsheet-Excel

2. Arrangement with XXX-chemotherapy-not in normal contract-has to keep record to arrange billing. (This was an authority that did not currently have its own dedicated cancer treatment facility and so was using this centre's personnel)

3. Puts data on spreadsheet and to give to financial Director (for contracts and billing)

12. Doing spreadsheet-doing database-names and addresses-financial spreadsheet (details of drugs) ' .. it comes back here because the Pharmacy system doesn't talk to anyone else..' (Surgeons go to peripheral hospitals-at XXX authority-she gets activity figures from hospitals-faxed through-activity consists of new referrals and follow ups-which forms the basis of contracts).

24. Doing spreadsheet-ZZZ district '.. they recorded her as having seen no new patients when in fact she'd seen 20 correcting figures on spreadsheet .. amending consultants sheet (Knew that the figures 'looked wrong' so phoned surgeon)

32. Back entering info into spreadsheet-YYY cancer-names and addresses of new patients seen in January-'I type in name-then it goes to Chemotherapy Day Care Centre where the nurse types in the drugs-then it goes to Pharmacy where they do the costing-then it goes to me and ..(Financial Director)' (She gets two types of information cost (drugs and transport) and activity).

33. Back to spreadsheet .. 'the important thing is the postcode .. because from the contracting point of view it determines which Health Authority picks up the bill..'

Abstract from recording

What it is important to stress here is the obvious and routine way in which IT usage is woven into everyday managerial work. Furthermore, the accomplishment of managerial work often has little directly to do with the technology; instead various features of the mundane interactional competencies of those involved are regularly and routinely observed to play an important part in the work. This includes, for example, knowing how to produce formulations, tell stories, present scenarios and so on. These interactional competencies provide members with the opportunity and facility to present their understanding of the institutional interaction that just took place, and the implicativeness of that interaction. In the following extracts from the fieldwork, for example, the Manager has received a phone call from Personnel concerning the pay of a nurse working on 'flexi-time'.

1	Phonecall-gets staff attendance sheets .. going through the figures 'Oh God, I don't know what's going on here..'
2	Staff nurse is claiming she's been underpaid when the statistics seem to suggest she's been overpaid . Explaining over the phone .. . '.. sometimes they miss the deadline and so claim the next week..'
3	Goes to get flexi-sheets-looking at sheets to work out how many hours worked-looking at sheet and checking against calendar.
4	Goes to pile of unfiled documents-gets staff attendance sheets-comparing handwritten sheets against computer print-out
5	Gets another folder out with more computer print-outs
6	Doing calculations-additions/tallies on blank sheet of paper.. ' .. it gets a bit complicated . they work flexi and she had to work a weekend and also she did some work for the Medical Directorate (a different unit) .. and she's saying she's not been paid..'
7	Looking at tallies/numbers on sheet .. 'I put in September .. she said she's worked.. (looking at list)..'
8	Phoning Personnel.-'. I've looked back .. I think its something to do with August .. because in August she worked 4 hours for the Medical Directorate but looking in my copy .. 10 hours flexi paid off and 9 hours extra working .. I didn't put it in ...in August .. if you look in the September sheet I put 4 hours worked in the Medical Directorate..'.(phone conversation continues for some time about how many hours)... 'I don't know .. I think we'd better start again from scratch .. she thinks she's been underpaid and we think she's been overpaid and neither matches what's down on the sheet..'
9	Checking pile of papers to see if there's any more documentation-finds some pay sheets.. begins process of tallying again. 'I'm putting it in some semblance of order and then I can explain it to Personnel..'

The interactional competencies, the formulations produced here, are put forward to propose particular views of both 'how things are' and 'how they came to be that way'. In this case it includes notions about how this particular pay claim came to be disputed and the possible origins of the dispute. The formulations and scenarios produced over the phone, for example, include instances of the kind of working up of a presumed sense of shared experience, knowing how to make a story of working hours and their calculation relevant, and to project its significance in some way. Knowing how to build a recognisable and coherent scenario draws upon assumed sets of common-sense understandings about 'how we do this kind of work'; and 'how we resolve this position' which in this case involves 'starting from scratch'. Thus in their work with the technology and in communication with other units managers are not simply 'reading the figures' or 'reading an account' but are involved in 'interpretive work' with the aim of translating the circumstances of a patient or staff or unit into an appropriate organisational formulation. Data and information provided by managers to the various distributed units are produced to construct a case, sufficient to direct the immediate course of action, in this instance whether the nurse has been correctly paid.

Conclusion: managerial work and systems design.

These accounts of everyday managerial work, with and without information technology, would merely be a series of interesting vignettes or 'war-stories' were it not for the implications such accounts have for the design of new technologies and the support of working practices. In 'The Computer Reaches Out' Grudin (1990) considers how we might design technologies for distributed working in everyday organisational life, and presents a persuasive case for a movement beyond the engineering mentality to attend to some of the everyday realities of organisational life. This requires paying serious attention to 'being a user' of the technology in an organisational setting. At the same time a number of studies, in both medical and non-medical settings, have suggested that systems failure is commonly associated with inadequate attention to the social context of work. As design attempts to accommodate some of the complexities of organisational working, so the challenges facing systems designers necessarily increase. These new challenges involve attending to the lived reality of organisational groups, much as we have described it here, in order to design effective systems.

The challenges posed by systems evolution have not been matched by organisational strategies for systems configuration. Vendors, systems integrators, implementers and users all suffer from difficulties in initially adequately characterising the nature of organisational work, and subsequently tracking how that work changes in the presence of a new system. These difficulties are especially significant in the context of organisationally complex, large-scale work settings. Most prescriptions for increasing the fit between system, and user and organisational needs succumb to the 'design fallacy', that failure is due to inadequacies of the requirements gathering and design phases. In contrast, we argue that as software systems and artefacts penetrate more and more into people's working lives, the 'design problem' is not so much concerned with the creation of new technical artefacts as it is with their effective configuration and integration with work practices. As Berg argues:

> *'Seeing that different tools can carry different logics, seeing how different tools reshape practices in different ways, opens the way to a much more fruitful strategy. Breaking away from having to either embrace formal tools or denounce them by shifting the terms of the debate creates new space, new leverage, and new potentials for intervention, comparison, preference, and maybe even choice.'* (Berg, 1997)

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