Depending On Digital Design: *Extending Inclusivity*

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Abstract

This paper documents work from the EPSRC 'EQUATOR' and 'Dependability Interdisciplinary Research Collaboration on Computer Based Systems' (DIRC) concerned with the appropriate design of dependable assistive technology to enable older and disabled people to maintain a quality of life within their own homes. Technology, especially so-called "smart home" technology, can only be used to assist people if it is effectively designed. Designers are therefore required to consider certain key questions such as what situation they are designing for, what solutions should do, and who should use them. The focus in this paper is on understanding and identifying user needs and system requirements for dependability in the complex challenge of inclusive design. The feature of inclusive design we address is the new emphasis on the user, a living, breathing person situated in real world settings along with others, rather than some designer's abstraction.

The acceptance or rejection of assistive technology relies on the users perceptions of the designed technology as well as the appropriateness of the technology designed. Consequently, this paper suggests that despite highly imaginative views of future technologies, getting such dreams to work generally means they must, at some point, meet the real world and engage with the needs of users if they are to be sufficiently grounded. Given this emphasis on users the highly personal character of domestic settings presents conventional research techniques with obdurate problems that can make research practically and ethically difficult. Researching domestic spaces and domestic values requires different methods to understand the unique needs and experiences of residents. Accordingly, we report on our experiences of using observational studies and adapting 'cultural probes' to foster an ongoing dialogue with the members of our user groups, to gain insights into their needs and generate design relevant information and inspiration. We discuss how such information might feed into dependable design through consideration of a model of dependability.

Key words: assistive technology, support systems, designs for dependability

(1) Introduction: Disabling Environments, Assistive Technology and Inclusive Design

As the population of older people increases worldwide, Assistive Technology (AT) - "*An umbrella term for any device or system that allows an individual to perform a task that they would otherwise be unable to do or increases the ease and safety with which the task can be performed"* (Cowan and Turner-Smith, 1999) - can be successfully used to support them in their home environment, performing background tasks and augmenting the supporting process. Through the appropriate use of technology older and disabled people can be enabled, just as they can be further disabled by poor design (Dewsbury et al, 2002). But it is important to consider that older people and disabled people constitute heterogeneous groups and as such need to be considered from a person centred perspective as individual *needs* will differ and cannot be based upon individual impairment, disability or medical conditions (Dewsbury et al, 2004). Consequently, designing appropriate assistive technology to support people in their homes requires a qualitative shift in the understanding of the translation of needs into *design specifications*. This paper seeks to take seriously, and thereby extend, both the challenge and promise of 'Inclusive Design' by suggesting that traditional Inclusive Design considerations, *by themselves*, are rarely enough to adequately facilitate appropriate and acceptable design. This may be because 'Inclusive Design' as an abstract principle and as applied to disabled people rarely amounts to more than 'wheelchair users'. Now, undoubtedly many disabled people have gained a better quality of life through design features such as wider doors and the fact that new homes need to be '*visitable'*, but many more have lost out through their particular disability and particular needs not being considered or recognised, due to this equation of disability with "*someone in a wheelchair*". This obviously excludes older people as well as people who are hard of hearing, partially sighted, mentally confused, emotionally unstable, or have learning difficulties, as Imrie argues:

> "*Most designers also conceive of disabled bodies as mobility or ambulant-impaired, with little perception of the wider range of physical and/or mental impairments which need to be catered for*

in producing inclusive design. Where designers do produce design for disabled people's needs it tends to be for wheelchair users"

(Imrie, 2002)

Clarkson and Keates (2001) also illustrate the need for widespread questioning of fundamental design principles:

"It is known that many products are not accessible to large sections of the population. Designers instinctively design for able-bodied users and are either unaware of the needs of users with different capabilities, or do not know how to accommodate their needs into the design cycle".

This paper proposes a design framework that is person centred, whilst avoiding the "special needs" approach and suggests a method for obtaining design specifications based on the work of the authors in designing assistive technology support for people in their own homes. We advocate design criteria that are informed through engaging with real (rather than abstract) users and that concentrates on important, and often neglected, notions of social and system dependability.

(2) Cultural Probes: Person Centred Design in Action

Assistive technology provides an interesting test-bed for the exploration of fundamental issues of design and dependability within a context of disability and impairment that forces us to reappraise traditional notions and perhaps seek alternative visions of inclusivity. In focusing on dependability, we are taking a social perspective, informed by users, that we later develop within more traditional, computer science, models of dependability. In these circumstances the means for ensuring traditional notions of dependability - fault tolerance, fault removal, fault forecasting - can be problematic. Some of these problems arise because of difficulties in obtaining useful

access to user requirements with what can be very sensitive user groups. Methods for eliciting needs in complex care settings are under-developed and gaining an adequate or perspicuous understanding of user needs has long been a general problem of researching the elderly and disabled people. Our approach is methodologically eclectic – being guided by the context rather than adherence to any theoretical or methodological orthodoxy – but is broadly ethnographic (Lebbon et al, 2003), for, as we have commented in a number of studies:

> *"By placing the social actor's conceptions and activities as the centrepiece of the analysis, a more realistic and 'real worldly' grounded portrayals of the interrelationship between activities, technologies, and organised settings could be produced and be of more help to system design's needs to be informed by a social perspective."*
>
> (Cheverst et al, 2003b)

Insert Image 1 here

One way in which we have attempted to expand the repertoire of available research techniques is through using and adapting of 'cultural probes' (Cheverst et al, 2003a). 'Cultural Probes' (Gaver et al 1999) have been deployed in a number of design projects to provide 'inspiration' for design activity. Within a domestic context, the approach is concerned to address what role technology might play in design for the home of the future and, specifically, how it can support domestic values (Gaver, 2001) and the varying motivations underpinning technology adoption and use. We use 'cultural probes' (Figure 1) (which include: cameras, diaries, maps, Dictaphones, photo-albums, postcards etc), as a way of uncovering mundane information from settings and people that are difficult to research by any other means and as a way of prompting responses to users emotional, aesthetic, and social values and habits. The probes have enabled us to engage in a dialogue with our (often difficult and suspicious) users, and thereby attempt to meet what Edwards and Grinter (2001) regard as a major challenge for designers in domestic environments – grounding designs in everyday realities, the stable, subtle and compelling routines that are such

an important part of everyday life. Our interest is in using probes to elicit this kind of mundane information. Probes are about understanding people *in situ*, uniquely not abstractly en masse, and the results of the probe exercise are highly individual, emotive, idiosyncratic and revealing of participant's personal lives as these "*fragmentary glimpses*" of people's home lives are transformed into "semi-factual narratives" informing design.

Although not all participants used all the probes available to them, each person found some of the probes to be of use. The illustrations below demonstrate the types of responses from participants from two diary entries.

Insert Image 2 here

Insert image 3 here:

Clearly the use of the probes is more than just looking at diary entries, photographs interview scripts etc, and single entries, by themselves, only provide glimpses of the real issues that people deal with daily. Nevertheless it is through such 'fragmentary glimpses' that the designer can begin to understand, and design for, the true and individual needs of the person. Both the above examples demonstrate different qualities that can affect the design outcome. The first illustrates the rhythms and temporal aspects that are most appropriate for the individual; the pace of the person's life in which the day is punctuated by periods of rest directly informs the design and assessment of the AT requirements. These temporal aspects become a central building block as a system should support these rest periods or assist the person in other ways. The second entry illustrates the common problem of loneliness. Technology can do many things, but it cannot provide company except in remote/virtual forms such as television or radio etc. Due to the second respondent's impairments, getting out of the house has become an ordeal. This has exacerbated the feelings of isolation and loneliness that could be allayed by a technology that allows her to go outside safely. It is at this point that technology design interfaces with architectural design.

The use of ‘cultural probes’ has generated a number of fundamental design requirements through facilitating a consideration of everyday, yet important, individual activity patterns and needs; illuminating the rhythms of daily life as well as the possible problems and difficulties that people are faced with in relation to technology in their homes. The rhythms of daily activity orient people to their present and future activities and requirements and plan accordingly (Zerubavel, 1985). Current activities are crafted with an orientation towards expectations of future events - for example, knowing that a visit and talk, or a trip to the shops or the dentist etc will take place at a particular time. The importance of this is that any technology is required to fit into these temporal regularities or temporal rhythms in order to sustain the patterns and routines of the occupier (Tanzi 2000). Socio-technical systems are not static but evolving and modulating with the rhythms of daily life (Dewsbury et al, 2003a). Furthermore, such rhythms change, as people age, and technology design should be guided by and reflect such shifting patterns. Certain aspects of daily life are characteristically standardized, such as getting up, going to bed, having meals at certain times etc, but such patterns change throughout the life cycle. Bedtime changes with age as do most activity patterns, yet these rhythms are central to dependable design as technology should fit into these patterns and enhance the person’s life. For example, a doctor's appointment at 9.30am may require that an elderly person get up two hours earlier in order to be ready on time. This possibly means waking at four in the morning to be assured of being washed and dressed.

(3) Collaborative Dependable Design

> *“The application of advanced technology to the home does not inherently provide ease-of-use. It does provide increased design flexibility, which in turn creates an opportunity for optimal system performance. In a domain as diverse as elder care, it will be necessary to first establish the range of users and situations of interest.”*
>
> (Miller et al, 2002, 3)

Alongside the use of ‘cultural probes’ we have developed a collaborative design framework that places the user at the centre of the design. As Hughes et al (2001) note, developing useful and applicable guidelines for systems design is a difficult and thorny issue, as it requires a balance to be struck between the need for the emergence of general principles and the importance of detailing everyday situated practice. In our case technology design needs to be tailored to meet their needs and reinforce standardised routines and behaviours. Technology is not ‘added’ into the home, it is ‘integrated’ forming a seamless integration into the fabric of the dwelling when possible. The resulting designs should be aesthetically pleasing, non-invasive, reliable, individualised dependable systems that should assist the person in maintaining a way of life that they wish to maintain. The ‘probes’ have also allowed us to consider both appropriate and inappropriate aspects of design by, for example, unearthing tales of woe from respondents. A good example is the following illustration from a couple who live in a purpose-built ‘*smart house*’ in Scotland (Figure 4), who inform us in the ‘probes’ that:

> *“Door openers - why do they have to have writing on them (PRESS TO OPEN) when they are in a domestic setting? It makes you feel you’re in hospital or a residential home.*
>
> *“Hoist - why does it have to be bright yellow? I think (my husband) knows it's there and won't hit his head off it whatever colour it is!*
>
> *“The bathroom is kitted out with all mod cons but there isn't anywhere to put anything except a window shelf behind the toilet that I can’t reach or on the sink itself but then everything falls over when you raise or lower the sink. Where do you put toiletries, towels etc?*
>
> *“The door opener, light switch and key have been centrally positioned on the walls - which looks attractive - but they're outwith my reach.*
>
> *“The (kitchen) hob is very fancy and can be height adjusted so I can cook for myself. BUT they put a hob in with very stiff controls that I am unable to grip/use and there is no piece of equipment available to help. A touch-control hob would be the answer but this seems to be like asking for the world and no-one will take responsibility for replacing it so, one year down the line I still can't boil an egg myself, so what is the point of the fancy technology. I’ve gone from a house with a hob*

I could use but which was slightly too high to a house with a hob at the perfect height but I can't turn it on!

"In "Smart" housing there are many controls/switches on the walls but the designers seem to forget that you still need to put furniture in the rooms - where are you meant to put it if not against the walls and if you do put it against the walls, how do you reach the controls?

Insert image 4 here:

For design to be Universal or Inclusive, the real needs of the person are required to be effectively met through the technology design. Clearly in the case above this is far from the case, yet the dwelling was a purpose built design specifically for people with disabilities. Unfortunately the person with disabilities that inhabited the residence did not fit into the mould from which they gauged the design specification. It is critical to understand how the user will interact with the spaces as well as their own personal needs being reproduced and responded to from the design. There is a critical interface between technology and overall inclusive architectural design. It might be wonderful that there is a ramp allowing easy access to the front door, but if the opener is not within easy reach then the ramp becomes useless. Assuming the correct positioning of devices is not really appropriate, there cannot be standards as every person has different requirements and will need these items positioned appropriately for their needs. Similarly, technology cannot be determined by a medical condition ("because you have this condition … you will need one of these devices"). Through our research we have found that people use technology differently, not always for the intended purpose (often extending the original purpose to suit themselves *for example the shower rail described above*) and are not prepared to go through extensive training to use the technology, it should just do what they want it to when they need it.

The use of the information gleaned from the 'probes' enables us to focus on specific bespoke dependable socio-technical designs that meet the real needs of the user. But such work has also led us to reconsider or reframe the notion of dependability as applied to domestic settings and older or disabled people. Traditional concepts of dependability (for example Laprie 1995) are

concerned with faults, failures and errors and their minimization within software development. These can be framed within the notions of 'fault prevention', 'fault tolerance', 'fault removal', and 'fault forecasting', which enable the software designer to trace and prevent undesirable problems (Aviz¡ienis et al, 2001). We accept that as far as general systems design is concerned this notion of dependability has some validity, but it is not sufficient in relation to the home as a socio-technical system, when technology is used to support people. The home is rarely a standardised, ordered environment; how people relate to and utilise technology is not necessarily or simply standardised. Often there is an assumption by manufacturers that people '*know'* how to use technology appropriately, and this is where dependability analysis comes to the fore. The theme of dependability reflects wider concerns about the reliability, security and fundamental trustworthiness of computer systems as they become ever more complex and essential. Achieving sufficient dependability in these systems, and demonstrating this achievement in a rigorous and convincing manner, that is, in a way that will enable people to 'trust the technology' and effectively 'forget it', is of crucial importance (Proctor and Rouncefield, 2001). Assistive technology systems designed to support older or disabled people in their own homes have greater dependability requirements than conventional technologies as people increasingly rely completely on these systems, and it becomes internalised and part of their everyday experience (Lupton and Seymore, 2000, Kellaher, 2001).

Through our work on the DIRC and EQUATOR projects we have begun to sketch out an alternate model of dependability that relates to the home. We have called this dynamic model the interdependent model (Dewsbury et al 2003a, 2003b and Bagnall et al 2004). The model can be represented as follows:

Insert Image 5 here

For domestic systems, we need to consider the dependability of the socio-technical system as a whole where the system includes the user, the home environment and the installed assistive

technology (Figure 5). To achieve system dependability, we propose that the required characteristics of the assistive technology should be considered under four headings (for more detail see Dewsbury et al 2002, 2003a, 2003b, 2004). These are:

1. ***Trustworthiness:*** In order for a system to be dependable, the user must trust that the system will behave as they expect. We define this attribute to be the equivalent of 'dependability' in Laprie's model. That is, it includes the traditional dependability attributes of availability, reliability, etc. However, we suggest that these need to be re-interpreted to some extent to take into account the particular and peculiar characteristics of domestic systems. We include in this category: *Availability and Reliability, Safety, Maintainability, Confidentiality and Integrity*.

2. ***Acceptability:*** We have argued above that a system that is not acceptable to users will simply not be used. Therefore, it is essential that system characteristics that affect its acceptability such as the system learnability and aesthetics are considered in the design process. We include in this category: *Usability, Learnability, Cost, Compatibility, Efficiency, Responsiveness, Aesthetics*

3. ***Fitness for purpose:*** Fitness for purpose is taken for granted in most of the dependability literature but socio-technical system failures regularly arise because a computer-based system is not fit for the purpose for which it was designed and users of the system have had to adapt their operational processes to accommodate the system's inadequacies. When the purpose of a system is to cope with disability, users may simply not have this option and the system may simply be unused. We include in this category *Transparency*

4. ***Adaptability:*** Within the home both the environment itself and the user's of the systems change over time. This is particularly true for elderly disabled people whose capabilities

tend to decline as they age. Therefore, if system dependability is not to degrade, then it must also be able to evolve over time, generally without interventions from the system's designers. We can identify three types of modification that may be made to domestic systems: addition of new equipment; system configuration or re-configuration by its users; configuration or re-configuration of a system by its supplier. We include in this category: *Configurability, Openness, Visibility, User repairability*

(4) People, Dependability and Supportive Technology

> *"We certainly don't want a smart house. Those are dreadful. Computers in the 21st Century are scarcely a whit "smarter" than they were in 1965. Besides, to live under Windows-for House would mean a cruel automation of domestic routine that jerked us around in our own kitchen, chained by apron strings to the tyranny of a glass box or WIMP interface. No housekeeper needs that service and no sane person should pay for it… The crying need is for a house that is in touch with the authentic nature of house-ness… what's needed is a modest, intelligence-free house that mimics sensory activities*."
>
> (Sterling 2002, p254-255)

We suggest that this model of dependability provides one mechanism for extending our notions of inclusive design for, as technology has become more pervasive and integrated into the fabric of the home, there are still important challenges that need to be overcome by inclusive designers. Current usage of so-called "smart" home technology is often too functionalist and reductionist, reducing systems to specific tasks that can be automated, based on spurious algorithms of habitual behaviour, thereby reducing the skills and abilities of the person '*benefiting'* from it. As Bruce Sterling (2002, 255) observes "*a home exists in order to shelter people, not to boss them around with algorithms*". Technology designed to support people by determining when activity

patterns do not match to prescribed patterns will be unstable (Miller et al 2002). Through the use of more sophisticated notions of dependability, designers can dynamically begin to determine if systems and structural designs will meet the individual needs of potential residents without reducing their skills and responsiveness.

Insert image 6 here

Illuminating how people live and relate to technology contributes directly to issues of the appropriate and acceptable designs for the built environment. We have documented many houses that have been specifically designed to support people with varying impairments, yet in most cases it is their immediate physical environment that does not cater for their needs. Spaces are not constructed to provide the resident with a good quality of life. Adaptations might have been utilised to support various conditions which are incorrectly positioned, or incorrectly specified, such as cooker hobs which are unusable, cupboards that the resident cannot reach etc. Technology might have been included to provide support, but this is often inappropriately specified and inappropriately positioned as well as aesthetically displeasing. This means that many of the specific intended designs are made redundant by the fact that the resident will not use the technology as intended. In some cases this can be acceptable, for example, you do not need to know what all the menus on a mobile phone do in order to receive a phone call. But when considerable finance has been outlaid on making bespoke user defined homes, it often appears that somewhere the designs are not meeting dependability criteria.

Insert image 7 here

Although what we have done is abstracted notions taken specifically from computer science and reinterpreted them within a social context, this does not mean that there should be less of an impact. We suggest that just as dependability is central to software development it can be generalised into the social fabric of design. How technology operates is a social as well as technical issue. Supportive and assistive technology can become a crucial aspect of the social

fabric of a person's life and as such can become an intrinsic part in their self-perception, providing them with levels of functional support that could be of benefit. Should the technology or the physical structure of the home not be fully acceptable or appropriate then the resident is unlikely to reap the full benefit and, at worst, there might be critical consequences. Currently systems are becoming more complex and allowing people to be remotely monitored for health characteristics and behaviour pattern changes, (Porteus & Brownsell, 2000) just as the "smart" home can alert the resident that the front door is open, or the fridge is not closed (Puckett 2003). But the system is a static entity in most cases (Doughty and Fisk 2001). It is not intelligent. It is only as intelligent as the person who designed and programmed it (Ross, 2001). Telecare and Telehealth systems are becoming increasingly used to support people in the home and these generic systems potentially might fail to meet the true needs of the user if inappropriately designed (Baxter et al 2004).

Through the research conducted on the DIRC project, we have been able to work with older and disabled people in order to determine how dependability and inter-technology are connected. Our work has illuminated many areas where technology has been *mis*-represented, *mis*-understood, *mis*-used, *mis*-designed, *mis*-placed, *mis*-configured *mis*-installed and effectively at times a *mis*take or *mis*adventure. People who have not taken the time to determine the real needs and activity patterns of the user have designed unacceptable systems, having not found out how the person will use or want to use the technology. Our work has also shed light on the fact that technology can only be used effectively when other structural and architectural elements are attended to. Just as Maslow's 'hierarchy of needs' (Maslow, 1943) postulates that until basic needs are met then higher needs cannot be considered, we have found that when the living environment of a person is substandard, due to structural constraints or inappropriate attention to detail, then considering advanced technology is simply impractical.

> *"Not everyone will benefit from or accept new technological aids and devices, and each individual's situation must be carefully assessed. Many people may welcome the technology, although a few might view it as an invasion of privacy."*
>
> (Miskelly, 2001,458)

Our work has documented several cases where assistive technology has been supplied and installed in residences, but has become redundant or inappropriate on installation as the needs of the residents have changed or not been fully accounted for in the design specification. For example, in one residence, a man is looking after his wife who has rapid onset dementia and has had a second banister installed to assist her getting up and down the stairs. This became redundant even before the second handrail was installed as the woman became so confused that she was no longer safe to negotiate the stairs herself. As a consequence, her husband physically carries her up and down the stairs everyday. There is now more chance her feet might accidentally catch on the second banister sending them both flying. In this worst-case scenario, it is clear that neither of them is likely to be able to benefit from the second banister. A stair lift might enhance their life together and be safer, but as the stair case is split with a severe turn at the top and steps beyond, this might again provide minimal help and possibly more problems as there could be a danger when the woman dismounts from the chair at the top of the stairs. The house is too small to accommodate a through-floor chair lift. Therefore, the question of the unsafe stairs remains. Technology does not appear to be the most obvious appropriate or acceptable solution.

We have also recognised the importance of communication. Many older and disabled people are cut off from the community around them. Even living in residential accommodation where a building is made up of people of similar ages does not restrict people in feeling lonely and desiring communication. We live in an age where technology can support communication in a number of different levels from standard technology such as telephones through to high-tech networking solutions such as WAP, SMS, P_2P etc. Although the technology is available is

delivery has not be used effectively to support people with impairments. Although some might advocate the mobile phone as a great achievement in Universal Design, it is clearly flawed by the fact that few people with restrictive movements can use the small buttons, and people with visual impairments cannot see the screen, people with hearing difficulties cannot hear the phone when it rings or receive audio feedback, and people with cognitive disabilities have difficulty negotiating the menus. The project is currently looking at alternative communication strategies and designing technology to support collaborative communication (Cheverst 2004, Bagnall et al 2004).

> *"Most disabled people want to live in the community as independently as possible. The extent to which that can be achieved depends to a large extent on the accessibility of the built environment, at home and in public. Few homes are built with any real thought for more complex individual needs of the people who may live or use them. When physical disability prevents convenient independent living the first option usually considered is to try and adapt the home."*
>
> (Bradford 1998)

(5) Conclusion: Dependability and Design

> *Building working ensembles of technological components, social relations and working practices is the challenge that IT practitioners face. They have to act on limited knowledge and with limited control as they try to configure together offerings from diverse sources. They need to consider not only the here and now, but also the trajectory of technological development, both within the organisation and outside it. In all this, they have to act with the limited resources available to them in the 'here and now' and need to consider the moves that other players make as they pursue their (often conflicting) aims.*
>
> Voß, et al (2003)

This short paper has begun to outline some of the work we have been undertaking in the *DIRC* and *EQUATOR* projects. We have tried to demonstrate that designing assistive technology systems in the homes of older and disabled people requires a user centred design framework which we advocate could be developed using the collaborative design tools of 'cultural probes'. We have shown that through the adapted use of the 'probes' we can elucidate fragmentary *glimpses* into the routines and activity patterns of older and disabled people that can inform the socio-technical systems design process. This paper considers the role of 'probes' and ethnography in the socio-technical design for system dependability. We reconsider traditional notions of dependability within a domestic framework and advance a dynamic model called the interdependent model that can be used to assist in the design of dependable socio-technical systems.

As housing design moves from the 'special needs' approach to as more universal and inclusive form of design, the problem still exists of how to ensure that real needs are met. Through the use of 'cultural probes', observations and interviews, we have found that design criteria are illuminated from the perspective of the resident. The use of dependability analysis has enabled us to frame the design to ensure that is will meet non-typical criteria. Together these tools provide a useful instrument for designers, beneficial not only to technology design but also applicable to many other areas that are of importance to disabled people within domestic spaces. Technology is becoming more pervasive and integrated in the support of people at home and it is essential that socio-technical systems are inclusively designed and fully responsive to the needs of the user allowing bespoke designs as well as generic systems. The use of the 'probes' and social dependability analysis can potentially assist in this task.

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For more details of the EQUATOR (digicare) project see http://www.equator.ac.uk

For more details on the DIRC project (Project activity 7} see http://www.dirc.org.uk

Information on the work of both projects can also be found at http://www.smartthinking.ukideas.com

(7) References

1. Aviz¡ienis A, Laprie J-C, & Randell B (2001) Fundamental Concepts of Computer System Dependability, *IARP/IEEE-RAS Workshop on Robot Dependability: Technological Challenge of Dependable Robots in Human Environments* – Seoul, Korea, May 21-22, 2001
2. Bagnall P, Dewsbury G & Sommerville I (2004) Easy for Everyone: Using Components to offer specialised interfaces for software, in Baxter G and Dewsbury G (Eds) *HEAT 2004: The Home and Electronic Assistive Technology, the Proceedings of HEAT 2004, York March 16-17th 2004*, Computing Department, Lancaster University
3. Baxter G, Monk A, Doughty K, Dewsbury G, (2004) Standards and the Dependability of Electronic Assistive Technology, in Keates, S.; Clarkson, J.; Langdon, P.; Robinson, P. (Eds.) *Designing A More Inclusive World,* Springer Verlag
4. Bradford I (1998) The Adaption Process in Bull R, *Housing Options for Disabled People*, Jessica Kingsley, London and Philidelphia
5. Cheverst K, Clarke K, Dewsbury G, Fitton D, Hughes J, Rouncefield M, Sommerville I, (2003a) Cultural Probes: Eliciting Requirements For Dependable Ubiquitous Computing In The Home in Stephanidis, C. (ed) *Universal Access In HCI: Inclusive Design In The Information Society*

Volume Four of the Proceedings of HCI International 2003, Lawrence Erlbaum and Associates, London,

6. Cheverst K, Clarke K, Dewsbury G, Hemmings T, Hughes J & Rouncefield M, (2003b) Design With Care: Technology, Disability And The Home, in Harper R (Ed) *Inside The Smart Home*, Springer-Verlag, London Ltd

7. Clarkson PJ, & Keates S (2001) *A practical inclusive design approach*, Proceedings of INCLUDE 2001, London, 72-73

8. Cowan D & Turner-Smith A, (1999) The Role of Assistive Technology in Alternative Models of Care for Older People, in Sutherland I (ed) *With Respect To Old Age: The Royal Commission for the Long Term Care of the Elderly,* Research, HMSO, 2, (4)

9. Dewsbury G, Clarke K, Hemmings T, Hughes J, Rouncefield M, & Sommerville I, (2004) The Antisocial Model of Disability, *Disability and Society*, 19, (2), March 2004, pp 145-158, Taylor & Francis Ltd, ISSN 0968-7599 (print)/ISSN 1360-0508 (online)

10. Dewsbury G, Clarke K, Hughes J, Rouncefield M & Sommerville I (2003a) *Designing Dependable Digital Domestic Environments*, In Proceedings of HOIT 2003, 'The Networked Home and the Home of the Future', April 6-8 2003, in Irvine, California

11. Dewsbury G, Sommerville I, Clarke K, Rouncefield M (2003b) A Dependability Model Of Domestic Systems, In Anderson, Felici & Littlewood (Eds), *Computer Safety, Reliability And Security: 22nd International Conference, Safecomp 2003, Proceedings, Lecture Notes In Computer Science, 2788*, Springer Verlag, pp103-115,

12. Dewsbury G, Clarke K, Rouncefield M, & Sommerville I (2002) Home Technology Systems, *Housing Care and Support Journal*, Pavillion, 5 (4), November 2002

13. Doughty K & Fisk M (2001) Extending the Scope of Community Alarm Services, *Housing, Care and Support Journal*, 4, (2), pp24-27

14. Edwards, K & Grinter R. (2001) At Home with Ubiquitous Computing: Seven Challenges in G. D. Abowd, B. Brumitt, S. A. N. Shafer (Eds.): *Proceedings of Ubicomp 2001, LNCS 2201*, pp. 256-272, 2001. Springer-Verlag Berlin Heidelberg 2001

15. Gaver, W., Dunne, A. & Pacenti, E. (1999) Cultural probes, *Interactions*, vol. 6 (1), pp. 21-29.

16. Gaver, W. (2001) The Presence Project. *Computer Related Design Research Studio*, RCA, London.

17. Gearing, B & Dant, T. (1990) Doing Biographical Research In Peace, S.M. (1990) (ed) *Researching Social Gerontology: Concepts, Methods and Issues*. London. Sage. pp143-159.

18. Hughes J, Jon O'Brien, Rodden T, Rouncefield M & Viller S (2001) P*atterns of Home Life: Informing Design For Domestic Environments,* Equator Working Paper

19. Imrie R, (2002) *Inclusive Design - Designing And Developing Accessible Environments*, paper presented to Joint PRESCO-CRISP Workshop, 24-25 June 2002 - Ostend, Belgium

20. Kellaher L (2001) Shaping Everyday Life: Beyond Design, in Peace M and Holland C (Eds), *Inclusive Housing in and Ageing Society: Inclusive Approaches*, Policy Press

21. Laprie J-C (1995) Dependable Computing: Concepts, Limits, Challenges, *FTCS-25, the 25th IEEE International Symposium on Fault-Tolerant Computing, Pasadena*, California, USA, June 27-30.

22. Lebbon C, Rouncefield M & Viller, S, (2003) Observation for Innovation, in John Clarkson, Roger Coleman, Simeon Keates Cherie Lebbon (Eds), *Inclusive Design: Design For The Older Population*, Springer, London

23. Lupton, D. & Seymour, W. (2000) Technology, selfhood and physical disability, *Social Science & Medicine*. 50. 1852.

24. Maslow A, (1943) A Theory of Human Motivation, *Psychological Review*, 50, pp 370-396

25. Miller C, Haigh K, & Dewing W (2002) First, Cause No Harm: Issues in Building Safe, Reliable and Trustworthy Elder Care Systems, *paper presented to American Association for Artificial Intelligence*

26. Miskelly F (2001), Assistive technology in the elderly care, *Age and Ageing*, 30, 458

27. Porteus J & Brownsell S, (2000) *Exploring Technologies for Independent Living for Older People: A report on the Anchor Trust/BT Telecare Research Project*, Anchor Trust

28. Proctor R & Rouncefield M (2001) Dependability and Healthcare Informatics, in *Proceedings of the First Dependability IRC Workshop Edinburgh, 22nd-23rd March 2001*, Lancaster University Press.

29. Puckett K (2003) Sensor Sensibility, *Housing Today*, 16th May 2003, pp30-32

30. Ross A (2001) The New Smartness, in Trend D (Ed), *Reading Digital Culture*, Blackwell, pp354-364

31. Sterling B, (2002) When Environments Become Really Smart, in Denning P (Ed) *The Invisible Future: The seamless integration of technology in everyday life*, USA, McGraw Hill,

32. Tanzi, D (2000) Time, Proximity And Meaning On The Net, *C-Theory*, 3/8/2000, Article 081

33. Voß A, Procter R, Slack R, Soutter J & Hartswood M (2003) "It's All a Big Clockwork" Achieving Dependable Systems in Practice *Paper presented to the Dependability Interdisciplinary Research Collaboration (DIRC) Project Workshop*, e-Science Institute, Edinburgh, Scotland, 14-16 April 2003

34. Zerubavel, E (1985) *Hidden Rhythms: schedules and calendars in social life*. University of California Press.

Images:

Image 1: 

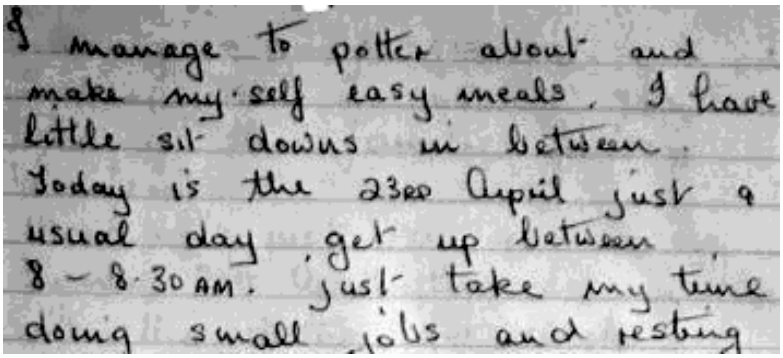
Image 2: 

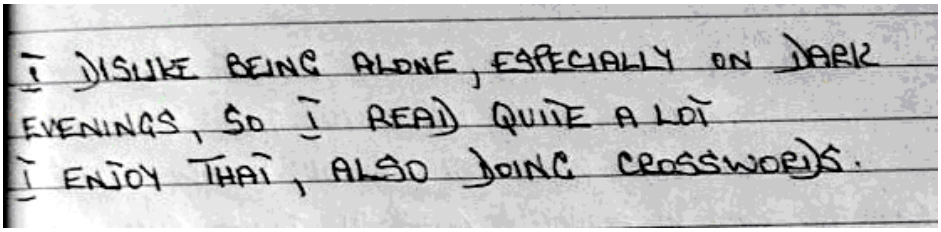
Image 3: 

Image 4: 

Image 5:

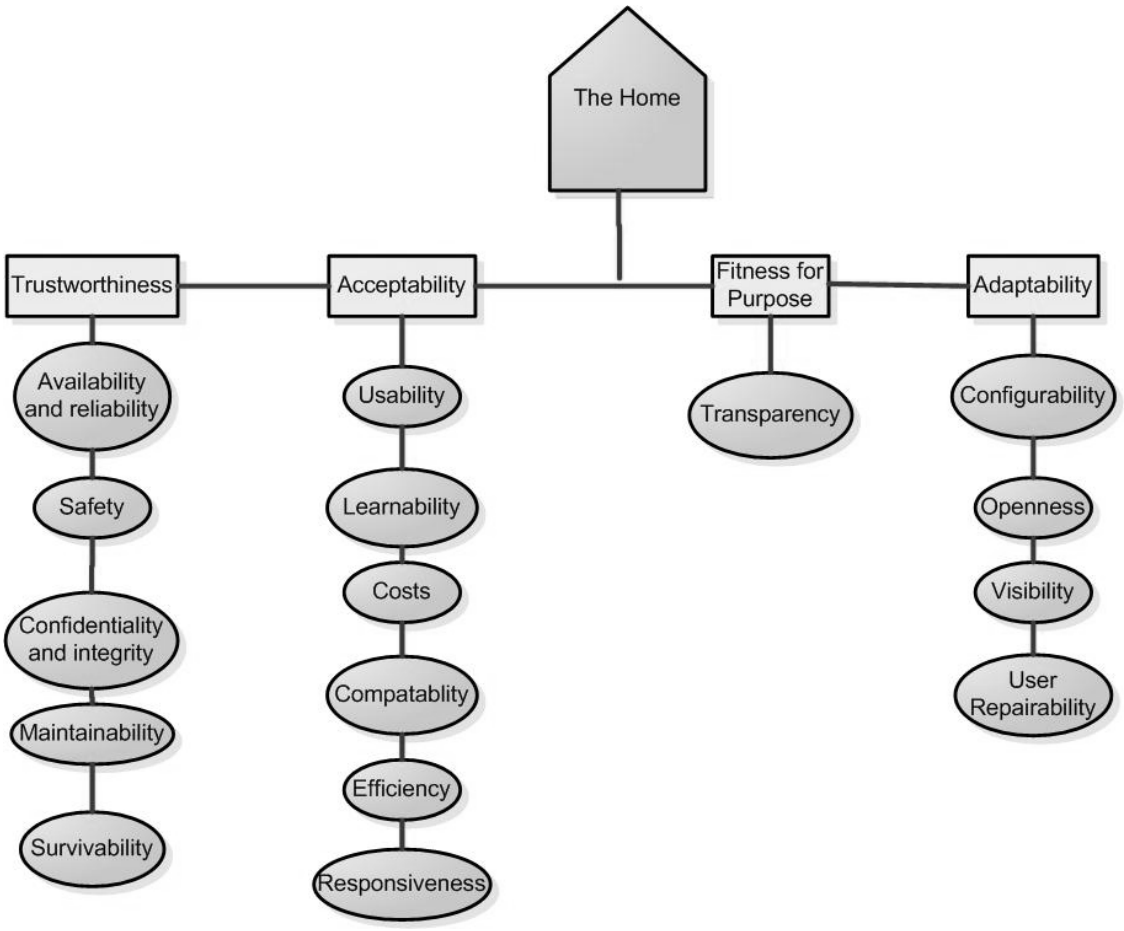


Image 6:

Image 7: 

Captions

Figure 1: The "Cultural" Probes Pack

Figure 2: A diary entry

Figure 3: Another diary entry

Figure 4: “*The door opener… they're outwith my reach*”

Figure 5: The Interdependent Model

Figure 6: Easy to reach switches?

Figure 7: Aesthetically pleasing?