technology

HOME TECHNOLOGY SYSTEMS

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This paper is interested in the design of technology in domestic, or home, settings. The systems themselves have become increasingly complex and the need for dependable systems correspondingly important. The design problem is not so much concerned with the creation of new technical artefacts as it is with their effective and configuration and integration. Inadequate understanding of the context of the lived reality of use and user needs is often a significant cause of lack of dependability. The paper aims to illuminate and highlight some fields of investigation that might form the basis for future research and development agendas technology in domestic settings.

Introduction

The notable rise in the use of domestic technology in the last four decades has had considerable, implications. Labour saving devices such as vacuum cleaners have enabled people to achieve cleaner households but have not saved domestic labour time, as standards of cleanliness have increased proportionately. There has been also been a blurring of the boundaries of technology within recent years, such that devices that were previously only seen in cars, offices, or hospitals are now finding their way into the average home. The original design and layout of rooms, for specific and static purposes, has been modified such that there has been a blurring between designated spaces while activities are no longer confined to pre-designated spaces.

Getting used to it

New information and communication technologies, such as the home computer, have enabled the isolated to find friends, the person with speech difficulties to find a voice, the non-communicative to communicate, and the disabled person to be enabled. Clearly technology has empowered a number of people, just as, some suggest, it has the potential to enslave similar numbers. Technology has become part of everyone's life. We now accept that the key to ones car will lock the doors remotely, that the windows of the car will remain free of mist and that there is a good chance of walking away from a collision in modern cars. We accept that washing machines will wash clothes of all types and not shrink or allow colours to run and refrigerators will keep things cool whilst freezers keep things frozen. We accept that it is the norm for a home to have a television, a video, a cooking facility, a bathroom with shower, a stereo system, (or even a home theatre system) a mobile phone, and a personal computer. We have clearly become used to it relying and accepting the benefits and disadvantages of technology.

The misery of failure

Although we may embrace it, technology can and often does work against us. Computer users will all recognise the blue screen or the feeling that occurs when the mouse pointer refuses to move any more as the computer has crashed. Cars tend not to start in cold or wet weather, when they are needed most. Power is lost in extreme weather conditions for many remote communities. Technology systems are excellent

when they work appropriately but can cause severe misery when they fail to respond in the appropriate or expected manner. We seek to consider and review the role of advanced technology in relation to homes and covers issues concerning assistive technology, home automation (smart homes), and telecare in relation to developing a potential model of 'appropriate' technology specification. This is difficult. It depends on understanding the interactions between users and the technology and issues such as privacy or security.

The paper also attempts to demonstrate that this area is highly relevant and important to current legislation and Government policies of ensuring people receive adequate care in their own homes. We seek to consider and review the role of advanced technology in relation to homes and covers issues concerning assistive technology, home automation (smart homes), and telecare in relation to developing a potential model of 'appropriate' technology specification. Overall, appropriateness is based on, built around, developing interactions between users and the technology.

Dependability is clearly critical involving safety, security, reliability and usability. Work currently being undertaken by Lancaster University considers how systems failures occur, what is a fault and what is an error; how systems can be made more reliable and safer; how issues of timeliness, structure, responsibility, diversity, risk and maintainability are addressed within the areas of advanced home technologies. Ultimately, our aim is to develop a set of design tools that will support the deployment and dependability assessment of assistive technologies in the home.

Home Technology and Home Networking

The increase in home networking is having great effects on the lives of older and disabled people. A home network allows a residence to be connected to the outside world through a residential gateway that passes information down an ISDN or DSL phone line. Home networking allows the home to become fully connected, controlled externally as well as internally. The increase in telemedicine and telecare as initiatives that extend beyond the conceptual into the real world are only possible through the home network.
The smart home, in which devices are interconnected (networked) and programmed to act in predetermined patterns, has been extended through the home network to allow external monitoring and control. For a disabled or older person, home networking offers the potential for their home to be programmed to monitor and respond to cues whilst allowing the occupant the safety and reassurance that should a fault develop or a problem occur within their home then the correct people will be informed by the technology within the home network.

A clear and practical use of technology is the introduction of home networks, involving smart homes, telecare, telehealth and telemedicine, to allow people with possible illnesses or disabilities to retain a quality of life within their own home. Home networks and smart homes can assist in undertaking operational tasks, telecare enables a person to remotely assessed and monitored by medical staff and telemedicine allows a full virtual medical service to be brought into the home of the person requiring the specialist service. The figure below illustrates how extensive the role of technology is within the home. Moreover, the application of this technology extends into a number of areas which are enhanced by home networks.

Technology area	Applications
Supporting life at home	Smart house Multimedia environmental control Systems to support cognitively impaired people Assistive devices Aids for daily living 'Design for all' products
Remote care and services	Alarms/security Monitoring systems Telemedicine
Mobility and transport	Navigation systems within large buildings Accessibility information systems Advanced wheelchairs Road transport informatics
Control and manipulation	Compensatory devices Assessment tools
Restoration and enhancement of function	Optimised hearing instruments Portable communication equipment Rehabilitation systems Fitness devices
Interpersonal communication	Voice Text Video
Alternative media	Text interpretation Electronic newspapers Television text captions and audio description Multimedia translation systems Alternative interfaces
Access from a distance	Information access Teleshopping Telework Distance learning Entertainment and leisure

Key Areas of Research & Development in Community Care Technologies
Source: Porteus and Brownsell (2001, 21)

Available Technologies

In fact, there are an almost infinite number of technologies available for older and disabled people. They range from individual one-off bits of kit to solve a specific problem through to whole house smart home/telecare systems. Home technology is available in three main types: Powerline; Busline: and Radio Frequency (RF)

Powerline systems are made of devices that can be connected directly into the main power supply. These devices use the standard wiring to send data to the devices to activate or deactivate them. Powerline technology is used by amateur smart home enthusiasts as the devices are simple to configure and a system can be up and running cheaply and quickly. Should the system fail then the installer should be able to repair

it on the spot or by locally sourced devices. Frequently, Powerline systems require a computer to be attached to the system to monitor the devices. Many Powerline systems are in use today and some are used to support older and disabled people. Often the major problem with this system is related to interference and powers cuts and are not therefore entirely reliable, without provision for these eventualities.

Busline smart homes use a separate 12-volt cable to transmit data to devices (through the busline), which runs in parallel to the traditional mains cable. The use of this cable means that devices are independent of conventional mains borne power supplies. Busline has, to date be proven to be the most effect and reliable form of smart home, as it can be configured to prevent devices malfunctioning during power cuts. The two-way protocols also allow the systems themselves to monitor devices without recourse to external computerised systems. Busline technology was developed for large buildings such as offices and factories and therefore uses high quality components that have been tested rigorously which is ideal for use in high dependency systems. This is also reflected in their high price.

Radio frequency (RF) and Infrared (IR) systems are becoming increasingly more popular with users as there are no wires and therefore no modification to the home is required for installation. Most manufacturers of smart home technology have a RF product range. These products have tended to be perceived as less reliable due to problems with interference and short-range identification issues, although recently there has been a shift towards more robust whole systems. Many social care alarm systems are use RF components as standard although they may configure these into a busline or Powerline system for extra functionality.

Telecare, Telehealth Technology

Telecare systems are still in their infancy and there are few proprietary systems available on the market at this time (Anchor Trust 1999, Porteus and Brownsell 2000,). Systems are usually designed using one-off AT devices such as blood pressure monitors and configured into a standard systems such as a smart house system or a call system. Both telehealth and telecare systems rely on the use of the Internet or telephone lines as a means transferring information from the source (the house) to the receiver (the doctor/nurse etc). This relies on a Residential Gateway (RG) and a number of security issues surround the use of this form of data transference.

Dependability

The Issue of systems dependability is critical to the development of appropriate technology solutions Gann et al 1999 suggest that appropriate design is divided in to different components:

- Affordability
- Ease of use
- Flexibility and adaptability
- Functionality
- Interactivity
- Reliability and maintainability
- Replicability and ease of installation

- Upgradeability

As a benchmark, the above components demonstrates that systems are required to be responsive and flexible to the needs of the user, yet it suggests that the design process is standardised and uniform, which experience dictates is rarely the case. Clearly, if design is to reflect real need then two preconditions need to be met. Firstly that the design is dependable (free of failures) and second that the needs are truly reflected in the design.

Some failures might be part of the design, where as other failures might be unforeseen and a consequence of unpredicted circumstances.

Within a standard call system there are a number of potential points where errors can occur. The first point of error is that the signal needs to be detected and sent, if the hardware is not functioning correctly (device error) then this will not occur (system failure one). The second point is that the remote call centre needs to receive the call; once more the system could be susceptible to hardware or software problems, or simple human problems in that the person at the call centre is not able to action the call (system failure two). Having received the alert, the call centre is required to contact the appropriate person from a list. This clearly could be difficult if no one answers them or if there is a time lag that is too great (system failure three). By seeing the system purely in terms of hard or software the whole picture of failure is misrepresented as human and mechanical errors can play a significant part in the process.

Some Elements of Appropriate Design

The designer undertakes what appears to be a standard process, yet within this process there are a number of elements that should be considered. The eleven main elements of a dependable system are described below, although it should be noted that these elements do not signify the all the possible elements of appropriate design and dependable systems, they are some of the more common considerations.

1. **Affordability**: Costs of installation and use, maintenance, Upgradeability, Is there built in obsolescence in the designed system?
2. **Configurational**: Location of devices, Are all the devices necessary? Are the devices compatible? Do some devices act as peripherals not talking to the main core devices effectively?
3. **Functionality**: Location aspects, Flexibility and adaptability, Ethical considerations (choice, privacy), Does the system do what the occupants expect it to do always? Security, Sensitivity, Safety.
4. **Interactivity**: How interactive should the system be, Can the level of interactivity be modified? Can the devices in the system interact reliably? Will the system be weakened by the addition of extra devices at a later stage? Privacy, Sensitivity, Safety,
5. **Interoperability**: Protocol issues, Standards of compatibility across applications and when upgrading within specific applications, Does the system have any points where protocols might conflict? Sensitivity, Safety.

6. **Maintainability**: Ease of installation and maintenance, Replicability, Foreseeable servicing costs, Upgradeability, Safety.
7. **Personalisation**: Dehumanisation of care, Anonymous care, Too much focus on physical needs with too little attention for social/emotional needs, Addressing non-existent needs, Does technology create needs, Lacks of information, Privacy, Personal Security, Safety, Sensitivity.
8. **Reliability** and **susceptibility to breakdown**: Does the system do what it is supposed to do? Are then any unforeseen events likely to occur? What happens if the system fails? What back-ups are required? Sensitivity, Safety,
9. **Technological**: Is the technology appropriate? Does it mean need? Does it produce dependence? Privacy, Security, Safety.
10. **Usability**: Ease of use, Complexity in use, Can the occupants use the technology appropriately? Sensitivity, Safety.
11. **Utility**: What is the use of the technology? Sensitivity, Safety,

As part of some work by the Computing Department at Lancaster University in conjunction with the Psychology Department at the University of York we are currently looking at issues of dependability. It considers how systems failures occur, what is a fault and what is an error; how systems can be made more reliable and safer; how issues of timeliness, structure, responsibility, diversity, risk and maintainability are addressed within the areas of advanced home technologies.

The types of systems that we are focusing on here are so-called assistive technologies that enable and support elderly and disabled people to live independently.

The first stage of the project is a collaborative activity with a group of elderly people to help us understand how they might use assistive technologies and to get their opinions as to what technologies would and would not be useful. A number of different methods to record their stories, including drawing, talking to a Dictaphone, photography and keeping diaries. Not all of these methods will be used by each person; it is up to them to determine which method of recording is most appropriate to them. Should a person have disabilities that make it too difficult to use any of the methods, the older person is requested to seek a friend or family member to act as a scribe on their behalf.

Conclusion

This paper has attempted to outline some the main issues relating to appropriate design of home technology to meet the need of the occupant. It has clearly shown that the notion of appropriate is required to be flexible and adaptive to evolving needs. Similarly, appropriate design is required to be reflexive and sensitive to future needs as well as technological needs. Finally, appropriate design is required to meet need through appropriate technology, which in itself is required to be dependable and reliable etc. Overall, appropriate design of home technological solutions required a dependable base set of criteria to be met. Technology is evolving, need is not static, people's relationship to technology in the home is constantly changing.

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