

***Designing the Home to Meet the Needs of Tomorrow
... Today: Deconstructing and rebuilding the home for life.***

**G. A. Dewsbury
H. M. Edge**

**Scottish Centre for Environmental Design Research (SEARCH)
The Robert Gordon University
Faculty of Design
Garthdee Road
Aberdeen
AB10 7QB**

Tel: +44 (0) 1224 263537

Fax: +44 (0) 1224 263737

Emails:

m.edge@rgu.ac.uk

g.dewsbury@rgu.ac.uk

Web Page:

<http://www.rgu.ac.uk/subj/search/research/sustainablehousing/custodian/home.html>

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Abstract

This paper considers the role of smart home technology in relation to current housing design principles. Initially the changing role and function of the house are explored and discussed. The concepts of barrier free 'lifetime homes' and universal design¹ are considered and UK community care and Building Regulations are investigated in relation to the design process. It is contended that the current role of assistive technology in relation to people with disabilities and older people can be developed through the use of smart home technology.

The paper examines smart homes and suggests that, through the adoption of smart home technology, occupants can gain independence and become more empowered. It is proposed that the concept of the home design should extend beyond the 'bricks and mortar' physical approach to take account of the rise in information technology. The paper highlights the international EU funded research² project CUSTODIAN³ which has developed a piece of software that enables specified smart homes and smart home solutions to be created by non-technically minded individuals.

This paper concludes that 'lifetime homes', barrier free and universal design should be reconsidered in the light of the development of smart home technology so that smart homes are incorporated within the 'virtual' design concept. The home, it is contended, should be considered as more than just a physical entity. Moreover, it is proposed that smart technology should be thought of as an essential part of the design process and not an after-thought. The paper argues that through the development of the smart home specifying tool, smart homes can be integrated into the initial design phase of future homes for older people and those with disabilities.

Introduction

Housing design must support independent living for all people- irrespective of disability or circumstance⁴

The concept of a home has modified considerably over the last century as a response to changing demographic, health and family patterns. The design of the home has responded to the differing needs of those who inhabit them and has attempted to accommodate the differing utilities of the internal spaces. Legislation has attempted to keep pace with these changes by placing the needs of older people and people with disabilities at the forefront of policy. Within the UK, this policy is manifested within the 'Community Care' ideology and attendant legislation. Although conceptually the home has accommodated the needs of the individual, in reality, this is a reactive

¹ Also known as 'Design for Life'

² This project is funded under the European Commission DGIX 'TIDE' Programme dedicated to developing the role of 'Smart Home Systems' in the homes of older people and people with disabilities.

³ *Conceptualisation for User involvement in Specification and Tools Offering the Delivery of system Integration Around home Networks*

⁴ The Scottish Office, 1998a.

Designing the Home to Meet the Needs of Tomorrow...Today

event, a 'knee-jerk' response to changes in the individual's needs which have become more acute or do not fit an imagined 'norm'. The home as a fixed entity is unresponsive and unable to accommodate the new demands placed upon it. The social care/ housing sectors act as reactive bodies to situations such as this and provide mechanical aids to enable the individual to reside within the home, but here there are obvious limitations and constraints imbedded in this process.

This paper considers the evolving nature of the home in relation to the concept that its design rests to date on concrete ideas about the house as a physical entity. Arising as it does from research done in the UK, it considers these issues from a largely British perspective. Current designs suggest that through simplifying the built space and removing barriers to individuals or groups, and adding adaptations, the home becomes suitable for most occupiers including people with disabilities and older people. This paper contends that the addition of new technological solutions and services within the house will facilitate the removal of barriers, increase independence and in many cases empower the user. It reflects on the effects of health and independence of individuals in relation to the technological advances that can and are being applied within the home. In pursuing a 'lifetime homes' analogy, the paper considers the role of smart home technological solutions that can be configured to domestic dwellings and the utility of a software tool named 'CUSTODIAN', developed, in part, by the authors to design and specify smart home technological solutions for individuals with disabilities and older people. The paper proposes that smart home technology should be integrated into the current 'lifetime homes', barrier free or universal design as standard and not an afterthought.

A home for Life?

The conceptualisation of the traditional home for life has undergone considerable reorganisation over the past century. Family structures, such as the extended family, have diminished in relevance within analytic concepts of the family. The notion of the traditional family home has consistently been modified to reflect the demographic ramifications of inconsistent family patterns. As demographic and lifestyle transformations occur within society, the single person occupancy of individual dwellings is becoming increasingly common⁵. This is applicable to older people as well as younger people, as a recent MORI poll suggests, 95% of the older people interviewed did not wish to live with relatives⁶ and in Britain, in 1996, in the 65-74 age group, 21% of men and 39% of women lived alone, and 31% of men and 58% of women aged 75 and over lived alone⁷. Moreover, the number of older people of pensionable age in the UK is projected to increase from 10.7 million in 1996 to 11.8 million in 2011⁸. The implication of these figures is that there will be a much larger number of older people living alone in the near future. With the demise of the extended family, the consequent rise in single occupancy has meant that the home has to cater for the needs of the infirm without the traditional internal support features that were associated with extended familial structures.

⁵ Age Concern, 1997, Statistics

⁶ MORI, 1999.

⁷ Office of National Statistics, 1998

⁸ Office of National Statistics, 1999

Designing the Home to Meet the Needs of Tomorrow...Today

The design of the built environment has evolved in order to adapt to these changing patterns of occupation. Yet this evolution has been to provide reactive solutions to identified problems. This is often reflected in the legislative and policy frameworks, which inform, influence and control the design of domestic buildings. The home has been linked directly with influencing health and consequently has been redesigned to account for the need for fresh water supplies, sanitation, preparation of food, and ventilation⁹. An acceptance prevailed that the quality and quantity of housing had a direct impact on health outcomes.¹⁰

When illness or adversity strikes someone, they are increasingly required to take care of themselves within their own home, with the help of external agencies and service providers. The design of the home has not, however, kept pace with these societal changes. The home environment is traditionally something the *occupier* needs to adapt to. It is often difficult to make the environment adapt to the changing needs of the occupier.

The Design Concept

In responding to the changing needs of society, the design of buildings has attempted to assimilate and accommodate to these new pressures placed on the home. The design of the built environment for people with disabilities and older people has undergone a number of theoretical and practical changes. The major influence on design has been barrier free design, lifetime homes or universal design.

Barrier free design connotes an architectural design that meets requirements for accessibility that allow the widest range of people to move freely around and use with ease the provided facilities¹¹. Typically, this is reflected in terms of the built environment being responsive to the needs of wheelchair users, people with visual or hearing impairments and people with disabilities in general, providing mechanical adaptations and other forms of assistive technology (AT), the use of products or equipment, used to help maintain or improve functional capabilities, whilst considering the actual room space concerns within the home to remedy the situation. As Martin (1992) suggests

Barrier free design is about making the environment a more accessible and usable place for a wider range of people with a range of disabilities¹².

Although critics of barrier free design advocate other names for this inclusive design process, there are many similarities between the different approaches.

...advocates of barrier-free design and architectural accessibility recognised the legal, economic, and social power of a concept that addressed the common needs of people with and without disabilities. As architects began to wrestle with the implementation of standards, it became apparent that segregated accessible features were “special,” more expensive, and usually ugly. It also became apparent that many of the environmental changes needed to accommodate people with disabilities actually benefited everyone. Recognition that many

⁹ Ineichen B, 1993.

¹⁰ Hawtins M, 2000

¹¹ Martin F, 1992 p7

¹² Ibid p8

Designing the Home to Meet the Needs of Tomorrow...Today

such features could be commonly provided and thus less expensive, unlabeled, attractive, and even marketable, laid the foundation for the universal design movement.¹³

It is important that in future designs these common themes of utility and attractiveness and costs are born in mind. Barrier free design has impacted greatly on the design of the built environment providing ramps and other modifications to allow people with disabilities to access services and maintain a greater level of independence that had been the case. To date, barrier free design has only flirted with technological solutions for the home environment, providing basic environmental controls etc.¹⁴

Universal design, like barrier free design, seeks to be '*holistic and inclusive*'¹⁵. The use of barrier free, lifetime homes or universal design principles can facilitate a modification in housing design, which would enable homes to be more user friendly and accommodating to life experiences and events. Yet, this form of design is not the complete solution to housing design problems. Appropriate housing design is especially important within the care sector, where social housing provision is central to care planning and implementation of policies.

The Care Sector and the UK Policy Framework

This section will concentrate on two main forms of legislation, namely the recent building regulatory changes and the development of community care.

The major piece of legislation on this area in the UK was the 'NHS and Community Care Act (1990)'. This legislation ushered in the shift from acute services to primary care. The Act encouraged a needs led strategy for people with disabilities and older people. It allowed the traditional medical model to be challenged by social models of disability¹⁶. The result of the UK Community Care Act is the policy of encouraging the maintenance of residence within the community, ideally in the person's own home. The Act also encourages independence, empowerment, needs assessment and promoting 'quality of life'. These specifications also apply to housing provision within this sector.

In Scotland, the rise of home care, as well as the purchaser/ provider relationships evolved such that in 1998, 79,519 individuals were in receipt of some form of non-residential service provision¹⁷. Currently, 59,138 houses are provided in Scotland for older people and people with disabilities, which is over 10% of the total of the over 65's housing in Scotland¹⁸. Moreover, the number of people of pensionable age is estimated to rise by 7% to 0.98 million by 2021¹⁹.

This rise in the population requiring care is likely to stretch already over-extended and over-burdened resources. Care managers will need to find accommodation and home

¹³ Story M, Mueller J & Mace R, 1998, p10.

¹⁴ Bain K & Leger D (eds), 1997.

¹⁵ Edge HM, & Milner J, 1998.

¹⁶ Finklestein V, 1998.

¹⁷ Scottish Office, 1998c.

¹⁸ Scottish Office, 2000

¹⁹ Scottish Office, 1999.

Designing the Home to Meet the Needs of Tomorrow...Today

care staff to accommodate the increase. However, as care management teams attempt to follow Government initiatives and uphold the needs led approach to service provision, the main area of difficulty that will be experienced is that of resources. The Scottish Office is encouraging 'Staying Put Options' which are designed to meet end user needs and reducing the 'pressure on social rented housing stock'²⁰. Therefore, in the future, greater emphasis is likely to be placed on the person's dwelling than in the past.

...Barrier-free or Lifetime homes can be created by relatively minor design modifications. The installation of digital control and communication systems represents the next stage on from changes to the physical environment and installation of mechanical aids. *Telecare* is an evolving field in which care, health and support services are partly provided for using new high-speed digital telecommunications infrastructure.²¹

The home environment and its design are central to developing effective community care packages²². It is also likely that the future increase in the use of home based community care services is likely to be predominantly amongst those groups designated as high to moderate needs²³. Therefore, the design of the home, not merely reflect current political ideologies, but attempt to facilitate the potential care packages and provisions within interagency collaborations.

While government policy fails to links housing policy to other social policy areas, local government fails to integrate disabled people's housing needs into their mainstream activities and housing and social services departments fail to work together, disabled people will continue to be condemned to institutional care or imprisoned in housing which unnecessarily restricts their lives.²⁴

Madigan and Milner (1999) suggest that due to the Disability Discrimination Act (1995), the future design of the home needs to be flexible and responsive in order to meet the needs and aspirations of the potential new user²⁵. Mace (1998) suggests that the adoption of universal design principles would benefit individuals with disabilities and older people and have 'long term value'²⁶. Through lifetime homes, barrier free and universal design principles, homes can be designed that are user friendly irrespective of age, ability, culture and lifestyles²⁷.

...not only can well-designed housing-such as 'lifetime homes' or forms of adaptable housing- help people stay in their homes, but this can create more stable households which in turn lead to more stable communities²⁸

Current UK legislation on building regulations has recently begun to embrace the Disability Discrimination act by the recent incorporation of Part M (England) and Part T (Scotland) of the 1999 Building Standards. These amendments mean that all buildings to be constructed to specified standards that allow physical accessibility. Although the new regulations do not cover all sixteen of the principles of lifetime homes²⁹ they do address accessibility although the legislation only refers to

²⁰ Scottish Office, 1998b,

²¹ Gann D, Barlow J & Venables T, 1999,

²² Meredith B, 1995.

²³ Munroe, M, et al. 1996.

²⁴ Morris J, 1998.

²⁵ Madigan R & Milner J, 1999

²⁶ Mace R, 1998.

²⁷ Weisman L, 1999.

²⁸ Hawtins M, 2000, p147

²⁹ Brewerton J & Darton D (eds), 1996.

Designing the Home to Meet the Needs of Tomorrow...Today

‘visitability’ in housing, not living in the home for a longer periods of a person’s lifetime³⁰.

The Influence of Assistive Technology on the Built Environment

Traditional responses to disability and rehabilitation have tended to be confined to the role of assistive technology in providing differing levels of support to the client. Barrier free housing and universal design principles often incorporate generic elements of AT, such as ramps etc., into their core designs. Story et al (1998) define assistive technology as follows:

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.³¹

Designing and implementing assistive technological solutions requires that the provider uses a client centred approach to accurately evaluate the needs of the end-user. As Baum (1997) contends

The client-centred approach requires professionals to alter their behaviors (*sic*) from those traditionally employed in the medical model. Professionals must encourage client partnership in decision making and enable clients to identify their needs and build on their strengths. The approach must be flexible and individualised. The provider of services must respect the clients’ values, goals and priorities without judging what is right and wrong.³²

Therefore, the providers of assistive technology need to be responsive to the needs of end-users, respectful of their needs and views, and to incorporate them into a ‘*partnership*’ with technology, so they are not alienated from the new technology. Yet, assistive technology is perceived by some care providers as an ineffective solution to care needs. Low cost, low technology solutions are often considered in preference to their higher technological counterparts, as they provide the end user with the ability to be independent. However, as Baum (1997) suggests this is not the case.

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?³³

Moreover:

There is also a large and growing potential market for assistive technologies in the home. The market ranges from young people with interactive educational and entertainment requirements to the growing number of older people who have wide ranging health and care needs. Many people are also concerned about issues such as safety, security and energy use in the home. Requirements vary considerably depending upon the type of property and individual circumstances.³⁴

³⁰ Disability View Magazine, 1998.

³¹ Story M, Mueller J & Mace R, 1998, p10.

³² Baum C, 1998, p138.

³³ Ibid, p144.

³⁴ Gann D, Barlow J & Venables T, 1999.

Designing the Home to Meet the Needs of Tomorrow...Today

Assistive technology can play a central role in the lives of older people and those with disabilities, empowering the user by allowing them to lead autonomous lifestyles. Although technology is unable to replace the human interactions that are essential to daily living, they can provide support and security for the individual user. It is important to reflect that as care in the community increases so will the number of people who are dependent on their home as their main source of support. Technological solutions can enable the occupant to lead a quality life in the community.

The Impact of Assistive Technology on the User

It is naive to perceive older people and people with disabilities as disparate groups; theoretical constructs; and not as individuals with thoughts and feelings. Although the whole structure of the Community Care policy framework is designed to personalise and empower the consumer, often, due to the processes of assessments and evaluations the consumer can become subsumed in the process. Individualisation and personal preferences can be lost as care providers respond to financial constraints or localised restrictions. This can be the case with assistive technology as Bazinet (1995) suggests:

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.³⁵

It is important to recognise the place that technology plays in the lives of people who use it. Lupton & Seymour (2000) contend that AT devices become integrated into the self-concept of the user.

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.³⁶

Moreover:

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 entry into the workplace for people with disabilities. As such, they may go some way towards redressing the disabling features of many work environments.³⁷

As assistive technology can become central to the core evaluation of selfhood of an individual, it is increasingly central for the end user to be incorporated in all decisions where technology is concerned to assist their future. It is at this point that the issue

³⁵ Bazinet G, 1995, p 329.

³⁶ Lupton D & Seymour W, 2000, p1852.

³⁷ Ibid, p1853

Designing the Home to Meet the Needs of Tomorrow...Today

becomes one of usability, and a proactive approach to technology needs to be employed. Lupton & Seymour (2000) continue:

The positive attributes of technology identified by the participants contributed to an integral aspect of selfhood and bodily experience: the opportunity to engage more easily in social relationships. For most of the participants, technologies were valued for allowing them to tame the disorderly aspects of their bodies and thus to facilitate social integration. They drew an important distinction, however, between the technologies they considered more 'normalising' and others, which they saw as marginalising or stigmatising.³⁸

Engaging the user in the definition of assistive technology is essential. Devices that are intended to assist people should not become the millstone around their necks. It is important to consider the needs of the individual at present and in the future in order to provide the best solution for their specific circumstance. It is also important to convey the true meaning of the technological solutions that might be intended for the end user. This is especially important when the end user has cognitive impairments. The technology provider should attempt to demonstrate the appropriate devices and show how they are to work and discern any possible problems that might be encountered by the user. There is little point in having an alarm system if the user does not understand what the alarm sound is trying to convey.

Smart Homes

Smart homes (also known as automated homes, intelligent buildings or integrated home systems) are a recent design development. Smart homes incorporate common devices that control features of the home environment. In its early days, Smart Home technology has been primarily used in the homes of the rich. Devices such as door openers, activated by telephone, have not been considered for use within the care sector. Assistive technology has begun to be accepted by the care sector although the use of smart home technology has not been embraced significantly to date.

Smart Home technology uses many of the same basic devices that are used in Assistive Technology to build an environment in which many features in the home are automated and devices can communicate with each other. The root of this ability to communicate between devices lies in the use of the 'Busline'. A Busline is a cable that connects all the devices together and enables interconnectivity between devices in different room throughout the home.

Originally, smart home technology was used to control environmental systems such as lighting and heating, but recently the use of smart technology has developed so that almost any electrical component within the house can be included in the system. Moreover, smart home technology, does not simply turn devices on and off, it can monitor the internal environment and the activities that are being undertaken whilst the house is occupied. The result of these modifications to the technology is that a smart home can now monitor the activities of the occupant of a home, independently operate devices in set predefined patterns or independently, as the user requires.

³⁸Ibid, p1857.

Designing the Home to Meet the Needs of Tomorrow...Today

Smart home systems can enable people with disabilities to engage with and control their environment. The introduction of this new technology demands that we rethink our ideas about the idea of barrier-free, or universal design. Unlike other aspects of assistive technology, large aspects of smart home systems are neither physical artefacts nor separable from the architecture of the home. Sophisticated systems will become a kind of 'virtual architecture', inseparable from the physical architecture, which contains it.

In this context, it will not be possible simply to conceive of 'barriers' merely as physical obstructions, such as stairs or narrow doorways, put in the way of a person with disabilities. In the future, the disabled person who is aware of his or her rights may say: "*My housing provider is placing barriers in my way by not having installed a smart home system sophisticated enough to allow me to live in my home as independently as any able-bodied person*".

For the last century, the home has been becoming more and more a collection of services delivered by changing technology, as opposed to a mere physical structure of floor, walls and roof. As the exponential development of information technologies impacts more and more on the home environment, housing design philosophies based only on the optimisation of the physical envelope of the house will rapidly become philosophically, practically and legally redundant.

With the increased development of the Internet and other aspects of information technology, the potential for home working and *teleworking* is becoming a reality. The vision of the home being the locus for employment, family life, education, entertainment and social encounters could be realised. This could influence directly the individual's relationship to the home. With the increasing use of Internet technology, the home can be perceived in the future as becoming the centre for employment, purchasing and providing services as well as a living space. The necessity to move beyond or outwith the home could well be lessened. Therefore, designs need to embrace this forthcoming potential redefinition of the home.

Smart home technology can perform a useful role in the design of the homes of the future, today. The design of the home can be developed to accommodate whoever is to live within the building, by using proactive design principles and smart home technology. The house does not need to be retrofitted to suit the requirements of a new occupier, if the potential for further installations existed in the original design. Moreover, the likelihood of retrofitting would be diminished if the overall design of the home reflected general principles relating to the use of spaces and incorporated some of the features of barrier free design as standard.

A Possible Solution to the Housing Dilemma: The technological response

The role of higher technological solutions within housing is a relatively recent phenomenon although technology has been impacting within the domestic sphere it has also begun to interact within the domain of assisted living. Gianutsos (1992)³⁹

³⁹ Gianutsos R, 1992, p26-35

Designing the Home to Meet the Needs of Tomorrow...Today

and Kirsch *et al* (1992)⁴⁰ describe the early potential for computer-assisted interventions for living. These early developments are important in consideration of the relationship that exists between technology and people with disabilities. More recent work in this area heralds from Magnusson L *et al*, (1998) and Elger G and Furugren (1998)⁴¹ who demonstrate the potential application of smart home technological solutions for meeting needs of different user groups and differing abilities.

Gann *et al* (1999)⁴² and Barlow and Gann (1998)⁴³, demonstrate the efficacy of smart home technology for individuals with disabilities drawing on research conducted over a two-year period into the feasibility of this form of technology. In collaboration with *the Chartered Institute of Housing* and *Joseph Rowntree Foundation*, the researchers were able to evaluate two demonstration flats to determine the effectiveness and suitability of smart home technology to people with disabilities and older people. Although the research also concerns itself with rationales and potential market strategies, the overall conclusion of this research suggests that little experience exists in this field to specify the appropriate technological smart home solution on an individual case basis.

Although technology has always played a central role in medical innovations, disability, whether physical or psychological, has often been responded to by the utilisation of mechanical adaptive devices, which allow the user to adequately function in society, rather than actively participate in it. Increasingly the role of medical technology is interfacing with adaptive and assistive technology to provide solutions to problems of disability and impairment, in order to enable and empower individual users^{44 45}. Virtual reality technology is beginning to be used in the medical field to facilitate the rehabilitation of adults with cognitive impairments and the rehabilitation of adults with brain injury^{46 47}. Yet, the technological solutions have tended to be confined to improvements for individuals, which are unconnected to the users home. Often these solutions tend to be perceived as 'normalising' and not always appropriate to the needs of the person with disabilities or impairments. This leads French (1998) to contend that:

The onus is very firmly placed on disabled people to cope and adapt in a society adapted to the needs of non-disabled people.⁴⁸

Smart home technology can augment and facilitate the quality of life for people with disabilities within the home. Smart home technology can allow the house to become adaptable and provide the possibility of increasing independence for the home dweller. As a provider of independence, smart homes should not be conceived as external to or outwith housing design. It is suggested that it should become a possible new standard to be incorporated within the lifetime homes, barrier free or universal

⁴⁰ Kirsch N, Levine S, Lajiness-O'Neill R & Schnyder M, 1992, p13-25

⁴¹ Magnusson I, Berthold H, Britto L, Chambers M, Emery D & Daly T, 1998 and Elger G & Furugren B, 1998

⁴² Gann D, Barlow J & Venables T, 1999,

⁴³ Barlow J & Gann D, 1998,

⁴⁴ Cooper R, 1999, p319.

⁴⁵ Foster G, Wenn D & Glover J, 1998.

⁴⁶ Pugnetti I *et al*, 1995

⁴⁷ Johnson D *et al*, 1998

⁴⁸ French S, 1998, p45.

Designing the Home to Meet the Needs of Tomorrow...Today

design. Smart homes should not be an afterthought and placed in the same category of other forms of assistive technology, because smart home technology can be integrated into the fabric of the home. It should be considered at the design stage.

The 'CUSTODIAN' Research Project

The Scottish Centre for Environmental Design Research (*SEARCH*) at the Robert Gordon University in Aberdeen, Scotland, is currently developing a software suite of tools called CUSTODIAN. CUSTODIAN aims to empower strategic decision-makers, carers and medical practitioners and facilitate communication between these sectors and the designers, providers and installers of 'smart home' technology. The product of the research project is a software tool to be used to design 'smart home' networks to meet the needs of individuals with disabilities.

The use of the completed CUSTODIAN tool will involve the analysis of individual user need, spatial and network design, product specification and, importantly, the costing of 'smart home' systems. The project also involves the establishment of a network of 'Process Facilitators', who will be able to make informed decisions on the design of systems for individuals with particular impairments or disabilities. Although the Process Facilitator could be derived from any occupational area, the tool has been specifically devised to support specified health related occupations. Using the tool, smart homes can be specifically designed to meet the needs of older people and people with disabilities. The tool should also facilitate the increased acceptance of smart home technology into the care sector, making smart home design accessible to the non-technically trained. It is useful to contemplate a warning by Gann et al (1999) who state:

The future implementation of *Smart Home* systems will largely depend on the extent to which they offer improvements in the quality of life, solutions to actual household problems and reductions in occupiers' costs. There needs to be proven benefits and not burdens from their installation. At issue, is how technology will affect everyone – young and old, those who are active, fit and healthy and those with illnesses and disabilities⁴⁹.

A central tenet of the CUSTODIAN tool is its needs led assessment protocol in designing the home specification. Quality of life and user empowerment are key themes that have informed the methodological design of the tool and are crucial factors in its output.

The design of the CUSTODIAN tool can act as a mediator between this rise in technology and the effective rehabilitation of adults with disabilities. Although, the implementation of smart home technology will not necessarily directly 'free' resources for care management, as care packages and homecare will still be required, this technology allows end users to become functioning adults, who can be empowered and more independent within their home. Time spent by the carer with the end user can be qualitatively more effective as the need for the checks relating to the safety and security of the end user will be diminished.

⁴⁹ Gann D, Barlow J & Venables T, 1999

Designing the Home to Meet the Needs of Tomorrow...Today

As smart home technology becomes more widely used, possible savings to care and housing providers will accrue. Moreover, this could also have a significant impact on house design of the future, as the move towards universal and barrier free design principles grounded in the realisation of 'lifetime homes' become established as the norm.

...not only can well-designed housing-such as 'lifetime homes' or forms of adaptable housing- help people stay in their homes, but this can create more stable households which in turn lead to more stable communities.⁵⁰

Through smart technology, lifetime homes, universal design and barrier free design is enhanced, as the house can be modified to meet the changing needs, requirements and aspirations of the potential user, by altering the programming of devices and modifying which devices are used in the home. It is important to note that this corresponds to the current aspirations of the community care philosophy and UK Government policy^{51 52 53 54 55}. CUSTODIAN enables technical designs to be produced by non-technicians who can augment care provision and facilitate the empowerment and quality of life of the end user of the smart home.

Conclusion

The design of 'lifetime homes', barrier free or universal designed buildings has moved away from the '*special needs*' approach. These approaches are most applicable in consideration of social housing provision and social care options. 'Lifetime homes', barrier free and universal design seek to develop homes that will meet the needs of most households, without providing extraneous, ugly or uncomfortable features. Ideally, through these design approaches, houses can be made to be functional and flexible, no matter what life events occur.

This paper has considered the UK community care policies and suggested that the provision of suitable user-friendly housing within the care sector is intrinsic to the current UK care ideologies. Housing policies in the UK are beginning to incorporate some of the features of 'lifetime homes'.

The use of smart home technology assists the process of allowing barriers to be broken down in the home. This technology needs to be considered in both a holistic manner and with user needs led strategy in mind. Ideally, the end user will be empowered by the process of being engaged in the design, as Imrie (1999) notes:

...to empower people with disabilities in the design process is a multi-faceted, multi-dimensional, process which, as a minimum, requires an engagement at the level of values and ideology, as well as the material base of building processes.⁵⁶

⁵⁰ Hawtins M, 2000, p147.

⁵¹ Coleman R, 1998, p78-83.

⁵² Flynn R et al, 1996.

⁵³ Scottish Office, 1996

⁵⁴ Scottish Health Executive, 1999

⁵⁵ Scottish Executive 1999

⁵⁶ Imrie R, 1999.

Designing the Home to Meet the Needs of Tomorrow...Today

Smart home technology delivers the opportunity of empowering people both in the design process and as a result of this design process. The CUSTODIAN design tool offers the opportunity for control over the design process to be taken by non-technically oriented individuals whose main concern is for the specific needs of individual end users and other stakeholders.

This paper has sought to question and redefine 'lifetime homes', barrier free and universal design by suggesting that smart home technology should not be conceptualised as an addition to these designs, but rather as a fundamental part. It further suggests that through the ever-increasing rise in information technology, the design of the home needs to be reframed. The inclusion of smart home technology into this reframing is an essential consideration. The development of CUSTODIAN could facilitate this redefinition of housing design, enabling the design to move beyond the physicality of the building and enabling considerations of the functionality of the internal spaces in relation to the needs of the person inhabiting the home.

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