AT HOME WITH AT

Introducing Assistive Technology into the Existing Homes of Older People: Feasibility, Acceptability, Costs and Outcomes

A Brief Report of work undertaken as part of an EPSRC-funded research programme

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BACKGROUND

This research is about people over the age of 70, the houses they live in and the role of assistive technology in enabling them to live as independently as possible in their own homes. It builds on earlier work for the Royal Commission on Long Term Care and has considered how far, and at what cost, existing housing stock can be modified with Assistive Technology to enable older people to remain in their own homes.

“Assistive Technology” (AT) encompasses community equipment, housing adaptations, community alarms and the burgeoning variety of devices associated with “smart” and “telecare” (see Tinker, 2003 for a discussion of the changing terminology in the context of housing policies). Use of AT increases with both severity of disability and age.

With the growth in the number of older people in the United Kingdom (Figure 1), policies that enable older people to “age in place”—to remain in their own homes—become increasingly important. This recognises a widespread desire by older people to maintain their independence, which becomes more difficult with the onset of ill health and disability. The most likely disability at older ages involves locomotion, but other significant impairments can also affect dexterity, reaching and stretching. Although intellectual function is a major concern, physical and sensory incapacity are more common. For example the percentage of people over 80 with difficulty walking 200 metres is 45%, with climbing 12 stairs 34%, picking up shoes 23% and getting in or out of chairs 16% (Hirani and Malbut, 2002).

Disability is the product not only of impairment of bodily function, but also of the design of the physical environment and the social context. So while disability can affect people of all ages, older people are particularly vulnerable because of the age and relative inflexibility of our physical environment.

The design and structure of houses and their facilities are critical to older people’s ability to manage independently. This research has focused on the social rented sector in which there are disproportionate numbers of disabled older people, with 6% greater probability of being disabled at all ages, than those in their own home (Grundy et al, 1999, Table 4.12).

The aims of social policies for older people have been consistent since the 1960s: older people should be enabled to remain in a home of their own (not necessarily the one they have always lived in) and not have to move to institutional care. However many reports from then until now have shown that AT has been a low priority in health and social care strategies. Meanwhile there has been a substantial reduction in provision of new public housing so that approximately 50% of the existing stock is over fifty years old. Moreover declining space standards in housing have made adaptations of properties more difficult.
In the public sector an Occupational Therapist usually assesses for and prescribes AT. Among types of portable AT (e.g. Community Equipment, Disability Equipment), information-related equipment is the fastest developing area. Much of this relates to safety in the home, for example community alarms, monitors and detectors. Funding has varied according to postcode and local NHS or Social Services policy. However additional funding of £105m between 2001 and 2004 has been provided to assist the merger of equipment provision from NHS and social services (Integrated Community Equipment Service, ICES). In contrast Fixed AT requires building work or “housing adaptations”. An important development in funding was laid down in the June 2003 DH circular Changes to Local Authorities charging regime for community equipment and intermediate care services (LAC(2003)14. This stated that ‘Any item of community equipment which a person (or their carer) is assessed as needing as a community care service, and for which the individual (or their carer) is eligible, is required to be provided free of charge. All minor adaptations costing £1000 or less (which includes the cost of buying and fitting the adaptation) are required to be provided free of charge.’ Community equipment is defined as an aid or a minor adaptation to property.

Funding for tenants of Registered Social Landlords\(^1\) is extremely unclear and results in them receiving the most variable provision of fixed, or structural AT. Although AT is generally recognised to have great potential in supporting older people, with financial benefit to social services, health providers and the social security system, the costs of adaptations is born disproportionately by housing sources.

Enabling more people to remain in their own homes ‘will demand much greater attention to and investment in housing as an essential component of long term care needs’ (Royal Commission on Long Term Care, p. 82). Current policy supports this view, recognises the importance of AT, and stresses the value of adaptations in countering the disabling effect of aspects of construction, design, and layout of housing.

Older people see their quality of life as closely bound up with their health, their family and social networks, their home and their capacity to remain independent. This research examines the possible contribution of AT to these ambitions and the extent to which it reduces or delays the quantity of formal services required. It is directly relevant to three major policy issues relating to older people: quality of life, prevention of accidents and long term care.

The overall research question shown in the box was explored by considering five main subsidiary questions, including:

1. Which AT devices have the potential to provide the greatest benefit, taking account of need, usability and acceptability?
2. How suitable are existing homes for the installation of AT?
3. What are the costs and outcomes for the housing provider of installing AT?
4. Where AT is already installed in the home, do older people use it effectively and do they experience benefits?
5. What guidance can be given to policy makers, housing and other providers, designers, manufacturers and installers of AT, and older people?

Engineering, buildings and people are at the heart of this research, which was undertaken by a multidisciplinary team representing building surveying, rehabilitation engineering, social policy, social gerontology, occupational therapy, statistics, economics, and management.

The focus of the research was social housing and the fieldwork involved the cooperation of ten housing providers (five local authorities and five registered social landlords) – our Housing Partners. These were chosen to obtain a geographical spread, to take account of rural/urban differences and demographic criteria.

\(^1\) A Registered Social Landlord (RSL) is the technical name for social landlords who are registered with the Housing Corporation, a Non-Departmental Government Body sponsored by the Office of the Deputy Prime Minister. RSLs – invariably Housing Associations but also trusts, cooperatives and companies – are the main providers of new social housing in the UK. Some specialise in housing for particular groups including older people. All are run as businesses but do not trade for profit.
ASSISTIVE TECHNOLOGY

Information and costs
Information required for the acquisition and installation of an item of portable AT in a domestic environment includes purchase price, maintenance cost, design life, reconditioning cost, and cost of disposal. Portable AT does not generally require installation or building work apart from mains electricity and/or a telephone socket. Additional parameters required for fixed AT include physical size and shape and installation requirements (power, etc). These may be as simple as fastenings for a grab rail or as complex and costly as adaptation for a through-floor lift or ceiling hoist. Some portable AT may also require an adapted environment, e.g. a wheelchair or mobile hoist which need access and storage space.

All relevant data for the wide range of AT currently used in the home were compiled within a comprehensive database. Information was collected from a wide range of sources including charities, manufacturers, and purchasers of AT, including our Housing Partners. Manufacturers and suppliers were generally reluctant to be specific about the costs of fixed AT due to the variability of installation requirements and the wide range of accessories available.

Suppliers of AT and sources of funding are constantly changing. The information resource contains references to most of the national and local government and charitable information.

User Profiles
In order to evaluate the feasibility and costs of installing AT a set of seven hypothetical users were ‘housed’ in each of the 82 buildings surveyed. The packages of AT for these hypothetical users were devised firstly to include as wide a range of AT as possible and secondly to represent feasible real-life requirements. Each profile describes the user, their disabilities and the AT that would help address their functional needs. The profile is repeated five years later. An example is shown in the box on the right and the AT for this profile is shown in Table 1.

The domains of disability considered were Locomotion, Dexterity, Hearing, Seeing, Reaching and Stretching, Continence, and Personal Care. Dementia was deliberately omitted from this research as its manifestations are complex but the AT currently available imposes no installation difficulties that are significantly different from those in the existing profiles. The user’s

User Profile 4

Current
Mrs T is 78 years old and suffers from arthritis. She currently only experiences a slight restriction in her mobility and a mild visual impairment. She experiences some pain in her joints but not such that it significantly affects her ability to complete activities of daily living.

Locomotion: cannot walk 400 yards without stopping
Outside the home: uses public/private transport where possible to travel distances greater than she is able to achieve with comfort.
Dexterity: pick up and carry a pint of milk with one hand but not the other.
Reaching and stretching: has difficulty placing one arm behind her back but no difficulty with the other arm.
Seeing: has difficulty reading newspaper print.

Activities of daily living (ADL)
Food and nutrition: can prepare her own meals independently.
Shopping: uses public and private transport where necessary and delivery services to remain independent with this activity.
Housework and washing: no problems.

Future
Now 83 years old, her mobility has reduced and she is experiencing some problems relating to her range of movement and dexterity.
Locomotion: can only walk up and down a flight of 12 stairs if she holds on and takes a rest.
Mobility within the home: can move through the house unaided but often uses a walking aid. Stairs problematic, causing her severe discomfort.
Mobility outside the home: attendant-propelled wheelchair.
Dexterity: cannot pick up and carry a 5lb bag of potatoes with either hand.
Seeing: has difficulty seeing to read ordinary newspaper print.
Reaching and stretching: has difficulty raising either arm above her head.

Personal care needs:
Getting in and out of bed: Mrs T finds changing position from lying to standing painful and needs assistance due to her reaching impairment and pain experienced with lower limb joint movement.

Bathing: Moving from sitting with legs extended to standing and vice versa in a confined space is difficult because of her reaching impairment and pain experienced with lower limb joint movement.

Dressing: Although achievable this takes an increasing amount of time because of her reaching and dexterity impairment.

Toileting: finds getting onto and off the toilet difficult due to her reaching impairment and pain with lower limb joint movement.

Activities of Daily Living needs

Food and nutrition: food preparation takes increasing amounts of time and effort due to the reduction in her range of movements and dexterity.
Shopping: can only take part in this activity with assistance due to her increased mobility and dexterity impairment.

Housework and washing: requires assistance with these activities due to her increased dexterity, reaching and stretching impairment.

Summary
Mrs T requires intervention both human and via AT. AT enables personal care tasks and some limited household tasks to be completed independently.

Summary - ICF disability score

<table>
<thead>
<tr>
<th>Function</th>
<th>Current</th>
<th>Future</th>
</tr>
</thead>
<tbody>
<tr>
<td>Locomotion</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Dexterity</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Hearing</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Seeing</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Reaching &amp; Stretching</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Continence</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Personal Care</td>
<td>0</td>
<td>1</td>
</tr>
</tbody>
</table>
support network was also excluded so that the effect of the presence of a carer could be considered in relation to costing AT. The summary of disability score at the foot of the user profile box refers to scores for domains defined by the International Classification of Function (ICF).

### Smart Home Technology

A Smart Home contains devices that interact and which are monitored by a central computer. These may include sensor-activated devices (intelligent gas or hot-water taps, infra-red-controlled lights, etc), time-of-day-dependent lighting and heating sequences, alarm systems, telecare (including community alarm services), or telemedicine systems. The aim is to increase safety and comfort while removing the cognitive demand that often accompanies multiple “intelligent” devices. A number of other terms are currently associated with this technology: Electronic Assistive Technology (EAT), Information and Communication Technology (ICT), Environmental Control Systems (ECS) (see Tinker, 2003).

Until recently smart homes have required special wiring for the control circuits and expensive computing and communications hardware and software. However developments in wireless networks and mobile phones has created a consumer platform on which smart home technology is now riding. These new consumer technologies may ultimately replace existing wired home technology and prove to be cheaper and more flexible to install, and cheaper to maintain. Also, as it is standard consumer technology, it is likely to find increasingly easier acceptance and use by a new generation of older people and their families.
ADAPTING THE HOMES

The sample of properties

In order to assess the feasibility and costs of installing AT in as many circumstances as possible the study needed to examine as wide a range of properties as possible. Property characteristics considered were:

1. Type of property – bungalows, terraced houses, semi-detached houses, purpose-built and converted flats, including at least one classified as sheltered or extra-sheltered.

2. Type of construction – traditional, timber framed, reinforced concrete, other.

3. Age of property – particularly 1930s, 1950s, 1980s and modern but also older properties, reflecting different methods of construction and housing standards especially space.

4. Location of property – particularly in relation to access to facilities such as shops and health centres.

Although the aim was to examine a wide variety rather than a representative sample, the 82 properties studied were representative of the diversity of main property types to be found in the UK (Table 2).

<table>
<thead>
<tr>
<th>Category</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Small terrace house</td>
<td>6</td>
</tr>
<tr>
<td>Medium and large terrace houses</td>
<td>6</td>
</tr>
<tr>
<td>Semi-detached and detached houses</td>
<td>3</td>
</tr>
<tr>
<td>Bungalows</td>
<td>14</td>
</tr>
<tr>
<td>Flats in converted houses</td>
<td>5</td>
</tr>
<tr>
<td>Ground floor flats in low rise</td>
<td>15</td>
</tr>
<tr>
<td>Maisonnets in low rise blocks</td>
<td>5</td>
</tr>
<tr>
<td>Upper floor flats in low rise</td>
<td>12</td>
</tr>
<tr>
<td>Ground floor flats in high rise</td>
<td>4</td>
</tr>
<tr>
<td>Maisonnets in high rise flats</td>
<td>3</td>
</tr>
<tr>
<td>Upper floor flats in high rise</td>
<td>9</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>82</strong></td>
</tr>
</tbody>
</table>

Design Guidance and Audits

It was not straightforward to identify relevant advice and good practice:

1. Most of the commonly available design guidance applies only to new building work, although a number of local authorities have drawn up their own guidelines.

2. Statements in some design guides were too ambiguous to encourage consistency in specifying adaptations.

3. Where specific design guidance did not exist, a pragmatic but documented common sense approach was adopted.

For this study an extensive set of clear assumptions were drawn up that adopted a pragmatic approach, incorporating minimum dimensions. An audit pro-forma was designed to aid consistent and efficient gathering of property information: location, external details, internal details of each room and a floor plan. Photographs were taken of each property.

The Property Records

The audit data was transferred to a spreadsheet, which was subsequently used to estimate costs of the alterations and other work required for each property, based on the needs identified in the User Profiles. The resulting large number of potential adaptations were supported by a set of prompts for key information that would be required if the adaptation were to be recommended (such as external floor dimensions, travel height, landing spaces, additional building costs). These were arranged under the headings shown in Table 3. For most adaptations one of a set of cost codes could be applied. Some properties could not be adapted for certain profiles, usually because of wheelchair accessibility issues. Typical adaptabilities are shown in Table 4.

<table>
<thead>
<tr>
<th>Easiest to adapt to profiles</th>
<th>Difficult to adapt to profiles</th>
</tr>
</thead>
<tbody>
<tr>
<td>Accommodation on one level</td>
<td>Changes in floor level within</td>
</tr>
<tr>
<td>no vertical circulation</td>
<td>the same floor</td>
</tr>
<tr>
<td>Spacious layout with rooms</td>
<td>Restricted accommodation</td>
</tr>
<tr>
<td>separately approached from</td>
<td>layout</td>
</tr>
<tr>
<td>hall or landing</td>
<td></td>
</tr>
<tr>
<td>Large bathrooms or space</td>
<td>Small bathrooms and no scope</td>
</tr>
<tr>
<td>to enlarge existing</td>
<td>for enlargement</td>
</tr>
<tr>
<td>Two bedrooms or more</td>
<td>One bedroom or bed-sit.</td>
</tr>
<tr>
<td>Large walk in cupboards,</td>
<td>Restricted spaces around the</td>
</tr>
<tr>
<td>Internal stud partitions and</td>
<td>property – limiting space for</td>
</tr>
<tr>
<td>timber floors</td>
<td>ramps, scooter stores and</td>
</tr>
<tr>
<td></td>
<td>extensions</td>
</tr>
</tbody>
</table>

Table 3 Adaptation headings

- Communal entrance
- Individual and rear entrances
- Horizontal circulation
- Vertical circulation
- Personal care
- Food preparation
- Living and leisure
- Sleeping
- Windows
- Electrics
- Heating
- Alarms
- Remedial building work
<table>
<thead>
<tr>
<th>Profile</th>
<th>Details</th>
<th>Number of Properties</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Basic Provision for Safety</td>
<td>Grab/hand rails, lever handles, exterior lighting</td>
</tr>
<tr>
<td>2</td>
<td>Safety, Stair lift</td>
<td>1 + Communal lift, stair lift, over-bath shower</td>
</tr>
<tr>
<td>3</td>
<td>Safety, Stair lift and Scooter</td>
<td>2 + Door release and intercom, external or internal scooter storage, w/chr accessible entrance and horizontal circulation to storage area, level access shower tray, wall mounted seat</td>
</tr>
<tr>
<td>4</td>
<td>Safety, Stair lift and W/chr Accessible Entrance</td>
<td>2 + Ramp and rails, wider external door, manual w/chr storage, toilet frame, adapted taps (no scooter)</td>
</tr>
<tr>
<td>5</td>
<td>Safety, Stair lift, W/chr Accessible Entrance and Horizontal Circulation</td>
<td>4 + Wider corridors</td>
</tr>
<tr>
<td>6</td>
<td>Safety, Stair lift, W/chr Accessible Entrance, Horizontal Circulation and Shower Room</td>
<td>5 + Gulley shower (not tray), w/c shower room</td>
</tr>
<tr>
<td>7</td>
<td>Safety, Vertical lift, W/chr Accessible Entrance, Horizontal Circulation and Bath Room</td>
<td>6 + Electric w/chr storage (not manual), through floor lift (not stair lift), bath (not shower), w/chr bathroom</td>
</tr>
<tr>
<td>8</td>
<td>Safety, Vertical lift, W/chr Accessible Entrance, Horizontal Circulation, Bath Room and Hoists</td>
<td>7 + Special toilet, fixed hoist bedroom to bathroom</td>
</tr>
</tbody>
</table>

Cost Estimates

Some items of equipment, such as stair-lifts, include installation cost; otherwise, wherever possible building costs for adaptations were taken from BMI Building Maintenance Price Book 2001, RICS, London, 2001 and BCIS Access Audit Price Guide 2002, RICS, London, 2002; other costs were put together from appropriate labour and materials constants. It must be acknowledged that estimation of building costs for adaptations can be wildly incorrect due to unanticipated technical problems only apparent after work has started. The estimates were found to be similar to published data and to data provided by the Partner housing providers. The additional cost overheads for occupational therapist, surveyor, and housing management have not been included but may add 50% or more. Maintenance costs of equipment, the design life of the equipment and the resale value of the equipment after five years were developed. Resale or re-use values are generally negligible due to high refurbishment costs. Sensitivity analysis suggests that these values are not critical to the final economic analyses.

Mobility Profiles

Mobility requirements have the most obvious implications for adaptations and costs. To clarify the impact of the mobility requirements eight further profiles were developed from the fourteen User Profiles in order to focus on mobility by excluding the AT costs associated with other physical and sensory impairments, Table 5.

Certain types of property are more amenable to the full range of adaptation than others (Table 6) and costs range correspondingly (Table 7). It is particularly noticeable how the costs of adapting two-storey properties increase much more quickly compared with single-storey properties. The sources of variation in costs were also explored with respect to elements of the properties, in particular communal and individual property entrances, horizontal circulation, vertical circulation, and personal care.
User Profiles

The average adaptability of the property types with respect to all disabilities may be judged in terms of the number of User Profiles that may be accommodated. This is illustrated in Figure 2, which shows the poor adaptability of flats in converted houses and maisonettes in large blocks, and the high adaptability of ground floor flats.

Comparison of costs between the sheltered and mainstream properties within each property type was largely inconclusive because of the small numbers but there was a suggestion that, for the simpler profiles, sheltered bungalows were more expensive to adapt than mainstream bungalows, whereas sheltered flats in small blocks were easier to adapt than the mainstream flats.

The oldest properties, built before 1900, were associated with poor adaptability. All were either houses or flats in converted houses. Other differences related to the period when properties were constructed were surprisingly difficult to discern.

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### Table 7 Average Total Cost (£) of Adaptation for Each Mobility Profile

<table>
<thead>
<tr>
<th>Mobility Profile</th>
<th>Low rise block</th>
<th>High rise block</th>
</tr>
</thead>
<tbody>
<tr>
<td>All Properties</td>
<td>214</td>
<td>323</td>
</tr>
<tr>
<td>Small terrace</td>
<td>295</td>
<td>494</td>
</tr>
<tr>
<td>Medium/large</td>
<td>204</td>
<td>272</td>
</tr>
<tr>
<td>Semi-detached</td>
<td>198</td>
<td>128</td>
</tr>
<tr>
<td>Bungalow</td>
<td>171</td>
<td>957</td>
</tr>
<tr>
<td>Flat in converted</td>
<td>81</td>
<td>10,519</td>
</tr>
<tr>
<td>Ground floor flat</td>
<td>1,542</td>
<td>306</td>
</tr>
<tr>
<td>Maisonette</td>
<td>4,707</td>
<td>-</td>
</tr>
<tr>
<td>Upper floor flat</td>
<td>7,675</td>
<td>10,216</td>
</tr>
<tr>
<td>Ground floor flat</td>
<td>2,422</td>
<td>-</td>
</tr>
<tr>
<td>Maisonette</td>
<td>5,299</td>
<td>34,851</td>
</tr>
<tr>
<td>Upper floor flat</td>
<td>-</td>
<td>13,516</td>
</tr>
</tbody>
</table>

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**Figure 2 Number of Profiles (out of a possible 14) accommodated in different building types in four cost bands**
USER ACCEPTABILITY

Four perspectives from contemporary social science research informed the research with users:

**Independence:** Older people’s driving goal is to maintain their independence for as long as possible – in the sense that they exercise control over a situation by choosing what they will, or will not do for themselves, and how it should be done. Two major factors that threaten independence are increasing functional impairment and the challenges imposed by the built environment.

**“Successful ageing”:** The “successful ageing” approach suggests that when an individual is faced with changes either they re-adjust their goals, compensate in some way, or try to make the best of things.

**The meaning of home:** The large majority of older people want to remain in their own home. Home contributes to a person’s sense of identity. So there are reasons related to continuity why people might prefer to remain in the same property.

**The social model of disability:** focuses attention on the disabling impact of social organisation and attitudes. Limitations on independence within the home may be imposed by the combined effect of the individual’s declining functional capacity, the disabling effects of their accommodation, and their perceptions of how to remain independent.

The extent to which AT can narrow the gap between environment and individual capacity depends on older people’s willingness to use it. Attitudes to Assistive Technology appear to vary little with age and users particularly value the independence given to them by such items.

The importance of listening to older people has been shown in many studies (see for example Tinker, McCreadie, and Turner-Smith, 2003). In this research, respondents were recent recipients of AT from the housing providers and were selected with a view to sampling a wide range of AT, particularly electronic devices. 67 people over the age of 70 were interviewed in their own homes. Respondents were largely in their seventies or eighties (range 70 to 97), and were predominantly female. Most lived on their own but were in touch with their family, who generally offered considerable support. Only a few were receiving formal care.

An interview questionnaire was created that drew on the Easycare Assessment system to give an approximate score of disability and assess disability in terms of activities of daily living, including instrumental activities (housework, meal preparation, going shopping) (Sheffield Institute for Studies on Ageing, 1997). Approximately half the respondents were classified as having “moderate” disabilities, and about one quarter “mild” and one-quarter “severe” disabilities. By far the most common disabling condition (45%) was arthritis. Respondents were usually stoical in talking about their pain and disability, stressing that they wanted to manage and cope for themselves – to control their life as far as was possible.

Nearly 60% of respondents were living in flats/maisonettes and the remainder were equally divided between houses and bungalows. The vast majority of respondents visibly had a pride in their home and their accommodation expressed a strong sense of individuality, comfort and homeliness. Respondents were not specifically asked about moving, but some expressed a strong desire to remain in their present home. However there were many examples where respondents had general accessibility problems. *Stairs* were cited as a reason for moving to other accommodation. There were examples of respondents whose safety needs were addressed by a wide range of alarm technology, but who still had mobility needs relating to stairs and bathing.

Seven (10%) of the respondents were dependent upon wheelchairs indoors, but these caused considerable difficulties, even in some most recently designed accommodation. Users commented on the difficulties of managing with a wheelchair, damage to paintwork, opening and going through doors, and storage.
Table 8 shows the AT found in the respondents’ homes. There were considerable differences in the amount of AT that people had, quite often they were managing with very little.

**Mobility** in the home includes getting in and out of the accommodation moving around within the it, using the bathroom and toilet, using the kitchen and being able to get in to and around the garden. The majority of respondents reported difficulties in using stairs, going shopping and doing housework. In order of frequency the following fixed AT was noted: Grab rails/ramps in/out, level thresholds, specially widened doors, vertical lift, stair-lift, and overhead track hoist. Portable AT included walking sticks, walking frames, wheelchairs, and mobile hoists. Half the houses had grab rails or ramps outside and over 90% had grab rails inside, a very much higher proportion than in either bungalows or flats. No house had specially widened doors.

Key items of assistive technology for helping with bathing and toileting include showers, raised toilet seats and frames. Showers over the bath were sometimes installed even though an individual’s disability might well soon prevent them from using it. Respondents liked both the simplicity and reliability of level access showers.

The AT for safety and security included community alarms, smoke detectors and other forms of environmental alarm, some of which were at the innovatory end of AT – fall detectors, flood detectors and movement detectors. Overall 72% of respondents had a community alarm – 77% of those living in specially designed older people’s accommodation, 48% in mainstream housing. All were quite clear about how their community alarm worked and approximately half had used them in an emergency, mainly because of a fall or a heart attack, but there was a good deal of resistance to wearing pendant alarms.

Virtually all in sheltered housing and 85% of those living alone had a smoke alarm. Those without were in the older age range. Smoke alarms had very rarely gone off in an emergency. The most frequent comment about them was that they were over-sensitive:

43% of respondents had a door entry phone. Nearly half of these were in mainstream housing, reflecting their use in blocks of flats. Experience with a newly installed video entry and door opening system was largely positive with a strong feeling that it provided much valued security.

Although 95% of respondents used a remote control for their television and a number of people used it for the video recorder or for their radio, no one had a remote control for any other function. 45% of respondents had either raised sockets or lowered light switches or both. These adaptations were more likely to be found in sheltered housing.

43% of respondents had lever taps in their homes, but they were not necessarily installed in both kitchen and bathroom. Most people liked them. Twelve people had had some changes made to the kitchen and eleven of these were in sheltered housing.

Existing research together with the analysis of the interview data has led to a model for explaining the acceptability of AT to older people shown in Table 9. Eight possible benefits were identified in the research:
Table 9 Acceptability of AT to older people

<table>
<thead>
<tr>
<th>Effective use and benefits of AT depends on</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. A felt need for assistance arising from the interaction of user factors with the environment</td>
</tr>
<tr>
<td>User Factors</td>
</tr>
<tr>
<td>health and disability, living arrangements, carer needs/status, and personal motivations and preferences</td>
</tr>
<tr>
<td>2. Quality of AT Mediated by dependent on</td>
</tr>
<tr>
<td>information &amp; advice and the capacity to pay</td>
</tr>
<tr>
<td>operational efficiency, reliability, simplicity, safety, design, and back-up, in the form of maintenance</td>
</tr>
<tr>
<td>3. Access to assistance depending chiefly on</td>
</tr>
<tr>
<td>Information &amp; advice and the capacity to pay</td>
</tr>
<tr>
<td>readily accessible and addressing “whole needs”</td>
</tr>
</tbody>
</table>

Assistive technology:

1. assists in performance of everyday activities – enabling people to be independent, to manage;
2. assists a carer, both formal and informal;
3. assists in promoting a sense of safety or security;
4. assists as a substitute for formal or informal care;
5. assists in preventing accidents;
6. assists in promoting quality of life;
7. assists in enabling people to remain in their home;
8. assists other family members in their own right.

A TOOL FOR MATCHING PEOPLE, AT AND BUILDINGS

In this project social gerontologists have investigated the relationship between older people and AT and suggested a model for acceptability, building surveyors and occupational therapists have investigated the relationship between buildings and AT and developed a systematic method for auditing properties with respect to installation of AT (a prototype “expert system” to guide prescribers has been prepared). Rehabilitation engineers have completed the analysis by creating a systematic link between person, property and AT.

The seven domains used to describe an individual’s disability in the User Profiles (see page 4) were scored using the World Health Organisation recommendations in the International Classification of Function (ICF), see Table 10 and the profile example on page 4. A person with multiple disabilities is scored with non-zero values in several of the seven domains.

The same scoring system can be used to describe AT, in which case the score represents the level of disability at which the item of AT can help (is indicated). The same item of AT may have scores for contra-indication. Thus a user-controlled powered wheelchair, for example, might have a mobility indicator score of 3 but also a vision contra-indicator score of -3—it would be inappropriate to prescribe the wheelchair for someone with very poor vision. Each item of AT is scored with a set of seven indicator and seven contra-indicator values.

To score the suitability of an item of AT for an individual, the personal disability and AT indication and contra-indication for each

Table 10 Disability scoring scheme in ICF

<table>
<thead>
<tr>
<th>Level of problem</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>None: a problem that is absent or negligible</td>
</tr>
<tr>
<td>1</td>
<td>Mild: a problem described as slight or low that is present less than 25% of the time with an intensity a person can tolerate, and which happens rarely over the last 30 days.</td>
</tr>
<tr>
<td>2</td>
<td>Moderate: a problem described as medium or fair that is present less than 50% of the time with an intensity that is interfering in the person’s day-to-day life, and which happens occasionally over the last 30 days.</td>
</tr>
<tr>
<td>3</td>
<td>Severe: a problem described as high or extreme that is present more than 50% of the time with an intensity that is partially disrupting the persons day-to-day life, and which happens frequently over the last 30 days.</td>
</tr>
<tr>
<td>4</td>
<td>Complete: a problem described as total that is present more than 95% of the time with an intensity that is totally disrupting the persons day-to-day life, and which happens every day over the last 30 days.</td>
</tr>
<tr>
<td>8</td>
<td>Not specified</td>
</tr>
<tr>
<td>9</td>
<td>Not applicable</td>
</tr>
</tbody>
</table>
domain are multiplied and then summed with the other products over all domains. Selection of items of AT is then a matter of ranking their scores.

The success of this scheme depends on accurate scoring of the person in the seven domains. However it is not easy to find simple questions that address just one domain. The solution is to score the likely contribution of each domain to a set of practical questions. For example, the answer to the question “Does the person go shopping without help” might be considered to be influenced 30% by mobility, 10% by dexterity, 10% by hearing, 20% by seeing, 30% by reaching and stretching, but not influenced by continence or personal care. By scoring the answers to several such questions on the ICF 0–4 scale and weighting by the matrix of estimated domain contributions a personal profile can quickly be built in terms of ICF scores in the seven disability domains. A suitable set of ten questions has been adopted from the questionnaire created for the user acceptability study.

To validate this method, the 14 profiles were scored and a recommended list of AT produced. With the provisional matrix parameters, the algorithm predicted all the AT or equivalent items that the experts had identified and also some further items which the experts subsequently acknowledged they had missed.

Table 11 Scores for building adaptability to an item of AT

<table>
<thead>
<tr>
<th>Level</th>
<th>Scope of intrusion</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>No adaptation required. Device set down and plugged in where necessary.</td>
<td>Large button telephone</td>
</tr>
<tr>
<td>1</td>
<td>Provision of facilities and appliances common to all types and in any location</td>
<td>Taps, windows and fastenings, handrails, switches and sockets, decorating to provide suitable contrast etc.</td>
</tr>
<tr>
<td>2</td>
<td>Level 1 plus minor structural or layout changes.</td>
<td>Stairlifts, movement of (or openings in) partitions for wheelchair access/turning circles within room, bath lifts etc.</td>
</tr>
<tr>
<td>3</td>
<td>Levels 1 and 2 plus suitability of type/structure to undertake major costly structural or layout changes or extensions.</td>
<td>Removal of load bearing walls, provision of downstairs toilet and bathroom facilities, extensions to the building etc.</td>
</tr>
<tr>
<td>4</td>
<td>Adaptation not possible</td>
<td>Planning restrictions, unsuitable geology</td>
</tr>
</tbody>
</table>

In the spirit that a person is matched to AT, a building may be matched to an item of AT in terms of the difficulty of installation. A provisional scoring system is shown in Table 11. For each item of AT, each level of building adaptability has been allocated an indicative cost. A new building may then be characterised by a set of levels of difficulty, one for each item of AT, from which the overall cost of providing a chosen set of AT can be computed.

These algorithms have been implemented in a database. Work is currently underway to validate this tool with a larger set of potential AT users and prescribers and a link to the building audit expert system, creating a complete, rapid advisory system to help optimise the match of person to AT and AT to place.

**SOME LESSONS FROM THE NETHERLANDS**

The project set up collaboration with the Netherlands to learn about the use of assistive technology from a country where its creative use was apparently well established, and to learn from a well organised network of Dutch older people who gave advice to policy makers (see Tinker, McCreadie, and Lansley, 2003).

In the Netherlands there is more pressure for older people to stay in homes of their own as there is a higher proportion of older people in residential care. Rather over half of the municipalities have a “senior council” representing the local branches of the three main pensioners’ national and welfare organizations. But, as in the UK, there is a confusing system with a variety of funding agencies involved and it appears that an older or disabled person needs to be assertive and wait a considerable length of time for the provision of AT.

As in the UK, older people appeared to hold contrasting attitudes to technology: some like every gadget they can get, others prefer human help wherever possible. A clear finding was the need for guidance about the use of AT. There is a need to explain to older people what the AT is and how it works.
A number of technical observations were made: for example that stair-lifts have been produced for Dutch housing that has extremely steep, narrow and winding staircases. As in the UK, use of smart AT (“domotics”) in housing for older people is still very much at an experimental stage. Some sophisticated examples impressed. One view was that AT needs to be introduced before people are too old, when it will be more difficult to learn new and quite complex procedures, in order to provide benefits through monitoring and alarm systems in later years. “Domotics” needs to be regarded as an investment for the future, rather than a cost-effective solution at installation.
COSTS

Detailed calculations were undertaken to examine the implications of introducing three packages of both fixed and portable AT over the estimated lifetime of the hypothetical users, and allowing for different property types. The three AT packages were:

1. **Basic** – those items that a user would require in order to remain in their own home, regardless of the care services provided.
2. **Augmented** – in addition to the Basic AT those items which would reduce the need for care services, for example, the provision of a level access shower would enable some users to bathe themselves and so obviate the need for a carer-assisted bathing.
3. **Maximum** – in addition to the Augmented AT those items that would improve quality of life of the user but with no reduction in care services. This is the most comprehensive package.

Two packages of formal care services (home care, community nursing, day care and meals) were estimated for each User Profile. The two formal care packages were:

1. **Full** – appropriate when combined with the Basic AT package or, for illustrative purposes, without any AT.
2. **Reduced** – appropriate when combined with the Augmented or Maximum AT packages.

The estimate of formal care required depended on three assumptions about informal care. The first assumed that a co-resident carer undertook all domestic and personal care tasks; the second that a non-resident carer only undertook domestic care tasks; the third that there was no informal carer input. An estimate also had to be made of the life expectation of the users, in order to discount the costs over time. Two assumptions were used in the calculations: (i) that the user’s life expectation is three quarters of the current life expectation of that age group; (ii) that it is the same as the current life expectation. Thirteen of the 21 situations (seven user profiles at two points in time with three different assumptions about informal care) were considered for each of the different packages of formal care and levels of AT. Because the informal care available for the remaining eight situations obviated the need for any formal care services they were not considered further.

Table 12 illustrates the results for User Profile 4 (see Box on page 4 and Table 1). It was judged that this user would only need formal care services if they were without any informal care. Two different property groups are shown – bungalows and ground floor flats, and houses. The cost estimates vary quite considerably between property types, and are sensitive to the assumption about life expectation.

**Table 12 Initial comparison of Assistive Technology and Formal Care Service Costs for User Profile 4 (age 78) with no carer in two different property types. No informal care.**

<table>
<thead>
<tr>
<th></th>
<th>With Maximum AT:</th>
<th>Without any AT:</th>
<th>Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Fixed AT, £</td>
<td>Portable AT, £</td>
<td>Formal care, £</td>
</tr>
<tr>
<td><strong>Assuming a projected lifetime of 7.4 years.</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bungalows and ground floor flats</td>
<td>6494</td>
<td>2330</td>
<td>3073</td>
</tr>
<tr>
<td>Houses</td>
<td>11065</td>
<td>2330</td>
<td>3073</td>
</tr>
<tr>
<td><strong>Assuming “normal” life expectation of 9.9 years.</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bungalows and ground floor flats</td>
<td>6560</td>
<td>2653</td>
<td>6016</td>
</tr>
<tr>
<td>Houses</td>
<td>11642</td>
<td>2653</td>
<td>6016</td>
</tr>
</tbody>
</table>

Table 12 shows the initial comparisons, which compared Maximum AT with no AT at all. The conclusion was that total costs are higher for Maximum AT plus Reduced formal care services alone than for Full formal care alone. However, this is an unrealistic assumption as it is very unlikely that the user would be able to remain in their home without any AT. Also it may be unrealistic to cost the Maximum package of AT as the user may not want all the specified items. Table 13 shows a second, and more realistic,
comparison. This is between Augmented AT plus Reduced formal care services and Basic AT plus Full care services. In both cases the illustrations give average costs and include Portable AT (e.g. wheelchairs, rollators) much of which might be supplied through private or other funds, whether or not the fixed AT was provided. Moreover, no allowance has been made for benefits in terms of improved quality of life, reduction in accidents, or reduced claims on other services e.g. visits to GPs.

**Table 13 Second (more realistic) comparison of Assistive Technology and Formal Care Service Costs for User Profile 4 (age 78) with no carer in two different property types. No informal care.**

<table>
<thead>
<tr>
<th></th>
<th>Fixed AT, £</th>
<th>Portable AT, £</th>
<th>Formal care, £</th>
<th>Total, £</th>
<th>Fixed AT, £</th>
<th>Portable AT, £</th>
<th>Formal care, £</th>
<th>Total, £</th>
<th>Difference, £</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Assuming a projected lifetime of 7.4 years.</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bungalows and ground floor flats</td>
<td>2744</td>
<td>1524</td>
<td>3073</td>
<td>7341</td>
<td>962</td>
<td>398</td>
<td>9616</td>
<td>10976</td>
<td>+3635</td>
</tr>
<tr>
<td>Houses</td>
<td>3562</td>
<td>1524</td>
<td>3073</td>
<td>8159</td>
<td>1455</td>
<td>398</td>
<td>9616</td>
<td>11469</td>
<td>+2310</td>
</tr>
<tr>
<td><strong>Assuming “normal” life expectation of 9.9 years.</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bungalows and ground floor flats</td>
<td>2753</td>
<td>1747</td>
<td>6016</td>
<td>10516</td>
<td>971</td>
<td>456</td>
<td>18823</td>
<td>20250</td>
<td>+9734</td>
</tr>
<tr>
<td>Houses</td>
<td>3597</td>
<td>1747</td>
<td>6016</td>
<td>11360</td>
<td>1490</td>
<td>456</td>
<td>18823</td>
<td>20769</td>
<td>+9409</td>
</tr>
</tbody>
</table>

The results are sensitive to assumptions made about formal care. Maximum costs will be incurred where there is no informal care and minimum costs where there is a co-resident carer. This is because of the assumption that the co-resident carer undertakes all personal care tasks, and therefore the input of formal care services is reduced substantially. However maximum savings are not always where there is no informal care; it depends on the needs of the users. So, for example, maximum savings may be achieved when there is a co-resident carer or a non-resident carer. In cases where they exist there are likely to be benefits for the informal carer but the analysis has not taken account of these.

When considering normal life expectation (and leaving aside differences between property types) in 12 of the 13 situations the packages of Augmented AT with Reduced care were found to cost less than the packages of Basic AT with Full care and in 11 situations the packages of Maximum AT with Reduced care cost less than the Basic AT and Full care. In the case of reduced life expectation, nine situations showed lower costs when Augmented AT with Reduced care was compared with Basic AT with Full care, and six situations had lower costs for Maximum AT with Reduced care compared with Basic AT with Full care. In some cases the savings were considerable.

Further analysis showed that the additional cost of the care-reducing AT (needed to achieve the Augmented package) was usually recouped through lower care costs within between one and three years and that the cost of the good-practice AT (needed for the Maximum Package) was usually recouped within two to four years. The difference in property types could have a substantial impact on the cost differences sufficient to accelerate or delay by up to two years the achievement of the point where the costs of different packages broke even.

The potential of AT can be put into perspective by a crude comparison with the cost of a care home place, at an estimated cost of £459 weekly (Laing, 2002, *Calculating a fair price for care*). This price, although higher than many local authorities pay, is compatible with long-term stability of the private care home sector. Three months in a care home would cost £5500.
CONCLUSIONS

Buildings
• The extent of adaptation required of buildings in order to accommodate a user’s needs varies greatly. However the main factors that influence the extent of adaptation are related to mobility.
• As user needs become more extensive and complex, so the costs of adaptation rise and more properties are encountered which cannot be adapted to meet user needs.
• The degree of adaptability of buildings is largely dependent on their design and configuration.
• The most adaptable property types are ground floor flats and bungalows. The least adaptable are flats in converted houses and maisonettes in high-rise blocks.
• The single most important factor affecting adaptability is the number of storeys within a property, particularly where users need to use a wheelchair inside the home.
• The cost of adaptations varies considerably, between different types of adaptation, between property types, and within property types.
• Some of the Partner housing providers had properties that were impossible to adapt, others had properties that were easily adapted to meet quite extensive and complex needs, whilst others could achieve a high level of adaptability only through incurring very significant costs.
• The development of user profiles has enabled quantitative analysis of combinations of AT and buildings.
• The methodology has generated data that has both face validity and is capable of analysis and interpretation.

Assistive technology
• There is confusion about terminology of AT.
• Users need information about opportunities for AT. Information is in the wrong place, described using the wrong terminology, and with wrong or unhelpful associations (“disability”). It is not clear who pays or how to obtain AT.
• Information is needed for both housing providers and staff. AT advisers require interdisciplinary skills.
• There are not enough builders in some areas to install and maintain AT.
• Providers and assessors need to take a holistic view of the older person’s needs. AT appeared to be installed as a response to particular health problems while little thought was given to other disabilities.
• Thinking through the full needs of the person will lead to more effective AT provision.
• It is no use installing AT unless people feel they need it. On the other hand, if they do not know about it, they will not even be able to consider whether they feel they need it!
• A number of positive developments are occurring at national level. All agencies need to think about AT as integral to community care packages and not just a response to a particular personal need.
• There is a danger of the latest AT being seen as different instead widening existing opportunities. The idea of the “smart house” and of alarm technology needs to be demystified.
• There are inadequate national statistics on AT.
Older people

- There were considerable variations in AT provision between respondents
- There is need to listen to older people. They are quite clear about their needs, but very much less clear about what AT is there to help them, how they can access it and what they have to pay.
- Older people want to be able to control as many day-to-day routine activities as possible and AT can help them in this.
- Older people welcome AT when it addresses a FELT need
- Older people have variable access to AT and therefore variable help from AT. They often have unmet needs.
- Installation of AT is not usually a problem, but the on-going reliable operation of the AT is essential (McCreadie, 2004).

Costs

For most profiles the total costs over the lifetime and reduced lifetime of the hypothetical users were lower for the realistic scenario of Augmented AT plus Reduced care services than for Basic AT plus Full care services. Even when Maximum AT plus Reduced care services was considered this was the case for normal life expectancy although when reduced life expectancy was considered the number of profiles for which there was a saving and those for which there was not was balanced, such that on average the costs were no greater. That is to say taking the most conservative of assumptions, the savings on costs of care services made possible by AT were no greater than the cost of the AT when the costs of installation and the supply of portable AT were taken into account. However, more realistic assumptions show substantial savings; even more so if related to the cost of institutional care. Account has not been taken of the other benefits which would accrue from the provision of AT, in terms of the prevention of falls and improved quality of life.

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REFERENCES


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