Department of Health

Chronically Sick and Disabled Persons Act 1970

Research and Development Work Relating to Assistive Technology 2005-06

Presented pursuant to c.44 1970 Section 22

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Introduction

Over the past year there have been several policy initiatives which will impact significantly on the future development of assistive technology. These initiatives focus on the challenge of an ageing population and how choice in health and social care can be delivered in the community. The research projects highlighted in this report indicate the potential for assistive technology to play its part in addressing these challenges. All were funded by the Government or the European Union and commenced or reported final results in financial year 2005-2006.

Full details of research and development projects in assistive technology funded by Government are available on the Foundation for Assistive Technology (FAST) website (www.fastuk.org), together with information on research funded by commercial and voluntary sector organisations. FAST also provide information on events and conferences in the field of AT.

Assistive technology services – providing care at home

In January 2006 the Government published its White Paper on health and social care outside hospital 'Our health, our care, our say: a new direction for community services'. The White Paper recognises the importance of assistive technology in supporting people to live safely in their homes and highlights the potential of telecare and telehealth services.

Assistive technology clearly has a role to play in delivering personalised care in the community, supporting the management of long term conditions and helping prevent emergency admission to hospital. Local councils with social services responsibilities started to roll out telecare services from April 2006.. In February 2006 the Department of Health announced how the £80 million Preventative Technologies Grant is to be divided up amongst local authorities over the next two years, as part of its efforts to help older people stay in their own homes for as long as possible. Work to establish the effectiveness of remote monitoring will be carried out over the next two years.

The White Paper also highlights the 'Partnerships for Older People Projects' (POPP) initiative which is providing £60 million funding to council-based partnerships over 2006 and 2007 to evaluate innovative and preventative approaches in services for older people. In December 2005 the Department of Health announced the winners in the first round of projects which include development of assistive technology and telecare services, speedier provision of equipment, home safety checks and falls prevention.

The White Paper noted the need to build the evidence base for community services and this is likely to result in an increased focus on evaluation of a wide range of assistive technology. Evaluations completed over 2005-6 can be found at the end of this report.

Assistive technology is also likely to play a significant part in supporting proposals by the Department of Work and Pensions contained in the Green Paper on Welfare Reform and Incapacity Benefit. The Paper emphasises the need to support the capacity to work of disabled people and those with ill health and assistive technology is likely to play a significant role in bringing this about.

Developments in assistive technology research and development policy and implementation

The National Institute for Health Research (NIHR) was launched on 1st April 2006 as part of the new national health research strategy 'Best Research for Best Health'. The aim of the virtual institute is to establish the NHS as an internationally recognised centre of research excellence by providing support to individuals, improving research facilities, and by conducting leading-edge research focused on the needs of patients and the public. The Institute will provide the framework through which the NHS in England will position, manage and maintain their research, research staff and infrastructure.

Government initiatives specifically aimed at supporting the introduction of new technologies in health and social care services include development of the NHS Institute for Innovation and Improvement. The Institute was launched in July 2005 to bring together expertise in technology and product innovation and service transformation in the NHS, taking over the work in this area from the Modernisation Agency and the NHS University (NHSU).

NHS Innovations consists of a network of regional innovation centres known as NHS Innovation Hubs, set up by the Department of Health and co-funded by the Department of Trade and Industry and the Regional Development Agencies. Working with regional partners in universities, research organisations and the commercial sector, the Hubs support NHS inventors to develop innovative ideas for improved medical equipment and services.

Independent living for older people

Bathing

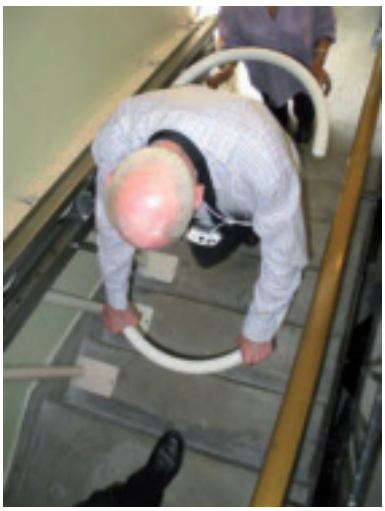
Many older people are worried about falling or slipping while taking a bath or shower and yet may be reluctant to install a specially adapted equipment with appropriate safety features. Some of that reluctance may be due to concerns that most adapted baths look very functional. The Department of Trade and Industry SMART award provided funding for Kingkraft Limited to produce the 'Lifestyle Bath', a bath which is functionally useful but also aesthetically pleasing. Development work ended in November 2005 and final production specification is currently being pursued.

Climbing stairs

Climbing stairs can be a major problem for older people with 10% of those over 65 reporting that they need help or cannot manage stairs by themselves. This has a significant impact on the quality of life of older people, increases carer support costs, and increases the likelihood of admission to hospital as a result of a fall.

Difficulty negotiating stairs is also a problem for older people who want to remain in their own homes since reduced strength and balance may make going upstairs hazardous. Stairlifts provide a potential solution, but they can be expensive and impractical to fit. Older people who experience difficulties sometimes continue climbing stairs unaided as they do not wish to be dependent on carers for assistance. Various types of stair climbing aids have been developed, but few take into account the requirements of people with a weak grip, provide appropriate support for descending stairs or allow easy installation and removal.

The Centre of Rehabilitation Engineering at Kings College London is working in partnership with Stannah Stairlifts, Harding Industrial Design and the London Borough of Hammersmith and Fulham to develop the 'stairWalker'. This is designed to be a cheap device that is easy to install and remove and which encourages stair climbing using the older person's own muscle power. It employs adjustable ascent and descent handles in different positions, depending on the height of the individual and whether they are climbing or descending stairs.



The project team, funded by the Health Technology Devices (HTD) programme between March 2004 and October 2005, have produced a working prototype which was tested in real life situations. Evaluation of the prototype included interviews with users, healthcare professionals and local authority housing providers. To ensure that the stairWalker encourages safe stair use, there was a biomechanical analysis of the way in which users climb stairs. The stairWalker has now been patented and the team aim to develop a commercial product.

Support for dementia in older age

The long-term effects of dementia affect an individual's cognitive, social and functional abilities. This can be stressful for individuals with dementia and for their family and carers, who have to find ways to cope with this progressive condition. Assistive technology, ranging from simple low-tech solutions to more complex telecare systems, can provide support for people with dementia and their carers, but many individuals are not aware of the potential of assistive technology to help. People with dementia, carers and professionals often have difficulty finding up-to-date and user-friendly information on what is available and how it can be accessed and used safely.

The Department of Health is funding a National Information Resource of Assistive Technologies for People with Dementia which began in September 2005 for three years. The project aims to raise the profile of cost-effective assistive technology appropriate to the needs of people with dementia. It will provide information about the application of assistive technology, publish up-to-date product information and provide guidance on the ethical implications of the use of various products. The National Information Resource will also encourage the exchange of information between users of the site and gather information on the website which will be accessible by all stakeholders – people with dementia, their carers and support professionals. The website (www.atdementia.org.uk) is currently undergoing testing and is due to go live shortly.

People with dementia and those with a range of physical and cognitive disabilities are increasingly choosing to live independently in their own homes instead of living in sheltered accommodation. MATCH (Mobilising Advanced Technologies for Care at Home) is a collaborative research project by the Universities of Dundee, Edinburgh, Glasgow and Stirling, which will look at how technology can assist people to make this choice.

Funded by SHEFC (Scottish Higher Education Funding Council) from November 2005 to October 2009, MATCH will create a Scottish centre of excellence in the field of technologies for home care. One activity will be to form a network of academic, industrial, care and housing partners that will use existing products, and establish care models for the ethical use of these technologies. MATCH intends to establish a demonstration centre as a focal point for the project to showcase project solutions and to assist in training young researchers.

CUHTec (The Centre for Usable Home Technology), based at the University of York, is being funded until October 2007 by the Engineering and Physical Sciences Research Council (EPSRC), to identify the needs of people with dementia which may be met by assistive technology. The project aims to understand the activities and problems faced in the home by people with mild to moderate dementia, through interviews with patients, caregivers and health professionals.

The research team will use this learning to design ways to support cognitive function. As an outcome of the project CUHTec intend to provide advice for manufacturers of domestic appliances about the difficulties experienced by people with mild to moderate dementia.

Extra Care Housing to support older people

A central objective of government policy to support older people is to enable them to remain in a home of their own. For older people this may be in their existing homes but for some people, the emergence of extra care housing with on-site care and support will be required. Some housing providers are therefore converting their existing sheltered housing schemes and residential care homes into extra care housing. However, there is concern that this may not be as cost effective as building new extra care schemes or installing new and emerging assistive technologies. One problem that they face is that no research has been previously undertaken on the technical issues involved and the potential benefits and outcomes of these conversions.

The Institute of Gerontology at King's College London and the Bartlett School of Graduate Studies at University College London are reviewing how local authorities and housing associations are remodelling their residential care homes and sheltered housing into extra care housing for older people. The study, funded by EPSRC for two years from May 2005 and supported by the Housing Learning & Improvement Network in the Care Services Improvement Partnership, is undertaking ten case studies of remodelled extra care schemes. An interdisciplinary team of architects, a rehabilitation engineer, an economist and social scientists are exploring issues arising from remodelling and seeking to establish the success of various approaches to conversion.

Architects and other construction professionals are being interviewed to understand the design decision-making process for each conversion. Residents, managers and care staff are being asked for their views both on the extra care approach and the remodelled building. An economist will be calculating the conversion costs of remodelling.

Telecare and telehealth assistive technologies

Pilot projects continue throughout the UK to bring much-needed evidence about the potential of telecare to support frail older people to live independently at home. The 'Going Home, Staying Home' project, supported by the Northern Ireland Housing Executive (NIHE), working in partnership with Fold Housing Association and the Foyle Health and Social Services Trust, ended in April 2005. The project was successful in providing a useful service for older people and resulted in significant learning and development for the partnership. Approximately 300 households have benefited, exceeding significantly the 25 households predicted at the start of the project. The other achievement of the pilot is the partnership developed between the NIHE, Fold Housing Association and the Foyle Health and Social Services Trust which has provided a good foundation for future joint work.

Kent County Council has been at the forefront of developments in telecare. Its project involved the piloting of telecare equipment across three district sites before wider roll-out across the county. An evaluation of the pilot was conducted in association with the Centre for Health Services Studies at the University of Kent, involving approximately 100 users, 24 carers and 15 service providers.

Stakeholders were generally positive about the pilots and felt that they had been successful in achieving the overall goals. However they emphasised the need to ensure that assessment, effective call centre monitoring and rapid response systems were in place rather than focus on the equipment. Participants found most of the equipment acceptable and did not think there was any stigma about its use. Generally users felt more secure and independent and thought the equipment had worked well in emergencies. Users were concerned about triggering the alarms accidentally but found call centre staff to be helpful and reassuring when this happened.

However, carers of people with a degree of confusion did report an increase in the frequency of call-outs. Frontline staff saw telecare as a way in which social services could enhance cost effective, independent living. They considered telecare especially helpful in reassuring clients whose confidence had been undermined by ill-health or by crime. Frontline staff felt that the pilots had benefited clients but expressed concern about the additional pressure which carers might initially experience. They also stressed the importance of getting the human elements of the system right.

For people with ill-health and long-term conditions which would benefit from closer monitoring, telemedicine approaches are being piloted with the aim of supporting independence and moving healthcare closer to home. Home monitoring systems are intended to provide end-users with feedback to give them insights into their own health and encourage self-care. The systems created can provide information to help implement integrated care pathways, which are an important part of the National Service Frameworks.

Healthcare@Home is funded by the Department of Trade and Industry's Technology Programme until summer 2007. The project will develop an integrated system for health data monitoring. Within the system, information about individual users can be recorded using physiological and clinical equipment. The project team aim to continuously monitor people in their own homes with the use of prototype wireless sensors and communications devices.

The project partnership is led by IBM, with contributions from Zarlink Semiconductor and Smart Holograms. Academic and clinical involvement will be led by the School of Computer Science and Diabetes Research Unit at Cardiff University. The research will produce a prototype demonstrator which can be used to develop future home monitoring models.

Tele-monitoring can also help to manage acute conditions which arise in client groups living in high-dependency residential care homes. A significant proportion of this client group are liable to experience 'silent' heart attacks. There are no symptoms, but the person may complain about not feeling well or may have a breathing problem. Residential homes usually have on-site staff with medical skills but may not have the means to determine the nature and severity of the illness. This uncertainty can result in unnecessary call out requests to the GP or for frail, older people experiencing long waits in Accident and Emergency units.

E-Vital, funded by the EU and developed by Brunel University, has introduced remote monitoring of vital signs in residential homes to support decisions on the management of residents with acute illness. The device allows staff to collect data which is sent to the resident's GP. The GP can remotely diagnose whether there is a problem that needs them to visit or if the resident needs hospital treatment. Although project funding ended in March 2005, the project is continuing as a service being delivered in Chorleywood in Hertfordshire and the London Borough of Newham.

Telecare on the move

Brunel University have also created a monitoring system which uses mobile phone technology to transmit information. The project was funded by the European Union's Information Society Technologies (IST) programme and aims to support people with a diagnosis of angina. This group of patients may be at significant risk of a heart attack, but often there is a delay before they can receive angioplasty treatment. They require reliable, non-intrusive health monitoring to give them warning that they are becoming ill.

Funding from the EU came to an end in 2005 but development of the system is continuing. The team at Brunel have produced a prototype which can be attached to a user's belt. Data is gathered using standard ECG leads positioned on the skin over the user's heart. If an incident of angina occurs, the device sends information using GPRS (a data service used by mobile phones) to the user's doctor or their cardiologist. They can advise the user by phone whether they need to attend hospital or if the discomfort is caused by an unrelated problem such as indigestion or other stomach upset. The use of telehealth can therefore reduce unnecessary bed use in hospitals. The doctor or cardiologist can also control the device remotely, minimising the number of visits to the doctor for resetting the device.

Telecare across Europe

Telecare systems may allow older people to be independent at home, but support is often confined to an individual's home or near environment. Across the European Union, around one in twenty of all households where people are aged 50 or over (approximately five million) are connected to a location-dependent alarm service, according to partners in the MobilAlarm project.

MobilAlarm was funded by eTEN, a European Community Programme until September 2005. The project assessed the suitability of an alarm system that will work across Europe, no matter where it is activated. This would potentially allow older people to be more independent and travel throughout the EU with a guarantee of support in an emergency. Devices and services developed in MobilAlarm were found to be suitable for this purpose. MobilAlarm project results suggest that there is a large potential market for an easy-to-activate emergency service across Europe.

Remote delivery of Assistive Technology services

Remote communication services

As well as supporting older people, telecare also has the potential to support people with a range of impairments. The Communication Aid Centre (CAC) at Frenchay Hospital in Bristol in a pilot project investigated how video conferencing equipment could be used to remotely assess communication needs. The project examined the most effective hardware and reviewed existing literature, then investigated whether assessment and training can be carried out effectively using video conferencing. Patients were assessed, trained and reviewed via a video conference at local facilities. The sessions mirrored events which usually happen face to face. The experience was rated by the patient, the local therapist, carer, relatives and the CAC therapist.

The results of the pilot revealed that 96% of the participants in the project felt that video conferencing was an effective medium for delivering a communication aid service. Based on the pilot results, CAC intends to offer video conferences as an alternative to face to face appointment for those individuals who are unable to travel to the centre due to health related issues. However, face to face appointments will continue to be held wherever possible. The project was funded by NHS Research and Development funding for two years until June 2005.

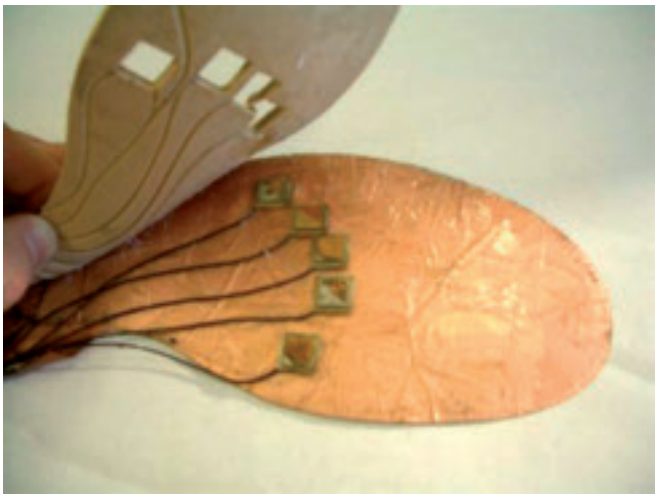
Remote prosthetic services

Clinicians prescribing footwear or prostheses and designers of these devices currently have no means of monitoring the performance of the device once fitted. This information is vital for effective treatment.

Real-PROF, a project funded by the European Union Fifth Framework Programme from January 2003 until October 2005, examined a means of remotely monitoring the performance of therapeutic footwear and lower limb prostheses. Users of therapeutic footwear include those with diabetes, for whom pressure sores can result in ulceration and, potentially, the need for amputation.

The system collects and interprets data from prostheses and footwear and transmits it to clinicians. Data collected includes: pressure; oxygen saturation; activity from a prosthesis socket; and vertical and shear forces and motion from the footwear. The data is sent over a wireless cellular network to a central server where intelligent decision support tools will help

early detection of problems. This could reduce painful ulceration and reduced mobility for the user and enable better use of targeted health care resources.



Findings from Real-PROF have been disseminated at a number of international conferences and through articles in Biomechanics journals during 2005. A range of approaches are being considered to use the learning from this project to advance amputee and footwear monitoring systems and to explore how this learning can be transferred to other health areas.

Management of long-term conditions

Technologies for continence

Approximately 3-6 million people in the UK have some degree of urinary incontinence, the risk of which increases as people get older, and which is twice as common in women as in men, particularly affecting women who have had children. In addition, many people who have mobility problems have to use incontinence products as they are unable to get to the toilet or transfer independently onto a toilet or commode.

The European Union has funded the Non-Invasive Continence Management System (NICMS) project, co-ordinated by Brunel University and University College London. Conventional solutions to continence management for women consist of using catheters or pads and both these approaches have significant drawbacks. The NICMS team has produced a prototype urine collection system for women that provides a practical, non-invasive approach.

The system consists of an interface system, such as a urinal or pad, a liquid handling system which actively draws away the urine and a rigid vacuum storage container. The liquid handling system enables the mixture of air and urine which is drawn from the urinal to be separated and for the urine to be drawn into the stored vacuum in the container. Because the device uses a stored vacuum, a very small pump can cope with the high flow rate that is characteristic of the first few seconds of urine flow.

The system including container, liquid handling system and the slim-line female urinal (detailed on the right) developed by the research team for this project.

Although the system is currently at prototype stage, it is envisaged that the leak-proof container would be available in 2 litre (all day) capacity or a 500ml version for people who are periodically able to empty the system.

The slim-line female urinal has been designed to enable it to be discretely slipped inside clothing as and when required. When urine hits the urinal a sensor is activated. This enables the system to automatically draw away the urine as quickly as it is produced, leaving the person dry and comfortable. The urinal is empty when removed so there is no danger of spillage.

The system using the urinal interface was evaluated by users. Overall, the ease of cleaning, lack of odour and ease of use were rated positively, with the urinal interface found to be easy to remove and clean, kind to skin and comfortable. Negative responses focused on the lack of reliability, and relative size, weight and noise. It should be possible to address these issues in the development from prototype to commercial product. The research team concluded that the NICMS with the urinal interface has the potential to provide an excellent toileting system for a significant group of women, reducing the requirement for carer support and increasing the user's comfort and independence.

The team has also developed a pad interface that can be used by women who are unaware of the need to urinate or who don't have sufficient manual dexterity to cope with the urinal. The small pad functions in the same way as the urinal but it is softer and comfortable enough to wear all day. A soft impermeable shell surrounds material that is soft enough to sit on but firm enough to keep the pad capacity. Preliminary user tests have shown that the pad is comfortable but that after some hours the pad tends to collapse and capacity is reduced, causing unreliability on further use. Material options are being explored.

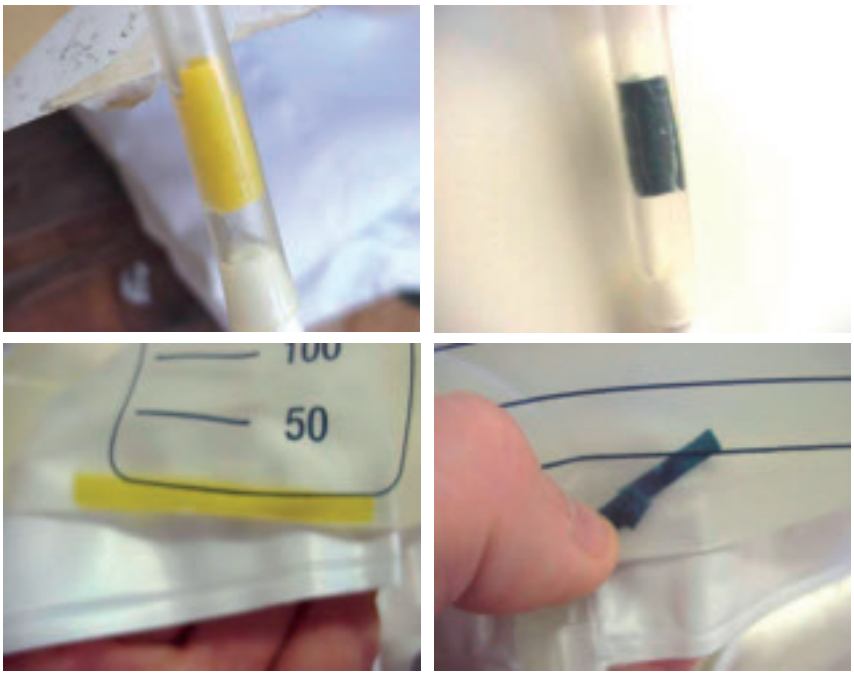
The project finished in June and results are currently being compiled for a report due shortly. The Brunel team is hoping to raise commercial money to continue pad development and produce a product design suitable for manufacture.

While Brunel University and University College London have been looking to develop a novel approach to urinary incontinence, other research teams have focused on addressing the drawbacks involved in catheter use. Many elderly and disabled patients have to undergo long-term use of catheters due either to problems with urinary continence or because of practical difficulties in getting to and accessing a conventional toilet.

Catheterisation can be complicated by encrustation and blockage of catheters, leading to lack of function, risks from infection and discomfort to the user due to the need for frequent replacement. Encrustation stems from infectious organisms, particularly *Proteus mirabilis* which colonise the catheter. The bacteria generate ammonia and the urine becomes alkaline, forming crystals which eventually block urine flow from the bladder. The problem is unpredictable and varies from person to person. Blockages can result in emergency referrals and long-term hospital stays for individuals with urinary retention. The experience can be very distressing for individuals and may lead to serious infection, septicaemia or death.

A sensor has been developed that detects, at an early stage, the formation of crystals on urinary catheters and can be incorporated into the catheter drainage system. The project was undertaken by the School of Biosciences at Cardiff University and funded by the Department of Health through the MedLINK programme.

Laboratory experiments using a model of the catheterised bladder showed that sensors gave clear simple signals by changing colour from yellow to dark blue in the presence of the *Proteus mirabilis* bacteria (see pictures on p 17). The urine bag was found to be the best location for the sensor and experiments using the models showed that strong signals could be detected at least 40 hours before the catheter blocked. Further work examining the performance of sensors in patients with long-term catheter usage will be undertaken.



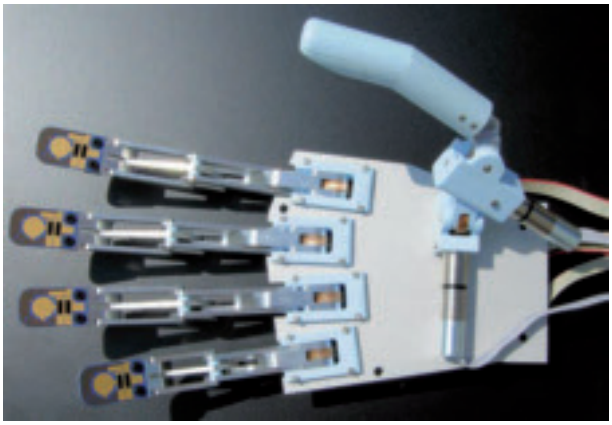
Indicator turns from yellow to blue to show the presence of bacteria, at such a small size the indicator could be used in various parts of the system, but was shown to be most effective when placed in the urine bag.

The BioMed Health Technology Co-operative (HTC) was set up in April 2005 with funding for three years from the Department of Health's Health Technology Devices (HTD) Programme. The HTC's purpose is to accelerate the development of new technologies and treatments for people with urinary incontinence. The programme aims to achieve its objectives by encouraging collaboration and consultation between users of continence devices, their carers, industrial partners, researchers and healthcare providers.

Environment-sensing assistive technologies

Smart prosthetics

Dynamic prosthetic arms use sophisticated electronics which work by being directly controlled by the nerve and muscle systems in the upper arm or shoulder. A user tenses their arm muscle, sensors detect the muscle current and the signal is transmitted to an artificial hand. The hand reacts by opening or closing the fingers enabling the user to carry out a wide range of daily activities. One problem has been to develop increased control over the hand function so that the grip is neither too strong nor too weak. One artificial hand under development, the Southampton Hand, is designed to be 'intelligent', using sensors, electronics and microprocessor technology to allow the prosthetic hand to maintain an effective grip.



The Engineering and Physical Sciences Research Council (EPSRC) contributed funding for three years until December 2005, allowing the Southampton Hand to be developed to allow force sensors to be added to the finger, thumb and palm surfaces. The chosen technology for the sensors is called 'thick-film fabrication'. This allows multiple robust and compact types of sensor to be added to the fingers at a relatively low-cost. Two types of prototype sensor have been developed and evaluated. Each array has been designed in the shape of a fingertip. Forces have been reliably detected by the sensors and the slip sensors have shown the potential to detect the vibration of an object as it slips from a grasp. Research results have been presented at international conferences in Portugal, Italy and Canada. Results have also been published in the scientific press, including New Scientist, The Institute of Electrical Engineers and Electronics (IEEE) Review and by the Institute of Physics Publishing.

Technology to assist learning and communication

Hearing to enable communication

A study, funded by the Chief Scientist's Office (Scotland) and undertaken by the Department of Experimental Psychology at the University of Cambridge, examined the process by which profoundly hearing-impaired children recognise speech and different sounds. Fifteen children between seven and fifteen years of age with severe and profound hearing loss were fitted with high-power hearing aids. Three different strategies relating to how the hearing aids processed sounds were evaluated. The children wore hearing aids programmed with each of the processing strategies, in turn, for at least one week. After using a particular strategy, speech perception tests were carried out. Results from the study indicate that children with severe and profound hearing loss do benefit more from some processing strategies than from others. This has implications for the establishment of good practice.

Supporting life-skill development for people with learning disabilities

Formed in October 2001 as part of the European Social Fund's Equal Initiative, the Portland Partnership introduced new ideas for hardware and software to be used within the adult learning environment. The project worked with a range of learners to develop ways in which they can access, use and apply Information Learning Technology (ILT). Through extensive learner and practitioner consultation, the project aimed to produce a package of accessible and appropriate ILT-based material that enables learners to benefit from tailored education, regardless of their impairment or learning style.

The Portland Project produced a Virtual Learning Environment (VLE) which was tested in April 2006. The VLE developers are considering its mainstream use in the future for supporting non-English speakers and also for older people who would like a simple internet access method.

A further project looking at the benefits of assistive technology for people with a learning disability is TATE (Through Assistive Technology to Employment). TATE began in May 2005 and will run for 30 months. This EU-funded partnership aims to assess where assistive technology can help to empower individuals with learning disabilities and enhance their employability. TATE will develop an assessment tool to identify barriers to gaining employment and look at whether the use of assistive technology can remove some of those barriers experienced by people with learning disabilities.

TATE will also develop accredited training for people with a learning disability in the skills needed to gain employment, including the use of assistive technology. The project intends to test assistive technology systems within different housing environments and develop software to develop life skills. TATE will continue to develop an existing support website for people with learning disabilities.

Project @pple, funded by the Economic and Social Research Council and the Department of Trade and Industry through the PACCIT initiative, from January 2004 to December 2005, investigated how people with cognitive disabilities could access and participate in virtual learning environments. Project @pple aimed to produce a media-rich online application so that young people with learning difficulties could create multimedia 'passports' which communicate their identities, hobbies and preferences. These passports will then be used as a form of self-advocacy by the young people so that they can participate in decisions about their futures – decisions from they are often excluded, because of their difficulties with spoken and written language.

Work with young people at two sites was undertaken. The research team at the RIX Centre, University of East London, has developed ways of engaging with young people with considerable language and cognitive difficulties. The project has developed a new approach to the evaluation of multimedia use by people with learning disabilities. Trials of the prototype virtual learning environment succeeded in engaging young people in evaluation. The challenges of working with this learner group required the research team to produce new approaches to computer access that could have implications beyond the project.

Tactile communication for education

A visually impaired student has no equivalent to a traditional pen-and-paper method, particularly in mathematics and it can take them much longer to complete homework. It is easy for them to become lost or confused on the page in the middle of an equation. A solution is to use a 'talking' electronic calculator for problems too difficult to be solved by mental arithmetic. These are widely available, from those with a simple tactile numeric keypad, to software graphics calculators. Some calculators have enlarged print and displays for users with residual vision. However, students are discouraged from relying too much on calculators. This is because no record is kept of any working and teachers cannot identify if wrong answers are due to a lack of understanding or simply that the student has pressed the wrong button.

The Department of Electronics & Electrical Engineering at University of Glasgow developed an electronic abacus for the visually impaired. The project, funded by EPSRC, also investigated the use of the abacus as a stand-alone device or as part of a larger computer-based system.

The abacus was developed with the participation of potential users from the outset. After the prototyping stage there were usability tests and comparisons with other methods of calculation. A number of usability problems were identified after the first testing session, but the modifications improved users' performance. Participants in trials were not as quick or as accurate using the abacus system as with a calculator, but this was after less than two hours training with the system. It would be expected that speed and accuracy would improve over time. The majority of users enjoyed participating in the project, although there was divided opinion from users over whether they would use the abacus long-term. While some have really taken to it quickly, others would rather use their existing calculator.

Rehabilitation

Rehabilitation using virtual reality

A stroke occurs when the blood supply to part of the brain is cut off. This causes damage to the brain which can affect the body physically but can also affect cognition, learning and emotional states. Everyday activities, easily undertaken before a stroke, can suddenly become difficult or impossible to achieve. Over 150,000 people each year in the UK are affected by a stroke. The Stroke Association note that more than 250,000 people live with disabilities caused by stroke. Rehabilitation to regain lost skills or learn new ways of doing daily tasks to encourage independence is therefore of great importance.

One of the most common and socially significant activities in daily life is making hot drinks. Although this may appear to be an easy task, it is in fact cognitively demanding and can become difficult for some individuals following a stroke.

The Division of Rehabilitation and Ageing at the University of Nottingham was funded by the Chief Scientist's Office (Scotland) and the Stroke Association in an evaluation of the use of virtual environments for stroke rehabilitation. The research programme developed a virtual rehabilitation environment to be used to regain the ability to make hot drinks safely and effectively after stroke.

To the user, the virtual rehabilitation environment presents a set of objects used in making a hot drink (cup, milk, kettle, etc) on a normal computer screen. The computer gives instructions to the patient to use the objects as required and, if they are successfully manipulated, a 'virtual' hot drink is made, and shown on the computer screen. Users do not need to use a computer keyboard; they interface with the virtual environment by moving real objects which are either seen using a digital camera, or 'felt' by electronic sensors.

50 patients in a stroke unit were assessed during rehabilitation on their real-world performance in making a hot drink. This was compared to their use of the virtual environment by using various measures of motor and cognitive function. Results demonstrated a relationship between real-world performance and performance within the virtual environment. This supported the research team's proposal that using a virtual environment gave valuable information that can contribute to an assessment of an individual's ability. The virtual environment highlighted a variety of cognitive processes and personal skills that influence the ability to make a hot drink. Further work is being undertaken to evaluate whether the virtual environment can be used as effective learning tool.

Rehabilitation using computer games

Accident, stroke and disability can cause individuals to have problems with control of posture. A project looked at the impact of cognitive-motor interference (CMI) on the assessment and rehabilitation of cognitive-motor skills following stroke. CMI is the interference caused by doing one task when performing another task, for example trying to have a telephone conversation while driving a car. CMI has an effect on postural recovery where individuals have to relearn their sitting balance. The research team at the School of Psychology at the University of Reading showed that interference between tasks is greater for people who have brain injuries. They also found that when an individual is recovering from stroke, there is a negative impact on their postural control when they are speaking or thinking.

Conventional exercises to recover posture might be regarded as repetitive and demotivating. Phase 2 of the project developed and evaluated a low-cost, entertaining method for re-training balance. A pressure sensitive mat with pneumatic sensor pads was developed. The mat has a USB connector which can be plugged into a computer. Windows 2000/XP sees the mat as a plug and play joystick. The mat "joystick" is placed on a flat surface and the user sits on the mat. The mat senses the centre of balance while the user is seated and they can play computer games by shifting their posture. This helps to provide guided re-learning of postural tasks.

The pressure mat can also be used for regaining standing balance. There is strong interest in the device from therapists and as result 12 devices have been built to be distributed to clinical collaborators for further pilot trials. The research was sponsored by the Engineering and Physical Sciences Research Council (EPSRC).

Rehabilitation using physical support

Provision of spinal bracing services is a costly and lengthy process, requiring multiple visits for casting, fitting and delivering the brace. Delays in this service could be reduced if new materials were available that could be cast directly onto the patient and then maintain the required rigidity for continued use as a brace. The Aspire Centre for Disability Sciences and Brunel University have developed an advanced material that is sufficiently flexible to enable it to be contoured to the body and then can be rigidly locked for use as a brace.

The project, funded by EPSRC until May 2005, has produced a material that has the potential for use in orthotic applications such as splints and spinal braces, but could also be useful for custom-made wheelchair seating, for body armour in sports and other applications where a material that can conform to different shapes is needed, but can be made rigid when required.

The material produced by the project is called FlexnLok and has been presented at the Medical Devices Technology exhibition in Birmingham, 2005 and 2006.

Electrical stimulation to enable fitness and control of function

Spinal cord injury (SCI) and various neurological conditions have an effect on the nervous system which can result in partial or complete loss of control over parts of the body. This can prevent normal exercise and secondary complications can result, including reduction in heart and lung performance, pressure sores and bone weakening. Functional Electrical Stimulation (FES) applies very low electrical currents to nerves in different parts the body to restore or assist body movement and control of functions.

Research network

Engineering and Physical Sciences Research Council (EPSRC) provided pump-prime funding for the FESNet network between November 2001 and April 2005. FESNet is a network of university, clinical and industrial centres which coordinated a range of activities. Two biennial conferences were held in 2002 and 2004 and a third conference was held in September 2006. It is intended that FESNet network activities will continue beyond the initial period of funding, primarily involving the maintenance of the FESNet website and periodic workshops and biennial conferences to continue activities involving research and commercial groups.

Funded, collaborative research projects which have emerged during the initial period include the development of a system for paraplegic cycling to improve health after spinal cord injury with involvement from University College London and the University of Glasgow. The project was funded by the EPSRC and ended in June 2006. The project measured the benefits of regular cycling using FES.

Although wheelchair sports provide beneficial exercise, its physical demands do not raise fitness to the level of sedentary non-injured people. Studies have shown that cycling via functional electrical stimulation, “FES-cycling”, can raise further the fitness levels of disabled cyclists. Previous research has been clinic-based, but this has limited the exercise time and prevented widespread use. The project intensively trained subjects at home using FES-cycling to establish whether they could cycle distances which are sufficient to be effective in raising fitness levels. The impact of this training was assessed in a health study which monitored lung and heart fitness, tissue bulk and bone thickness. These measures indicate the beneficial effect of exercise on cardiovascular fitness and on reducing the susceptibility of this client group to pressure sores and reduced bone strength.

FES-rowing provides an even higher level of beneficial exercise to people who have a spinal cord injury. The EPSRC, the Henry Smith Trust, Concept 2 and the David Tolkein Trust have funded research into FES-rowing which analysed users' increasing fitness levels.

The high point of the project was the participation of FES-rowers in mainstream sporting events. FES-rowers took part in the British Indoor Rowing Championships in 2004, the first time that individuals with paraplegia have competed on an equal basis in a national sporting event, as well as the International Indoor Rowing Championships in November 2005 and the British Indoor Rowing Championships in February 2006.

James Cracknell (UK team Captain and Gold Medal Olympian), centre, awarding Robin Gibbons and Sol Solomou medals at the Leander Club Henley-on-Thames, after their historic participation in the British Indoor Rowing Championships in 2004.

Rehabilitation supported by FES

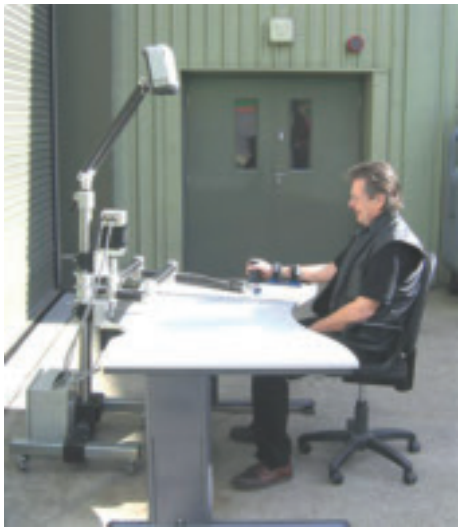
The benefit of FES for people who have had a stroke is being evaluated at the School of Health Professions and Rehabilitation Sciences at the University of Southampton. A study, that began in April 2005 for three years, will undertake a preliminary study for the re-education of arm function.

Previous research has noted that half of all the people who have experienced acute stroke and who are starting rehabilitation will have a marked impairment of function of one arm. Of this group only about 14% will regain sensory and motor function. Researchers propose that arm and hand function is more important than mobility in achieving independence following stroke.

Currently there is little evidence that conventional levels and approaches to rehabilitation are effective in improving function in this group, although intensive therapy has been shown to improve general recovery following stroke.

A team at Southampton are investigating whether training arm movements using the aid of a robot combined with using functional electrical stimulation (FES) of the arm muscles could be more effective.

The robot will adjust the level of stimulation in response to the user's movement, thereby teaching them how to move their arm. They will be asked to track a spot of light and as they move, their muscles are stimulated. If they track the target well, then on the next attempt the stimulation is turned down, if not, it is increased. Every time an adjustment is made, the effect is measured so that accuracy is continually improved. This process is called "Iterative Learning".



Development of the FES robot is nearing completion and initial studies on healthy volunteers have begun.

Tools to support inclusive design

Assistive technology can assist many people with different impairments to become independent. However, designers of equipment need to gain an insight into the difficulties people with various impairments have to overcome. Focus groups, questionnaires and the involvement of disabled and older people help designers and developers produce useful assistive technology, but it would be useful for designers to 'share' in the experiences of potential AT users.

The Department of Engineering at University of Cambridge, funded by EPSRC, is bringing on to the market a Simulation Toolkit that 'reproduces' the symptoms of physical impairments that older and disabled people may experience.

The Toolkit is intended to be used by decision-makers, designers, design educators and design students as a method of assessing product and service accessibility. The toolkit has already generated interest with designers and the project will ensure that it can be made available to the wider design and design education communities.

Technology Evaluation

Evaluation and audit of existing assistive technology

The Device Evaluation Service transferred on 1 September 2005 from the Medicines and Healthcare products Regulatory Agency to the NHS Purchasing and Supply Agency and will be known as the Centre for Evidence-based Purchasing (CEP). CEP aims to underpin purchasing decisions by providing objective evidence to support the uptake of useful, safe, innovative products and related procedures in health and social care.

All of the reports published by the Device Evaluation Service are now freely downloadable from their website (www.pasa.doh.gov.uk/evaluation/), together with information on forthcoming evaluations.

Following the reorganisation, CEP has published one evaluation report: 'Absorbent products for men with light urinary incontinence Report 05020 (May 05)'.

Evaluation of technologies to support walking and standing

Orthotic systems can help give physical support and assist in walking for people who have various difficulties in walking. Nearly all previous research has looked at the problems experienced by people who have recovered from stroke and are able to walk. The difficulties experienced by people who are currently undergoing rehabilitation following stroke are more difficult to treat.

A project, titled WEST, investigated the effects of walking sticks, foot drop splints and slider shoes on the walking ability of people undergoing rehabilitation to regain the ability to walk after a stroke. The project, funded by NHS R&D Support Funding, was undertaken by the Centre for Rehabilitation and Human Performance Research at University of Salford and South Manchester University Hospitals NHS Trust.

WEST, which ended in July 2005, found that the range of walking equipment made a significant improvement in participants' walking ability but did not treat participants' walking impairment. Participants liked using the walking equipment, found them acceptable to use and felt that they improved their walking. They were happy to use the equipment for their rehabilitation and in everyday life.

Evaluation of technologies to support posture and seating

A study at the Institute of Child Health at Great Ormond Street Hospital looked at the effectiveness of a commonly used seating system for children with cerebral palsy. The system is one that uses knee blocks which exert a backwards force at the knee to stabilise the hip and pelvis, with the aim of preventing deformity and increasing function.

The project, funded by NHS R&D Support Funding for three years to August 2005, aimed to provide evidence and guidelines to improve the practice of those who provide seating and positioning for children with cerebral palsy. Children were recruited from within Great Ormond Street Hospital for Children NHS Trust and the North Thames region. They participated in the project for six months during which they were measured once a month for their posture and seated functional movement, while sitting in their usual seating system with, and without, knee blocks.

Results reported at the Posture and Mobility Group conference suggested that the system is useful for controlling hip position, but may not be controlling or improving pelvic positioning for school-aged children with severe cerebral palsy. A further study, examining the 'Measurement of the efficacy of adaptive seating interventions for children with cerebral palsy' commenced in October 2005 and aims to develop a seating system with built-in instruments to measure the forces exerted on the bodies of children with cerebral palsy.

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