UK Focus for
Biomedical Engineering

Policy Paper

The Ageing Population: Challenges for Engineering

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Recommendations

The agenda of the research councils is such that Government funding for medical engineering is biased towards research that may only have an impact in the long-term[1]. However, while we acknowledge the importance of such research, there is an urgent agenda resulting from the demographic changes occurring in the UK. These changes are driven by the ageing population, leading to the increased dependency of a large proportion of the population on the financial, social and medical support of the community. Medical engineering has a major role to play in the provision of solutions to such problems, and in the provision of technologies to enhance the economic activity of this group.

We propose that the strategy of the research councils be modified in order to support more research in the areas that most immediately impact upon this group together with the development of appropriate technology.

The specific areas for increased funding are: surgical technology, rehabilitation devices, cardiovascular and respiratory mechanics, sensory prostheses and electronic aids for daily living. These are likely to have a large impact on the economic activity of the over 65 age group.

The research councils should address these areas with specific calls, the establishment of specific networks and collaboration with the medical charities that are particularly associated with these themes.

[1] UKCRC 2006

Executive summary
The rapid increase in the numbers of old and very old (85+) people has led to the need for a range of supporting technologies to ensure maximum mobility, independence and safety. The greatest technical need is for novel designs of sensors, high performance implantable materials and new approaches to the use of information systems accompanied by improved basic data on physical and neurological impairments. The priorities for development are suggested as follows:

1. **Mobility**

    - basic knowledge of functional impairments of older people;
    - improved accessibility and usability of personal and public transport;
    - further development of joint replacements for improved function and survival.

2. **Independence and safety**

    - basic engineering design of the built environment, domestic and other appliances;
    - “smart” homes to ensure maximum safety and independence;
    - neuroprostheses and advanced sensors for those with sensory impairments;
    - assistive and monitoring technologies.

Introduction

The rapid increase in the numbers of old and very old people forecast for the next few decades is now well acknowledged. Associated with these demographic changes is a range of issues relating to loss of physical and cognitive function that calls for solutions. These issues are being addressed by a number of engineering approaches that encompass cellular and tissue engineering research as well as applied research and development relating to assistive technology and equipment design.

This paper summarises the developments in the latter category and identifies priority areas for research and development in the short to medium term. While the document is concerned with engineering aspects, it is important to point out that any research in the arena must be highly interdisciplinary to ensure that proposed solutions are applicable to the users and that evaluation takes into account clinical, social and economic factors.

1. Ageing population: the major impairments and disorders[2]

The clinical conditions most frequently encountered in older people are stroke, Parkinson's disease, diabetes and Alzheimer's disease, all of which are likely to lead to cognitive, physical or sensory impairments. The likely impairments may be summarised as follows:

Cognitive	Dementia				
Physical	Arthritis	Falls and Fractures	Osteoporosis	Incontinence	
Sensory	Vision	Hearing	Smell	Taste	Touch/Pain

2. Loss or impairment of function as a consequence of ageing[2]

2.1 *Diseases*

Key illnesses affecting predominantly older people include Parkinson's disease (2% of those over 70) and dementia (25% of those over 85). Annually, in UK, approximately 112,000 people over 55 suffer a stroke. The social impact of this condition is particularly great because of the large number of people who survive but are left with significant motor and/or cognitive impairments.

2.2 Accidents

Many of the problems that older people experience in living their independent lives are compounded by accidents in their homes or in public areas, or involving traffic and roads. The pattern is for ever greater numbers of accidents, with the increase for the more elderly being more marked. Whilst younger people have more accidents, their ability to recover from them is much greater than for older people. The UK population aged 75 and over has almost five times the rate of accidental deaths as the total population. Falls represent the most serious risk for all accidents amongst older people, with the majority of them occurring in the home, and these being dominated by accidents involving stairs or steps.

[2] House of Lords 2005, page 35

The number of recorded non-fatal falls amongst men doubles from the 65-74 age group to the 75+ age group, whilst those for women triple[3].

3. Commercial and economic considerations[4]

The overall buying power of the over 50 age group has increased significantly in recent years. It is thus reasonable to assume that market forces are now sufficiently strong to support investment in a range of new products to maintain or promote independence. In addition, with the raising of retirement age and demographic changes, there is a need for the workplace to be kept accessible to those with impairments and disorders related to ageing.

4. Suggested priority areas

The following are identified as priority areas for relevant engineering and related interdisciplinary research. The subject areas listed in brackets after each topic refer only to the engineering contributions.

4.1 *Mobility*[5]

Driving

Mobility is central to independence and, for a large proportion of the population, is achieved by the use of private car. While many older people continue to drive (there are currently over 18,000 licence holders over the age of 90 in the UK), relatively little is known about the requirements of the older driver. In particular, there is a need for more understanding of the effects of visual impairment, increased reaction time, reduced physical strength and personal mobility.
(**automotive, control, sensors**)

Public transport

Currently, much public transport (trains and buses) is poorly accessible. Further issues identify with the need to study internal cab design to reduce the risk of injury due to braking and cornering accelerations. Improved information systems are also necessary to reduce waiting times and delays in cold and potentially unsafe places.
(**automotive, control, sensors, biomechanics, IT and communications**)

Assistive technology for personal mobility

Mobility can be maintained and enhanced by many traditional assistive devices (e.g. walking sticks, crutches, wheelchairs, motorised devices etc). While the design of such equipment is unlikely to change dramatically, there is a need to evaluate the effectiveness of different designs.
(**biomechanics, materials**)

[3] Department of Trade and Industry 2000
[4] House of Lords 2005, page 67
[5] Help the Aged 2002

Joint replacement[6]
The well documented increase in the prevalence of musculoskeletal disease with age highlights the importance of joint replacement. While the UK has been a world leader in the development of low wear total joint replacements, much remains to be done, particularly in terms of improving joint endurance in order to reduce the amount of revision surgery for patients who may have received a first joint replacement in their early 60's. Further research is also required to advance prostheses functionality.
(**musculoskeletal mechanics, materials, tribology**)

4.2 Safety and independence in the home and the community

A range of technologies must be harnessed to increase the safety and independence of the many older people who live alone.
Basic technologies and design
There is a need to devise improved packaging techniques to allow easy opening and adopt clear labelling (intelligent fridge). Many simple domestic appliances require a design review in order to identify potential improvements.
(**materials, design, sensors**)

Smart homes[7]
The "smart home" can provide a safe, monitored and responsive environment for a person who may have cognitive, physical or sensory impairments. At the most basic level it provides such facilities as central locking and automatic alarm systems. At the more advanced level it can provide intelligent appliances (cooker etc.) that respond to the needs of the user and recognise issues of forgetfulness etc. This area is in its infancy and calls for the use of a wide range of sensing and communication technologies.
(**sensors, communication, design, social studies**)

Neuroprostheses
High technology approaches to the problems of vision, hearing and smell call for the development of a new generation of neuroprostheses.
(neuroscience, nanotechnology, microelectronics, sensors)

Incontinence
Incontinence is a very common problem for older people leading to embarrassment and social exclusion. There is a need for continued research into the design of appropriate garments and catheters, as well as surgical approaches using implantable, externally controlled valves and other devices.
(materials, fluid dynamics, sensors)

Other assistive and monitoring technology
There is the possibility of introducing a range of technologies to combat loss of independence due (particularly) to sensory impairments and also to communicate critical physiological data (e.g. heart rate, blood pressure, blood glucose) to a monitoring centre. Smart clothing, using the integration of sensors into fabrics, has particular potential in this area.
Other applications can enable the provision of tele-medicine and tele-rehabilitation using haptic devices. The use of these devices for rehabilitation after stroke is still in its infancy. There is a need to develop low cost haptic systems with easy to use software to provide sophisticated rehabilitation games or exercises in the home. Such tools, by reducing disability and restoring function, have the potential to increase participation in leisure activities and so promote social interaction.

[6] House of Lords 2005, page 38
[7] Joseph Rowntree Foundation 2006

(**sensors, communication, haptics, informatics, biomechanics**)

Environmental design

The built environment is, in many ways, unsuitable for use by people with physical, cognitive or sensory impairments. While many of the weak barriers have been abolished (and replaced with ramps), much remains to be done. The use of Global Positioning Systems and mobile phone networks has the potential to make complex locations such as busy cities or airports accessible to older users. Similarly, sophisticated databases can provide all of the information necessary to use available modes of transport and access. Of particular significance in this area is the effect of allowing people to work beyond the traditional retirement age. This necessitates a new focus on workplace design taking into account the use of office technology as well as the more obvious challenges of the built environment.

(sensors, communication, navigation, informatics, biomechanics, built environment)

Conclusions

The well documented increase in the number of older people in UK (and elsewhere) calls for innovative approaches to a number of problems with significant engineering content. The major issues relate to the physical, sensory and cognitive impairments associated with the increased prevalence of stroke, Parkinson's disease, diabetes, arthritis, osteoporosis and dementia amongst older people. Engineering solutions are required for the major issues of **mobility (including transport, assistive technology and joint replacement) and safety and independence (including smart homes, provision of rehabilitation, and problems of incontinence).**

The implementation of solutions to these problems calls for the application of both traditional and new technologies. These are likely to include the following:

- sensors, communication and navigation systems to promote independent living and "smart home" developments;
- novel materials for longer life orthopaedic implants and improved solutions to problems of incontinence;
- advanced biomechanics techniques to support innovation in joint replacement design;
- telecare including haptic approaches for implementation of e-health applications to neurorehabilitation at home or in the community;
- nanotechnology for novel implantable measurement devices e.g. blood glucose sensors, and sensory prostheses.

References

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