

# 21<sup>ST</sup> CENTURY ENGINEERING FOR AN AGEING POPULATION

Institution of  
**MECHANICAL  
ENGINEERS**

**It is part of an engineer's role to ensure that the equipment and systems they develop and produce are suitable for use. In some cases this may be items of capital equipment, for example railways or aircraft, or in others widely used household equipment, such as washing machines or lawnmowers. In all cases, designs must be appropriate now to a population containing an increasingly larger proportion of older people. In 1985, 15% of the population in the UK was over 65. This rose to 17% by 2010 and is projected to reach 23% by the year 2035. It is therefore ever more important that we take age into account in our design and planning.**

The Institution recommends that:

1. Government and industry must ensure that all major contracts for public infrastructure have an earmarked budget to cater for older users and customers.
2. The UK Government's innovation agency, Innovate UK, should put out a call for bids to create state-of-the-art design initiatives for older user-friendly ideas and products.
3. Companies developing household products, vehicles or other devices for mainstream use should introduce quotas in product design teams, to include, wherever possible, a significant proportion of older people – some of whom may be retired professional engineers.
4. Standards relating to engineering products should also be reviewed to ensure that they are keeping pace with the needs of their ever-growing application to older people in the UK and the rest of the world.
5. Universities, colleges and industry should ensure that training of engineers and designers includes information about the functional abilities and restrictions of older people.

# 21<sup>ST</sup> CENTURY ENGINEERING FOR AN AGEING POPULATION

The well-documented trend across the developed world for people to live longer has led to a significant shift in the age distribution of the UK population (**Figure 1**). This creates a wide range of socio-economic effects. While on the one hand, a growth in the number of older people may increase the costs of healthcare, the likelihood of a longer healthy lifespan may open an opportunity for an increased time at work. Alternatively, there will be a longer time in healthy retirement to learn new skills and/or make contributions to society.

The distribution by broader age groups is shown in **Figure 2** confirms this trend over the last 100 years. In the early 20<sup>th</sup> century under 10% of the population were over the age of 65 – this has now increased to about 15% (approximately 10 million people).

Figure 2: UK population by broad age group.

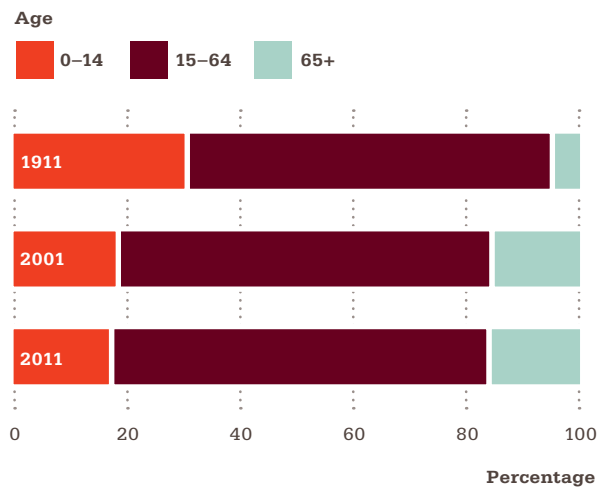
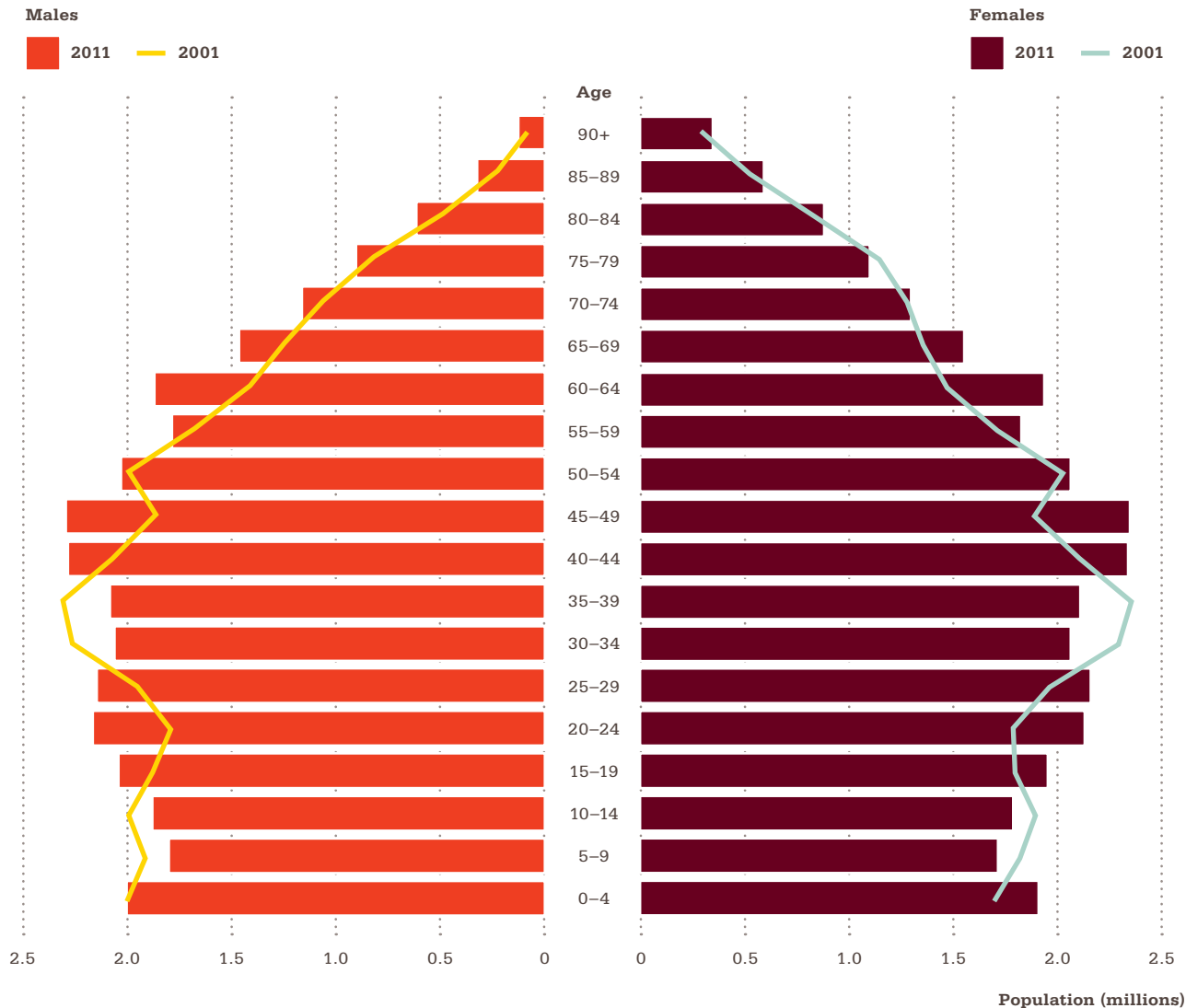


Figure 1: The age distribution data for the UK is summarised in the chart below showing the changes over the last decade.



THE OLDER OLD – 85+

The greatest change over the last few decades has been the increase in people surviving beyond 85. This has been particularly true of women, a large proportion of whom, about 70%, live alone in their own home. Indeed, it is the almost universal wish of older people (about 90%) to remain in their own home for as long as possible. Perhaps fortunately, this wish is consistent with the imperative to find the most economic approach to maintaining the care and safety of these older people. This then becomes the major driver for the application of appropriate technologies to maximise independence at home. A further consequence of living alone is that these people may become lonely and heavily dependent on suitable transport facilities to visit friends, family and meeting groups. Therefore the ambition for assistive technology development is to ensure safety and independence at home and to provide accessible and usable transport systems to maintain social interaction with friends and family.

It is clear then, that the engineering community has a large role to play in providing robust and appropriate technology, but how will these needs be satisfactorily met? Governments in particular, through the way they often use public funds to commission infrastructure, have a clear responsibility to show leadership. They should insist that all new public amenities, where appropriate, have additional features to make them more suitable for our older citizens.

CHALLENGES AND OPPORTUNITIES FOR THE ENGINEERING COMMUNITY

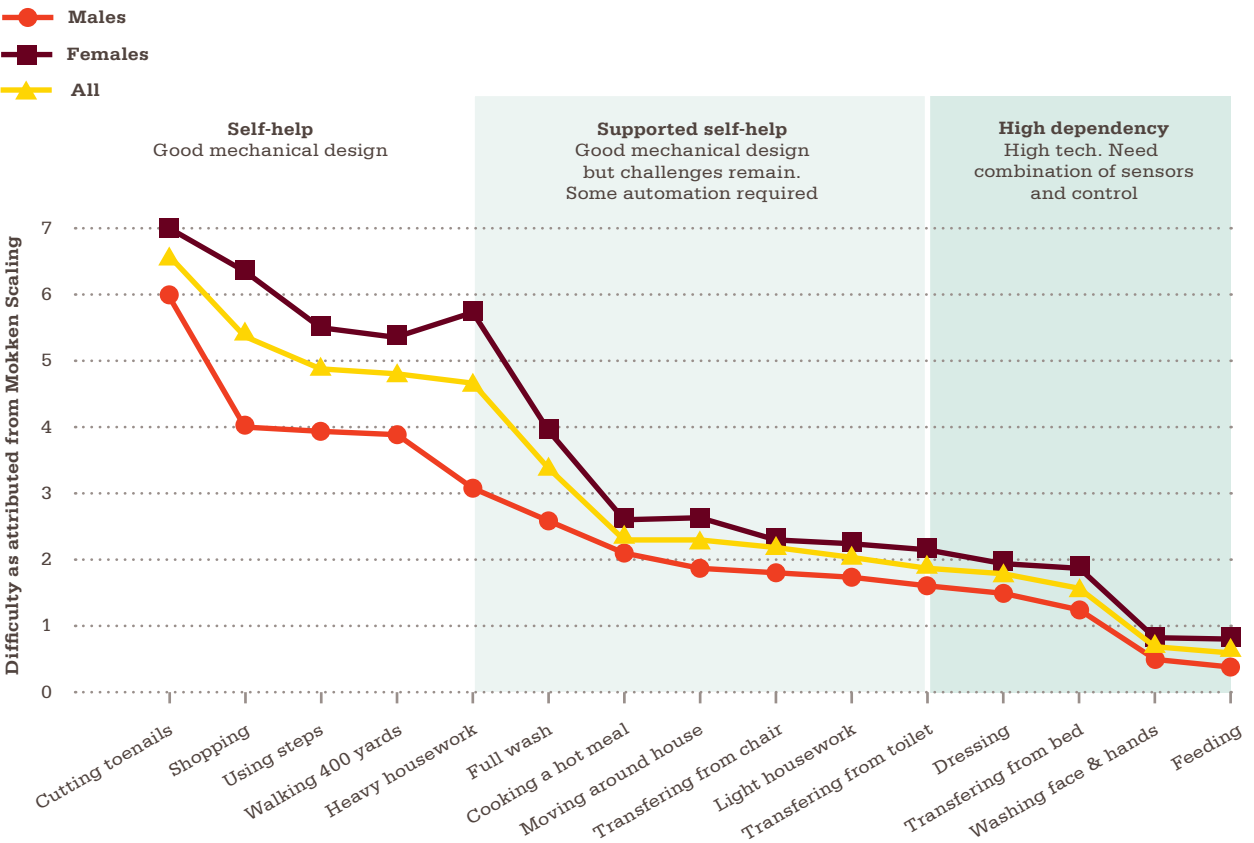
There are two major issues with the independence of older people – independence at home and the ability to travel independently and therefore maintain social function. The associated challenges result from well-documented issues faced by older people. While in some cases an older person may become seriously ill, the majority face a combination of long-term conditions with consequences for mobility, vision, hearing, balance etc. It is this combination that must be understood by the engineering designer. These age-related changes occur in a predetermined order and the physical changes are shown in Figure 3<sup>[1]</sup>.

From the point of view of equipment selection and design, it is convenient to divide this curve of decline into three areas where the needs are for:

- 1. Good, well-designed items such as grab handles etc at home.
- 2. Well-designed equipment which may have to be tailored to a particular user and environment and where some automation may be required. A stairlift for example.
- 3. A need for high-technology approaches meeting needs of both functional support and providing sensors and feedback to ensure safety.

These requirements may include telehealth equipment for remote monitoring of someone living alone and, in the not-too-distant future, robots to help with a range of tasks.

Figure 3: Curve showing decline in functional ability (Kingston et al 2012).



## INDEPENDENCE AT HOME

The required outcome for any assistive technology is increased wellbeing and independence. The needs and applications of technology however will be different depending on where they are on the curve of decline (**Figure 3**).

### Category 1 – Self-Help

These people are likely to be generally healthy but face certain challenges performing everyday tasks. These challenges can almost always be met by simple, but well-designed, mechanical equipment. For instance, an appropriately placed and sufficiently strong grab handle can restore the ability to get out of the bath; a telephone with large buttons and increased sound amplification will help maintain communication for longer. It is important to stress here that the functionality and safety of this type of equipment is dependent on the appropriate assessment of both the user and the home environment. Advanced expert systems are now available to support these decisions.

### Category 2 – Supported Self-Help

There are many similar issues here, but they may frequently require a level of customisation and, occasionally, automation. For instance, the safe use of kitchen equipment may call for automated switches or alarms. There may be similar safety issues in the bathroom. Safe mobility at home can commonly be ensured by suitable rails and hand holds etc. However, in some cases determined by a combination of personal circumstances and house layout, a stairlift may be required.

### Category 3 – High Dependency

At this stage, there are significant technical challenges and unsolved problems. In very many cases, people with this level of difficulty may require personal care from a relative, friend or professional carer and, in some cases, may live in a care home. Indeed, the inability to feed is regarded as a criterion for moving into care. The technical challenges here are very significant for two reasons – firstly, many of the issues are highly personal, making it challenging to produce personally acceptable devices; and secondly the actual activities are subtle and complex, calling for very clever and non-invasive technology. The major applications in this category are: telehealth, allowing remote monitoring of a person's health status (eg heart function, blood glucose) reducing the need for routine visits by health professionals; and, telecare, providing, for instance, personal alarms to alert a friend, relative or professional if someone falls at home or fails to get up in the morning.

All three of these areas require further product development and investment. It seems obvious that Innovate UK, with its assisted living innovation platform, is perfectly placed to fund further calls

for state-of-the-art designs that can help improve personal independence. Indeed the scaling back of the NHS “3millionlives” project (designed to bring telecare and telehealth to 3 million citizens by 2015) into a sub-section of the Technology Enabled Care Services programme fuels concern that without more positive intervention the full potential of assisted living will fail to be realised.

## INDEPENDENCE OUTSIDE THE HOME – MOBILITY AND TRANSPORT

Mobility either within the home or outside is vital for independence, to ensure access to shops etc as well as for social interaction with friends and relatives. Local outdoor (pedestrian) mobility can be maintained by simple technologies, often alongside surgical total joint replacement. However, once again the appropriate matching of equipment to user needs is essential to ensure safety. It is also important that the infrastructure should be appropriately designed and maintained with clearly marked safe road crossing points with adequate pavements and footpaths.

### Public and Private Transport

Longer-distance travel calls for combinations of the private car, rail and bus systems or aircraft. While in all of these there may be challenges of access and safety etc, the private car raises a number of additional issues. There have been a number of major studies of older drivers. Massie and Campbell<sup>[2]</sup> in the USA found a 3.8 times increase in accident rates. However, a Dutch study<sup>[3]</sup> clarified the situation by showing that if long distance driving is excluded from the younger driver data then older drivers are almost as safe as their younger counterparts, ie the likelihood per driver is little changed with age, although the overall accident rate per kilometre driven may well increase significantly as the distance older people drive decreases. There have also been developments of assistive technologies which may help older drivers. One study has shown that right turns (left for left-hand-drive vehicles) are challenging for older drivers just as they are for trucks. Satnav systems have been developed to minimise these manoeuvres by suitable route selection. It seems likely that further assistive devices will become available in the future.

The design of public transport systems raises a wide range of issues. The major challenges relate to information and vehicle access. Public transport interchanges are normally busy, requiring passengers to identify the time and place of the route required and then to reach the stop/gate/platform on time. Older passengers frequently have some degree of impairment of both hearing and vision and may also react less quickly to or not receive important information. These issues are a challenge for architects and designers, who will need to consider the design and placing of signs, the acoustics of announcements and design of staircases and corridors for easy movement, even at busy times.

## FUTURE TRENDS

There is considerable interest in the development of high-technology approaches to maintain the independence of older people. A wide range of novel telehealth and telecare systems are under development. Some of the most exciting developments are those that allow safe outdoor travel. The advent of driverless vehicles holds great promise for older people who can no longer drive – particularly at night. Additionally, some relatively simple robots are being developed to clean the floor or cut the grass. Others may help with moving food in or out of a hot oven. It should be stressed, however, that there are major social implications of increasing robot use in the home. While improved outdoor mobility may improve social interaction, there is a risk that indoor robotics/automation may increase isolation and hence have a negative effect on health and wellbeing.

There are two key factors that will be seen coming more to the fore in the near future:

1. Engineers will need to have changes to their education and skills development to ensure they are intrinsically more aware of the effects of reducing faculties on an individual's ability to use their designs. There needs to be a transition in thinking from products specifically for assisted living for the few to generally applicable solutions suitable for the many.
2. The safety and performance standards applied to products for public use need to be adapted based on the changing profile of those using them. The ability to see, hear, feel or even smell signs of failure or danger will diminish with age. Touch screens in general or miniaturisation in particular will take many devices beyond the capabilities of older users. Devices most likely need to be made which are simpler on the outside by being more complex and intrinsically safe on the inside.

## RECOMMENDATIONS

The Institution recommends that:

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## REFERENCES

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- 2 Massie and Campbell (1993) Analysis of accident rates by age, gender, and time of day based on the 1990 Nationwide personal transportation survey. University of Michigan <http://deepblue.lib.umich.edu/bitstream/handle/2027.42/1007/83596.0001.001.pdf>
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## ACKNOWLEDGEMENTS

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The design of capital or household equipment must be appropriate to a population containing a larger proportion of older people than 30 years ago.