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Design for an ageing population: promoting independence and quality of life

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REVIEW

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Abstract

Solutions to promote independent living in old age may occur at a systems level, where the health sciences, engineering and human factors work together. A better engineering response is needed directed at the problems encountered in the area of instrumental activities of daily living. Field studies can provide valuable insights, but survey data are needed to complement and pinpoint areas for design improvement.

Population ageing

The world population is getting older. In the next 40 years, the number of people aged 60 years and over will triple from 760 million to more than 2 billion. Today, one in every ten is in that age range and one out of every five will be by 2050. Developing countries will see the fastest growth of the older population over the next decades [1]. Trends in life expectancy and disability-free life expectancy support the 'expansion of morbidity' theory [2]. According to this theory, life is predominantly expanded through advances in medicine while exposure to non-fatal diseases (arthritis or hearing loss) increases with age; that is, the years of life gained are years with disability. When levels of disability can be differentiated, however, it appears that two opposing trends occur at the same time ('dynamic equilibrium') [3]. Cross-sectional and longitudinal data show that older people in the United Kingdom have lower levels of severe disability, but higher levels of poor self-rated health [4]. Whichever theory will prove to be valid, people become more dependent on others with age and they are less able to cope for themselves due to declining functional status. This contributes to an increasing dependency ratio.

Independent living & quality of life

In response to the growing need to reduce dependency during old age while also improving the quality of life, major funds are made available for innovative approaches to help older people live independently for as long as possible. Besides interventional strategies to improve physical activity, technological innovations may reduce the dependency of the ageing population [5]. However, it has been suggested that the roles of social networks and support were missing from that view [6].

A comprehensive literature review [7] identified five factors that are directly related to independent living in old age: autonomy/control; housing; economic security; familial and social networks; and health and social care. The weight attached to these is likely to differ between individuals, reflecting personal circumstances, and each inter-relates to the other. For example, it is known that most elders want to stay in their own homes for as long as possible and home ownership provides economic security. Familial and social networks are important for the provision of informal care, which can help to maintain independence and reduce the risk of institutionalisation.

Qualitative research [8] found that independence is only perceived as being lost if people are no longer able to exercise autonomy/control over key aspects of daily living, with the other factors being sub-components. This finding is important in two ways: First, the ability to perform activities on one's own is a major determinant of quality of life in older people (more than the presence of certain diseases) [9]. Secondly, access to services is mainly controlled by assessments of functional ability in daily activities.

Instrumental activities of daily living

The instrumental activities of daily living [10] determine how well older people can maintain performance of activities necessary for independent living. They include eight items: preparing meals, doing housework, laundering, shopping for groceries, using transportation, handling finances, managing medication and using the telephone. One way of categorising these activities could be based on the type of environment where they are performed – within the home versus outside the home. Alternatively, two separate domains may be conceptualised – a physical and a cognitive domain [11]. Difficulty with finances, medication and telephone more obviously point to problems in cognitive function; difficulty with cooking, housework, laundering, shopping, and transportation to problems in physical function (though all require some degree of both).

Time spent in an activity

Looking at the time spent in an activity can help to decide on the importance of design support; activities that consume more of the time budget should take priority. Difficulty with an activity may result in reduced efficiency (*i.e.* more time is required for completion), which increases fatigue and impacts on the ability to maintain independence. Time use data from a Belgian survey [12] show that people aged 66-75 years spend most of their time with sleeping/resting (60+ hours/week), followed by leisure for men (around 40 hours/week) and leisure and housework for women (around 30 hours/week). Men spend on average 19 hours per week on domestic chores.

Moss and Lawton [13] described typical activity patterns of community-living adults who were either independent or impaired and needed help. The mean hours reported in sleeping/relaxation was highest, then eating, cooking and home maintenance. Impaired individuals spent more time with relaxation and personal care than with cooking and home maintenance. Activities performed outside the home (*e.g.* shopping) consumed less of the time budget compared to those performed within the home.

Design for older people

The demographic shift poses a challenge to designers because products and services are required designed with due sensitivity to older people's needs. "Inclusive design is comprehensive, integrated design which encompasses all aspects of a product used by consumers of diverse age and capability in a wide range of contexts" [14]. The rationale behind this is to 'counter design exclusion' by systematically identifying capability demands placed upon a person, and to re-design features exceeding their capabilities [15]. The outcome should be improved products and services that minimise the exclusion of less capable people, without sacrificing aesthetics and desirability.

Improvements that benefit older people are thought to benefit younger people as well (although it is acknowledged that dynamic solutions are often required). For example, the greater use of technology in everyday life increases the cognitive demands placed on the population; limiting the complexity of tasks would benefit both old and young. However, design needs vary within the population and heterogeneity generally increases with age. Two subgroups can be distinguished: early and middle old age (65-74 years) and late old age (75+ years). The former are regarded as the target group for improved consumer products, with safety and comfort (*i.e.* ease of use) being the focus. The latter are seen as the target group for assistive devices that enhance performance of daily activities and help to maintain independence [16].

Human factors

The challenge of disability in later life cuts across the health sciences, engineering and human factors. Human factors is concerned with optimising the interaction between people and products or services. The underlying premise is that activity demands represent performance criteria, where difficulties occur due to a mismatch between the criteria and a person's capabilities [17]. Verbrugge and Jette [18] provide a simple example that illustrates the relevance of this concept to the disablement process: An older woman with arthritis in her hands ('pathology') may have weak grip and restricted finger flexion ('impairment'), causing her difficulty to grasp and rotate objects ('functional limitation') which, in turn, prevents her from opening jars and doors ('disability'). Kitchen devices and special door handles ('intervention') could reduce the task demand and help her overcome the difficulty.

Human capabilities

When interacting with products or services, people use a range of capabilities: motor (locomotion, reaching and dexterity), sensory (vision and hearing) and cognitive (thinking). Evidence suggests that these capabilities are lost at different stages in later life – locomotion is the first ability to be lost, followed by reaching, thinking, hearing, vision and dexterity [19]. According to this hierarchy, a person's lack of locomotion ability may exclude them from using a product or service regardless of any other ability. Reducing the strength and balance placed upon a person may help to include those with limited locomotion ability. This could be achieved by making extra allowance for the hands to assist moving the body around (*e.g.* handles). On the other hand, a product or service which places an excessive dexterity demand upon a person is unlikely to be compensated by a low vision, hearing, thinking, locomotion or reaching demand.

Design solutions

Designs focused solely on one of the abilities may produce a significant improvement, but the lack of a holistic approach that takes account of all needs can still lead to difficulties. It would be more beneficial to reduce demand in preference to another. For example, bright displays at a better, more viewable height reduce posture demand and address issues of readability and cognitive usability. Design solutions are most effective in narrowing the gap between individual function and activity demand if focused on motor and sensory capabilities, as these are closely related to chronological age. Cognitive capabilities are less likely to be helped by design without the provision of training [20]. It has been suggested that age differences in the performance of cognitive tasks can be reduced or eliminated by giving older people more effective instructions [21].

Capability assessment

Self-reports have traditionally been used to assess the functional status of older people; the methodology of surveys and interviews is well-developed. While instrumental activities of daily living represent broad categories, functional measures of tasks typically required for independent living would be more useful for design. The questions should be at an appropriate level of specificity and assess a large number of tasks. Asking respondents whether they are able to walk half a mile (the equivalent of a city block) or lift and carry weights over 10 pounds (*e.g.* a heavy bag of groceries) are not specific enough. In addition, knowing that a person can lift a certain weight is less informative than their comfortable maximum [22]. As such, epidemiological studies indicate population trends (problem identification), yet they do not help in formulating design principles for older people ('top-down approach') [16].

Objective outcome measures
Alternatively to self-reports, objective performance tasks have been developed as outcome measures. For example, the observed tasks of daily living examine problem-solving competence in financial management, medication adherence and telephone use [23]. However, the result of this instrument offers little to the development of intervention strategies for actual environments. Outcome measures should be identified that can be used to formulate design principles applicable to real-world settings ('ecologically valid') [24]. Practical questions are difficult to answer if the primary focus is on measuring reaction time or processing speed; it is unlikely that such measures correlate with success in the real world.

Field research

Field research involves the collection of data and provides a 'bottom-up approach' to design [16]. The setting in which the research is conducted (home *vs.* laboratory) can influence the results. Observing people in their own environment allows the study of how activities are performed in the wider context of home, but it is difficult to maintain scientific rigor and control. A drawback of laboratory testing is that it often requires performance at maximum levels and the participants might behave unnaturally. The advantage, though, is that performance difficulties can be investigated under controlled conditions. A task analysis (the study of what a person is required to do in order to achieve an objective) may be used to develop activity simulations that can be designed to represent a class of problems or situations to which the findings apply [24]. Task profiles of daily activities, including cooking, housework, laundering and shopping, are available from Clark, Czaja and Weber [25].

Ecologic validity
A study would be considered ecologically valid to the extent that its findings can be generalised. This is not only dependent on the simulation of important elements of real-world activities, yet also on the people who participate. Achieving a representative sample is critical. For example, mobility is a usual requirement for participation in a laboratory study. Candidate populations, however, would be those who are physically frail or disadvantaged in any other way [16]. Special attention must be paid to methodological issues such as sampling, recruitment and potential bias from non-participation. Inter-observer reliabilities should be assessed, and a cost-benefit analysis can help in deciding about design implementation. Finally, research should provide guidance for translating findings into solutions, including dissemination and implementation [24].

Randomised controlled trials
There have been relatively few attempts to assess the effectiveness of design changes on functional ability in older people objectively. The best evidence would come from randomised controlled trials (RCT) where an experimental group is compared with a control group observed under placebo conditions (which are identical in all respects except for lacking the interventions). A recent literature review [26] examined the effects of home modifications to reduce risk (*e.g.* removing barriers) or increase support (*e.g.* installing grab bars) on disability-related outcomes. More than half of the 29 original investigations and 10 review articles revealed supportive findings; five out of ten RCTs were supportive and three were partially supportive. The authors noted that the likelihood of supportive findings was generally higher if the study outcome was closely linked to a specific intervention. That is, more intense and skilled interventions resulted in greater improvements.

Conclusions

Despite the potential of human factors to favourably influence the daily lives of older people, most efforts to date have focused on designing support services to provide care in the community. The complexity of the concept of independent living in old age implies that solutions may occur at a systems level. Instead of dissecting the concept into isolated components, a systems approach allows the person and their environment to be viewed as a 'system', which accounts for inter-relationships between single components and their synergistic potential. By employing such an approach, greater independence and quality of life may be achievable to all whatever their level of functional ability.

In addition to other valued activities, older people allocate a large proportion of their time to (physical) instrumental activities of daily living. This emphasises the need for a better engineering response directed at the problems encountered in this area. Field studies can provide valuable insights but they have not been numerous enough to be helpful in developing design guidelines. Nevertheless, sole reliance on laboratory measures is unlikely to be sufficient to understand the types of problems that older people have.

Epidemiological data provide a good starting point to reveal areas where better design can improve quality of life. Population surveys of health and ageing could be expanded to include questions about the use of and satisfaction with products and services for instrumental activities of daily living. Further research and collaboration between the health sciences, engineering and human factors are warranted to assess the effectiveness of design changes on the ability of older people to function well.

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