

The role of Ergonomics in the design of consumer products for use in the home by elderly people

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The major aims of the discipline of ergonomics include making systems and products as usable and safe as is 'reasonably' possible. For product designers, the latter stipulation is an obligation not just morally, but also legally - as laid out in *The General Product Safety Regulations 2005 (SI 2005/1803)*. The elderly are specifically referred to in the UK legislation as "consumers at risk", deserving particular attention due to their vulnerability and increasing prevalence of impairment and disability concomitant with age. This essay focuses on the interplay between the attributes of the elderly and the design features of consumer products for use in their homes. This is done through an analysis of 4 interrelated but distinct roles that ergonomics fulfils: research on the capabilities of the elderly; research on generalizable ergonomics issues not specific to the elderly; direct study of the confluence of home products and the elderly; and aids for designers in the forms of tools, methodologies and standards. Any discussion of the role of ergonomics in the technological or aesthetic design considerations for a product is outside the scope of this essay, except where these may have direct impact on usability or safety.

For the purposes of this essay, ergonomics shall be characterised as the study of the effects of cognitive, physiological and behavioural phenomena on people's interactions with systems, objects and environments, focusing particularly on performance, usability and safety. The intended results are recommendations for real world applications. As a result of this remit, ergonomics has a clear role to play in the design of consumer products: to study the in vivo interactions with those products, as well as the human factors that affect their use, in order to effect better design solutions.

As a demographic, the elderly have a number of characteristics that designers should be cognisant of, and understand how to approach, when creating products for the group. Fortunately, this is an area in which much research has been carried out; indeed, it has a dedicated field of study - gerontology - which affirms its importance. The elderly have reduced sensory function, including visual acuity (Pinto et al., 1997), diminished executive abilities and psychomotor speed (Keys and White, 2000), a higher incidence of age-related diseases such as dementia (Topo, 2009), but also a tendency for more mature problem-solving strategies (Gregor et al., 2002).

It should be noted that there may be inconspicuous systematic error in many of the studies of elderly capability, such that the reported deterioration of cognitive and sensory functions are likely exaggerated. Desrichard and Köpetz (2005) found that elderly participants who were primed with negative age-related stereotypes¹ about memory in their instructions demonstrated significantly poorer performance than those

¹ Used here as 'commonly-held beliefs about a group of people'

presented with more neutral instructions. This is not limited in purview to functions of memory, nor in impact to the distortion of results. Age-related self-schemata also appear to affect sensory perception (Levy et al., 2006), but more (and more ecologically valid) research is required to elucidate the extent of the effect of priming on other cognitive functions. Ergonomists are tasked with determining the effect of product design, including instructions, on users' efficacy, and with finding methods to eliminate or reverse any negative ramifications - extant research suggests this is plausible (Levy, 1996).

Some capability deficiencies may have simple and intuitive design solutions: lower visual acuity - increase the size and contrast of text and symbols, use an easily legible font (Vanderplas and Vanderplas, 1980); poor dexterity - increase the size of buttons and knobs on the interface such that they can be operated without precision. These can typically be easily operationalised and thus easily studied quantitatively with simple experimental design. Other age-related impairments are more complex and harder to understand and/or design for: how can we suitably account for issues with confidence in using a product? What design requirements might a person suffering from dementia have? These concepts are more difficult to both intuit and research and so explicit solutions are less forthcoming. Ergonomics is needed to enable designers to effectively empathize with their audience and to provide design recommendations that are understood on a practical level. Some work here has indeed been carried out both on a theoretical level (Topo, 2009) and as actionable advice for designers (Jönsson, 2003), however coverage is currently far from comprehensive. As Bharucha et al. (2009) stated, there are "few clinical studies specifically involving persons with dementia".

Part of the role of ergonomists, then, is to synthesize the data targeted at their particular audience with other data and their professional experience in order to improve the design of product concepts and prototypes for use in the home by the elderly; and, more generally, to create and test hypotheses for direct study of product use by older people.

While in the aggregate we see that the elderly have limited function in a number of dimensions, it is important to remain cognisant that a large range of ability characterises the demographic (Fisk, 1993). In order to account for this variability, ergonomists have recommended a focus on inclusive design - creating products that account for users with a wide array of abilities. (Gregor et al., 2002).

Inclusive design is at its best when products are functional and usable for the most impaired segments of the target population (as well as the more able), and appeal to even the most capable of users by evoking strongly positive visceral, behavioural and

reflective affects as described by Norman (2004)². Ergonomics allows design teams to move their product towards this goal, however, as Gregor et al. (2002) emphasized, 'universal' design is rarely, if ever, achievable. It is for this reason that the term 'inclusive' is more predominantly used in this essay: good ergonomics may not be able to accommodate everyone in a single product, but it does attempt to include as many people as possible, and as Gregor et al. (2002) suggested, the language we use to describe product design should reflect this. One ergonomics study that would help teams design more inclusively (Piepenbrock et al., 2013) looked at both older and younger people and their proofreading performance when looking at screens with different display polarities. It found that positive display polarities (dark characters on a light background) improved performance for all ages when compared with a negative polarity display. Working with this evidence, designers can create products that cater to the visual requirements of the less capable elderly, simultaneously optimising the experience for everyone up to the unimpaired.

Ergonomics studies that look at the characteristic biases, weaknesses and limitations of people in general commonly have greater implications on the design of products for the elderly, as these constraints are often more pronounced in older demographics. For instance, a study by McGill et al. (2013) found that the load on the lower back was reduced when objects were carried with two hands rather than just one. Uy et al. (2013) found that a low handle with a vertical slope minimised strain on the shoulder when performing pouring tasks. Combined with the knowledge that muscle strength in the elderly is typically diminished (Goodpaster et al., 2006), (Landers et al., 2001) and that there is age-related degeneration of the acromioclavicular joint (Petersson, 1983), we can make strong inferences about the way in which we should design handles for consumer products that are held during use, with the importance of this emphasized for an elderly consumer-base. Designing for the elderly is neither single-faceted, nor a discrete entity entirely distinct from design for the rest of the population. It can be considered the examination of a number of ranges in multiple continua, such that ergonomics research focusing anywhere along these spectra will likely generalise to affect the elderly population.

A number of peer-reviewed papers have directly investigated the design of consumer products for an elderly population, leading to design considerations that better cater to the needs of older people. One such paper was presented by Gardner et al. (1993), in which 28 consumer products marketed at the elderly were analysed with close attention paid to the functionality, usability, safety and quality of the products. One

² These can be approximated as: visceral - the emotional 'gut reaction'; behavioural - the feel of using the product; reflective - the product's influence on self-image

of the products with usability issues was a dual-purpose walking stick that, if it was needed for its primary purpose of support, could not be used in its secondary function as a 'grabber' of small objects, negating its usefulness. The authors suggested that mindfulness of the aforementioned four areas during the design process would resolve the more conspicuous design failings. Ergonomics can provide analysis of previous technologies and products for a group, such that designers can learn from past mistakes and make improvements for future projects.

Fisk (1993) took a more proactive approach to the purview of ergonomics than many. While many researchers focus on compensating for the symptoms of impairments and handicaps, Fisk proposed that the design of products for the elderly should be able to alleviate some of these and return to the user some of the capability lost, rather than simply slow their decline. The paper gave, among others, the example of a walking stick that would provide progressively less support over time, such that the elderly users who needed assistance temporarily would not come to rely on it as a literal and figurative crutch, and would regain their independence with practice. This would suggest that the implementation of ergonomics in products may be able to have an actively positive impact, not just a damage mitigation role.

The impact of ergonomics on design for the elderly is not limited to theoretical research. There have been pragmatic attempts to have a tangible effect on products by creating tools, methodologies, and guidelines for designers. The study of the capabilities of the elderly by ergonomists and researchers in intersecting fields has allowed us to create tools to provoke empathy from designers for representative positions in the spectra of abilities that the elderly possess (Goodman-Deane et al., 2013). These tools often come in the form of worn apparatus that debilitate sensation and/or mobility, or of software that simulates a wide range of visual and auditory impairment. Through their use, designers will be able to quickly see the more prominent issues with their prototypes, such as effective use requiring too great a level of dexterity. This is useful for broad refinement, however, due to discrepancies between simulated and real impairment, it is insufficient for determining the suitability of products for the intended group. Fortunately, methodologies have been created to attempt to comprehensively account for the range of abilities of the target audience, such as the Usability, Safety, Attractiveness Participatory (USAP) design model from Demirbilek and Demirkan (2004). In this model, elderly participants are involved from a conceptual stage through to user trials, and the designer also consults with engineers and ergonomists, who provide a wide experience-base to complement the in-depth experience of the elderly participants. Design considerations are ranked on matrices combining the technical design requirements and the user requirements. Beyond

providing methodologies, ergonomists have been substantively involved in the creation of guidelines and standards (BSI, 2011) as reference for designers and/or the ergonomist(s) in design teams.

To conclude, ergonomics has already played a role in the design of consumer products for use in the home by elderly people, having created tools, methodologies and standards for designers following theoretical and practical research both in vitro and in vivo. It remains crucial today as the research pertinent to the elderly population is far from comprehensive, particularly in naturalistic settings. An ethnographic approach would be particularly valuable as it would provide the design community with experiential data on how related products have been used in a non-deliberate manner that may be missed in reflection by the user. As technology evolves, ergonomists will continue to have a critical role in the design of products for use by elderly people.

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