Supporting ‘Design for All’ in Automotive Ergonomics

Dan HÖGBERG1* and Keith CASE2

1 Department of Engineering Science, University of Skövde
P.O. Box 408, SE-541 28, Skövde, Sweden

2 Mechanical and Manufacturing Engineering, Loughborough University
Loughborough, Leicestershire, LE11 3TU, UK

Abstract. The automotive industry faces increasingly tough competition in a global market. One key for competitiveness is product differentiation, in order to attract clearly defined market segments. However, designing cars for specific customer groups incorporates the risk that a car appeals to only a small number of potential buyers. Another issue is that the actual customer group in many cases differs from the initially targeted customer group. The use of the ‘design for all’ (DfAll) concept may very well enlarge a car manufacturer’s market and improve the vehicles by making them suit larger populations. This paper discusses the aims of a research project that seeks to identify areas where both the main targeted customer group and others can gain from a ‘design for all’ approach. Other objectives are to suggest working methods that enable ‘design for all’ in the automotive development process and the identification of computer tools, such as virtual manikins, that can support these objectives early in a virtual design process.

INTRODUCTION

Products offer value to people, and the product that offers greatest value is likely to have advantages over competitive products. Value can arise from practical benefits (functionality, usability) or emotional pleasure (Jordan, 1999), but quantifying a product’s value is complex since the value is typically experienced subjectively and individually; it is in the ‘senses’ of the customer. One way forward is to segment the market into groups of customers that appreciate value in a similar manner. The automotive industry faces increasingly tough competition, and one key for competitiveness is product differentiation, in order to attract clearly defined market segments. However, designing cars for specific customer groups increases the risk that a car appeals to only a small number of potential buyers. Another issue is that the actual customer may differ from the targeted customer since many factors influence ‘what product will be used by which customer’ and often the user is not the purchaser of the product.

This calls for an approach that enables the automotive industry to offer value to the targeted customer group, while at the same time, offering value to other users of the product. This may be economically sound, but it is also rewarding when considering factors such as long-term company reputation, customer loyalty, quality of life issues etc.

* Corresponding Author (Email: dan.hogberg@ite.his.se, Fax: +46-500-448599, Phone: +46-500-448549)
MARKET CHANGES AND COMMERCIAL RESPONSE

Demographic changes
The number of older people is increasing, as is their proportion in the total population due to declining birth rates, longer life expectancy and decreasing mortality (ANEC, 2000). The world population over 65 years of age is predicted to grow by 88% over the next 25 years, and approximately 10%, or 800 million people, will be over 65 years of age in 2025 (Smith et al, 2000). This fundamental change in the age structure of modern societies is only just being recognised. The World Health Organisation (WHO) predicts that by 2025 twenty-six countries will have life expectancy of above 80 years of age. These figures emphasize the importance of using data on older adults when designing products for these older customers to avoid poor product usability or lower quality of life for older people (Smith et al, 2000).

Mobility
Mobility for people with disabilities is not just a matter of equality; it is also of major importance for health, autonomy and general well-being (Peters, 2001). Coleman and Harrow (1998) state that perhaps the most important desire of older people is to keep their independence for as long as possible and car ownership can be important in achieving this. Mobility is a key factor in life-quality, and meeting friends, visiting relatives, shopping, recreational and educational activities, are all essential parts of an active life. Visits to doctors and hospital are likely to increase with age (Coleman and Harrow, 1998).

The use of public transport is encouraged by society due to the lower environmental impact. However, a private car is still the most common form of travel, offering freedom and independent mobility in a way that public transport does not. In particular, access to private cars can bring a new dimension to the lives of disabled and elderly, who may otherwise have lost, or be starting to lose, their mobility (Nicolle and Peters, 1999).

Halkamies-Blomqvist et al (1999) showed that for elderly drivers mobility is important for participation, health and well-being and can be financially justified with respect to public expenditure. To illustrate how ‘soft values’ can be transferred into ‘hard financial values’ they use ‘the mobility snake’ which consists of: mobility → activity → health → functional capacity → autonomy → small need of public support → saving of public funds. This indicates that society could gain economically from enabling elderly and disabled people to stay mobile.

Likely commercial response
So what is the likely response from the automotive industry regarding demographic changes and the call for mobility for all members of the society? Will the industry bother at all? One argument for a commercial response is that, if society can economically gain from keeping its members mobile, it is reasonable for that society to promote those associated with the enabling process, e.g. the automotive industry. Another argument for a response is that increased numbers of older consumers are forming a significant buying force (ANEC, 2000). Also, these customer groups in general are predicted to be relatively wealthy, representing a high buying power, meaning that they are an important target group for companies (Jordan, 1999b).

Two alternative business approaches would be ‘design for the elder/disabled’ or ‘design for all’. The latter concept is proposed and discussed in this paper.
‘Design for All’

A ‘design for all’ approach attempts to design products for all members of society. The objective is to consider the needs of old and disabled people alongside the younger and able-bodied population to ensure that products are equally appealing and suited to all users. This is to be contrasted with a ‘design for the disabled’ approach where the special needs of disabled people are considered in order to provide products that may only be appropriate for that section of society. ‘Design for all’, makes good commercial sense by extending markets, but it also satisfies the desire for non-stigmatised products. It is recognised that this objective is ideal rather than totally achievable and there will be relatively small groups that require products that are unattractive to mainstream markets (Case et al, 2001).

Coleman (1999) suggests that with good design it is possible to address the needs of very large numbers of people at present disabled by poor or inconsiderate design, and that future technologies will reduce the need for specialised products. Aging or physical and mental impairments ought to be seen as part of the human condition, which all people will more or less encounter.

RESEARCH OBJECTIVES

The use of the DfAll concept may very well enlarge a car manufacturer’s market and improve the vehicles by making them suit larger, more diverse populations without a loss of competitive edge. This approach makes commercial sense, but it also makes sense from a quality-of-life point of view by improving the way people interact with products.

One objective is to identify areas where ‘win-win’ situations are feasible, i.e. aspects where both the targeted customer group and other customers can gain from a ‘design for all’ approach. For this, it is central to consider both practical benefits, such as functionality and usability, and emotional pleasures. A customer is likely to perceive a product as a whole, a totality that represents values. The customer does this appraisal more or less consciously. Focusing on certain issues solely, e.g. physical ergonomics or aesthetics, incorporates the risk of sub-optimising the product. This calls for a holistic approach. Naturally this complicates the identification of ‘win-win’ situations considerably since there are more issues to take into account, but also since the comprehension of pleasure is as complicated as it is individual, sensitive and hard to express and grasp. Examples of methods to handle matters connected with user’s emotional reactions to products are Kansei Engineering and SEQUAM (Jordan, 1999c). A different approach would be to search for ‘win-win’ situations for certain issues, e.g. physical ergonomics, which can be isolated from other issues, e.g. where one may state that: this is held as a better solution for all users, independently of the actual final styling of the product.

Another research objective is to suggest working methods that enable ‘design for all’ to be catered for by designers and ergonomists alike in the automotive development process. This includes studies of how ergonomic related requirements are specified and achieved, and how balancing between different product requirements is carried out.

The research also aims to identify how computer tools, such as the use of virtual manikins/human modelling systems, can support the DfAll approach, especially at the early conceptual stages of the design process, where the product often only exists virtually, i.e. as computer models.
INTEGRATION OF ‘DESIGN FOR ALL’ INTO THE CAR DESIGN PROCESS

Saab Automobile in Trollhättan/Sweden is involved as co-operating partner in the research, and information and discussions are influenced on the understanding gained from interviews and observations made at the company this far. Saab Automobile belongs to General Motors, and it is reasonable to assume that many issues discussed here are relevant for other carmakers as well.

Human Modelling Systems
Ergonomics evaluation often comes late in the design process, and may not be performed until physical mock-ups are produced (Porter et al, 1995). This can lead to time consuming and expensive iterations, or products that do not meet the full ergonomics specification. The use of computer aided design (CAD) in the automotive industry, encourages a digital design process where expensive, inflexible and time-consuming physical mock-ups are only built towards the end of the process. Ergonomic evaluation will be put ever further back unless ergonomics can be evaluated in a virtual product, and for this human modelling systems (HMS), such as SAMMIE, JACK or RAMSIS can be used. These use digital humans, of varying sizes, shapes etc, to allow CAD modelling of users/humans as well as products. This supports visualisation and evaluation of ergonomic issues such as fit, reach, posture and vision.

Current Situation
The co-operating company’s intention is to move towards a digital car development process so it is important that methods and tools for ensuring good ergonomics follow the same pattern. At present the company is using HMS for ergonomic simulation, visualisation and evaluation. However it is not fully integrated into the design process, and is only used where it is thought to be worthwhile. In the present set up the software only assists the designer to assess the seated driving position. Other important issues such as ingress/egress or loading/unloading the luggage boot have to be evaluated in other ways, e.g. by using more unsophisticated approaches or by building physical mock-ups. The latter is often expensive and time consuming, which means that it is unattractive, especially if the mock-up is only built to evaluate ergonomics.

Today ergonomic evaluations are sometimes performed late in the design process, which means an increased risk for ergonomics problems not being detected until too late, leading to, expensive and time consuming iterations/modifications, or to reduced product quality. One reason for this is a lack of methodology for digital evaluation, but it is also due to late design changes. Iterations, changes and balancing of requirements are all natural components of design, and the goal is not to remove them, but rather to handle them attentively. Great advantages arise out of moving these ‘woolly activities’ earlier in the design process, i.e. to the conceptual stages, where modifications in the design are simpler, quicker and cheaper to handle. Indeed it is Saab’s plan to bring ergonomics forward in the design process. Another reason for late design changes is poor communication. This is especially true between different professionals, e.g. between ergonomists, product designers and engineers. Porter and Porter (1999) list three problems: 1) communication of ergonomics information at an inappropriate point in the design process; 2) communication difficulties caused by educational and practise differences; 3) communication of ergonomics information and data in an inappropriate fashion. Designers stress that design information needs to be in a relevant, concise and usable format and also complain about the lack of graphics in ergonomics references. Design is essentially a visual activity and knowledge or data expressed in a graphical format has a subtlety of meaning that cannot be found in a completely textual representation.
CONCLUSIONS

To date the research has established fundamental arguments for the automotive industry to employ the ‘design for all’ approach when developing future cars. It has also identified some of the common problems of enabling ergonomics input in the design process. In the future it is proposed that the research will expand knowledge about how to ‘design for all’ in the automotive development process. This will cover design guidelines as well as methods and tools, such as human modeling systems.

Acknowledgements

Thanks to people involved in the VERDI research project at Saab Automobile. Part of this work has been made possible through support from The Knowledge Foundation in Sweden.

REFERENCES