Visualisation of human characteristics in vehicle and health care product development

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Abstract

The purpose of the research project described in this paper is to improve the efficiency of product development processes by exchanging knowledge and experiences about user centred design methods and technologies between the two branches: vehicle and health care industries. The health care industry can benefit from visualisation and simulation tools that include computer manikins, a physical representation of the human, and the vehicle industry can benefit from manikins having personal characteristics, which has proven to be successful in the health care industry.

Keywords: visualisation, simulation, human characteristics, user representation, product development

1 Introduction

Visualisation in industry is often referred to as the process and result of illustrating information. This can be done with different techniques, such as CAE (Computer Aided Engineering) and simulation software. A key advantage of visualisation is that it enables an illustrative presentation of phenomena, such as the overview and relationships of processes and products. It has also been established that visualisation can work as a common language between persons with different backgrounds and specialities, thereby supporting communication and exchange of knowledge in a multidisciplinary and collaborative working manner [Blomé, 2004].

The vehicle industry can be seen as a representative example in this context, where multidisciplinary organisations develop complex products with a clear human-product interface, and where there is a need among specialists to agree on an appropriate balance of a range of product requirements for the final vehicle design and its production system. Not surprisingly, the vehicle industry is a pioneer when it comes to using visualisation techniques. Their vision is to develop and evaluate the product and production systems in virtual environments more or less throughout the entire development process [Lämkull, 2006]. Visualisation and simulation techniques are employed when possible to evaluate conceptual and detailed solutions without the need for physical prototypes. This makes it possible to increase the number of evaluations in the design process compared with the traditional approach based on expensive and time consuming physical prototypes and evaluations. The objective is to save time and money, but also to result in better vehicles (products) and more efficient and ergonomic production [Chaffin, 2001]. The virtual approach is considered more efficient and effective, provided that the simulations are performed correctly and based on relevant and correct data [Ziolek and Nebel, 2003].

Technical vehicle performance and manufacturability has traditionally been the focus in the vehicle development process. Most companies acting on the market today, however, meet these basic demands. Customer appreciation of additional product properties, such as aesthetics and attractiveness, has had an increased impact on products' (vehicles'), commercial success [Jordan, 2000]. Furthermore, vehicle assemblers' health and job satisfaction have been highlighted in the production system design process [Falck, 2007]. Since the targeted customer group and assembly personnel often are complex when it comes to personal requirements and expectations, it is hard to estimate and describe the diversity of the groups, and hence to simulate the interaction between the product and humans. This complicates the design process, and the difficulty is significant with respect to the range of personal and emotional characteristics among the users.

The health care branch has increased the visual and virtual approach in product and production development, but this is mostly related to the interaction between the user and the product. It is based on descriptions and visual illustrations of archetypical users, without utilising computer based simulation technology. Still, the users' characteristics are emphasised since the main function of the products is to support everyday life for a wide range of individuals with disabilities or impairments, which often call for different design solutions. The health care industry approach is in line with the vehicle industry's because it too aims to employ computer based visualisation and simulation technology to enhance the product development process efficiency and product quality.

2 Current user representation principle

The present methods for visualising human characteristics in the product development process are described in the following sections, in the health care and vehicle industry respectively. The descriptions are based on interviews with key persons as well as experiences of the research group.

2.1 Health care industry

Arjo, the health care company linked to this project, has been involved in the development of equipment and working techniques in elderly care for over 50 years. Their development activities are based on mobility issues. They have a tradition of working in close cooperation with staff and planners of elderly care facilities, focusing on both the caregiver and resident. Some years ago Arjo developed the *Resident Gallery*, a communication tool based on five levels of functional mobility: from totally mobile and independent residents to those who are entirely bedridden. This system was initially developed to support the product development process and the communication between professionals with different competencies in the development process. Today, the *Resident Gallery* is also used as a sales tool to help customers accommodate their facilities with the right equipment. Figure 1 illustrates the five typical user characters used by the company.

Figure 1: User characters in Arjo product development, classified according to their degree of mobility. (Courtesy of Arjo)

One can identify the most mobile to the most dependent resident by their alphabetical names: Albert, Barbara, Carl, Doris and Emma. A detailed description of characteristics and background is linked to each character, which includes information about age, weight, mobility and individual traits. Using this system and all its benefits led Arjo to the next step, the development of the *Mobility Gallery*. That gallery includes additional characters to accommodate other settings, such as hospitals, special care and home care. These characters are used initially in the design process, but currently have no natural place in the subsequent development process. Therefore, Arjo requested a method in which these characters can be applied in the design, modification, visualisation and analyses of health care equipment. The use of the characters (also known as *personas*) has been successful and the method supports the designers since the characters' situations are easier to visualise and to discuss. Similar effects are reported in Pruitt and Grudin [2003]. The characteristics of the different types of customers have spread from the design department and are now also being used by sales people and buyers. For example, purchasers from health care institutions express their needs of products by describing their patients as four Alberts, six Barbaras, two Carls, one Doris and one Emma.

2.2 Vehicle industry

The Swedish vehicle industry has a well established tradition of using computer manikins – a replica of the human – to design the vehicle-driver interface to suit potential users [Hanson, 2004], but also of adapting production equipment and working tasks to the conditions of the production personnel.

Figure 2: Manikin for ergonomic vehicle interior design. (Courtesy of Saab Automobile)

Figure 2 illustrates a female computer manikin testing the interior of a Saab 9-3. The female manikin can then "tell" the designer how comfortable the driving position is, if it is possible to reach all instruments and what she sees in the mirror, etc. Figure 3 illustrates a male computer manikin testing the assembly of an antenna on a Volvo C30. The male manikin can "tell" the designer about the physical workload on his back and shoulders and if the visual requirements are met for the assembly.

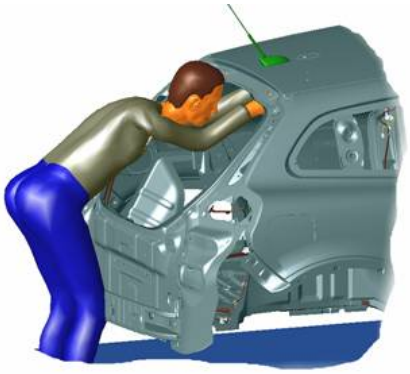

Figure 3: Manikin for evaluating vehicle assembly ergonomics. (Courtesy of Volvo Car Corporation)

The manikins can show this type of information with numbers, but the simulation engineers usually choose to view the results as pictures and colour coded areas. This can, for example, be the view as seen from the eyes of the manikin, or a red coloured shoulder indicating heavy workload, or a coloured area indicating the maximum reach of the manikin.

Visualising information and simulation is a successful approach since it supports communication within and between different disciplines in the vehicle development process. If problems are mutually understood by ergonomists, designers, production engineers and managers, modifications of the product or the workplace are more easily agreed upon. Visualisation is therefore an important approach towards fulfilling drivers' requirements of comfort and control in the vehicle, or healthy and effective assembly on the production line. [Hanson, 2004; Lämkull, 2006]

The manikins utilised to evaluate vehicle interiors or assembly activities aim to represent potential customers of the vehicle or assembly personnel. This is a difficulty for the simulation engineers since each individual is unique in several ways. The current approach used by simulation engineers is to let the manikin represent the bodily (physically) side of the human only. Hence, the manikin is described in anthropometrical terms, typically determined according to corresponding stature. The software defines the remaining body dimensions in order to build up a "normal" person, using existing correlation data. Sometimes a slightly more sophisticated method is utilised where stature, corpulence and proportion are entered to define the manikin's anthropometry. In the literature and at vehicle companies there are strategies for how a reduced number of manikins can represent the anthropometric diversity that exists among vehicle customers and production personnel [Högberg, 2005; Wirsching and Premkumar, 2007]. However, movability is not taken into consideration even though it is possible to alter the movability in the different joints of the manikin. As a result, it is always healthy manikins without any impairments that test the vehicles or the assembly tasks at the virtual (computer simulated) stages of the design process.

The vehicle industry uses descriptions of representatives of the market segments they target in terms of customers' buying power, driving style or hobbies, for example. These characteristics are not reflected in the manikins used and visualised during the development work. However, researcher such as Högberg and Case [2006] as well as Alexander and Conradi [2007] have promoted the introduction of personal characteristics on manikins.

3 Rationale and projected outcome

Based on the descriptions of the situations in the vehicle and health care industries, mutual benefits can be gained from sharing and integrating knowledge and experiences from the two in the consideration and visualisation of user aspects in product development. Introducing efficient visualisation and simulation tools that include computer manikins from the vehicle industry into the health care industry is one such benefit. In the opposite direction, the vehicle industry can benefit from manikins having personal characteristics, which has proven to be successful in the health care industry (but without the use of computer manikins). In essence, the purpose of the research project is to improve the efficiency of product development processes by exchanging knowledge and experiences about user centred design methods and technologies between the two branches: vehicle and health care industries.

3.1 Vehicle industry

After this project the vehicle industry is projected to have a more human centred design process. Although the vehicle industry uses computer manikins in the design process for visualisation, the staff involved frequently treat manikins as anonymous physical objects only. The manikin has the same status as a battery. Both require space in the vehicle to fit either in the cockpit or under the hood. By giving the manikins personal characteristics, based on the experiences from the health care industry, the vehicle development engineer's attitude to them can change. In future discussions, supported by the visualisation of manikins with mapped characteristics, the manikins are more likely to be treated as representing humans. Such a shift may affect the design of the products and product systems positively for the drivers, passengers and assembly personnel. For example, a larger number of users may be accommodated by a more careful and adaptive product or production system design, thanks to the user centred methods and tools employed. Furthermore, there may be a higher degree of customer satisfaction due to the user centred approach in the product design process. Pictures or animations of manikins with personal characteristics using the product or working on the assembly line are expected to encourage and enrich understanding, empathy and communication of user diversity between professionals in different competence groups involved in the development process (e.g. marketing, industrial design, product development, manufacturing engineering and production staff).

3.2 Health care industry

After this project the health care industry will have a formalised evaluation procedure where the results are visualised using computer manikins with personal characteristics. The computer support is expected to result in shorter product development lead time, fewer major iterations and enhanced product quality. The number of physical prototypes will decrease when visualisation and simulation tools are used as a complement to verifying physical prototypes. The personal characters, now sporadically used in early design stages, will be used throughout the entire design process. Such a user centred design process, supported by manikin visualisations can lead to products that to a higher degree meet the demands of the users. Using a set of manikins in the design process for evaluating health care products can lead to products that consider and cater for user diversity in a richer way. A visualisation of a manikin with personal characteristics using health care products is projected to provide enhanced communication between different stakeholders in the health care development process.

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