

Ergonomics Requirement Verification Development at Volvo Bus Product Development

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The aim with this development work was to provide product designers and designers at Volvo Bus, in their work with driver compartment, with support within ergonomics in an accessible and easy way. A screening of today's ergonomics standard and requirements connected to driver compartment ergonomics was carried out. In a participatory way, 3D requirement models for, e.g. vision and reach, were developed with the help of the manikin software V5 Human. The result includes a number of 3D-models and a number of support documents, Global Development Instruction (GDI) to be used by product designers and designers within Volvo Bus.

Ergonomics requirements, ergonomics tool, verification, manikin, 3D, methodology, participation

1 Introduction

Time to market as well as time for a number of development loops in product development decreases. In this setting, virtual product and production development are becoming more and more important. Of importance is to early verify and eliminate problems in all areas, including ergonomics. Here the use of 3D-modelling and analysis is in focus. Generally, the visibility of ergonomics and also how early the ergonomist can affect the product development process is considered poor. Beside this, it has historically been difficult to argue for ergonomics solutions and requirements. This due to the difficulties to prove, explain and visualize ergonomics issues in relation to and in cooperation with other areas such as design and industrial engineering (see e.g. Chaffin, 2001 and Sundin & Örtengren, 2006). By an increased availability and use of 3D-modelling tools for ergonomics, computer manikins, the possibility to cope with above mentioned problems have become much higher.

Volvo Bus Corporation and Driver Compartment 86120 at Global Body Development continue their effort and strive to evolve and integrate ergonomics and human factors into product development work. However, today the support for the designer on how to consider ergonomics criteria in the daily development work is limited. As one step in this strive, the Technical Area Ergonomics at Caran, together with Volvo Bus, have developed practical and easy-to-use solutions to support mainly product designers and designers of the driver compartment, but also other parts of the company. The developed models and supporting documents started to be used in the beginning of 2007 in the bus project New Coach. The aim has been to develop an ergonomics framework of parts of the driving compartment. The central result of the assignment include 3D ergonomics requirement models as well as supporting document in the form of a

number of Global Development Instructions, GDI, to be used both by product designers and designers at Volvo Bus.

2 Method

The methodology contained the following steps.

1. Review of today's ergonomics standards and requirements
2. Formation of a working group with varying disciplines
3. Development of ergonomics 3D requirement models
4. Development of support documents

2.1 Review of today's standards and requirements

Available requirements documents was collected and reviewed, such as the Volvo Bus Global Development Process GDP and a variety of ergonomics standards and directive. Interviews were also conducted with employees in various positions within Volvo Bus.

2.2 Formation of a working group

A working group with various disciplines was formed at Volvo Bus to ensure a participatory development work. The group contained of product designers, designers, ergonomists, IT-personnel and the product manager driver compartment. The project also formed a steering group with managers from within Volvo Bus.

2.3 Ergonomics 3D requirement modeling

Based on the legal requirements, sometimes reinforced by Volvo Bus internal demands, the manikin software Delmia V5 Human was used to build and develop new 3D requirement models for e.g. vision and reach. Also Catia V5 was used in some parts.

2.4 Support document development

Finally, support documents were created. Those documents were developed within the ordinary used document system Global Development instructions, GDI. One GDI was written for each area, e.g. hand control reach, and one general GDI was written as a general and nomenclature guide to be used by the designers.

3 Results

After collecting and reviewing available documents the following situation was described to summarize; standards and recommendations existed in the company, but its use and availability were not wide and also sometime unclear. Also "how"-document were not visible enough, i.e. support documents with information on in what way a designer should work with an ergonomics issue or problem.

Other things that have been a base for the development work were output from the interviews, where the following items were seen central; a wish to have support and competence close in an easy way, and to gain support on e.g. manikins/percentiles, envelopes; foot areas, reach envelopes of arms, vision, ingress/egress and reference points.

In the project, Volvo Bus and Caran jointly limited the areas to be developed to three areas:

1. Hand control reach
2. Forward direct visibility
3. Pedals. Reach and clearance

For each area, a 3D requirement model was developed. This so called ergonomics 3D requirement model is a CAD-model representing the limiting or governing area (or envelope/plane/space) of ergonomics requirements from standards and requirements used within Volvo Bus (see e.g. Figure 1 and Figure 2). All developed 3D-models were not strictly based on the standards, but created with the standards as a base/guideline and when needed made stricter to improve the future bus environment even more. Modifications have continuously been jointly agreed on by Caran and Volvo Bus. In those cases the requirement in the standard has been strict enough; the standard has been used without modifications to act as input to the 3D requirement model. The models were developed with the help of the manikin software Delmia V5 Human, where reach studies were carried out and analysed. The developed 3D requirement model themselves were finally produced in Catia V5.

The 3D-models were then placed in KOLA, the Volvo Bus product structure system, easy accessible for all at Volvo Bus. Considerations have been taken regarding who will be able to use the model and who will be able to make changes, i.e. part of a changed work procedure. The developed models had the Catia Part format to be used by product designers and designers.

Early, a pilot testing phase was carried out where 3D-models were used by product designers in their work with concept design of a new coach. The results from the pilot phase were positive, where the product designers considered the 3D-models as very helpful in an early and easy way take ergonomics requirements into consideration.

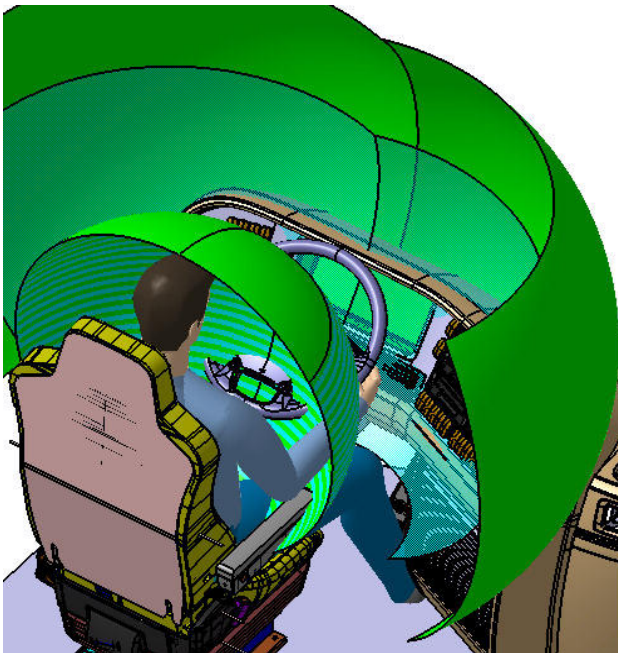


Figure 1. The ergonomics requirement model for primary reach (turquoise) and secondary reach (green) visualised with the computer manikin V5 Human.

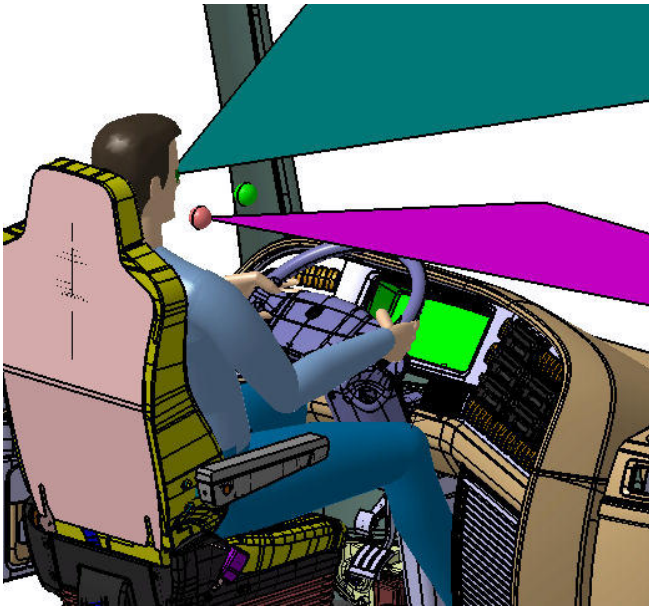


Figure 2. The ergonomics requirement model for up- and downward visibility

Beside the 3D-models, the result also included a number of support documents, Global Development Instruction, GDI. The GDI documents includes a description how to work with the 3D requirement models and also a nomenclature for the area, e.g. explanations and definitions of H-point, direct forward vision etc. The documents were put in the Volvo Bus document database.

In total, five GDI for the use of ergonomics 3D requirement models were developed and written in the project:

- GDI General information
- GDI Hand control reach
- GDI Forward direct visibility
- GDI Pedals. Reach and clearance
- GDI Ordering of ergonomics simulation

The last GDI, Ordering of ergonomics simulation, was written to support ergonomics simulation tasks to be carried out by Volvo Bus or external parties. It is to be used when an ergonomics analysis/simulation is to be carried out. By filling this document in, the scope with the simulation is easier to be reached. The template can be jointly filled in by the simulation engineer and the person ordering the simulation for easier and more correct result. The use of an ordering template strives to help to improve the quality of the simulation and time needed for both parties, the orderer and the analyst. As more thorough filled out and shared in the ordering phase, the less are the questions and errors during the simulation process. Thus, the ergonomics application engineer (simulant) knows the task better and the orderer knows what the results will be and how results will be presented.

4 Discussion

The aim with this assignment was to improve and visualise the daily work with ergonomics in product design and design at Volvo Bus. The output, 3D requirement models and GDIs, has been met positively by product designers and designers. This type of information, i.e. easy accessible CAD-models determining the boundaries regarding ergonomics and physical attributes, will play an even more central role in product development and ergonomics work. Especially vehicle development companies have put effort in this direction for some time already and have reached high quality. Challenges during this development work were the mitigation of new demands and requirements into the existing requirements, both standards and directives, and thereafter model the demands to fit Volvo Bus.

5 Acknowledgements

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