# Computer-based Protocol for Human Simulation Report

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*Published in:*
Proceedings of IEA 2003

2003

# COMPUTER-BASED PROTOCOL FOR HUMAN SIMULATION REPORT

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The aim of the present case study is to present and evaluate a computer-based standardized procedure to order, perform and document virtual ergonomic analyses. Results showed that the use of the new working methodology increased the number of factors considered during analysis. Participants indicated that the proposed methodology, including task analysis and use of manikin families, would increase the reliability of the results. The increase in numbers of factors considered during analysis and the improved reliability of the results is also likely to reduce the number of iterations needed in the design process to make products meet established requirements, therefore reducing total development time.

## INTRODUCTION

In the vehicle development process, people at different departments in the company use a variety of human simulation tools to represent users, e.g. drivers, passengers and assemblers of the vehicle. The tools assist designers and engineers in considering different human-vehicle interaction issues and focus on different physical parameters, e.g. geometry. For the last few decades, the utilization of human simulation tools has supported human-vehicle interaction analysis to be performed in virtual environments, hence making it possible to analyze a variety of human interaction aspects with relevant populations before any physical mock-up is built.

In order to store gained experiences, knowledge preferably is saved in the world, for example, ergonomic facts in guidelines instead of in the head of the engineer who evaluates the vehicle (Reason, 1997). Several surveys have shown that the ergonomic knowledge available in guidelines and documents often is hard to acquire, incomplete or not suited to the process or users (Simpson and Mason, 1983), (Woodcock and Flyte, 1998).

However, guidelines about ergonomics will not automatically solve the situation of the simulation process. The ergonomic data have to be used properly in order to generate good ergonomic evaluations. To do so, there is a need for deeper understanding of the tools' limitations and their evaluation methods (Rönnäng, et al., 2002). Furthermore, the simulation tools need to be used according to a proper work methodology to fulfill important considerations (Green, 2000).

A survey on human simulation utilization performed at Saab Automobile identified some deficiencies in their process (Blomé, et al., 2003). No common working methodology could be identified. The virtual ergonomic evaluation/analysis was performed in different ways depending on who performed it, from which department and what issues were verified, e.g. head clearance, field of view, force. Furthermore, the survey showed that human simulation tools were not utilized to their full potential due to little or no time spent on settings, e.g. motivation of the analysis and evaluation criteria. Deficiencies were also noticed in communication between departments performing human simulation, leading to redundancy in the work performed. Finally, the study showed lack of routines to

document the procedure.

The aim of the present case study is to present and evaluate a computer-based standardized procedure to order, perform and document virtual ergonomic analysis.

## METHOD

Inspired by Wilson's (Wilson and Haines, 1997) participative approach in workplace design, a concept was developed based on Green's (Green, 2000) generic process and Sundin's (Sundin, 2001) suggestions of task analysis and documentation for human simulation usage. The concept was visualized as a web page inspired by internal ordering formulas within the GM group. The methodology supported by the web application was demonstrated and discussed within a group of three human factors engineers at Saab Automobile. The first engineer had basic ergonomic education and experience of human simulation work, the second had basic ergonomic education but did not use any human simulation programs, and the third was the project coordinator among the human factor engineers and had no significant experience of human simulation work or ergonomic education. The discussion was led by two of the authors and careful observation notes were taken.

## RESULT

### The prototype

The human simulation task settings/requirements were to be stipulated in a request formula on an intranet web site by the simulation customer, e.g. the ergonomic project coordinator or a project manager.
These settings included:

- background to motivate the analysis
- the objectives of the analysis
- descriptions of tasks to simulate and evaluate
- evaluation criteria and specifications, e.g. documents from marketing, ergonomic guidelines, technical specifications and brand profile competencies
- user population definitions, e.g. nationality, sex and age, body height, sitting height and waist circumference
- description of environment where the simulation takes place, e.g. CAD drawings.

The request formula was visualized with checkboxes and drop-down menus to present the procedure clearly. Furthermore, some explanations such as human body dimensions were visualized with pictures (Figure 1).

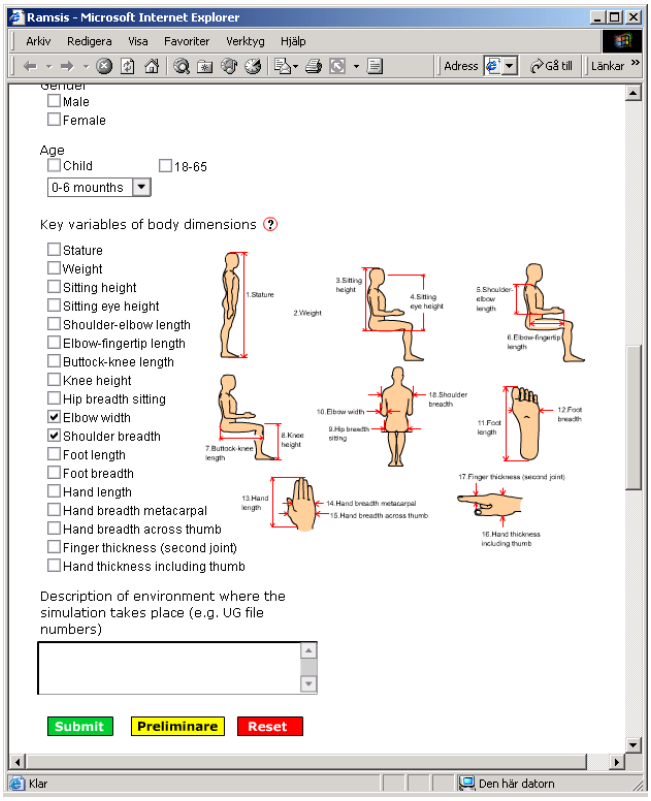

Figure 1. Screen dump of the request formula on a web page.

The performer of the human simulation is then expected to progress through the documentation by filling in corrections and/or limitations, by adding information to the request and, also by completing the documentation in the following steps:

- define simulation software used, e.g. RAMSIS
- show and comment on results towards evaluation criteria, e.g. pictures and tables
- list related documents, i.e. references, sources, generated files during simulation
- recommendations of actions to be taken

The progress formula was visualized to complete the request formula and add information such as pictures and tables (Figure 2).

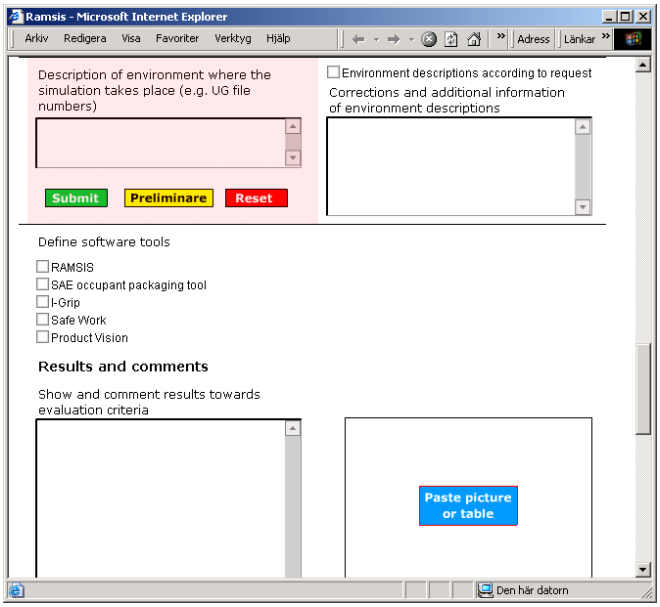

Figure 2. Screen dump of the progress formula on a web page.

**Evaluations**

The participants considered the documentation requirements to be too extensive if the simulation tasks in total would take a few hours, but appropriate if the simulation required several days. A computer-based solution might be necessary if it were to be used between companies within the GM Corporation to which Saab Automobile belongs. If that was going to be the case, the approach and the contents were applicable with some adjustments regarding how the detailed information should be presented, e.g. coordinates of target points.

The simulation tasks are at present formulated by the persons performing the simulations, based on a vague problem definition. Hence, they thought it would be difficult to receive well-defined tasks from someone other than themselves.

The participants wanted different Word document templates for different kinds of human simulations, including physical prototypes as well as virtual human simulations, with detailed information required, such as coordinates of target points.

## DISCUSSION

The human simulation work is considered to be poorly defined at the department studied. It is the authors' belief that a standardized procedure could be regarded as a guideline and guide the work according to a visualized request and progress formula on the intranet. This approach would provide new employees with an appropriate introduction as well as supporting the experts in performing human simulation work according to stated requirements. The computer-based formulas would save the procedure in the world instead of the engineers' head, thus reducing the mental load and the risks of different results depending on the performer of the human simulation work.

Furthermore, a well-documented procedure would justify the work done at the department. If its importance cannot be demonstrated, there is a risk that the ergonomic factors will be reduced to common sense judgments and that ergonomic evaluations will only consist of human factors opinions. Thus, the company will not be able to develop ergonomic innovations.

The participants in the study were skeptical about the suggested computer-based procedure, since they currently ordered and defined the simulation jobs themselves. A suggestion presented to the participants was to make the project coordinator for ergonomic matters responsible for ordering and initially defining the human simulation work from the human simulation engineers at the department. However, a well-defined request was considered to require experience of human simulation, knowledge about limitations and possibilities of the simulation tools as well as fundamental knowledge of ergonomics, something making the project coordinator's role more specialized towards ergonomic simulation than required today.

A structured documentation would increase the possibilities to search for information and analyze the working procedure. Results showed that the use of the new working methodology increased the number of factors considered during analysis. For example, consideration of driver population variety was higher when using the new method compared to the old one. Participants indicated that the proposed methodology, including task analysis and use of manikin families, would increase the reliability of the results. On the other hand, the analysis time for the proposed methodology may increase compared to the old one.

However, the total completion time of evaluation may be reduced with the proposed methodology when users become accustomed to it, and if information can be traced and reused through proper documentation of the simulation results. The increase in numbers of factors considered during analysis and the improved reliability of the results is also likely to reduce the number of iterations needed in the design process to make products meet established requirements, therefore reducing total development time.

## ACKNOWLEDGEMENT

This research was performed within the VERDI project (virtual ergonomic design integration) supported by the Program Board for Swedish Automotive Research.

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