

Title: Design of safer workstations: digital manikins are hard at work at INRS

Author: SAVIN Jonathan

Abstract

Over the last 20 years, digital manikins have been integrated into computer tools (Computer Aided Design – CAD, virtual design environments) implemented by machine or workstation designers. These virtual humans can be used for evaluating the ergonomics of a workstation or work situation. For a number of years, INRS has undertaken various actions aimed at assessing the degree of confidence we can attribute to these tools.

Initial results have confirmed the prevention advantages of digital manikins at design stage, but have also identified certain utilisation constraints. Today, INRS work in the digital manikin field continues in order to stimulate improvement in these tools and offer their developers new functions ensuring enhanced prevention at design stage.

Text

Over the last 20 years, acceleration of markets and competition has created an essential need to implement digital tools for designing better and quicker. At the same time, application of safety principles at work equipment design stage has become compulsory at European level through the so-called "Machinery" directive [1]. This prevention development, called "integrated prevention", has gradually led designers to take better account of "man-machine" interactions in order to protect operators against work accidents and occupational diseases.

This context of competitiveness and design stage integration of prevention, along with ever increasing capacity of computer resources, has prompted the appearance of digital manikins, such as DELMIA Human, in design tools (i.e. CAD) and, more recently, in design virtual environments.

This immediately raises a question: what degree of confidence can we then place in biomechanical assessments performed using these digital manikin software application at design stage compared with those conducted in real situations?

To answer this question, since the year 2000, France's Institut National de Recherche et de Sécurité for the prevention of occupational accidents and diseases (INRS) has launched different actions implementing these technologies, in particular Delmia-Human software (cf. figures 1 and 2).

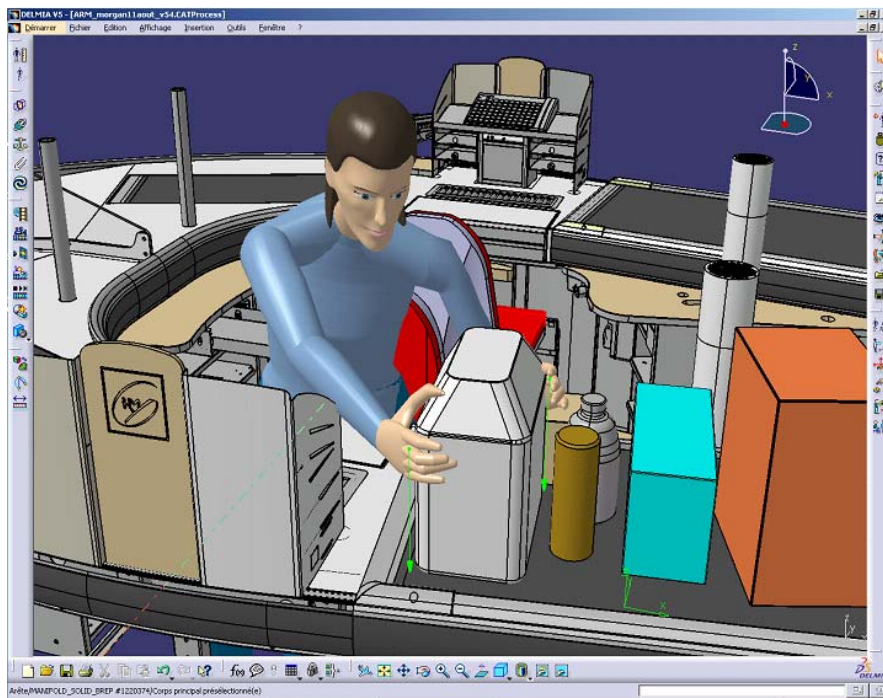


Figure 1. Simulation of boxing up workstation activity using the Delmia-Human manikin

Initial results show that it is now possible for designers possessing digital manikin software, such as DELMIA-Human, to tackle certain physical aspects of work activity and anticipate the consequences of various design decisions in terms of operator health risks: comparison of different configurations or versions, checking compliance with ergonomic principles or proposing corrective measures far upstream in the design cycle.

However, it should be recalled that there will always be differences between a task simulated using a digital manikin and the corresponding real task. Despite the advances made, these software applications are in fact based on both biomechanical approximations (number of human model segments and their degrees of interaction, related anthropometric databases, inconsideration of dynamics) and on describing a probable future situation (forecast versus real). These approximations necessarily have repercussions on the ergonomic assessments made [2]. Resorting to an experienced ergonomist is therefore essential for interpreting a simulation obtained using these applications.

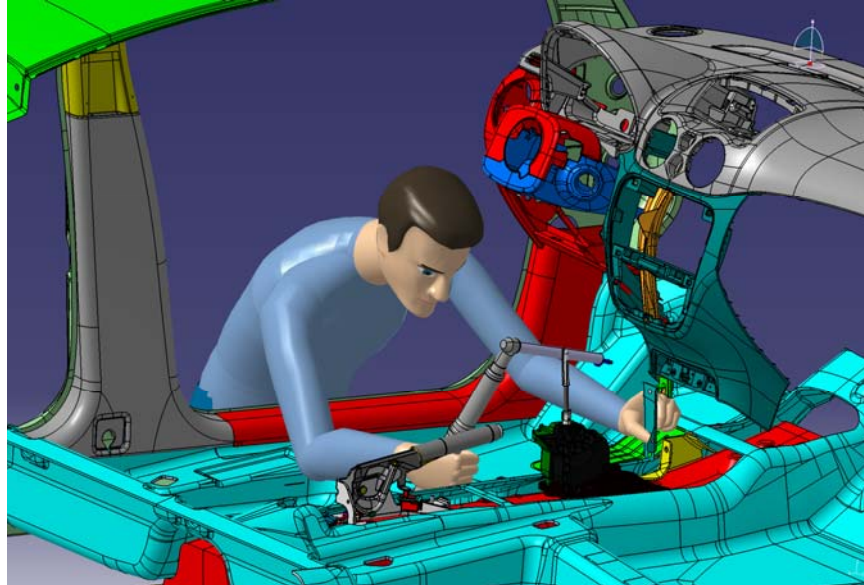


Figure 2. Model of a car assembly activity for the PERF-RV2 project – car CAD model courtesy of PSA Peugeot Citroën

Today, INRS is pursuing its digital manikin-related actions and, in particular, with DELMIA-Human. For example, in conjunction with technical teams from Dassault Systèmes and its subsidiaries (Kéonys), INRS is developing new macro-based (Visual Basic) functions in relation to demonstrating feasibility. These modules include implementation of the ergonomic evaluators recently defined in European Standards EN 1005-1 to 5, which support the “Machinery” directive in helping designers to integrate aspects involving operator physical performance characteristics (strength, postures and movements, repetitive high-frequency handling operations, etc.). Within the framework of projects such as PERF-RV2¹, INRS also contributes to developing biomechanical models that take better of muscular phenomena associated with postural support and movement dynamic aspects.

For INRS, the objectives of this research are multiple: firstly, to inform designers and prevention specialists of the advantages of digital manikins, such as DELMIA-Human, in terms of enhanced design; secondly, to warn them of the limiting conditions when implementing these tools, thereby ensuring that their improper usage does not lead the opposite of the desired effect; finally, to propose avenues of improvement for these tools to software developers and the scientific community, whilst maintaining constant concern for better prevention right from design stage.

Bibliography

- [1] “Directive 2006/42/CE of 17th May 2006 on Machinery”, JO-UE n° L 157 of 09/06/2006 – pp. 24-86.
- [2] L. Claudon "Apports et limites des mannequins numériques pour la conception des postes de travail à travers deux études de cas" [advantages and limits of digital manikins in workstation design based on 2 case studies] ERGO IA 2008, Biarritz, 13-15/10/2008, ESTIA, pp. 199-204.

1 « Plate-forme française de réalité virtuelle – L'humain virtuel au travail dans l'usine du futur » [French virtual reality platform – Virtual reality in the factory of the future].
French national research project supported by the Ministry of Research and Technology within the framework of the Software Technology Research and Innovation National Network (<http://www.perfrv2.fr>)