THUMS USER COMMUNITY: BACKGROUND, MOTIVATION AND STATUS OF THE COLLABORATIVE PROJECT

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Background

In recent years Finite-Element (FE) Human Body Models (HBMs) considerably gained in importance not only for the evaluation of occupants' passive safety systems, but also in the field of pedestrian protection. HBMs are characterised as complementing conventional dummy models when limits of crash tests or simulations with dummies are reached. The advancement and enormous improvements of passive safety systems demand tools which are more accurate in terms of biofidelity and injury risk prediction, like HBMs, for the evaluation of their quality. However, users of HBMs are facing numerous challenges. The complex anatomy of the human body has to be generated using imaging techniques such as CT or MRI and to be represented by suitable meshes for a correct model geometry. In terms of material modelling, choosing adequate constitutive material models and parameters for the different biological tissues demands great experience and knowledge from the users due to the non-linear, anisotropic and viscoelastic characteristics of these tissues [1]. Furthermore, the variety of available models and crash codes impedes harmonised results of crash simulations. Outcomes depend on the model and code used for the simulation [2-4].]. Finally, hardly any or just rudimentary procedures and methods have been discussed and agreed within the safety community in terms of pre-or post-processing of HBMs and its simulation results.

Motivation

Currently, the HBMs are used by the project partners in the three different codes Abaqus, Ls-Dyna and VPS. Within the project THUMS User Community it is aimed to develop a harmonised master model which is capable of delivering credible **harmonised crash simulation results** even when using different crash codes. Especially the **robust and effective application** of the HBMs together with their **biomechanical validity** is major aim of the project's activities. In the long term, the usability and robustness shall be safeguarded by sharing and exchanging pre-competitive know-how and experiences with the application of HBMs among the users. The Total Human Model for Safety (THUMS) V3 developed by Toyota Motor Corporation and Toyota R&D Labs is used within the project.

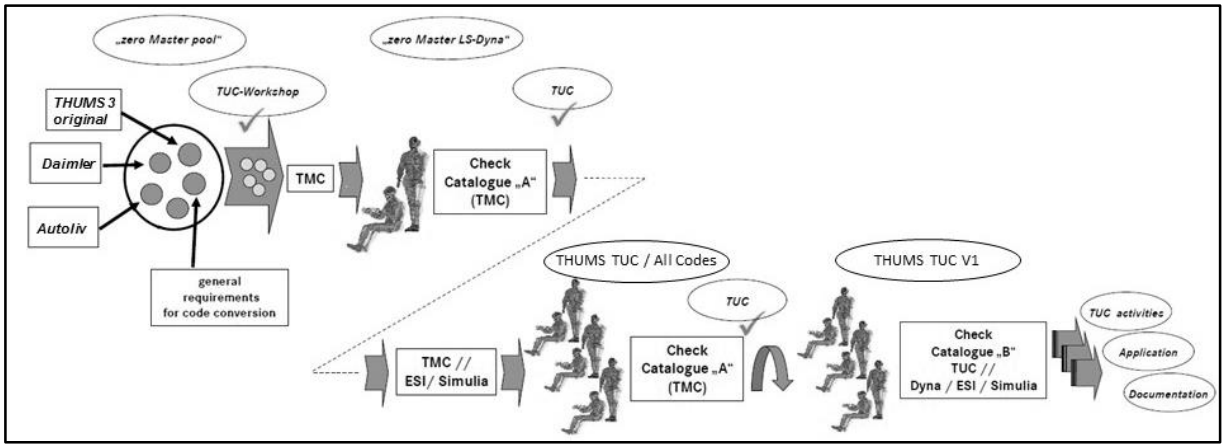

Fig. 1 process to a harmonised Human Body Model

Status

Past experiences with translating HBMs from LS-Dyna into VPS and Abaqus were analysed for developing model guidelines to define exact requirements a human model should fulfil to ensure an improved convertibility from one crash code into another, in this case from LS-Dyna to VPS and Abaqus. In a second step, model updates and upgrades were integrated in the original LS-Dyna version of the human model THUMS V3.

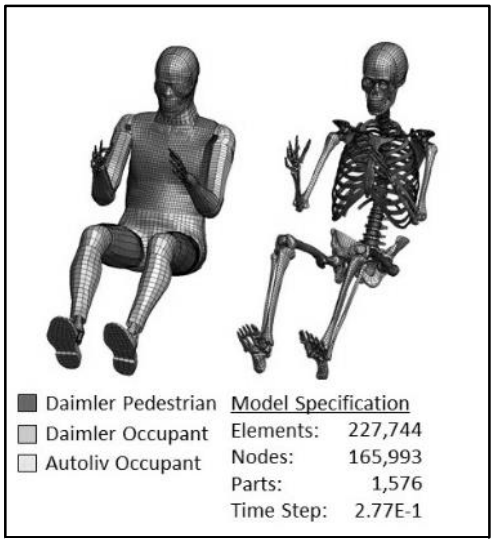

Fig. 2 model integration (basis: original LS-Dyna version of THUMS V3)

As a third action, a multi-stage **validation catalogue** was developed representing different levels of validation based on published research results. A basic validation check was conducted ensuring a robust model that can be translated into the other crash codes without major changes and delivers comparable results even if different crash codes are used. Purpose of a second-stage catalogue will be to assess and improve the biomechanical quality of the models. Running a simulation of a car-to-pedestrian collision proved to be an adequate demonstrator of the robustness and is seen to be a good benchmark for code-dependency of results.

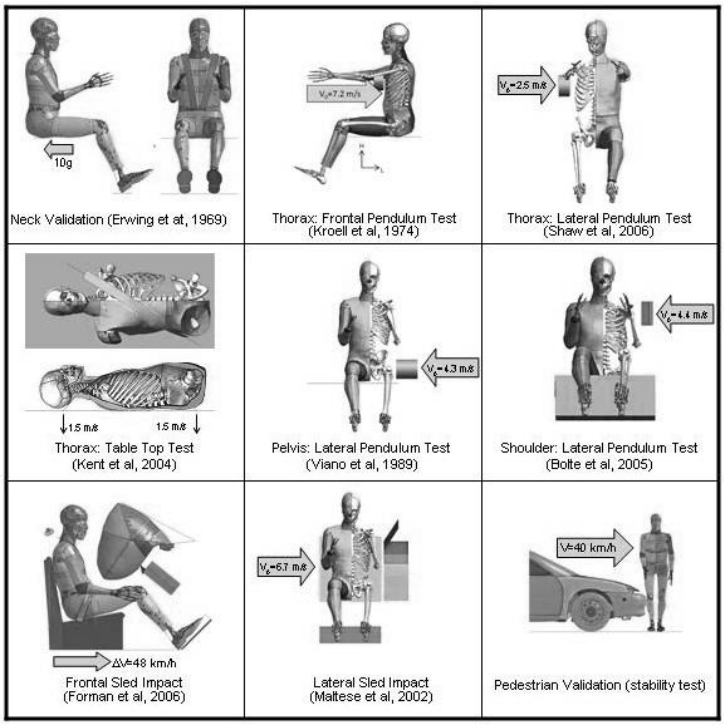

Fig. 3 basic validation checks conducted

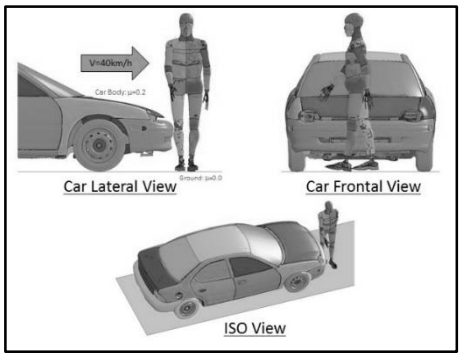

Fig. 4 car-to-pedestrian impact

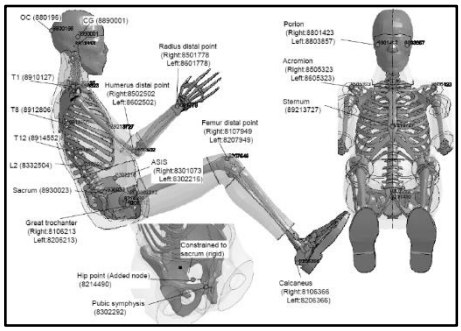

Fig. 5 tracking points for code comparability

Outlook

Furthermore, harmonised methods for the application of HBMs are being discussed and shall be developed within the scope of this project. This includes the development of a **harmonised positioning** and **scaling** method. **Objective criteria** shall define broadly accepted and harmonised requirements for the performance of the models in simulations and evaluate the validation results properly. Furthermore, methods to compare the harmonised THUMS models between the different codes are currently identified and developed. Therefore, mesh-independent reference points defined on the basis of CT scans are developed and attached to local structures of the model.

Acknowledgment

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