

Automated Process for Occupant Safety Simulation

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Abstract:

In recent years, the demands on occupant safety simulation have increased exponentially. There are several reasons for this, for example more stringent requirements from legal and consumer tests, shorter development time and simulation in place of hardware tests. This leads to higher demands on the simulation process to provide more accurate answers.

Due to these increased requirements on the occupant safety simulation, the models become more complex and the number of load cases increases. By working in the normal way, many failures occur as a result of handling many and varied load cases. For solving this problem an automated process for occupant safety simulation has been developed in which it is possible to make a status, optimise and explore the design area or make detail calculations with only a few mouse clicks

Keywords:

Occupant Safety Simulation, Automated Process, DSPEX, LS-OPT

1 History

At AUDI AG, the development of occupant safety systems for frontal impact by using Finite Element (FE) Simulations has increased significantly over the last years. The number of load cases simulated in FE has risen to 26. When handling a large number of load cases, it happens that for example a Euro-NCAP load case is used as a base for an US-NCAP simulation. These two load cases have different trigger times (this is the time to activate the restraint systems after initialising the crash) for belt and airbag. After solving the new build US-NCAP it occurs sometimes that not all trigger times are updated and the calculation has to be repeated. Even worse, the failure may go unnoticed and incorrect conclusions could be drawn from this simulation.

One of the advantages of simulation over hard ware tests is the relative simplicity with which modifications can be made to a restraint system and estimations on the effect of this change on all load cases without investing money and resources in expensive hard ware tests. It often occurs for example that an airbag shape is changed during car development. With this new shape, it is necessary to understand the overall effect of this change on all load cases and therefore gather a status over all load cases. Then it is necessary to update the models and run an analysis on all load cases with the new airbag shape. Without an automated process a lot of time is spent building the models, transferring data for calculation and analysing the results separately for all simulations.

As mentioned above it is obvious that the demands on an automated occupant safety simulation process have increased. In such a process it is desired to have a development process with less failures and a benefit in time for building, running and analysing the models.

An automated process for occupant safety simulation must meet the following requirements:

- it must be possible to review the status of selected or all load cases
- it must be possible to improve the performance of an occupant restrain system by using optimization or exploring the design area
- the original use of FE-simulations for detailed questions or design of components must be available

A tool named "Variator" from AUDI AG is programmed which includes the above listed requirements. The evolution of this process at AUDI AG is displayed in figure 1.

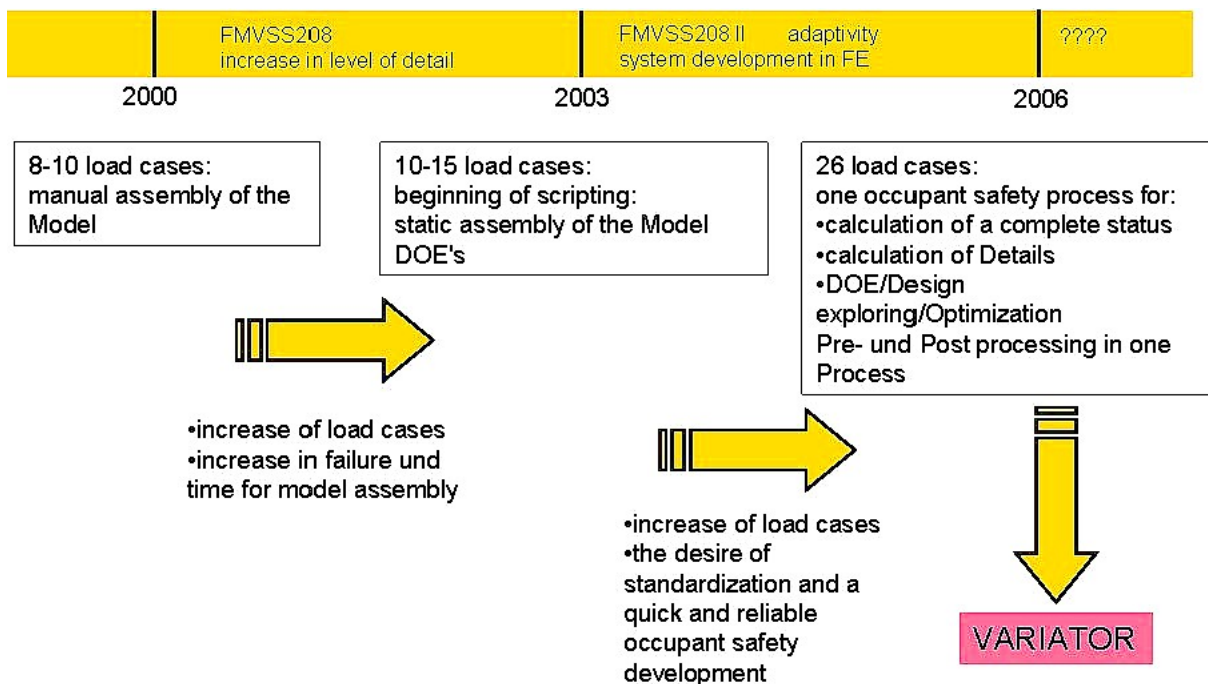


Figure 1: History of automated process for occupant safety simulation development

2 Philosophy of the Program

In occupant safety simulation, the models are formed from different modules (include files) for example dummy, airbag, steering column, seat belt and cockpit. When using Variator, it is necessary to work with prescribed conventions. For example, the communication between the includes is described and it is necessary to have a nomenclature for the model files, include files and configuration files.

For each car project, one data pool is available. Only one module version of a component can exist. It is also possible to use components from other projects. The big advantage is: a module exists only once and the well known question: "which include file should be taken" is no longer necessary.

Variator is able to determine which models are to be built. This is achieved by a unique characterisation of the actual models, replacement of all load case dependent variables by wild cards in a data pool and the above mentioned convention,

In Variator, it is possible to select between different run modes:

- building and/or running selected models
- automated running a status of chosen load cases including analyses
- optimization mode for exploring the design area or optimization by using defined variable

Variator can be used in "script-mode" and in a Graphical User Interface (GUI).

3 Range of Applikation

When running Variator in the "status-mode", the simulations are automatically imported in a data base called CAE-Bench from MSC. In CAE-Bench it is possible to create curve/value reports for comparing different versions or load cases. In the import routine there is also an automatic status sheet creator implement. This is done with the tool Evaluator from GNS (see figure 2).

In the "opti-mode" it is possible to choose defined variables for the optimization or the exploration of the design area. Variator creates the configuration files for LS-OPT. After running LS-OPT the program DSPEX from DYNAMORE can be used for the design exploration. This tool has many helpful features for the exploration of the design area (see figure 2):

- With the calculated results it is possible to create a meta model (mathematical description of the problem) on the base of a neural network.
- This meta model can be displayed and explored both in 2D or 3D and the non visible variables can be set by using sliders.
- Utilizing predefined outputs from the FE dummy for instance head, pelvis or chest acceleration over time curves or chest forward displacement over time curves, it is possible to display the curves and the dependency on the variables by colour. It is also possible to mix curves: take one acceleration and one displacement over time, then it is possible to create an acceleration displacement curve.
- It is possible to take a really deep view into the physics by clicking on one or more of the result points in the DSPEX-viewer to open an external viewer like Evaluator. Then one status sheet from the selected calculation out of many can be analysed with all representative Occupant safety curves and values.

When running Variator in the "auto-mode", the models are built for calculating details, for example the behaviour of a cockpit and steering column during a specific crash.

The above described applications are displayed in figure 2.

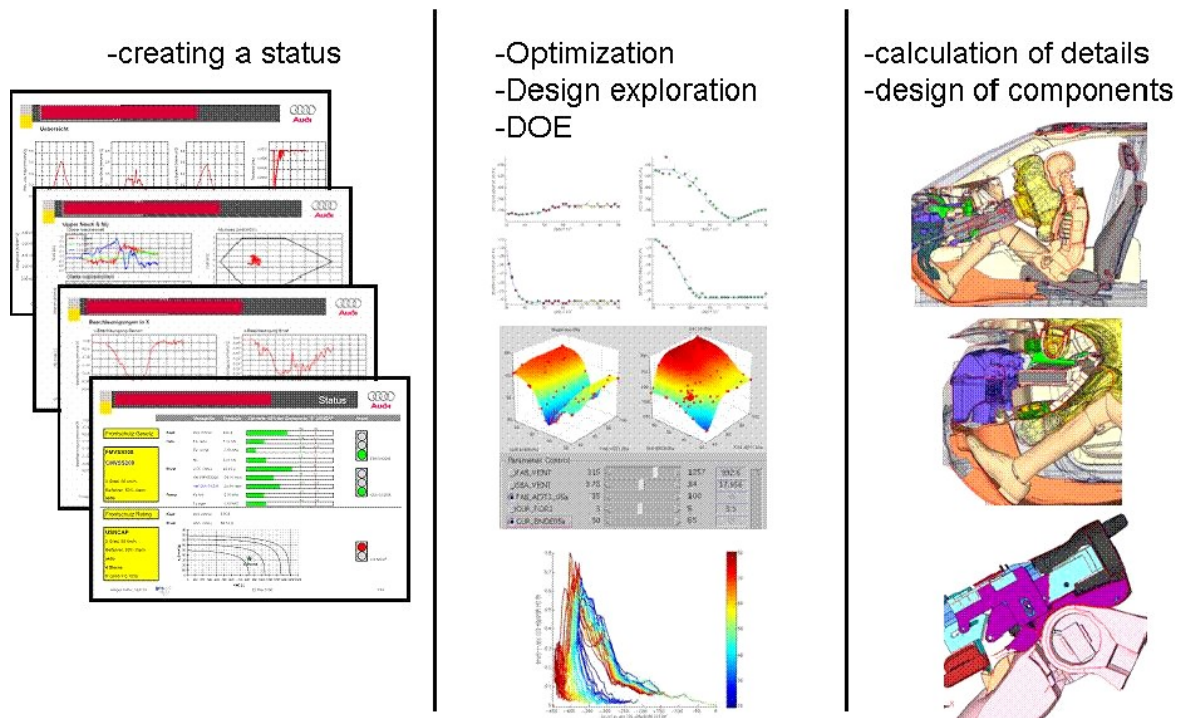


Figure 2: Range of application of Variator

4 Conclusions

By using Variator it is possible to handle the 26 considered load cases. Currently the development process at AUDI AG occupant safety department has:

- less failures when handling more load cases
- saved a lot of time for generating the models
- a standardised working process
- a more robust development of the restraint system. This is achieved with the capability to make a status, optimization or an exploration of the design area with just a few mouse clicks (only calculation resources are necessary)
- following a common strategy for all projects, a simple building block development process becomes possible