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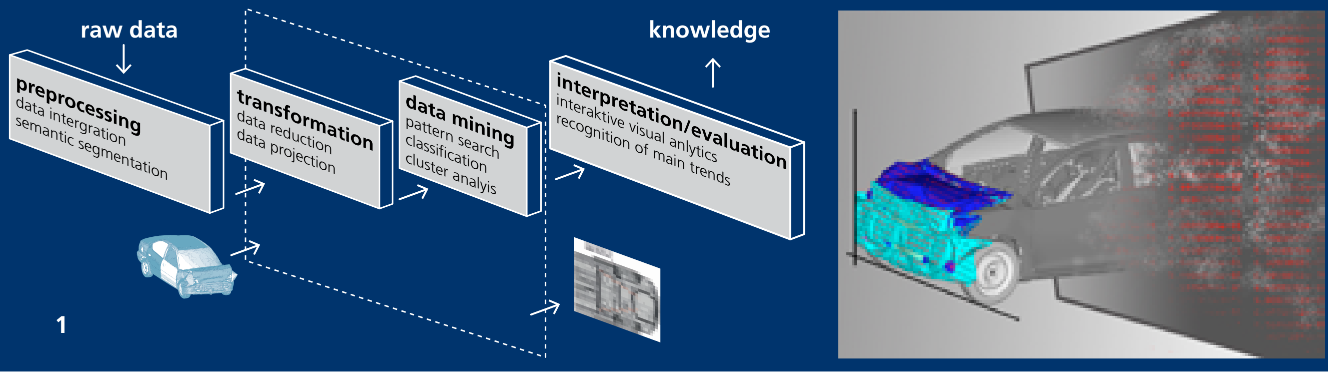

1 *Process for the comparative analysis of hundreds of simulations*

FEMMINER: ACCELERATED ANALYSIS FOR HUNDREDS OF SIMULATIONS

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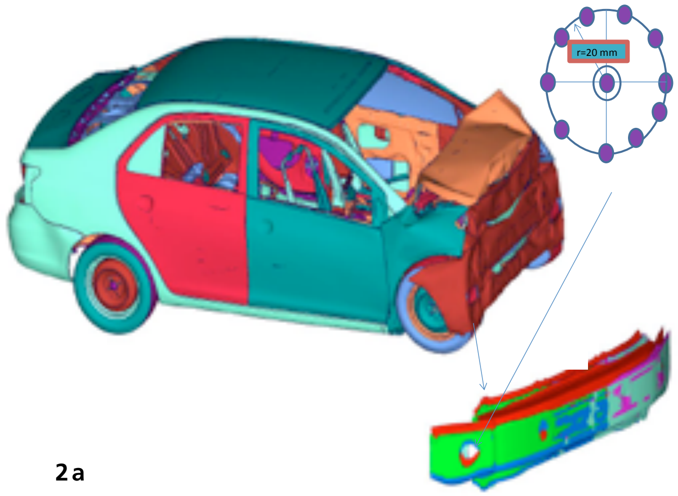
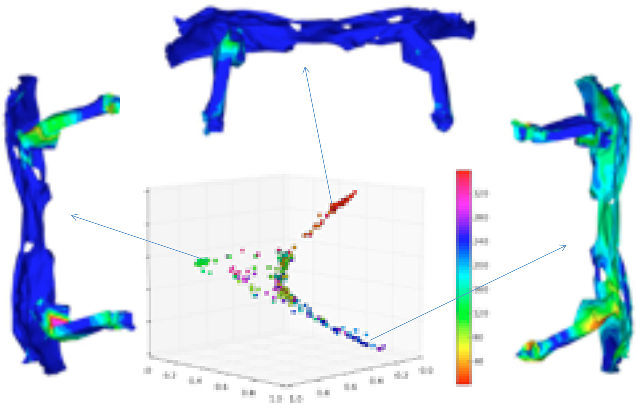
The demand for improved product development in industry has led to a tremendous growth in the number of large-scale finite element simulations being performed. Dimension reduction techniques that extract the essential variations between designs and simulation results provide a new approach for analyzing product variants stored in huge simulation repositories.

In this context Fraunhofer SCAI investigates innovative solutions for the automotive industry.
The goal is to develop an easy and inter-active method to support the engineer in the evaluation of many model variants. This task currently can take several days using standard post-processing tools since each 3D simulation must be evaluated and compared with all others by hand. This is necessary to identify the design with the best product properties under constraints like cost. The methodology developed in the joint project FEMMiner extracts intrinsic low dimensional structures from the data using methods from machine learning. As a consequence of the low dimensional embedding, an intuitive overview of all simulations variants is enabled, speeding up the post-processing for hundreds of simulations from several days to a few hours.

The methodology can be used for the evaluation of simulation variants in the automotive industry where huge reposito-ries of CAE (Computer Aided Engineering) models and simulation are common. A large automotive company will have a repository of over 500.000 CAE-models which grows by more than 1000 models a day. For the first time post-processing of such huge amounts of numerical simulation data has been made possible by our approach (Figure 1).



2a



2b

An industrial example in frontal crash

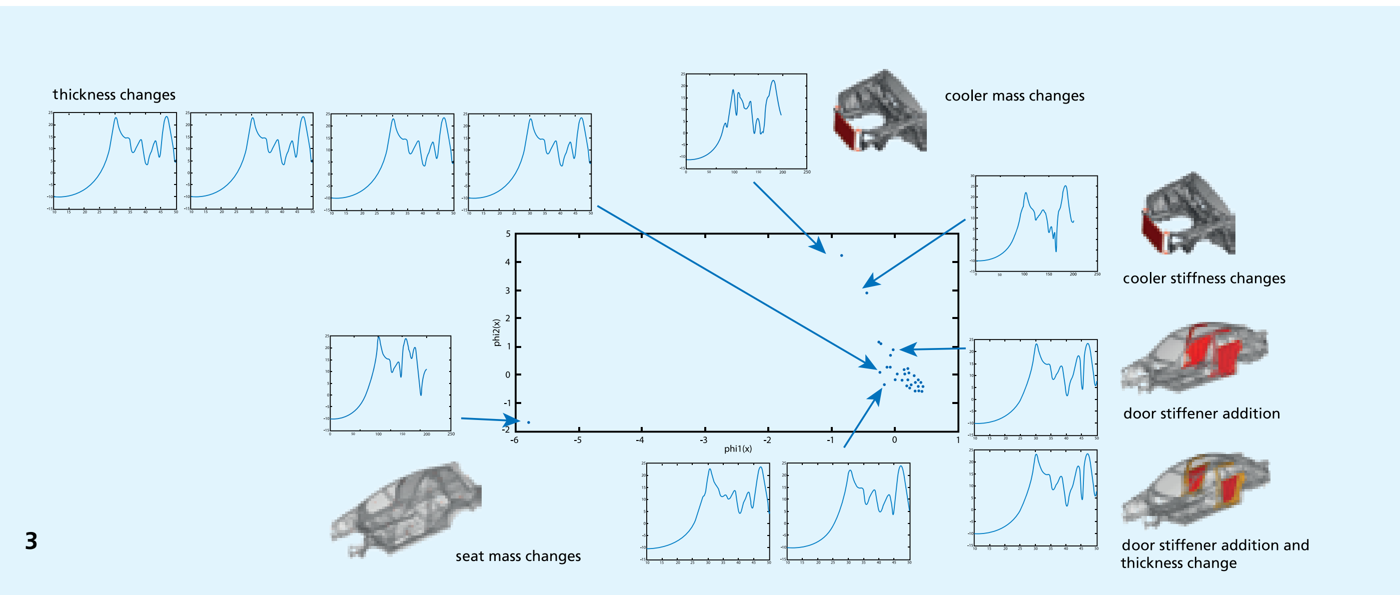
The industrial applicability of the methodology is demonstrated by an analysis test of the location of a bumper for a Toyota car in a frontal crash, performed together with GNS mbH. The bumper location is varied along a circle with radius 20 mm (Figure 2a). A total of 243 LSDYNA simulations have been done, covering uniformly an angle of 360 degrees. Using the newly developed nonlinear dimensionality reduction approach three principal deformation modes with corresponding causal range of angles could be clearly identified in short time (Figure 2b).

An industrial example for vibration analysis

Another use case is the reduction of undesired vibration noise in a car structure. Figure 3 shows the application of the method to NVH-simulations (Noise Vibration Harshness). Car companies develop such simulations in order to analyze the vibration modes of the car structure. From such simulations so-called transfer functions at different points in the structure (like at the console) are extracted. Model variants are generated by changing the geometry of specific components or the material parameters like component thicknesses or mass. FEMMiner (the developed software prototype) processes the transfer curves without any knowledge of the actual changes. Figure 3 shows that the implemented method is able to organize the different curves along the parameters that were changed.

SCAI introduces a unique way to analyze engineering data. It provides an automatic overview of all model changes and allows the extraction and visualization of individual model variants, reducing dramatically the post-processing time in the virtual product development. The software prototype is currently being extended into an industrial software product in particular as a plug-in for existing post processing software. Together with services based on the new analysis tool, software licenses will be provided to the industry.

2a *Robustness analysis of a frontal crash (bumper positioning)*
2b *Deformation modes clustered according to the effect of the bumper positioning. The deformed parts are the frontal supporting beams at a specific time step and they are colored according to the difference to a reference simulation. Each point in the 3D plot represents a deformation and is colored according to the positioning angle of the bumper.*
3 *Analysis of transfer curves for NVH simulations, the vibration transfer curves get organized according to the realized model's input variations (geometrical and material based).*



3