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## FSI MAPPING SOLUTIONS

### Market Demands

Fluid-structure interaction is a quite common problem in computer aided engineering. Dedicated software solutions exist for fluid dynamics as well as structural mechanics. But in many real world applications the two phenomena influence each other. In these cases computing separate solutions for each problem would be a simplification.

For many problems the influence of the CFD solution on the CSM solution is a lot more remarkable and significant than vice versa. If a one-way connection between the fluid and the solid solver shall be established, quantity values namely temperature or pressure values that were calculated as part of the CFD solution have to be transferred from the CFD to the CSM mesh. Then the structural mechanics solver can use these values as boundary conditions during calculation. At the interface between the fluid and solid domain the two meshes usually do not match and interpolation of quantities becomes necessary. This

transfer of quantity values from one mesh to another can be done easily with the FSI Mapping solutions from Fraunhofer SCAI. These solutions can be used for »one-way« fluid-structure interactions to map values from one mesh to another.

### General Features

Fraunhofer SCAI offers different solutions to transfer results from CFD simulations to follow up CSM calculations:

1. EnSight FSI-Mapper-plugin
2. FSI-Mapper
3. Customized and integrated Mapping

All solutions are available for 32- and 64-bit Windows and Linux systems. Support for other systems is available on request.

### EnSight FSI-Mapper-plugin

EnSight is one of the most widespread postprocessors for interactive visualization of simulation results. In teamwork with CEI,

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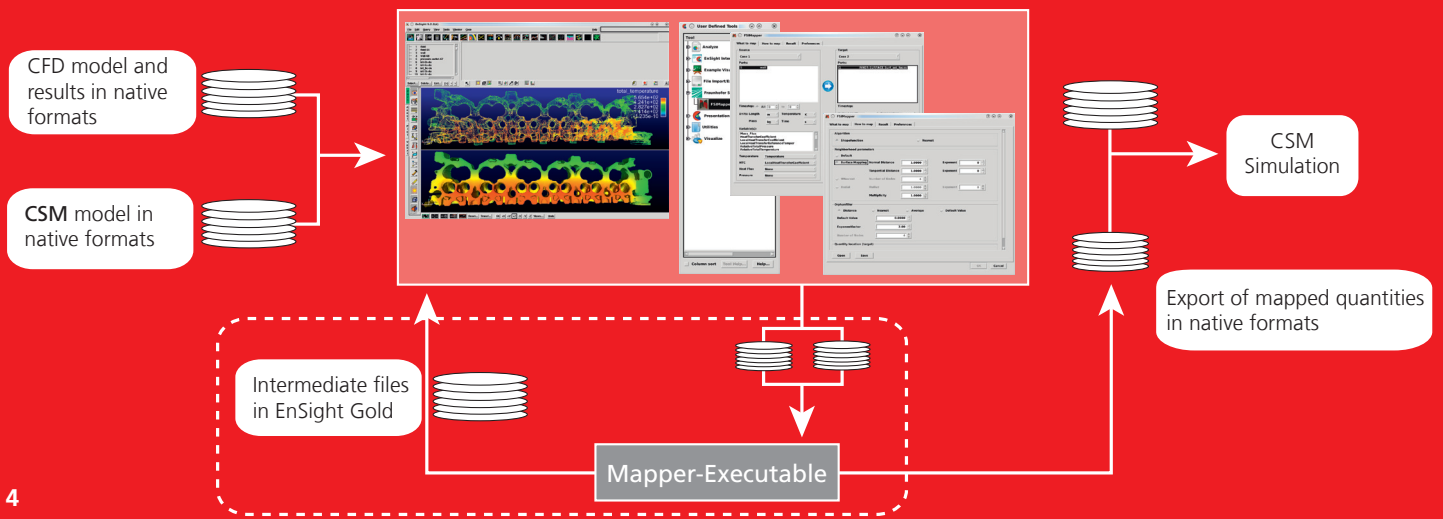
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#### 4 Mapping workflow for the EnSight FSI-plugin.

SCAI has integrated its FSI-Mapper as a plugin solution for the EnSight tool. The effort made use of the Python programming interface and the open file format EnSight Gold. The engineer can use EnSight interactively to select the areas for data transfer, to define the coupling quantities and to specify the numerical mapping parameters. Finally, the user can view in parallel the distribution of values on the source model and the mapped quantities on the target.

The FSI-plugin uses the EnSight Python interface to communicate with the active EnSight tool. The model definition of the selected parts and the quantity values located on these parts are exported to intermediate files in EnSight Gold format. The FSI-plugin provides a direct export of the mapped quantity fields to native file formats.

##### Abaqus input deck (\*.inp)

- Filmtemperature
- Heat transfer coefficient
- Heat flux
- Pressure

##### Nastran bulk data (\*.bdf)

- Temperature
- Pressure

#### FSI-Mapper

The FSI-Mapper is able to read Fluent .cas and .dat files as well as Abaqus input decks and Nastran Bulk data input files. The two meshes between which the

interpolation shall take place have to be 2-dimensional surface meshes in a 3-dimensional space. The quantities that can be read and mapped are film temperature, wall heat transfer coefficient, the wall heat flux and pressure.

A specific feature is the possibility to compute »Average over Rotation Axis«: If the Fluent model uses the frozen-rotor option the quantity values from the frozen-rotor computations will be averaged and these quantity values will be mapped to the CSM model. This specific feature is already in daily use at a turbocharger manufacturer. For Abaqus and Nastran the mapped quantity values can be written to a file in Abaqus .inp or Nastran Bulk format respectively, that can be easily included in the original CSM input deck. Furthermore, it is possible to compare two geometries with the FSI-Mapper.

Usage of the FSI-Mapper is quite simple: only a few parameters are needed that can all be set in the configuration file. During the mapping process the FSI-Mapper writes two files in the open .vtk visualization format containing the two geometries and the original and mapped quantity values. These models can be visualized with the open source visualizer Paraview to get a better feedback about the quality of the mapping.

#### Customized and Integrated Solutions

As a third option Fraunhofer SCAI offers customized mapping solutions for engineers. Based on the C++ -MapLib coming

from the co-simulation environment MpCCI SCAI already has realized dedicated mapping solutions.

In the automotive thermal management workflow at Daimler a customized MapLib version is used to transfer data from complete engine or underhood CFD models to thermal stress analysis models. Typical size of surface models is in the range of one to ten million elements.

In another automotive application at Volkswagen the MapLib is used to smoothen coarse grained wind tunnel data sets (from a matrix of pressure measurement points) as initial wind loads to a much finer NVH calculation mesh.

#### Multiphysics at Fraunhofer SCAI

Fraunhofer SCAI has developed various solutions for multidisciplinary engineering. MpCCI is the leading and open interface to couple simulation codes from different vendors in one single application. There are dedicated solutions for a seamless data transfer in manufacturing process chains (e. g. metal forming workflows) as well as code independent FSI mapping tools. Finally, the generic C++ based mapping library »MapLib« can be integrated into your own CAE application code.