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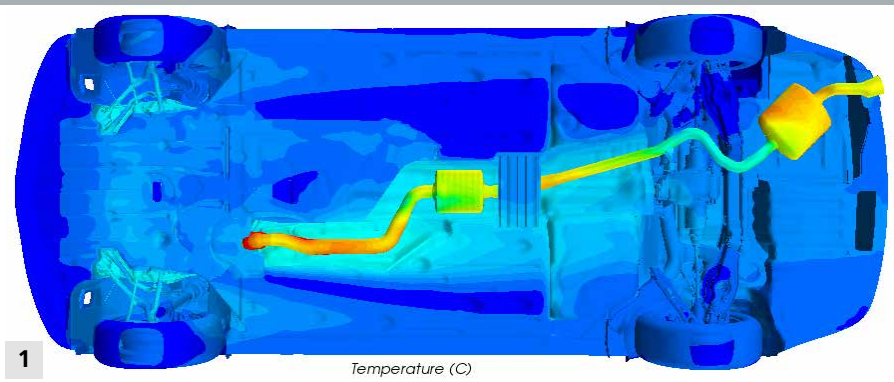
FRAUNHOFER INSTITUTE FOR ALGORITHMS AND SCIENTIFIC COMPUTING SCAI



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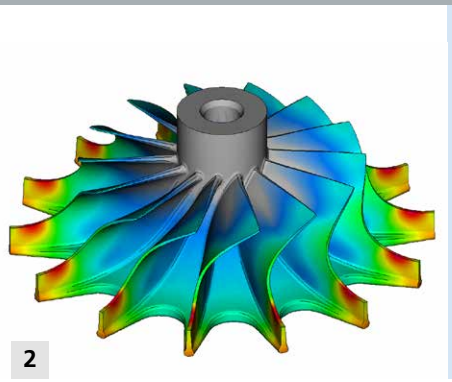

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1 *Automotive thermal management using TAITherm and STAR-CCM+.*
2 *Thermal loads on a ceramic impeller – Abaqus coupled with FINE Turbo*

COUPLING ENVIRONMENT

Vendor Neutral Interface for Coupled Simulation

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MpCCI
CouplingEnvironment

Multiphysics Modelling

MpCCI is a vendor neutral interface for co-simulation. MpCCI offers advanced features for multi-physics modelling:

- Accurate and robust neighbourhood calculation and mapping algorithms
- Various synchronisation schemes
- Predefined setups for typical applications
- Open programming interface
- Quasi-Newton relaxation method for fluid-structure interaction (FSI) applications with incompressible fluids, moving walls and light solids
- FSI coupling with rotating parts modelled in different reference frames

Supported Codes

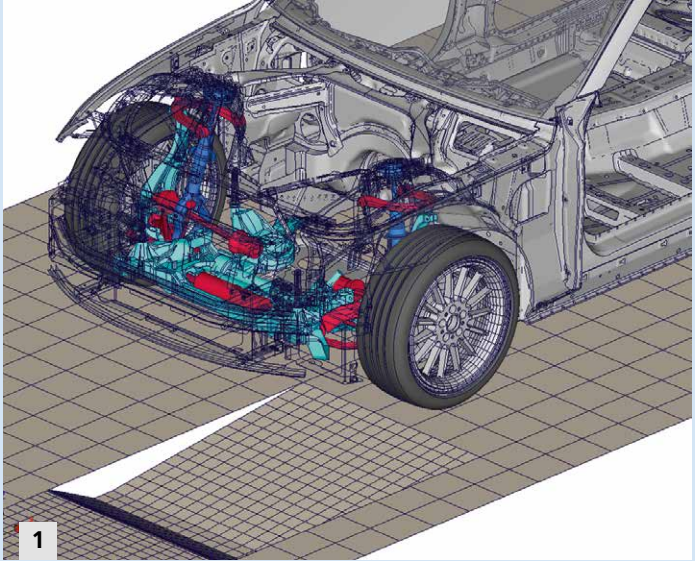
Structural Analysis
- Abaqus
- ANSYS Mechanical
- MSC.Nastran
- MSC.Marc

Computational Fluid Dynamics (CFD)
- ANSYS ICEPAK
- ANSYS Fluent
- FINE/Open
- FINE/Turbo
- OpenFOAM
- STAR-CCM+
- STAR-CD

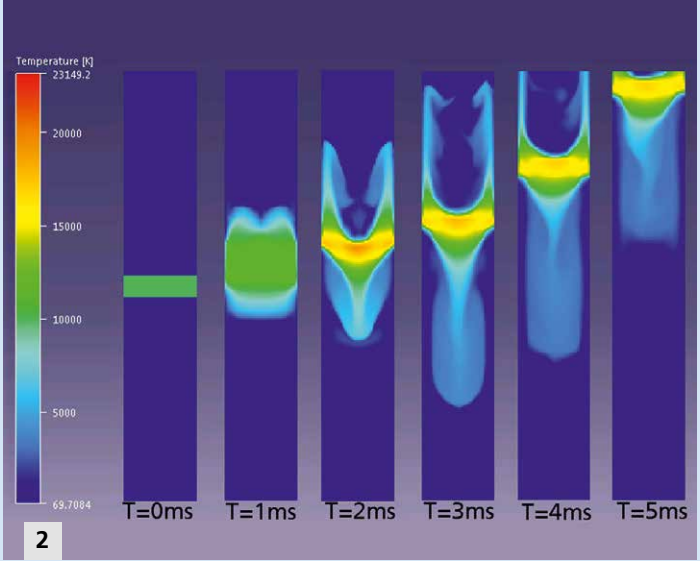
Electro Magnetic Modelling
- ANSYS Emag
- FLUX
- JMAG

Radiation
RadTherm/TAITherm

System Models
- Flowmaster/FloMASTER
- MATLAB
- MSC.Adams
- SIMPACK
- FMI/EAS-Master (on request)



1 *Vehicle dynamic dimulation using Abaqus and MSC.Adams.*



2 *Electric arc running in a busbar system (ANSYS Emag & ANSYS Fluent).*

Aeroelasticity and Fluid-Structure-Interaction

Wing and Spoiler Design

The deformation and dynamic flutter of aircraft wings or racecar spoilers can be analyzed using combinations of suitable structural mechanics and CFD codes. Customers from aircraft industry and leading Formula1 teams have integrated coupled Fluent-Nastran or Abaqus-OpenFOAM solutions in their daily development processes.

Hydraulic Pump Layout

In cooperation with Gdansk University, Bandak Engineering developed a new type of axial pumps with cam-driven commutation units (PWK pumps). An Abaqus-Fluent combination was used to determine the optimal layout for the different chambers and to minimize noise and vibration of these pumps.

Automotive Thermal Management

The calculation of the thermal behavior of automotive vehicles has to take into account the full complexity of a vehicle's geometry and heat transport phenomena including convection, radiation and conduction in fluids and solid bodies. For this task, original equipment manufacturers (OEMs) use a combination of TAITherm/RadTherm with STAR-CCM+ or inhouse CFD solvers.

Vehicle Dynamics and Non-Linear Component Behavior

Driving over Obstacles

Various automotive OEMs use a combination of Abaqus and MSC.Adams to model the non-linear behavior of single critical components and their interaction with the complete vehicle system. Applications with strong dependency on accuracy, like e.g. fatigue life calculations, benefit from co-simulation.

Wading Simulation for Off-Road Vehicles

Vehicle wading refers to situations where vehicles traverse through water at different speed. One of the major challenge is computing the inertial field of the vehicle while wading. In cooperation with Jaguar-Landrover, Fraunhofer has developed a new method of co-simulation between CFD (STAR-CCM+) and MBS (SIMPACK).

Thermal and Vibration Loads in Turbomachinery

Thermal Loads on Ceramic Impeller

In order to increase the efficiency of micro gas turbines by higher gas temperatures, new material concepts for the high temperature loaded parts are required. Fraunhofer has developed a new impeller concept (using a thermally coupled FINE/Turbo – Abaqus solution) and applied it for rotation speeds up to 120,000/min.

Life-Time Estimation of Turbine Blades

To estimate the long term behavior and high cycle fatigue in operation, the periodic pressure oscillations of the flow and the excited oscillations of the turbine blades have to be known. A transient coupling of fluid pressure and blade deformation delivers stress oscillations and thus the basis of fatigue analyses.

Electrical Devices

Cooling of a 3-Phase Transformer

The thermal performance of an oil-immersed power transformer is governed by the oil flow for the heat transfer generated in the windings and core toward the tank and the surrounding air. A JMAG-Fluent coupling has been used to detect the local hot spots.

Electric Arc in Switching Devices

Switching arcs can be modeled using ANSYS EMAG to solve the magnetic field problem and Fluent to solve the fluid dynamics problem – coupled in volume through MpCCI.