Multi-Physics Analysis with JMAG-Designer:
Current Capabilities and Future Directions

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Abstract ：

This presentation will outline the capabilities for multi-physics analysis with JMAG-Designer and the plans for forthcoming versions which will enhance the capabilities for coupled simulation. To enable a wide range of solutions, coupling with other applications will also be supported. Initially links to Abaqus and LMS Virtual.Lab will be available.

JMAG-Designer Version 10.4 will introduce the ability to couple JMAG simulations with Abaqus. The link will allow stresses to be mapped from Abaqus to JMAG and forces and heat generation to be mapped to drive Abaqus simulations. For motor noise calculations, the electromagnetic forces in calculated in JMAG-Designer can be imported into LMS Virtual.Lab.

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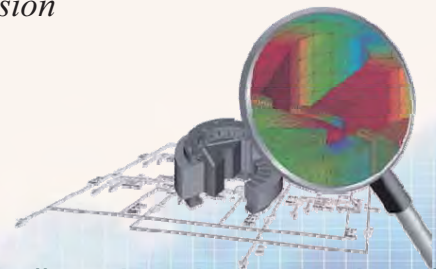
Overview

The presentation will outline what can you expect from JMAG for Multi-Physics simulation in the near future. This will include both improvements to JMAG-Designer and links to other applications

- *Links to SIMULIA Abaqus for structural and thermal analysis*

- *A link to LMS Virtual.Lab for noise calculation*

- *New functions coming in Designer 10.4*

- *New functions coming in Designer 10.5 and 11*

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Creating a link between JMAG and Abaqus

The new link enables the full power of both Abaqus and JMAG to be focused on a simulation problem. This increases the range of phenomena that can be modeled in a single analysis.

▪ *Phase 1: One-way coupling (10.4)*

- *Initially one-way coupling between JMAG and Abaqus will be supported for both thermal and structural coupling. Heat generation and electromagnetic forces can be mapped to Abaqus and stresses from Abaqus used by JMAG to control material properties.*

▪ *Phase 2: Two-way coupling (10.5)*

- *Full two-way coupling will be supported in the later version of JMAG-Designer*

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JMAG – Abaqus: Thermal coupling

The heat generation calculated in JMAG-Designer from Joule heating and hysteresis loss can be used as the heat source for an Abaqus thermal simulation.

• Support for different meshes for magnetic and thermal calculation.

• Average heat generation over one magnetic cycle or from a specified step

• 2D magnetic simulation can map onto a 3D thermal simulation.

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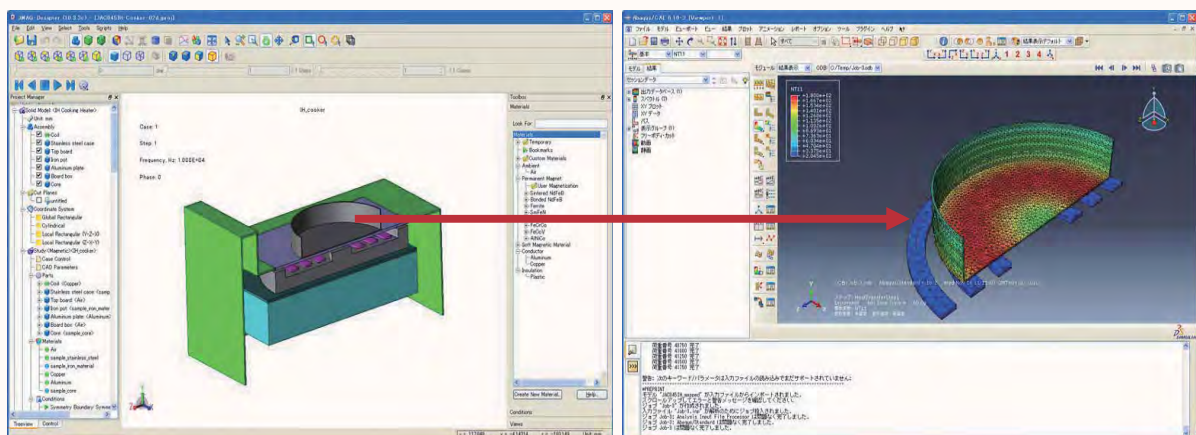
JMAG – Abaqus: Structural Coupling

For vibration analysis the electromagnetic forces from a JMAG simulation can be mapped onto point loads (*CLOAD) in an Abaqus simulation.

• Support for different meshes for magnetic and structural calculation.

• 2D magnetic simulation can map onto a 3D structural simulation
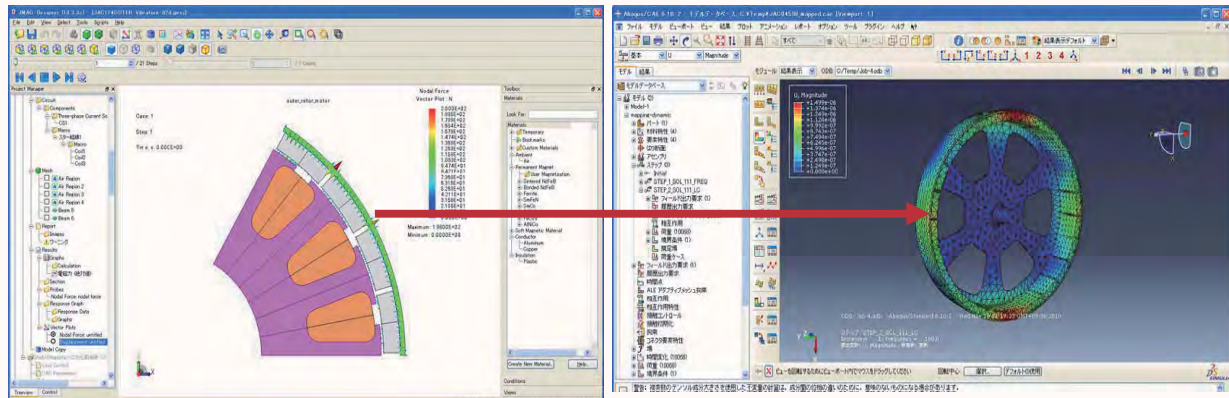
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JMAG – Abaqus: Mapping Stresses to JMAG

To account for the stress dependency of material properties a static stress distribution from Abaqus can be mapped onto a JMAG mesh and used to modify the material properties.
• Different meshes for structural and magnetic simulations
• Uses existing "Stress Distribution Condition" so JMAG interface is the same as for JMAG-DS coupling
• Abaqus must be installed on the computer used for the JMAG calculation
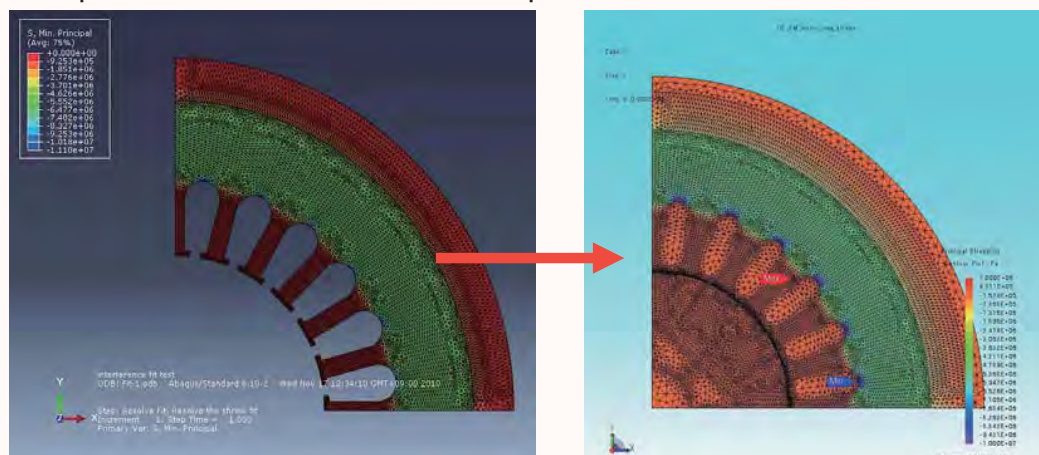
Min Principal Stress in Abaqus   Min Principal Stress in JMAG after mapping

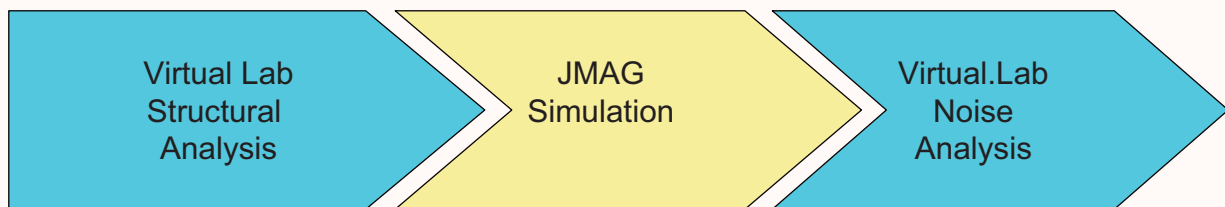http://www.jmag-international.com/   **JMAG**   6

JMAG Link to LMS Virtual.Lab

The link from JMAG to LMS Virtual.Lab provides users with a unmatched ability for noise calculation. Electromagnetic forces calculated by JMAG are passed to Virtual.Lab to drive the vibration and noise anlysis.

- *Initial link is implemented using JMAG's Force Mapper tool*

- *Future development will make this a seamless process to take a JMAG result file and use it directly in Virtual.Lab*

Virtual Lab Structural Analysis	JMAG Simulation	Virtual.Lab Noise Analysis

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Looking forward to Versions 10.5 and 11

JMAG already supports a full range of multi-physics capabilities. However, these functions are not always directly available from JMAG-Designer's GUI and there are inconsistencies between the different coupling functions. For 10.5 and 11 we want to improve the coupling capabilities and access to these functions:

- *Improve consistency between coupling types*

- *Improve usability of coupled analysis*

- *Better data sharing with other tools*

- *Introduce simulation data management*

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Simulation Data Management

Coupled and parametric analysis can produce a large number of related project and result files. Keeping track of all these files can be a challenge.

With JMAG-Designer we plan to introduce a new data management system which will help manage the large volume of data

- *Manage large volume of results*

- *Quickly obtain key parameters and view reports*

- *Search results using keywords*

- *Select previous calculations for further simulation*

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Conclusions

This presentation has outlined the new links to SIMULIA Abaqus and LMS Virtual.Lab and how using these tools can be used for multi-physics simulation with JMAG.

Some of the new functions which can be expected in JMAG-Designer 10.5 and 11 were also outlined.

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