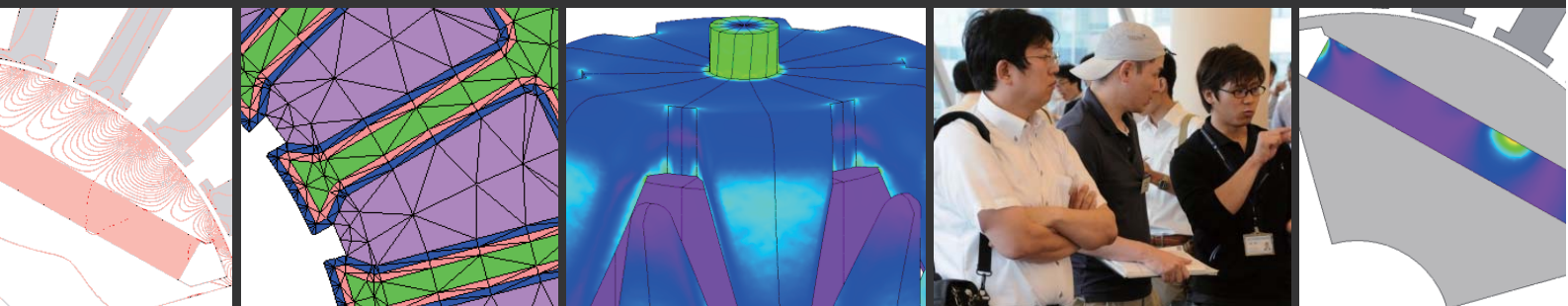


JMAG Newsletter



July, 2015

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JMAG Newsletter: Highlights of the July Issue

We hope you are surviving through the extremely hot and humid temperatures of the summer. We are pleased to present you with the July issue of the JMAG Newsletter.

The "Product Report" introduces JMAG-Designer Ver.14.1 released in June. We will be introducing new features that have improved the overall usability of JMAG.

"Solution" will be a summary of the Seminar on Advanced Computational Electromagnetics held on July 7th.

"Common Questions for JMAG" will be introducing 4 items related to iron loss. Please read a category that matches your interest.

"Event Information" will be informing you on the latest event information. Please join us at the JMAG booth when you arrive at the conference.

The JMAG Newsletter is intended for everybody, from those who are currently using the product to those who have not started yet. So please feel free to pass this newsletter on to new users as well.

We hope you enjoy this information-packed issue and find something of value on each page.

JSOL Corporation

Solution

6th Seminar on Advanced Computational Electromagnetics

-Toward Putting High-Precision Loss Analysis Into Practice Follow-up-

On July 7, 2015, we held a seminar explaining the latest trends in simulation technology focusing on loss evaluation of motors. This seminar will be a follow-up to the "5th Seminar on Advanced Computational Electromagnetics Seminar: Toward Putting High-Precision Loss Analysis Into Practice" held in 2013.

This issue includes brief summaries of presentations provided by researchers and engineers that are active in various fields including topics on theories of new material modeling technology, simulation technology required in future motor development, advanced application case studies, use of materials and evaluation technology.

"Topics on Applications of High Accuracy Loss Analysis"

JSOL Corporation – Dr. Takashi Yamada

Despite the fact that analysis accuracy has been an important topic in electromechanical design, analysis methods have not changed for nearly 20 years. Analysis accuracy and reliability have definitely shown improvement in the past few years, but this relies heavily on the "skill" of the user and not the analysis method. Iron loss of superimposed DC is a common example as it has troubled many engineers.

The current state and issues of loss analysis are shown in the table. Basic evaluation under ideal conditions is already possible and widely used, but issues arise when magnetic saturation, bias magnetism, and harmonics have a strong effect on the results. Algorithms to solve these issues need to be devised, but materials, evaluation technology, and application technology also need to be developed. In addition to technological advancements and maintenance of environment,

sharing experiences are also extremely important in the application of analysis technology.

As a method to solve these issues, we introduced the applications of the play hysteron model for hysteresis loss and the homogenization method for eddy current loss, as well as a method to balance the input/output of energy in the entire analysis without handling them for post processing. Applications of excess eddy current loss, stress dependent iron loss characteristics including process degradation, high frequency alternating current loss of winding, and stray load loss were also introduced.

Table Current Situation of Loss Analysis

| Loss Categories | | Issues | Analysis echniques | | |
|-----------------|----------------------|---|-------------------------------------|----------------------------------|--------------------------------|
| | | | Practical | New | Future |
| Iron Loss | Hysteresis Loss | Sinusoidal wave | Harmonic analysis/ Maximum value | | |
| | | Waveform distortion, the number of minor loops | Loop count | | |
| | | Minor loop location | Play model | | |
| | | Energy balance | Direct method | | |
| | Eddy Current Loss | Sinusoidal wave | Harmonic analysis | | |
| | | Skin effect | Homogenization method. | | |
| | | Excess eddy current loss | Segregation | Homogenization method correction | New modeling |
| | | Energy balance | Direct method | | |
| | | Spatial harmonics | 3D analysis | | New modeling |
| | | Stress Dependency | Stress distribution | Coupled stress analysis | |
| | Loss properties data | | Stress dependency measurement | | |
| | Process Degradation | Stress distribution | Estimation from measurement | | Punching simulation |
| | | Loss properties data | Stress dependency measurement | | |
| Copper Loss | Coil/Conductor | High frequency loss | High parallel processing | | Zooming |
| Stray Loss | Magnet | High frequency component | Parallel processing | High parallel processing | Ultra-high parallel processing |
| | Other Structures | 3D eddy current analysis | Parallel processing | High parallel processing | Ultra-high parallel processing |

"Basics of Hysteretic Magnetic Field Analysis"

Kyoto University - Graduate School of Engineering, Department of Electrical Engineering,

Professor Tetsuji Matsuo

Hysteresis loss, vector characteristics, excess eddy current loss, laminated structure and stress properties need to be accounted for as iron core material, and especially as magnetic properties of electromagnetic steel sheets. Combining the play model, Caue circuit, and the homogenization method has allowed

highly-accurate evaluations of eddy current loss in the lamination direction even with magnetic properties of residual magnetism and the bias magnetism state, the non-linear magnetic properties in the lamination direction and high frequency.

Issues that the conventional method has in relation to hysteresis loss include magnetic properties and hysteresis loss at the residual magnetism and bias magnetism state. Many hysteresis models are developed to simulate hysteresis properties such as the Chua model, Jiles-Atherton model, Stoner-Wohlfarth model, Preisach model, and the play model. We

introduced an algorithm related to the Preisach model and the play model that may be effective when considering applications in the finite element analysis. BH properties that change in the S-shape can be simulated with high accuracy when the play model and the Preisach model are equivalent mathematically and when using a play model having input of magnetic flux density instead of a magnetic field.

The frequency limit in measurement can be considered an issue of eddy current loss evaluation using the iron loss properties table. Modeling with the homogenization method is available for solving this issue. Eddy current loss can be calculated by deriving the relationship between the average magnetic flux density per electromagnetic steel sheet and the surface magnetic field of steel sheets, and running a 1D FEA in the lamination direction. As a method to estimate excess eddy current loss not included in this eddy current loss, the method by Dr. Bertotti was introduced. In addition, a method to simulate high frequency alternating current magnetic properties necessary during PWM excitation with the Cauer circuit has been developed. We combined this with the play model, and introduced a model that simulates the non-linear magnetic properties in the lamination direction as an equivalent circuit and its effectiveness through calculation examples.

"Recent Development and Influence of Manufacturing Process on Magnetic Properties of Non-Oriented Electrical Steel Sheets"

JFE Steel Corporation - Senior Researcher, Steel Research Laboratory, Electrical Steel Research Department
Dr. Hiroaki Toda

Material development is necessary to reduce the effects of the motor manufacturing process for increasing the performance and reducing energy of

motors. We introduced development trends aimed towards high performance of non-oriented electrical steel sheets used commonly in motor iron cores.

Effects of punching / shearing, interlock, fixing (such as shrink fitting, press fitting) on magnetic properties have been measured and evaluated. As a result, we discovered that hard materials and thin materials are less likely to be affected by the effects of shearing, and that iron loss increment is small. In addition, the 6.5% Si steel sheet and the steel sheet with Si concentration gradients as well as its manufacturing process were introduced as material development for high-frequency iron loss reduction.

We also explained that effects of hardness and sheet thickness on the amount of sagging on the shear end part, and the relationship between the amount of sagging and iron loss degradation degree. Amount of sagging and strain due to differences in hardness and sheet thickness can be predicted with structural analysis. With the hardening and thinning of materials, amount of strain during shearing can be made smaller, allowing control over iron loss increase.

As a result of making a prototype IPM motor using electrical steel sheets that have been sheared, and comparing of the iron loss measurement result of an actual machine with the analysis result, we confirmed that we achieved a good match with the measurement results when running analysis using magnetic properties and iron loss characteristics measured per shearing width.

"The Problem and Future Prospective of the Modeling for the Motor Design and Control"

Shibaura Institute of Technology – Faculty of Engineering, Electric Engineering
Professor Kan Akatsu

Low cost, high efficiency and high torque density

(miniaturization) are some of the objectives of motor design; making motors smaller and more efficient leads to lowering costs. Increasing either torque density or efficiency (decreased losses) is dependent on materials in many areas, and to have a strong command of material development, material modeling is essential.

The one of the current issues in motor design and control design workflow is a lack of feedback. We proposed a method to obtain feedback between models as well as between a model and a prototype using JMAG (FEA) and JMAG-RT models. In order to simulate the characteristics of a prototype using a JMAG model, it is necessary to understand the characteristics and dimensional tolerance of electromagnetic steel sheets and magnets during punching and when stress is applied. Magnetic properties and iron loss properties were each shown as degradation properties due to punching electromagnetic steel sheets with a range difference of 1mm to 30mm. Characteristics of degradation due to punching obtained from the prototype are entered into the JMAG model.

We introduced the mechanics of applying online tuning (system identification) of the JMAG-RT model using the prototype and reflecting the temperature measured in the prototype to the JMAG-RT model.

In order to get feedback of harmonics eddy current losses from the JMAG-RT model to the JMAG model, or in order to efficiently obtain feedback between the prototype and each model, well as between models, it is necessary to turn feedback amounts into a database. By using the database and using JMAG in an interactive manner, it becomes possible to perform motor design and control design with the obtained feedback.

Calculations Using a Magnetic Field Analysis"

Denso Corporation - Material Eng. R & D Div.

Project General Manager, Mr. Keiichi Okazaki

We plan to keep producing more EV/HV motors on a global scale, and the main motors for vehicles are being required to be made smaller with higher rotation speeds. To make motors smaller and faster, lowering magnetic losses is vital, and developing loss evaluation technologies is essential.

Mechanical losses, electric losses and magnetic losses are well known types of losses occurring motors, but measuring magnetic losses is especially difficult, with a calculation error range of up to 30%. Iron loss evaluations are a challenge even in magnetic losses; when aiming to reduce the size of a motor the effects of residual strain are large, and in order to increase the rotation speed effects of harmonic magnetic flux is large. These items must be evaluated.

Even when attempting to measure residual strain distribution using the X-line, the diffraction peak is weak and reliability is low. The possibility of obtaining residual strain distribution using a punching process simulation was discussed. Structure analysis software was used, with the analysis flow involving a shear analysis and springback analysis. Magnetic properties and loss properties were measured separately under stress. When corresponding magnetic properties and loss properties were assigned based on the stress distribution around the processed area obtained from a structural analysis and an analysis was performed, the results closely matched the actual measurements. Further increases in accuracy for processing simulation and system improvements to more easily set residual strain distribution are required.

"Residual Strain Effects in Iron Loss

"Motor Design Accounting for Detailed

"Magnetic Properties of the Core"
Mitsubishi Electric Corporation –
Advanced Technology R&D Center,
Electromechanical Technology
Department
Senior Manager, Dr. Akihiro Daikoku

There is a trade-off in decreasing the size and increasing performance of a motor, and in order to implement these improvements, motor performance must be estimated with high accuracy during the design stage. Increased performance means the advancement of decreased losses, lowered cogging torque, lowered torque ripples, and lowered vibrations/noise. Causes for decreased accuracy in estimating performance during design are geometry errors, material characteristic degradation and other issues caused during the production process, as well as non-uniform material characteristics such as an iron core and permanent magnets. Taking a further look at the magnetic properties of the iron core, the effects of stress caused by shrink fitting and punching as well as the effects on cogging torque caused by electromagnetic anisotropy and hysteresis characteristics were discussed.


When an analysis was performed accounting for the direction and stress in the stator core caused by shrink fitting as the principal stress and by using the separately measured magnetic properties and iron loss properties of stress dependencies, we confirmed that the results closely matched the actual measurements. Furthermore, an iron loss analysis was performed by assigning materials based on the strain and maximum principal stress which were obtained from the punching analysis of the motor iron core. As a result, we learned that accounting for punching significantly increased the iron loss, especially hysteresis loss.

Non-directional electromagnetic steel sheets also have electromagnetic anisotropy in the rolling direction and its orthogonal direction. The magnetic properties of each direction were measured, and when cogging torque for a

SPM motor was evaluated using the 2D magnetization method, the results closely matched the actual measurements. When hysteresis modeling using a play model was performed and applied to the motor characteristics analysis, we verified that the loss, in which the hysteresis loss amount as average value is not zero, could be evaluated.

Conclusion

A seminar with the theme of putting loss analyses into practice was held. When thinking of the process to put an analysis into practice, this involves not only advances in technology and a framework, but also the sharing of experiences is extremely important. This relieves the feeling of uncertainty for new technologies, promotes their use, and advances knowledge. Analysis evaluations are established as the number of users increase, and these analyses increase, becoming integrated into the field of analysis technology.

This seminar brings us one step closer to practical utilization. It's not only technology development and frameworks which secure these technologies, but it must be stressed that the sharing of experiences also vital to advance the process. 

(Yusaku Suzuki)

Product Report

Introduction of JMAG-Designer Ver.14.1

JMAG-Designer Ver.14.1 (hereafter Ver.14.1) was released on June, 2015.

Operability of the Geometry Editor and post processing function has been improved. The new added functions will reduce step, straightforward operations will allow efficient analyses. Analyses incorporating specific phenomena such as iron loss accounting for the effects of residual strain, and global optimization calculations using the optimization engine of MATLAB can both be performed. This document will be introducing the new features of Ver.14.1.

Introduction

JMAG-Designer Ver.14.1 (hereafter Ver.14.1) was released on June, 2015.

The operability of the Geometry Editor and the post-processing function has improved in performance with Ver.14.1. Iron loss analysis accounting for production degradation, optimization function linked with MATLAB, as well as new modeling technology and evaluation analysis function have been developed for the purpose of performing detailed analyses and to avoid designs missing vital factors.

Improvements in the user interface of the Geometry Editor and the post-processing function have enhanced in efficiency and reduced analysis times. The latest version has reduces the number of necessary steps and improved the operability by incorporating a new mechanism.

Using the improved Geometry Editor, 3D models that have simulated specific details in the geometry can be easily created, in addition to the creation of 2D models. The automatic healing and mesh generation functions have been enhanced for the evaluation of these models. With these functions, analysis of magnet eddy current loss in PM motors and analysis of stray loss that occurs in the case of transformers (both require evaluations using 3D

models) can produce stable results.

As for the material modeling aspect, the function to account for deterioration in steel sheets due to punching can now analyze increases in iron loss due to deterioration and decrease in torque performance.

To search through a larger and complicated design space, a global optimization engine that supports the multimodality issue is necessary. The MATLAB global search optimization engine can now be used directly. In addition, JMAG has also developed an optimization engine using genetic algorithm, and practicality of the optimization function has improved.

Improved Operation

The toolbar buttons have been organized and rearranged for easier selection. Also, a button has been added to reduce the number of clicks. As a result, creating geometries and post-processing processes are made easier and faster. This allows reduction in time necessary in the entire analysis operation.

Improved Operability of the Geometry Editor

The Geometry Editor has been improved for

easier operation with fewer steps. Despite the increase in toolbar buttons with the addition of functions, the interface has been sorted for efficient operability. We will be introducing two major improvements in Ver. 14.1.

1. Only displays required functions

The new Geometry Editor has a mechanism that will switch the displayed toolbar buttons depending on the edit mode, such as edit sketch and edit part, allowing easier access to necessary tools. Unorganized buttons have been re-categorized by theme, and the user interface is friendlier than it was before (Fig.1).



Fig.1 Toolbar button display when the Edit Part button is turned on

Only the toolbar buttons that can be used in the edit part mode is displayed in the frame

The menu displayed when right-clicking on the entity has also been enhanced. In previous versions, right-clicking on a region displayed tools that seemed unnecessary in region edit, such as point and line creation. Ver.14.1 has been improved to only display functions that can be used for regions, such as region mesh generation and the region copy function in the menu (Fig.2). Necessary functions are now easier to be selected and operated through this improvement.

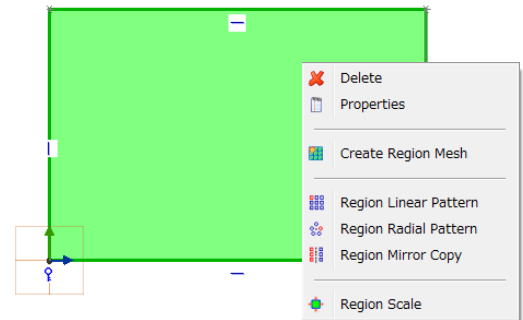


Fig. 2 Right-click menu for the region
Only displays mesh generation and region copy tools used for regions

2. Mechanism to reduce the number of clicks

A single region can be created with a small number of clicks, but the same would not apply for 100 regions. Just reducing one click for a region makes all the difference. The Apply button that was incorporated for converting sketches and creating fillets in Ver.13.1 has been added also for creating regions and generating manual mesh (Fig.3). This has realized continuous processes with minimal clicks.

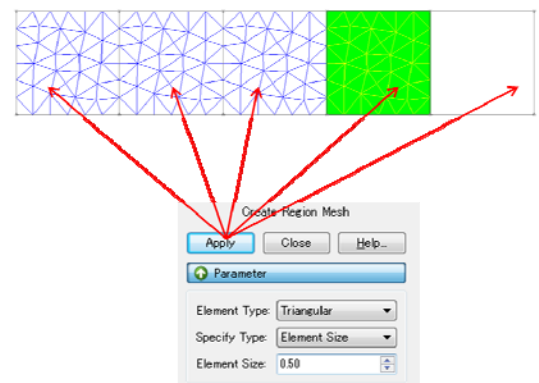


Fig. 3 Apply button added for region mesh generation
Mesh generation is continuously possible for 5 regions using the Apply button
Element size settings are succeeded and the number of clicks for mesh generation has been reduced

Improved Constraint Function

Geometry parametric analysis can be run by setting the appropriate constraint functions. In addition to the function to display excess

constraints with the color orange in Ver.14.0, a function to display perfect constraints in black has been added in Ver.14.1 to get a better grasp of the constraint state (Fig.4).

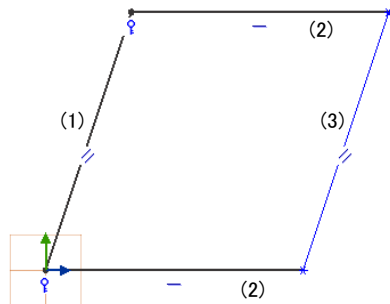


Fig. 4 Differences in complete constraints and constraint display

(1)、(2)highlighted in black have their end point and direction constrained, making it perfectly constrained
(3) is only direction so it is a regular constraint shown in blue

Perfect constraint is the state that all related geometrical constraints and dimension constraints are defined. For example, the line of (1) displayed in black within Fig.4 has fixed constraints on the end point, determining the position, direction, and distance. The two lines of (2) are determined in position and direction. For the line of (3), only the direction is determined, so it is in the regular blue constraint state. Geometry parametric analysis can be run without collapsing the geometry by putting a perfect constraint on the lines and arcs that configure the geometry, as well as determining the shape.

Simultaneous Output of Analysis Results for All Cases

A new function has been added to collect values of all cases for torque and loss used in the graph after calculating multiple cases in parametric analysis, then outputting them all to one csv file.

For example, let's look at results where torque variations of all cases have been output after

running a parametric calculation with changed current phase (Fig.5). Selecting [Torque] in the output information prior to calculation and specifying the folder path allows the output of all torque variations per case to one csv file. Importing all result files in JMag-Designer and exporting the created table of torque variations can be omitted, allowing reductions in time for post-processing.

This function can be used in distributed processing mentioned later. After distributed processing, specifying the path of the shared file system that can be accessed by the calculation node allows collection of important information to csv files.

| # | A | B | C | D | E | |
|----|-------------|-----------|------------|-----------|-----------|----------------------|
| 1 | Study Title | SlitWidth | Torque /Nm | | | |
| 2 | Case | 1 | 2 | 3 | 4 | Case No. |
| 3 | OST (3Pha | 50 | 45 | 60 | 75 | Parameter |
| 4 | Time(s) | untitled1 | untitled1 | untitled1 | untitled1 | |
| 5 | 0 | 299.6738 | 307.3124 | 311.2103 | 154.2427 | |
| 6 | 3.13E-05 | 276.2139 | 302.1006 | 293.129 | 174.7275 | |
| 7 | 6.25E-05 | 268.5483 | 311.5307 | 296.1827 | 233.901 | |
| 8 | 9.38E-05 | 292.6507 | 336.5588 | 329.9859 | 291.2363 | |
| 9 | 0.000125 | 330.684 | 366.1158 | 359.9699 | 314.2578 | |
| 10 | 0.000156 | 359.5024 | 377.1903 | 369.7200 | 263.3209 | |
| 11 | 0.000188 | 358.2716 | 367.2366 | 360.7772 | 243.6929 | |
| 12 | 0.000219 | 338.4102 | 342.543 | 336.0471 | 210.2708 | Torque of each cases |
| 13 | 0.00025 | 297.6669 | 315.9675 | 316.7711 | 163.8061 | |
| 14 | 0.000281 | 274.3719 | 310.4393 | 298.9608 | 164.2976 | |
| 15 | 0.000313 | 270.3406 | 317.1576 | 301.727 | 231.0491 | |
| 16 | 0.000344 | 299.6421 | 340.1548 | 331.0128 | 264.0601 | |
| 17 | 0.000375 | 343.7468 | 368.2194 | 355.1713 | 303.7012 | |
| 18 | 0.000406 | 363.9713 | 377.582 | 364.0894 | 261.7717 | |
| 19 | 0.000438 | 360.6363 | 365.9182 | 355.6082 | 214.8676 | |
| 20 | 0.000469 | 340.5629 | 340.4803 | 330.422 | 177.4057 | |

Fig. 5 Output csv data

Actual example of output data. The torque variations of all calculated cases are organized in case order
Data of all cases can be confirmed after calculation is completed

General Improvements in the Mesher

Mesh generated for complicated 3D models with a grasp on geometry details can be obtained with enhancements and improvements in the algorithm of mesh generation and the healing function.

With improvements in the algorithm, the success rate for mesh generation has improved for models with parts of various scales and models including numerous parts. Mesh generation is more stable than ever, with the removal of issues in the CAD model by adding a healing function that can control

geometry modifications. Here, we will be introducing enhancements in the healing function.

Enhanced Healing Function for Mesh Generation

Mesh can easily be generated for geometries including gaps between parts, interference, small faces and small edges by adjusting the tolerance of geometry modification.

Geometry models that have been imported from the Geometry Editor or other CAD may include displacements of parts or small geometries depending on the dimensional errors of the model or compatibility with CAD (Fig.6). The modification range of geometries can be controlled with the new added tolerance settings and modifications of geometries can be adjusted by the user (Fig.7). As a result, mesh can be created and calculation can be run without having to return to geometry modifications in the CAD (Fig.8).

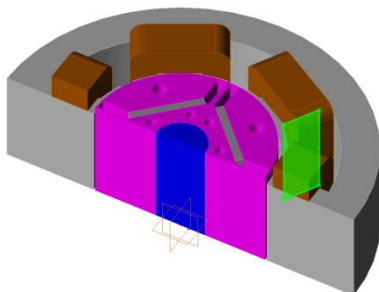


Fig.6 Model intervened by the coil and core

Model where there is an interference of 0.001mm in the highlighted area out of the areas where the coil and core are in contact

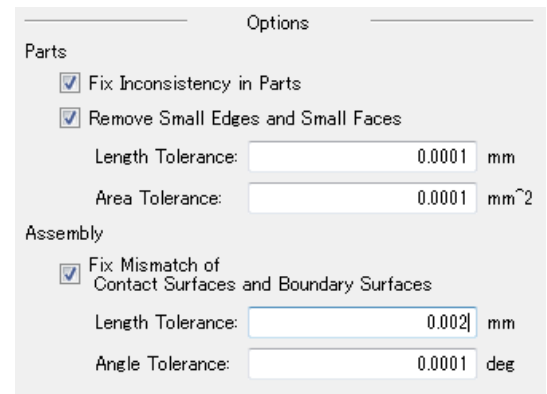


Fig. 7 Specification of tolerance to run healing
Specifies length tolerance of 0.002mm that is longer than the interference of 0.001m extracted in Fig.6, and runs automatic healing during mesh generation

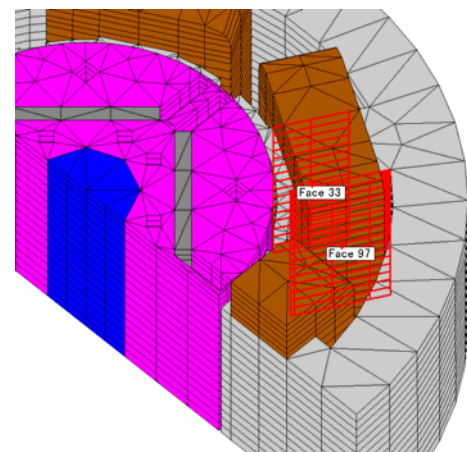


Fig. 8 Successful mesh generation

Interference less than tolerance that is automatically modified has been highlighted, and the modified area can be confirmed after mesh generation

Enhancements in Modeling Technology

In terms of modeling technology, we are working hard towards development in incorporating factors required in detailed loss analyses. Models that account for the effects of material properties that affect loss, such as production degradation in the magnetic steel sheet, have been added.

Other than high-precision loss analyses, new functions have been added for detailed modeling of temperature rise due to loss, and phenomena such as vibrations and noise caused by electromagnetic

force. The multipurpose file import / export tool has been improved to allow incorporation of vibration analyses that perceive the mover and the stator as the vibratory source.

Material Modeling for Production Degradation

We improved the analysis functions for evaluating iron loss increases and torque performance decreases due to residual strain occurring during electromagnetic steel sheet punching. The degree of degradation facing the inner-side from the cut plane can be identified, and residual strain effects can be grasped by using a function to automatically generate layer mesh expressing product degradation regions, and models which automatically assign degradation properties of materials corresponding to the distance from the cross section for each layer.

2 layers of 1mm layer mesh are generated from the stator core edge (Fig. 9). By adding the information of the degradation degree for the distance to every magnetic properties and iron loss properties of the material database used in the stator core, the material properties accounting for degradation are automatically defined in the degraded regions.

In this manner, by accounting for iron loss increases accumulating in the steel sheet edge due to punching, even more accurate loss amounts can be obtained (Fig. 10).

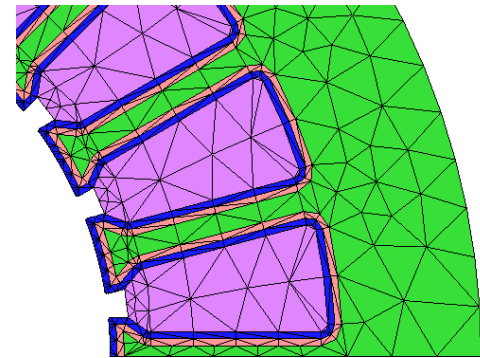


Fig. 9 Production degradation region layer mesh
Append residual strain condition to steel sheet edges which have been punched and automatically generate 2 layers of mesh with a specified width of 1mm.

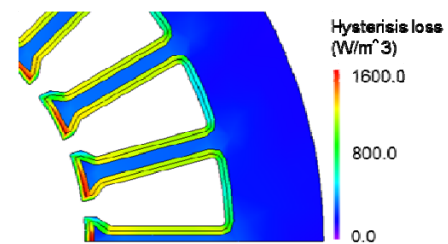


Fig. 10 Hysteresis loss distribution accounting for production degradation

Hysteresis loss increases in the degraded region 2mm from the punched edge, and concentrates especially at the edges of teeth where magnetic flux density is large.

Added Functions to the Material Database

Kobe Steel soft magnetic composites, Hitachi Metals/Arnold neodymium sintered magnets, ferrite, and Arnold SmCo and Alnico magnets have been added (Table 1, 2). Now 226 types of core materials and 534 types of permanent magnet materials are available in the material database.

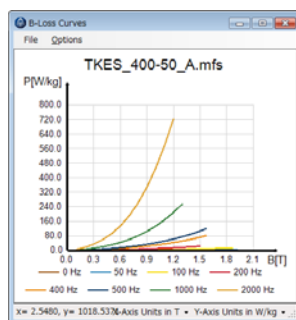
There are also an increased number of material data import formats. Text file material data exported from PowerCore® Explorer, a material data management tool developed by ThyssenKrupp AG, can be imported into a custom material. B-H curves and iron loss curves can be imported (Fig. 11).

Table 1 Number of core materials added to material data
and total number of materials

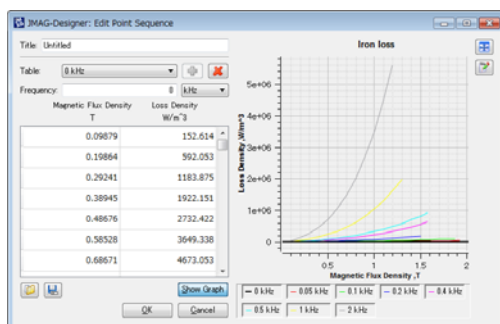
| Material type | Soft magnetic composite |
|---------------------------|-------------------------|
| Kobe Steel | 4 |
| Total number of materials | 12 |

Table 2 Number of permanent magnets added to material
data and total number of materials

| Material type | Neodymium Sintered magnets | Ferrite | smco | alnico |
|---------------------------|----------------------------|---------|------|--------|
| Hitachi | 6 | 2 | — | — |
| Arnold | 74 | 7 | 20 | 18 |
| Total number of materials | 221 | 119 | 25 | 38 |



(a) PowerCore® Explorer iron loss data



(b) JMag-Designer database

Fig. 11 Example of imported iron loss curves

Import iron loss frequency characteristics data from PowerCore® Explorer(a) into the JMag database (b) via a text file.

Improved Multipurpose File Import/Export Tool

We improved the function for mapping electromagnetic force distribution to structural analysis models. This improvement allows electromagnetic force to be automatically delivered to both movers and stators, and a vibrational analysis can be performed.

In many cases a periodic model is used in a magnetic field analysis. However, a full model is used instead of partial model in a structural analysis, since parts with no symmetry such as housing need to be modeled and they cannot be handled as a partial model. As for periodic conditions and anti-periodic conditions, mapping the analysis results to full model in a structural analysis has already been supported, but mapping for axial reverse rotational periodic conditions is also now supported.

Adding these two functions allows vibrational analysis of claw pole alternators to be performed easier than before (Fig.12).

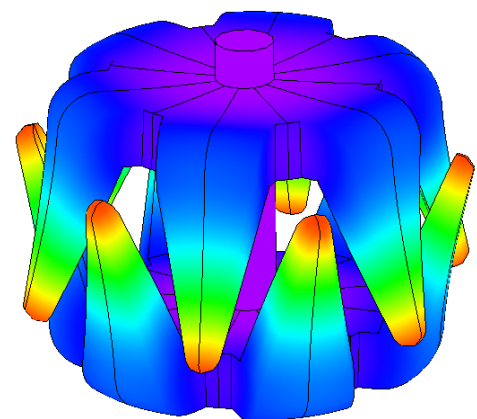


Fig. 12 Vibrational analysis of a claw pole alternator

Deformation and displacement distribution when performing a vibrational analysis of an alternator based on the electromagnetic force working in the rotor area of a magnetic field axial reverse rotational periodic model.

Enhanced Abaqus Coupling Interface

The direct interface for Abaqus and JMAG-Designer has been improved. Ver.14.1 now allows large deformation analysis to be performed with electromagnetic force.

The time intervals for Abaqus' explicit method procedure (Dynamic Explicit), which is required in a large deformation analysis, are too short in the transient response magnetic field analysis, and when these intervals are used in a magnetic field analysis, the number of calculations increases enormously. The subcycling coupling is now supported in this latest version, and a two-way coupled analysis can be performed without requiring the time intervals to match in Abaqus and JMAG-Designer. Calculations are more stable, and electromagnetic force and displacement can be passed with the required timing, enabling a coupled analysis with large deformations, such as an electromagnetic forming analysis for thin plate (Fig. 13). Thin plate deforming in the direction of the mold due to electromagnetic force (vector in the figure) can now be captured.

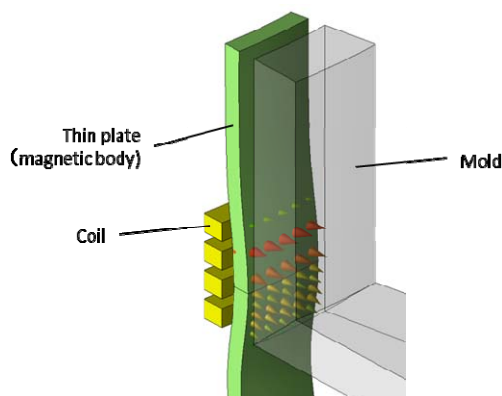


Fig. 13 Electromagnetic forming analysis of a thin plate
Example of performing a two-way coupled analysis with JMAG's transient response magnetic field analysis and Abaqus' Dynamic Explicit, and then analyzing the deformations of a plate.
Thin plate deforming in the direction of the mold due to electromagnetic force shown in the vector can now be verified.

Enhanced Evaluation Functions

As a function to analyze and optimize results, new evaluation functions have been added, and the optimization engine has been improved.

The frequency filter function added to the evaluation method of the transient analysis results visualizes specific frequency components or superimposed distribution amounts, which are difficult to grasp in the time axis. Evaluations connecting the positional relationship between geometries and the associated frequencies with distribution amounts contribute to improvement of design plans.

The MATLAB optimization engine can now be used directly, and the operability of optimization function has been improved. Distributed processing functions have also improved so calculations for several thousand cases associated with optimization can be efficiently performed. Direct job implementation for general-purpose batch systems such as LSF and PBS is now supported, and functions have been added for easier optimization using the existing environments.

Frequency Filter Function

The contours and flux lines of magnetic flux density where harmonic analysis has been carried out can be filtered for only specific frequency components and displayed in the time axis again. Including the positional relationship between the slot and magnet, the harmonic components of magnetic flux that may cause the magnet eddy current can be evaluated.

Let's look at the example of magnet eddy current generated in an IPM motor. Large eddy currents are generated locally in the magnet (Fig. 14). By running a Fourier transformation directly from the magnetic flux density graph obtained from

the point with large eddy current, it's possible to confirm which frequency component is causing the local eddy currents (Fig.15). By extracting only large components as a time variation component of magnetic flux density and looking at the magnetic flux lines on a time axis, the effects that the positional relationship between the slot and the magnet have on the eddy current of the magnet can be verified (Fig. 16). By accounting for the magnetic flux delay occurring in the stator and displaying it including before and after the frequency orders focused on, magnetic flux density wrapping around the teeth can be simultaneously verified.

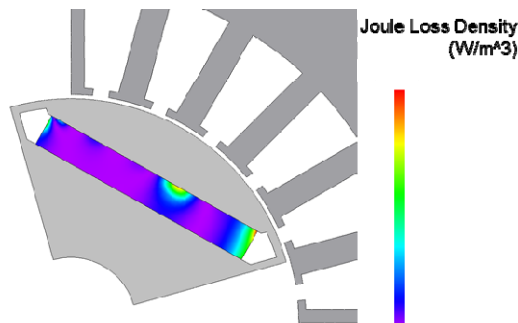


Fig. 14 Magnet joule loss distributoin

Joule loss distribution occurring in the magnet. We learn that not only in the ends of the magnet, but also a comparatively large amount of losses are also occurring in the center section.

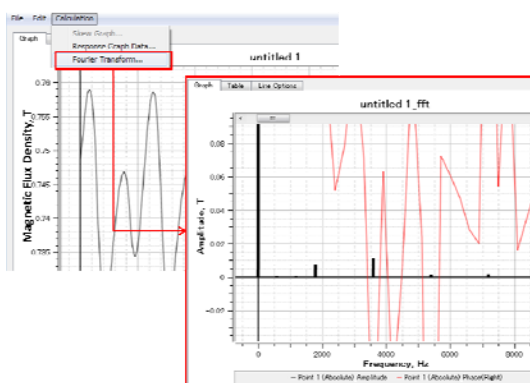


Fig. 15 Magnetic flux harmonic analysis

Fig. 14 Harmonic analysis results of magnetic flux density in the center of the magnet with large joule losses. We can see that the component increases significantly at 0Hz due to magnet magnetic flux and increases at 1800Hz (12th degree) again.

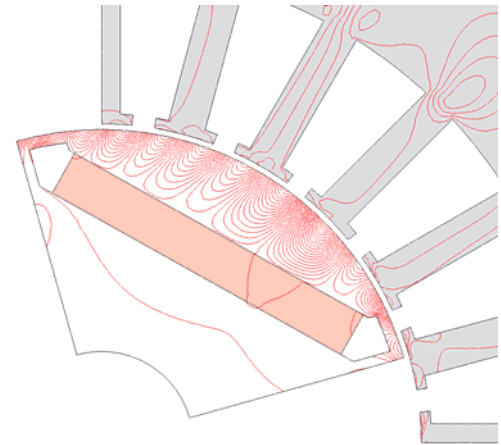


Fig. 16 Slot harmonic components for magnetic flux lines

After the 12th order component for the magnetic flux density obtained from the harmonic analysis in Fig 15 is added to the nearby order (11th and 13th) components, the magnetic flux lines are displayed with the time history. Magnetic flux interlinking areas with increasing joule loss shown in fig. 14 could be identified.

Added Genetic Algorithm Function

MATLAB optimization tool for global search method can be set in the same way as the existing optimization functions. Genetic algorithms as well as original optimization engines created in MATLAB can be used. Additionally, an optimization engine which used original JMAG genetic algorithms was developed.

Many of the problems for optimization are multimodal. By using the newly added genetic algorithm or MATLAB global search method, optimization can be applied to a wide variety of actual problems. This new optimization engine can be directly used from JMAG-Designer like before, and optimization calculations can be performed simply by setting the objective functions and selecting the genetic algorithm.

Directly accessing the engine through JMAG-Designer enables you to handle a case such as optimizing geometry accounting for the tradeoff between magnetic circuit design and structural design. By defining the constraint condition in addition to the objective function, the objective function can be maximized while keeping the

constraints. (Fig. 17). By using the analysis group function, torque can be maximized by setting the maximum value of the stress applied to the rotor as a constraint condition.

Objective Functions:

| | Description | Expression | Type | Value | Weight |
|---|-----------------|------------|----------|---------|--------|
| 1 | Mises Stress | Smax | <= | 7.2e+07 | |
| 2 | Maximize Torque | Tave | Maximize | --- | |

Fig 17 Objective function settings

Define torque maximization as an objective function, and set the Mises stress, acting as limit for strength design, as a constraint condition.

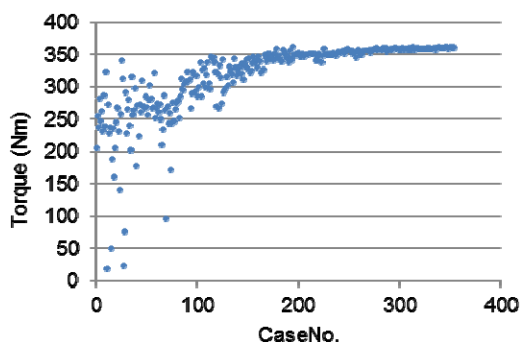


Fig. 18 Example of maximizing torque

At approximately 350 cases, average torque of more than 350Nm can be obtained. This graph shows that various design plans were searched for up to 100 cases from the torque variations, and as the number of cases increases, the design plans are narrowed down to optimum one.

Distributed Calculation using General-Purpose Batch Systems

For the HPC server environment to be effectively used, the method of execution was changed so the job could be directly added with LSF, PBS or other general-purpose batch systems. This saves the trouble of creating specialized scripts; distributed processing using a general purpose batch system can be performed in the same way as a regular local machine.

Obtain the required execution scripts and SSH login information from the server administrator and register the information (Fig. 19)

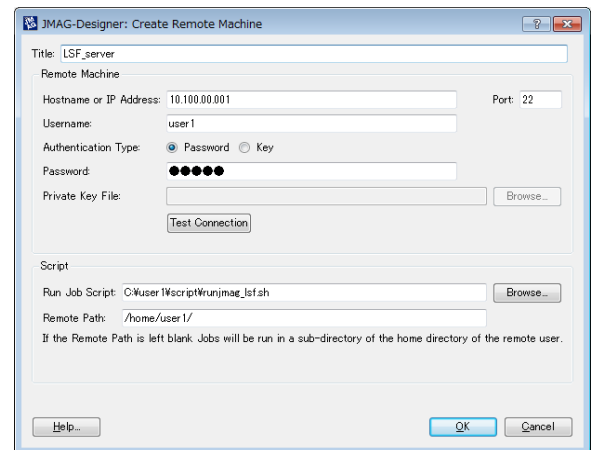



Fig. 19 Example of adding remote machine information

When the remote login information and execution scripts are registered in advance in [Tools] > [Settings] > [SSH], it is possible to select LSF_server registered in the server section of the batch execution.

Conclusion

We hope you like the new version. We introduced some of the new features available in Ver. 14.1.

To see all of the features, please visit our homepage to view videos of each function (*1). Also, there are sample data for each function (*2).

We hope that all of the latest features in JMag are useful for you. 

(Mari Nakamura)

*1 JMag Function Videos:

<http://www.jmag-international.com/products/jmag-designer/index.html#video>

*2 Sample data:

http://www.jmag-international.com/products/jmag-designer/index_v141.html

Please access sample data link on Introduction page of JMag-Designer Ver.14.1. User authentication is required to access there.

Common Questions for JMAG

We will be introducing 4 items related to iron loss from the FAQ posted on the JMAG website. We have divided the questions into two categories of "Operation Methods" and "Troubleshooting." Please select the category in which you are most interested.

OPERATION METHODS FAQ-980

Q1. What is "basic frequency" that is set in iron loss analysis?

A1 "Basic frequency" is the frequency of one period in a magnetic flux density waveform. It is used for defining the interval of the time series data used in iron loss analysis.

The defined interval data is FFT processed and obtains iron loss. The original time series data needs to be magnetic flux density waveform data of more than one period.

There are two types of methods to define the interval of time series data that will be used: automatic and range specification. The image of automatically determining the range of time series data to be used in the iron loss analysis is shown below (Figure 1).

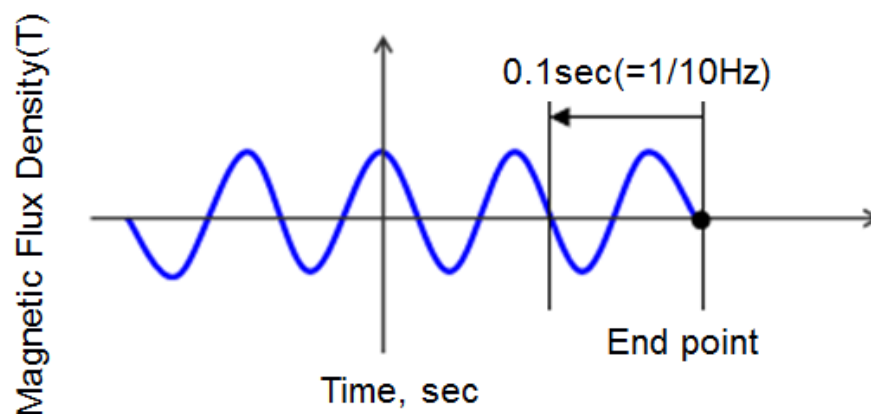


Figure 1 Basic frequency is 10Hz (Fig.1)

Q2. Tell me more about FFT processing for iron loss calculations.

I think that magnetic field analysis results are handled with fast Fourier transformation (FFT) during an iron loss calculation, but is there some sort of interpolation occurring? Tell me how to perform an analysis without interpolation processing.

A2. For FFT processing, interpolate the number of steps of the reference interval so that it exceeds the number of steps and minimum number of nth power of 2.

By specifying the number of referenced steps, the number analysis steps using the values below, FFT processing can be performed without interpolation processing.

The values below are input during FFT in JMAG.

Time in reference interval T [sec]

$$T = t2 - t1$$

t1 [sec]: minimum value (Minimum value for recorded time)

t2 [sec]: Maximum value (maximum value for recorded time. The default is the calculation time for the last step.)

Sampling number N to perform FFT

When M is made the number of steps included between t1 and t2, the sampling number N becomes the maximum number that satisfies the following formula

$$N = 2^n \leq M$$

Frequency resolution Δf

$$\Delta f = 1 / T$$

Maximum display frequency range for FFT fspan

$$fspan = N \times \Delta f$$

Number of lines in fspan Nspan

$$Nspan = fspan / \Delta f = N$$

Sampling frequency fs

$$fs = N \times \Delta f$$

Sampling time Δt

$$\Delta t = 1 / fs = 1 / (N \times \Delta f) = T / N$$

To define the step interval ΔT from the FFT maximum display frequency fspan and the frequency resolution Δf , obtain this using the procedure below.

- 1) Obtain recorded time T.

$$T = 1 / \Delta f$$

- 2) Obtain the number of samplings N.

$$N = f_{span} / \Delta f$$
- 3) Obtain step interval ΔT .

$$\Delta T = T / N$$
- 4) Obtain the number of steps M.

$$M = N + 1$$

TROUBLESHOOTING FAQ-982

Q3. The hysteresis loss becomes 0.

All results become 0 when a hysteresis model is used for the calculation method of hysteresis loss in the iron loss conditions. Please tell me how I could resolve this issue.

A3. When a hysteresis model is used in the calculation method, results will be output in the hysteresis loss (time-dependent) of the output results. Please check the results of hysteresis loss (time-dependent).

Please check the results of hysteresis loss (time-dependent) (Figure 2).

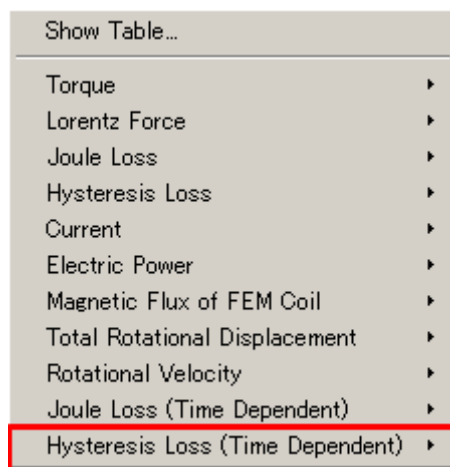


Figure 2 Results of hysteresis loss (time-dependent)

TROUBLESHOOTING FAQ-983

Q4. The hysteresis loss becomes negative.

Negative values are output for the hysteresis loss (time independent). Is this normal?

A4. The shift of operation point for hysteresis loss (time-dependent) is calculated with the following formula and shown as the hysteresis loss. Therefore, a negative value may be shown as an instantaneous value.

$H^*(dB/dt)$

H : magnetic field B : magnetic flux density t : time

To evaluate the hysteresis loss, please use the averaged value for one period instead of using the instantaneous value.


Technical FAQ on the Web

There are many other FAQs related to iron loss.

URL: http://www.jmag-international.com/support/en/faq/function_h.html (User verification required)

We have technical FAQ on our homepage, so come take a look if you have any questions:

URL: <http://www.jmag-international.com/support/en/faq/index.html> (User verification required)

The technical FAQ is a collection of actual questions from our clients, so you might discover some new ways to use JMAG if you go through them. We regularly update our website FAQ. Use this together with the JMAG Newsletter to make your analysis work more effective. Please don't hesitate to use JMAG technical support if you have any questions when using JMAG. We hope you will fully master JMAG! 

(Takashi Kondo)

Event Information

JMAG Users Conference Report

The JMAG Users Conference put focus on communication between participating engineers.

We have prepared a wealth of contents again this year, enabling all participants to spend a worthwhile time regardless of their proficiency with JMAG, so it's accessible to everyone those using the software for the first time through to veteran JMAG users. In this issue, we will look back at the Users Conferences held in Europe.

JMAG Users Conference in Germany

Conference Outline

Host : POWERSYS

Date : Wednesday, May 27th - Thursday, May 28th

Venue : Steigenberger Airport Hotel (Germany: Frankfurt)

URL : http://powersys-solutions.com/JMAG_UC/

The JMAG Users Conference in Germany was held as a place to share knowledge and experience of electromagnetic field simulation.

Day 1 is Technical Day. Three workshops and one-on-one technical consultations were offered as training with the objective of acquiring JMAG skills.


Day 2 was presentation day. Technical partners and of course JMAG users gave presentations on topics such as their honest experiences discussing advantages and difficulties of using JMAG to advance their business, as well as the presentation of coupled analysis use cases.

JSOL introduced the new features in JMAG-Designer Ver.14.1, which is to be released winter this year.

The next conference will be held in Spring 2016. We hope that you all attend again, and those that couldn't make it this time will join next year!

(Corinne Rocherieux)

The JMAG Users conference is held in many different cities. We hope that those of you who couldn't attend, and of course also those of you did attend this year will attend one of the conferences held in one of the cities.

Please spend your time well at the conference. 

Writer: Tomomi Igarashi

Event Report for August - December 2015

Attendees report on events held from August to December, 2015. We hope you will attend our next event.

NI Week 2015

Conference Outline

Host : National Instruments Corporation

Date: Monday, August 3rd - Thursday, August 6th

Venue : Austin Convention Center (America: Texas)

URL : <http://www.ni.com/niweek/ja/> (Japanese only)

NI Week is a yearly conference held by National Instruments Corporation, and sees around 3600 engineers from countries around the world gathered under one big conference roof. JMAG's booth will present a linked analysis with JMAG-RT and National Instruments' Motor HILS.

Please come and see our demonstration of JMAG-RT for precision plant models.

JMAG Users Conference in Taiwan

Conference Outline

Host : FLOTREND CORPORATION

Date : Tuesday, August 25th

Venue : GIS NTU Convention Center (Taiwan: Taipei)

URL : http://www.flotrend.com.tw/news_center/event/seminar/2015/08_jmag/

A JMAG Users conference will be held in Taiwan.

We will discuss the latest information on JMAG-Designer Ver.14.1. released in this June. This is an excellent chance to gain insight on current trends and utilization strategies for electromagnetic field analysis. We look forward to seeing you there.

2015 IEE-Japan Industry Applications Society Conference

Conference Outline

Host: The Institute of Electrical Engineers of Japan

Date: Wednesday, September 2nd - Friday, September 4th

Venue : Oita University, Dannoharu Campus (Japan: Oita)

URL : <http://www.gakkai-web.net/gakkai/jiasc/hp15/> (Japanese only)

We will participate in the IEE-Japan Industry Applications Society Conference business exhibition. Beginning with an introduction of JMAG-Designer 14.1, there will be a demonstration as well as advice for increasing efficiency of your work such as optimization. Please drop by at the JMAG booth when participating in the conference.

Presentation The Magnetics Society of Japan - Annual Conference

Conference Outline

Host: The Magnetics Society of Japan

Date: Tuesday, September 8th - Friday, September 11th

Venue: Nagoya University, School of Engineering (Japan: Aichi)

URL : <http://www.magnetics.jp/kouenkai/2015/> (Only Japanese)

Mr. Yamada from JSOL will host a lecture titled "Finite Element Analysis for Electromechanical Design". The history of FEM and JMAG's involvement will be discussed.

Presentation Electromagnetic field analysis application technologies for motor design

Conference Outline

Host: Kodo Polytech Center

Date : Thursday, September 9th - Friday, September 18th

Venue: Kodo Polytech Center (Japan: Chiba)

URL : <http://www.apc.jeed.or.jp/seminar/course/15semiP024.html> (Japanese only)

Mr. Nishio from JSOL will present on electromagnetic field analysis application technologies using JMAG. Participants will have hands-on experience learning methods to create a plant model extremely similar to the physical machine using the fundamentals of electromagnetic field analysis simulation, useful for control design.

We hope those that are aiming to sharpen your skills will attend.

Exhibition ECCE2015

Conference Outline

Host : IEEE

Date : Sunday, September 20th - Thursday, September 24th

Venue : Palais des congrès de Montréal (Canada: Montreal)

URL : <http://2015.ecceconferences.org/exhibitors/>

ECCE (Energy Conversion Congress and Exposition) is a society sponsored by IEEE that focuses on energy.

Presentations of JMAG's newest functions, case studies, as well as design demonstrations of JMAG-Express and JMAG-RT Viewer, will be given at our booth.

Exhibition CWIEME Chicago 2015

Conference Outline

Host : i2i Events Group

Date : Tuesday, October 6th - Wednesday, October 7th

Venue : DE Stephens Convention Center (America: Chicago)

Booth Number: K4

URL : <http://www.coilwindingexpo.com/chicago/>

CWIEME, known to be one of the world's largest exhibitions, gathers products related to coil such as winding machines, motor stators and insulating paper.

At the JMAG booth, we will be doing demonstrations of motor and transformer analysis case examples using JMAG-Designer Ver.14.1.

We hope you check of the latest use cases

JMAG Users Conference in USA

Conference Outline

Host : POWERSYS Inc

Date: Wednesday, October 21st - Thursday, October 22nd

Venue : THE WESTIN SOUTHFIELD DETROIT (America: Southfield)

URL : http://www.powersys-solutions.com/JMAG_UC_USA/

A JMAG Users conference will be held in America.

The event will take place over two days: The first day will be a technical day, and the second day will have user presentations. A training seminar will be held focusing on new features. This is an excellent chance to gain insight on current trends and utilization strategies for electromagnetic field analysis. We look forward to your attendance.

2015 JMAG Users Conference

Conference Outline

Host: JSOL Corporation

Date : Tuesday, December 8th - Wednesday, December 9th

Venue: Tokyo Conference Center Shinagawa- (Japan: Tokyo)

URL : <http://www.jmag-international.com/event/conference2015/index.html>


The schedule for the 2015 JMAG Users Conference has been decided.

Different from last year, the conference will be held on Tuesday and Wednesday. Please mark these dates in your calendars!

The 6th Seminar on Advanced Computational Electromagnetics went smoothly, and the staff has begun preparing for the Users Conference.

We are planning an even better Users Conference for you. Please wait a while longer before we begin accepting applications.

JMAG-Designer Ver. 14.1, which was released in June 2015, will be exhibited at each location.

We are also planning exhibitions and seminars in countries around the world, not limited to Japan and America. Please have a look at the event information on our website. We look forward to seeing you there. 

(Tomomi Igarashi)

Event Information

Event Report for April - July, 2015

Attendees report on events held from April to July, 2015. We hope you will attend our next event.

Presentation Optimus Seminar hosted by Cybernet

Conference Outline

Host: Cybernet Systems Co., Ltd

Date : Tuesday, April 21st

Venue: Cybernet Systems, Tokyo Head Office 18F seminar room (Tokyo, Akihabara)

URL : http://www.cybernet.co.jp/optimus/seminar_event/special/jmag2015.html (Japanese Only)

The following was announced at The Optimus Seminar hosted by Cybernet Systems Co., Ltd: At the presentation, titled "Optimization Case Studies of Reactor Sound Reduction with JMAG-Optimus Coupling", Mr. Hanzawa from Cybernet Systems Co., Ltd. and Mr. Nishio from JSOL took turns presenting. Also during the presentation, features from the latest version of Optimus were introduced, and useful features for optimizing geometry during a linked analysis were discussed.

With nearly a full house, a wide range of participants attended, from those just getting started in analysis to those who have already had experience in the field. Analysis novices inquired on the possibilities of linked analyses, and those more experienced in analyses asked about new features and solutions.

We will continue to improve upon our technologies to make even better analyses possible.

(Takayuki Nishio)

Exhibition CWIEME Berlin

Conference Outline

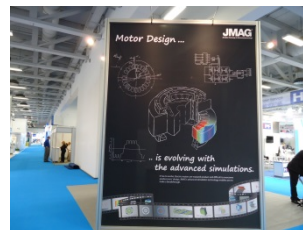
Host : i2i Events Group

Dates: Tuesday, May 5th - Thursday, May 7th

Venue : Messe Berlin South Entrance (Germany: Berlin)

Booth ID: 1.1/D10

URL : <http://www.coilwindingexpo.com/berlin/>



CWIEME, known to be one of the world's largest exhibitions, gathers products related to coil such as winding machines, motor stators and insulating paper. Solutions for motor designers such as JMAG-Express and solutions for large-scale transformers were introduced at the JMAG booth. We received more visitors with professions involved in transformers than motors at our booth.

When we set up a 4-meter "JMAG tower" which drew lots of attention last year, we were impressed to see our visitors staring up at the display.

Presentation Exhibition SIMULIA Community Conference

Conference Outline

Host : SIMULIA - Dassault Systems

Date: Monday, May 18th - Thursday, May 21st

Venue : InterContinental Hotel (Germany: Berlin)

URL : <http://www.3ds.com/events/simulia-community-conference/overview/>

We held an exhibition at SIMULIA Community Conference hosted by SIMULIA - Dassault Systemes. With about 750 participants, SIMULIA presented their plan and future vision of "3D experience", attracting their users' attention.

Many Abaqus users interested in structural analysis dropped by at the JMAG booth. Various analysis cases of JMAG and coupling cases with Abaqus were introduced at the booth presentation.

Presentation Exhibition Integrated Electrical Solutions Forum (IESF)

Conference Outline

Host : Mentor Graphics

Date : Tuesday, August 19th

Venue : Ford Motor Company (America: Detroit)

URL : <http://www.mentor.com/events/iesf/detroit/>

The Integrated Electrical Solutions Forum hosted by Mentor Graphics was held. Around 1000 users attended the forum. Hosted at a Ford Motor facility, we were impressed to see many users attended who were involved in the automobile industry, especially those involved with Ford.

We gave a presentation introducing JMAG-RT. We received more questions regarding HV motors than JMAG-RT from the audience members.

JMAG and SystemVision coupling was introduced at the JMAG booth, drawing in many forum attendees to see.

Exhibition TECHNO-FRONTIER 2015

Conference Outline

Host: Japan Management Association

Date: Wednesday, May 20th - Friday, May 22nd

Venue: Makuhari Messe (Chiba, Makuhari)

MOTORTECH Japan: 7C-211

URL : <http://www.jma.or.jp/tf/> (Japanese only)

This year's TECHNO-FRONTIER was held during the refreshing spring season at Makuhari Messe.

At the JMAG booth, we demonstrated JMAG-Designer Ver.14.1 released in June, JMAG-Express, our motor design tool, and JSOL's leading motor simulation technologies. One of the walls of the booth was used as a display to show case examples of analyses performed in JMAG, such as optimization, distributed processing, high speed parallel processing, and multi-physics. We also saw attendees thoroughly perusing articles on the iPad.

We were nervous to see if attendees would come even without a booth this year. Once we started, we were greatly relieved to often see attendees leisurely spending their time having technical consultations with the JMAG engineers.

We plan to bring you an even more powerful JMAG next year, so we hope to see you at our booth!



(Tomomi Igarashi)

Presentation Exhibition STAR Japanese Conference 2015

Conference Outline

Host : CD-adapco

Date : Tuesday, June 2nd - Wednesday, June 3rd

Venue: Yokohama Royal Park Hotel (Kanagawa, Yokohama)

URL : <http://www.cd-adapco.com/node/7560/> (Japanese only)




The STAR Japanese Conference was held over two days with approximately 700 users in attendance.

Sessions were held covering a wide variety of topics including engines, energy, architecture, electricity, electronics, and chemistry, serving as a forum for lively discussions.

This was the first event since JMag and STAR-CCM+ coupling was officially announced, and we are even more determined to ensure this partnership meets the expectations of those eagerly awaiting it. During the presentation titled "Electromagnetic Field Analysis Software JMag and STAR-CCM+ Coupled Analysis" we discussed how this partnership is not just software coupling, but also a support system backed by engineers from both companies.

(Mari Nakamura)

This issue has focused largely on reporting exhibitions and seminars held in Japan, the United States and Europe. JMag will continue to strive to not only provide technological support, but also to play a part in our customers' global strategy. 

Writer: Tomomi Igarashi

