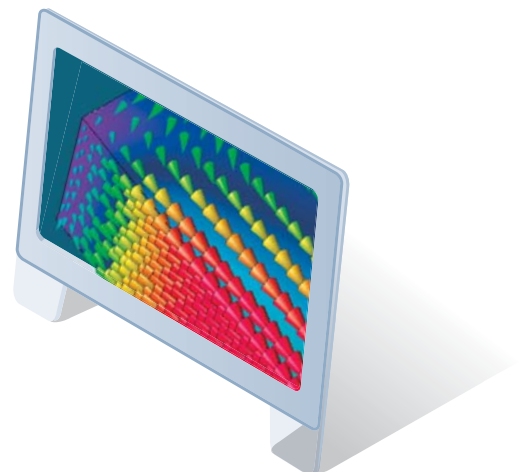# JMAG News Letter

2011 Fall

It is now simple to be precise

JMAG is a comprehensive software suite for
electromechanical equipment design and development.
Powerful simulation and analysis technologies provide a new standard in
performance and quality for product design.
Capture complex phenomena and gain valuable insights.

Contents

JMAG NewsLetter:
Highlights of the Fall Issue

The fall issue comes just before the JMAG Users Conference.

At this year's JMAG Users Conference we will organize a new program, "Section Meetings."
The section meetings are a progression of the poster exhibitions by the JMAG engineers, which were held until last year. As with the poster exhibitions, we used a wide variety of themes as our subject matter, making this a place where small groups can communicate through technical and information exchanges.
Please give the event information page a look and come to the Users Conference.
We look forward to seeing you there.

The interview at the beginning of the newsletter features Fuji Electric FA Components & Systems Co., Ltd., who jumped to the position of the leading company in the electromagnetic switch market. We asked them about everything from the story behind their JMAG introduction to the knacks that they use during application.

In " Model-based Development " we think about the reality of CAE usage, and by examining the things that we must strive for and the end goal of the present situation we introduce the fact that the world that Model-based Development contains has a broad range, and is not limited to coupling with control circuits.

We will bring you other quality contents, as well.

<div align="right">

JSOL Corporation
Electromagnetic Engineering Department
Engineering Technology Division

</div>

Implementing JMAG

Fuji Electric FA Components & Systems Co., Ltd. Using a merger with Schneider Electric S.A. and making the leap to become a leading company in the electromagnetic switch market

Fuji Electric FA Components & Systems Co., Ltd. is the leader in control instruments, such as electromagnetic switches that use electromagnets to open and close the contact points of electrical circuits. In 2008 they merged with the Japanese arm of Schneider Electric S.A., the second largest manufacturer in the same field. By merging the former Fuji Electric, the market leader in Japan, with the former Schneider, who provides the know-how of a global company, they are leading the market with a combination of global product power and solution proposals that have high added value. They are using "JMAG", JSOL's electromagnetic field analysis software, at their development site. We asked Mr. Masayoshi Sakata, the manager of the development and technical analysis group at Fuji Electric's technology and development headquarters and the driving force behind utilizing simulation, about how he uses JMAG.

Providing products at the world's highest level in the control instrument and receiving and distributing instrument fields

Fuji Electric FA Components & Systems Co., Ltd. Technical development headquarters Development and technical analysis group Manager Mr. Masayoshi Sakata

-The words "FA Components" appear in the name of your company. What do they mean and exactly what role do they play in your company?

Mr. Masayoshi Sakata The company's business fields are broken up into two main parts. There is the "Control instrument" field, for things like magnetic switches and operation displays, and there is the "Receiving and distributing instrument" field, which is for things like molded case circuit breakers and earth leakage circuit breakers.

To be precise, we operate with the assumption that it is a relay instrument, and then develop and produce the fuses and switches necessary for four types of things: 1. Molded case circuit breakers and earth leakage circuit breakers, 2. Electromagnetic switches and electromagnetic contactors, 3. Switches and sensors for all types of operation equipment as well as control relays, and 4. High voltage reception and distribution of electricity.

Getting a little more into detail, the device that opens up or closes off the flow of electricity (electrical circuit) when the circuit or electrical equipment is behaving normally is called the Switch. The electrical instrument that outputs an electrical signal for control in response to the switch or electrical equipment's condition is called the Relay. The instrument that is coupled to the electric relay and shuts off the current when an unexpectedly excessive load current hits the circuit, potentially causing considerable damage to the facility, is called the Breaker. The device that combines the apparatus (the electromagnetic contactor), which uses an electromagnet to open and close the circuit, with the Breaker is the Electromagnetic Switch.

Our company develops and manufactures switches and breakers used in factories and buildings in addition to electric switches for electric motor circuits for clients that range from

transformer stations on the power grid to the consumer side.

-What led you to implement the electromagnetic field analysis software "JMAG?"

Mr. Sakata At the Fuji Electric Group we have been using JMAG for some time for motor design and analysis. Here at the Fukiage factory we had been using a different analysis software, but it was hard to operate so the interface was not at a level that allowed the developers to use it easily.

While not limited to our own field, there is an unavoidable trend toward products that are smaller and save both power and energy. For that reason utilization of simulation methods is indispensible. Using simulation software with a good interface was an urgent issue.

At the company I have been involved with the structures of several various simulation techniques, but in 2007 I took the step of implementing JMAG to go along with my transfer to the Fukiage factory in Saitama Prefecture. My transfer itself was intended to spread the use of simulation techniques at the development and design sites, and the software that had an easy-to-use interface that would answer to those expectations was JMAG.

A versatile simulation range because it uses electromagnets

-When developing a switch, what kinds of parts do you use electromagnetic field analysis software on?

Mr. Sakata Let's go a little more into detail about structure by using electromagnetic switches as an example. Electromagnetic switches (commonly known as magnet switches) are a combination of electromagnetic contactors, which perform the controls of opening and closing electric circuits, with thermal relays, which give the motor overload protection.

Electromagnetic contactors are constructed with a frame that combines the electromagnetic part and the contact point into a single object. By running electric current through the coil of the electromagnet and generating magnetic force in the electromagnet itself, (excitation), it closes the contact point. If we cut the flow of current in the coil, however, it demagnetizes and the contact point opens.

On the other hand, with the thermal relay, if the motor becomes overloaded and there is a current surge that runs for more than a certain period of time, then the temperature in the bimetal of the heat element rises and it bends. Then the contact point of the electromagnetic contactor, which couples to the relay contact point and operates it, opens, preventing motor burnout before it happens.

- In other words, could you say that electromagnetic field analysis plays an important role in choosing materials and circuit design when developing and designing electromagnetic switches?

Mr. Sakata Exactly. For example, we do simulations on things like, what kind of magnetic force would be good to generate in order to make the contact part move more smoothly and what kind of involvement it will have.

When a current surge is produced, the contact part of the electromagnetic contactor opens immediately with a strong repulsive force, but it is vital to have a structure design and a wiring design that allow this power to be used in a way that produces a smooth movement.

And when the current is cut off a discharge arc gets produced, so we repeat simulations where we set up various trial arcs and use the arc's power instead of just clarifying its generation mechanisms.

Analysis of the contact part arc
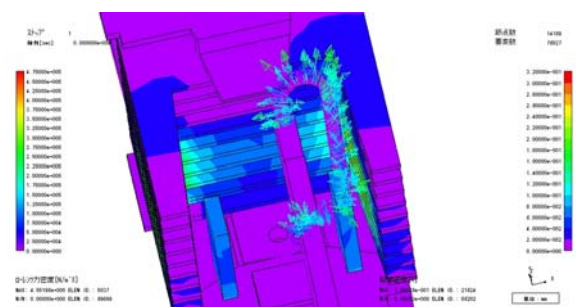
JMAG is a tool for more than just motor related analysis

- There is a full variety of examples of usage.

Mr. Sakata There really are a lot of ways to use it, aren't there. (Laughs) For example, if you take several small electromagnetic switches and line them up, when you use them they cause magnetic interference, so we do that simulation and we look

for magnetic changes that produce vibrations in the equipment, as well.

First we make several dozen patterns of the basic shape, and then we use JMAG for designs of the detailed parts beyond that. We use it for applied analysis of the structure, too.

I had thought that JMAG was specialized for motor types of electromagnetic field analysis, but, and pardon my rudeness here, I realized that it is a surprisingly easy to use and powerful tool for the electromagnetic switch field, as well.

People take it for granted that products in the class of devices that we develop and manufacture are used over long periods of time, ten or twenty years. That is why we perform endurance tests like repeatedly opening and closing them about 10 million times over a period of six to twelve months before we start mass production. This is precisely the reason that we cannot make the step to mass production without properly resolving various issues. That is the background behind the reason that JMAG has become an indispensible part of our worksite.

-You are using "JMAG-Designer," the new version of JMAG, at Fuji Electric, so we would like to hear your impressions of it so far.

Mr. Sakata The analysis supervisor takes care of the final detailed analysis and confirmation, but I feel that JMAG-Designer is getting easier and easier to use for those who are doing the designs In March of 2011, we used the upgrade to JMAG-Designer as an opportunity to hold an in-house study session targeting the designers, and all of the designers who had not been using JMAG until now got to be able to use it. You can really understand its strengths.

It has gotten to where it can handle CAD data and it is also possible to do both direct and geometric changes on the mesh model and obtain analysis results, so I think that the number of users will most likely increase further. However, I would be grateful if there were functions that allowed me to confirm the direction visually and not just numerically.


Encouraging the ability to search for further reasons with simulation software

-In closing, tell us any tricks of your own that you have for using JMAG.

Mr. Sakata There are not many people who can get a clear mental picture of a 3-D image from 2-D data, but thanks to the appearance of the 3-D CAD the threshold for designing while trying to think of a 3-D image has gotten quite low.

However, on the other hand if one designs in 3-D things progress automatically right until the actual figure, so the understanding of why it comes out in the way that it does, a basic point, is still weak. I think that simulation software has the effect of promoting understanding regarding this basic point by presenting validity through analysis.

To put it a different way, an answer comes out even if a person inputs the wrong numerical values, so by doing various simulations the designer thinks, "Why is it coming out like this?" and we have to teach the ability to be able to nail down the logic for things to turn out like that. This consists of nothing other than an increase in a person's ability as a designer. You could even call it a "Tool for the trial and error method." However, in order to do trial and error one needs the ability, not having the fear of failure, to do trial and error. 🄹
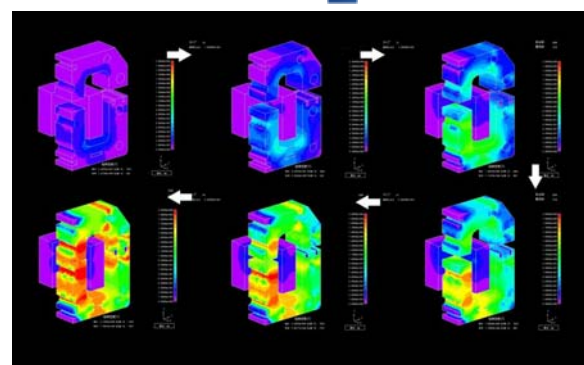
AC electromagnet analysis used for electromagnetic contactors

Business Overview

Fuji Electric was established in 1923 through both a capital and technical alliance between Furukawa Electric Co., Ltd. and the German company Siemens. In 1935 a company called Fuji Communications Instrument Manufacturers was set up after growing independent of the phone department and became the current company Fujitsu.

Fuji Electric Group was transferred to the holdings company system in October of 2003, and because of that, Fuji Electric FA Components and Systems Co., Ltd was established as the core business of the Equipment and Control Department. After that in 2008 they had a merger with the Japanese arm of the French Company Schneider, the world's second largest company in the electric receiving and distribution instrument business, and became the new Fuji Electric. In name as well as in reality they are Japan's leading company in the electric receiving and distribution instrument field as well as the control instruments field.

They have three manufacturing bases in Japan, at Fukiage (Saitama Prefecture, Kounosu City), Ohtawara (Tochigi Prefecture, Ohtawara City), and Chichibu Fuji (Saitama Prefecture, Chichibu Gun Ogano Machi).

Business Activities

Electric receiving and distribution instruments
Development, production, sales, and services of regulation instruments.

http://www.fujielectric.co.jp/fcs/

Company Name Fuji Electric FA Components & Systems Co., Ltd.
Established   10/01/2008
Location   Mitsui Sumitomo Bank Ningyo-cho Bldg., 5-7, Nihonbashi Odemma-cho, Chuo-ku, Tokyo, JAPAN
Capital   7,600,000,000 Yen
Consolidated Number of Employees   2600
President   Fumio Ito

Model-based Development Part 3

Easily Joining Complicated Physical Phenomena and Contributing to Improvements in Development Efficiency

In the last issue, we introduced the development intention of JMAG-RT that is one of the solutions for model-based development, resulting outcomes or the functions added with JMAG-Designer10.5. This time, entitling the issue 3 as the model-based development that gives an explanation of "Model-based development effectively connects with multi-complicated physical phenomena to each other" and this issue introduces the scene of model-based development includes is much more wide-range and it goes beyond coupling with the control circuit.

Reading this time's description may let you rediscover the idea of model-based development.

Current Status of the Coupled Analysis using CAE

Reality of CAE utilization

In today's research and development, utilization of CAE is very common, and it is used in wide-range development phase such as concept designs, further studies and reviewing of manufacturing process. From a viewpoint of physical phenomenon, however, the utilization of CAE does not go much beyond the purposes of upgrading and accelerating the design each physical phenomenon. For example, an engineer who needs to evaluate the structure aspect carries out structure CAE like measuring the actual machine using vibration testing machine and vend testing machine to evaluate the right and wrong of the design. Similarly, an engineer who needs to evaluate the electromagnetic force and loss of the motor utilizes the magnetic field CAE like measuring the output characteristics by motor-bench testing or measuring using the LCR meter.

A concern that comes up in this situation, a structural engineer and a magnetic field engineer may evaluate different models each other. Each engineer must comprehensively judge how does the improvement measure conducted in his own task effect to other tasks, or if total optimization is done. Viewing the different model, however, one

Prototype
Contains all the physical information

The relationship is easy to disconnect due to model separations.

Model for Magnetic Field Analysis
Remove the unnecessary information for magnetic field analysis aggressively

Model for Structural Analysis
Remove the unnecessary information for structural analysis aggressively
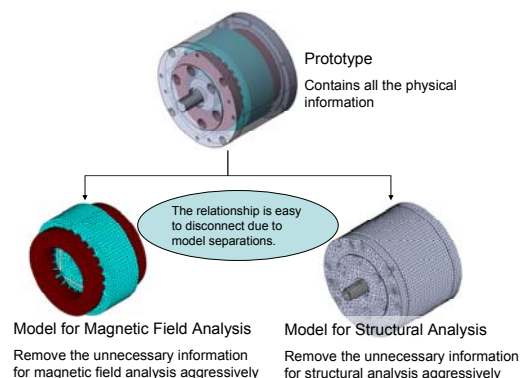
Fig. 1 Relationship between the Actual Machine and Analysis Model

sometimes makes a wrong synthetic judgment. See Fig. 1.

For example, when considering the countermeasure for the motor vibration that occurs resonance at 1000 Hz, it is very difficult to judge if conduct only one of the countermeasure of magnetic field or structures, or both of them simultaneously. In case conducting the countermeasure that reduces the frequency individually results in again the same resonance frequency at 800 Hz for both of the magnetic field or structures, which are terrible. Considering these two countermeasures simultaneously, such situation does not occur, but the concurrency that is expected to CAE will not be realized. Therefore,

interoperating with two different models requires extremely careful management.

Needless to say, all the physical behavior can be checked with the actual products and prototypes, so that will be a help to avoid the engineer of each field to view the different models that will be a problem with CAE. Structural countermeasure enables you to check the magnetic influence instantly. However, creating prototypes forces you to encounter the hard reality of the necessity of lots of time and a large cost.

Insufficient Performance of the Coupled Analysis

Current market released version of coupled analysis simulation successfully realized evaluating the same models linking the same models to each other with multiple themes " in theory". Actually, however, delicate and minute works just like appropriately converting physical quantity of the related model data or adjusting the link timing are required for actual operations, and, in many cases, such works are realized by analysis specialists' advanced technologies and mental strength.

In other words, no user-friendly coupled analysis simulator that lots of front-line engineers can utilize over the entire process of the daily development unfortunately exists. It's an unfortunate reality.

On the contrary, overcoming this problem enables CAE to make a contribution to improvements in development efficiency.

Dealing with the Model-based Development Links Multiple Physical Systems Effectively

What CAE should aim to

Just imagine the role CAD plays in machine designs. The greatest benefit of CAD is not that easy line drawing on the computer but multiple designers can share the information and discuss design studies simultaneously. This benefit enables lots of designers to cooperate, and mounting various functions in the limited space in a short time, and also realizes an excellent design. CAD model includes the information on dimensions, materials, and design know-how.

The target direction of the model-based development is incorporating information on

physical behavior to this shared information. The model-based development requires the models that take part in developments to enhance the information traffics, and it makes a contribution to the more smooth communication between involved contact personnel and departments. Needless to say, the ideal model that is used in model-based development is "A model that has all the characteristics of actual machines" and "Easily extract the characteristics". See Fig. 2.

For example, a control technician who is in charge of developing motor drive systems uses the models with being interested in torque characteristics and response to carry out design evaluation of control logic or using device. Concerning magnetic saturation or temperature distribution, however, its influence is only indirect, so control technicians have little interests of that. After handing off the model to a thermal system designer, it will be utilized for thermal system study and evaluated from the view of heating design.

If each person in charge utilizes control models or thermal models, they possibly check the different points, but a model includes all the characteristics and the information is easy to obtain, and information sharing is easy and it leads to improvement of development efficiency or product quality.

Linking multiple analyses must be done easily

Actually, it is not important to figure out the causal connection of complicated physical phenomenon in design works. In fact, actual machine includes the causal connection of complicated physical phenomenon at the point of being object. According to the entered input, outputs the response on the basis of the physical causal connection. An actual machine that is an anorganic substance has no way to its own causal connection, and it is easy for evaluation engineers to make a contribution to problem resolution if they know the causal connection, but they can evaluate good or bad if they do not.

Framework of the Conventional
Coupled Analysis

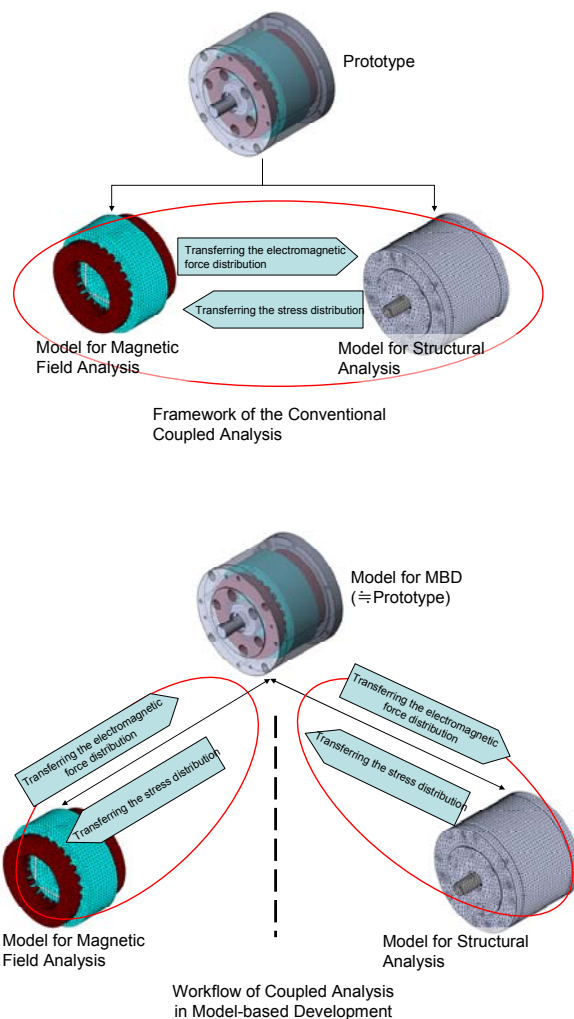Workflow of Coupled Analysis
in Model-based Development

Fig. 2. Framework Change of Coupled Analysis by Introducing
Model-based Development
(Upper: Conventional Coupled Analysis , Lower: Coupled Analysis
under Model-based Development Environment)

After all, the major cause of complicated physical phenomenon is insufficient performance of CAE that cannot express many faces. In order to make model-based development the substitution of actual machine evaluation, you should not force users to understand causal connection.

Current Achievement

JMAG give emphasis to basic performance like carrying out highly accurate magnetic field analysis in high speed, and also aims to be ready to utilize its results versatilely in model-based development.

It is impossible to reach the goal at a bound, so JMAG is going forward step by step.

Our action assignment at this point is to enhance JMAG's performance so that the machine designer can carry out structural analysis based on the magnetic field analysis results obtained from JMAG using his familiar structural analysis software without learning the JMAG operation. Similarly, another our assignment is enabling JMAG users to carry out magnetic field analysis based on the structural analysis results on his familiar JMAG without learning the operation of structural analysis software. Concerning these points, I would like to introduce the tasks we have already achieved and the ones we are realizing in the near future.

Linking to Abaqus

As I always explain, we have worked hard on enhance the linkage performance to the structural analysis software "Abaqus" manufactured by SIMULIA, and it is widely used in the filed of nonlinear structural analysis. At this point, it is possible to directly read the result file of electromagnetic force distribution obtained by JMAG on Abaqus, and input electromagnetic force to carry out nonlinear structural analysis. Similarly, it is possible to input the eddy current loss obtained by JMAG to perform the thermal analysis. On the other hand, it is possible to directly read the stress distribution file obtained by Abaqus on JMAG, and to perform the magnetic field analysis taking account of the stress magnetic properties. This enables structural analysis engineer to easily utilize the analysis results that is in charge of the electromagnetic field analysis engineer, and of course vise versa, so much higher information sharing is realized.

Also, we are developing a function to maintain linkages even in the phenomenon with model deformation that Abaqus is good at. It is going to be the function that can evaluate a complicated physical phenomenon with shape deformation like electromagnetic forming.

Linking to LMS Virtual.Lab

We plan to enhance the link features with Virtual.Lab manufactured by LMS International who offers solutions for vibration noise analysis. So far, the feature only outputs the data in Nastran format, it is going to directly read the result file of

electromagnetic force distribution obtained by JMAG on Virtual.Lab, and to input electromagnetic force to perform vibration noise analysis.

In the development of electrical devices, requirement of vibration noise reduction is getting higher, so we understand we have the responsibility of offering solutions in this field.

In Closing

We of course keep enhancing the basic features on the electromagnetic field analysis using JMAG, and also plan to make a contribution to the model-based development by strengthen the linkage so that the result can be easily utilize on the other simulation software. It's "OPEN" that has the task to embody it, and we indicate it in the development concept.

Future dream, concept on Virtual Test Bench

We are releasing Virtual Test Bench (from here on VTB) on the next version. VTB has two roles.

The first one is the function that easily gives the causal connection to models. It is setting physical causal connections such as of course the magnetic field characteristics and also temperature dependency and stress dependent and so on.

The second one is the function that easily evaluates the magnetic field characteristics. Without attending training sessions or seminars, we plan to prepare the environment of easy evaluation tasks for structural or thermal system designers.

At the first time, an electromagnetic field analysis engineer needs to design the modeling policies or evaluation flows, but we aim to make it possible to utilize them easily by other than electromagnetic field analysis engineers after designing them.

After realizing this, for example, in a case that a structural designer changed the clearance of shrink fitting of stator core, it is possible to perform the structural design while checking how influence appears on the output characteristics of the motor.

Even such accurate analysis as an electromagnetic designer cannot be realized, but you can check the effects of the magnetic field boundary done by design changes that the machine designer made with learning "only few" JMAG operations.

These facts match with the model-based development aim of easily revealing complicated physical phenomenon.

Forefront of Model-based Design

dSPACE Interview

Currently, model-based development (hereinafter MBD) for the field of power electronics、including motors, has yet to get into full swing, but a high percentage of the top ECUs that control motors have already incorporated MBD. Everyone presently using JMAG will eventually be implementing a MBD environment in the future. We talked with Takashi Miyano, Director of the Engineering Department at dSPACE Japan which provides the latest development tools to automotive ECU development and breaking new ground in MBD, to find out more about what is currently happening at the forefront of MBD.

Trends of MBD

Saying that automobiles have become a bulk of computers is not going too far as shown by the halted production of vehicles due to the microcomputer manufacturers for automobiles that feel victim to the earthquake in northern Japan.

Vehicles have to connect the ECUs utilized in engine units including the engine, power steering, and breaks as well as the ECUs built into amenity units like air conditioning and navigation systems.

A massive overall program is required to combine each of these ECUs that have their own control programs.

The overall evaluation is also enormous because each independent unit needs to be confirmed in addition to examining everything at a system level.
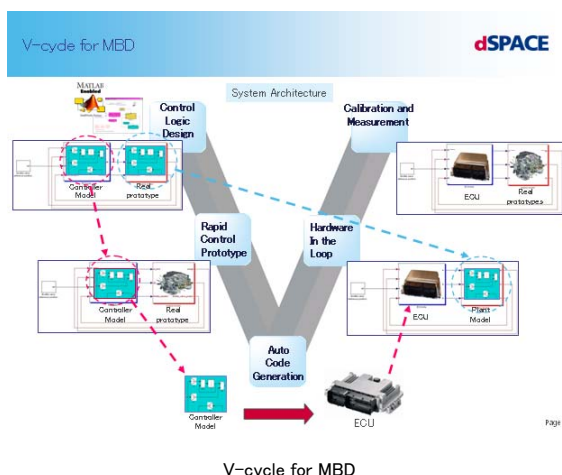
Mr. Takashi Miyano,
Director of the
Engineering Department
at dSPACE Japan

V-cycle for MBD

When designing control systems, models of the controller (ECU) for the plant (control targets) models to be controlled are produced and adjusted. One MBD environment provided by dSPACE is the RCP, a prototype ECU capable of quickly supporting a controller model. The RCP includes a small stand-alone MicroAutoBox system and a RapidPro system with expansibility.

A second environment is a HILS used to construct the plant (controlled targets such as motors, actuators, and sensors). Both environments can control the actual control target in real time and verify the ECU in real time. The basic point is to automatically generate the C code for the ECU from the ECU control model created in the upstream processes in real-time simulations using RCP and HILS.

While MicroAutoBox has a calculation capacity that is quite capable of replicating an ECU, a control period of around 100MHz/100nsec can be achieved using an FPGA board when required for extremely high performance calculations in areas like power electronics-related modeling or image recognition.

The MBD environments provided by dSPACE are MicroAutobox, a model to construct ECU and control

programs that are built-in and the RaridProunit to construct the plant (control targets such as motors, actuators, and sensors). These interfaces are arranged so that a hardware-in-the-loop simulation can be configured. The fundamental point is to automatically generate the C code for the ECU from the control model of the ECU created in upper processes in real time simulations using MaicroAutoBox and PapidPro. MaicroAutobox has a calculation performance that can reproduce the ECU, but a control period of100 MHz/10 nsec can be achieved by using an FPGA board, which is required for extremely high performance calculations of modeling related to power electronics and image recognition.

dSPACE HIL (Hardware-in-the-Loop) Simulation

Plant models, another vital key equivalent to ECUs in MDB, are refined by each user. The experience of the user is shown by what physical aspects should be embedded in the model. Evaluating the validity of a model is determined by rotating it through the V-cycle. Discrepancies in the model are found as a model moves to proceeding processes if the accuracy of the model is not sufficient because the system does not operate correctly, etc. If the cause of the discrepancies is the model, the problem is fixed and the V-cycle is repeated again.

In the case of automotive ECUs, one third of the source code is for diagnostics. It is necessary to confirm whether or not the control system is configured so as to prevent the system as a whole entering crisis mode as a result of a disturbance such as a broken wire, noise between a sensor and ECU, or plant failure-type damage.

For these checks, verifications are needed for various fault modes. Automatic testing using HILS is effective because as the system grows in size, the number of

tests needed increases exponentially. Because real ECUs are naturally tested, plant simulation also has to be performed in real time.

Mr. Miyano's lecture about the extreme advantages of using MBD for ECUs and program development has been very informative. I asked Mr. Miyano to elaborate further for me as a designer close to plant design.

(JMAG)
This has been very informative about the amazing advantages of using MBD for ECUs and program development, but implementing MBD doesn't seem to affect the JMAG users who are closer to plant design. What are the benefits of implementing the MBD environment for plant designers?

(Mr. Miyano from dSPACE)
Demands for plants using MBD allow more specificity and detail. For example, there are requests like the torque variations of the motor need to be kept under X.XN-m. On one hand, the requirements may become stricter, but the sensitivity and the priority during optimization of the entire system becomes clear.
An optimal design for the components that meets system requirements (including over-spec review) is possible.

This final answer has cleared up any misunderstands I had.
MBD is something that engineers are hoping for if it has fair tradeoffs between the plant and control designers, and not whichever side has the loudest voice. This interview has really showed that the efficiency of development using MBD not only reduces the time of development, but also effectively shares information and the decisions that have been made. J

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FEA Description Issue 3

FEA Expansion to the Product Development Process

Among those reading this magazine there are most likely some who think that, because they began development in an era when there was no FEA and their design process is already set in stone, there is no point in starting to develop with FEA at this late stage. There are also probably quite a few who are interested in FEA, but cannot picture how they would actually be able to extend it to the design process.

In this issue, by taking another look at the product development process up to the present, I would like to exhibit the fact that there are places in which FEA is actually able to play a large role in various development process situations, including design.

Being Able to Verify the Product Development Process

There is an image of FEA simulation as being an advance evaluation for the product design stage. However, it is a simulation technique that has a wide range of application and can be used in verifying and evaluating every stage of the product design process.

Here I will break up the product development process into three parts: "Development Process," "Production Process," and "Operation Process," and I will apply FEA to each of these. I would also like to show that FEA is a technique that does not just raise the efficiency of each process, but also makes it possible to build in quality as a long term viewpoint, from the initial steps of development to design, production, and operation.

I will focus on motors as concrete product examples.

Usage in the Design Process

Fig. 1 displays a typical, traditional motor design process that does not use FEA.

Generally, in a typical electrical equipment design, it is normal to proceed by fulfilling the required specifications while getting a balance between magnetic loading and electrical loading. However, in cases where there is no leeway in the design or when it is necessary to look for the optimal balance between both sides, there often arises a competition between thickening the iron core and avoiding magnetic saturation or getting coil space and increasing the number of turns. In studies using only empirical value and self manufacturing tools, there is a tendency for the level of reliability from a precision standpoint to be insufficient, especially in designs like those above that reflect even slight changes in geometry while accounting for magnetic saturation.

At this point I would like to address typical problems that arise in the design process.

- Magnetic circuit confirmation: In motors with strong salient properties there are cases which are difficult to evaluate without FEA.
- Magnetic permeance: Permeance evaluations during operation can be complicated because one must take the rotation motion, and not just the excitation current, into account.
- Induced voltage during operation: In motors with strong salient properties, quite a few harmonic components aside from the basic frequencies appear, so quantitative evaluations can be difficult.
- Loss evaluations: It is possible to estimate copper loss to a certain extent, but the distributions for iron loss and eddy current loss can be complex, so evaluations can be difficult.

Limiting usage to empirical value and self

manufacturing tools that are based on past data also produces the demerit of only being able to obtain ideas and outcomes in initial studies during design that are limited to the range permitted by such value and tools.

For example, the influence from demagnetization caused by eddy currents in magnets can be understood after going through an evaluation that takes such influences into account. Assuming that geometry and magnetic properties are the only things that can be accounted for with empirical value and tools, no matter how many times you replace this data and study it, it is impossible to arrive at a correct evaluation that takes eddy currents into account.

By using FEA for these problems, one can evaluate quantitatively and objectively.

For magnetic circuit confirmation, it is the most basic usage method for FEA, but seeing the flow of magnetic flux line density contour plots and flows of magnetic flux lines means that one is visualizing the magnetic circuit itself and confirming it. (Fig. 2) By also seeing the state of leakage of the magnetic flux, it becomes possible to confirm whether an unanticipated magnetic circuit was configured during the initial design.

For the magnetic permeance during operation, it is possible to follow chronologically to see whether the operating point for each part of the magnet is operating within the anticipated range. In places where the permeance degradation stands out, the user can obtain feedback telling him to reconsider the flux barrier geometry.

With motors that have strong salient properties that are found in implantable magnetic motors, there is a tendency for harmonic components to get on the induced voltage waveform, but waveform analysis using FFT can carry out analysis that takes this into account, in addition to being able to find out the frequency components that become problems. The loss that induces these harmonic components is also a problem, but it is possible to put it together with the induced voltage waveform and evaluate them both at once. It is also possible to use these results to divide the magnet in order to reduce eddy currents (Fig. 3), as well as to study the grade of the electromagnetic steel band.

By adding the necessary corrections after the initial design problems are brought to light from the FEA analysis results, as shown in Table 1, it

becomes possible to proceed to the next improved design proposal with only desktop simulations and without carrying out test production of an actual machine.
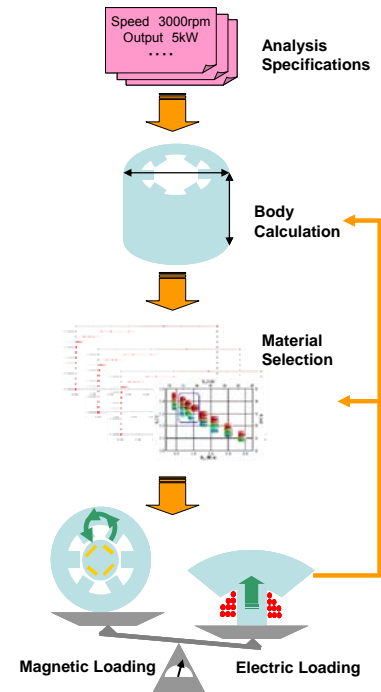

Fig. 1 An example of the traditional motor design process

Magnetic flux density in the teeth has a tendency to saturate, leading to torque reduction and large iron loss

The flux barrier is fully saturated → Possibility of salient pole ratio factor degradation
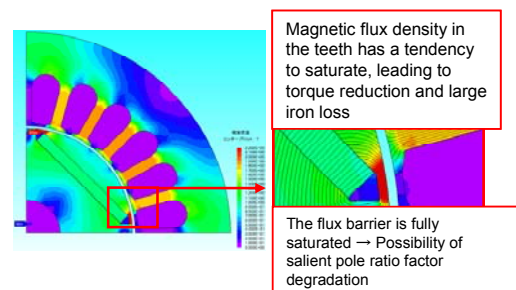
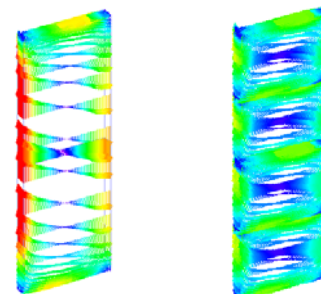Fig. 2 Magnetic flux density distribution for a motor in an initial study

Fig. 3 Eddy current distribution of
a motor magnet portion in an initial study
(Left: an undivided magnet) and post-study eddy current distribution
(Right: a magnet with 4 divisions)
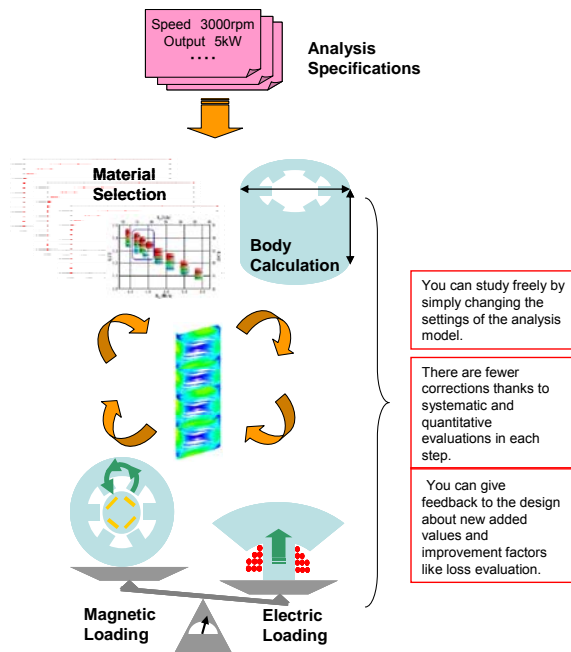(Permanent magnet eddy current analysis of a JAC022 IPM motor)

Fig. 4 Compression of the flow in Fig. 1 through FEM introduction, inclusion of added value

Table 1 Initial study case example

Magnetic saturation	Whether the flux path is secure as a magnetic circuit
	Whether the torque reduction is within the range of the design values
Permeance	Whether the permeance reduction is within the range of the design values
	Whether the torque reduction is within the range of the design values
	Whether demagnetization has occurred
Iron loss	Whether iron loss that exceeds the design values has occurred
Magnet eddy currents	Whether reduction of the magnetomotive force that exceeds the design values has occurred
	Whether thermal demagnetization has occurred

Usage in the Production Process

In the production phase, deviation from the cataloged value of the material properties due to processing treatment during production can become a problem. In particular, due to degradation from processing, there are times when the expected output characteristics cannot be obtained.

Traditionally people would be alright if they made a design that had a degree of leeway against degradation based on rule of thumb, but recently there has been an energy situation which has seen a trend toward hybrid cars and electric vehicles, leading to an even greater demand for high efficiency. In order to make high efficiency motors a reality, it will be necessary to cut down on this excess amount of leeway by quantitatively figuring out how much is needed.

Below I have presented the typical causes of degradation during production:

- Perforation by punching: This multiplies degradation of magnetic properties and iron loss.
- Crimping or indentation: This multiplies degradation of magnetic properties and both iron loss and eddy current loss.
- Cutting /surface fabrication: This multiplies eddy current loss.

With FEA it is possible to quantitatively compare differences in output characteristics that are found in the cataloged value by using analysis that accounts for the material property degradation associated with processing treatment. For an analysis, the magnetic properties that account for degradation need to be prepared ahead of time, but this is handled by preparing a test piece made from the same material as the product and then measuring the magnetic properties in a state of having been through a processing treatment that is equivalent to real production. Fig. 6 shows data comparing the stress dependencies of magnetic properties. Technically this is different from degradation caused by processing strain, but it is possible to confirm obvious magnetic property degradation as a function of the degree of stress.

Degradation due to processing does not only worsen magnetic properties, but also leads to an increase in iron loss. (Fig. 7)

Due to treatments like punching and crimping, the occurrence of eddy currents from upward bending in the insulation of laminated steel sheets is a problem that cannot be ignored.

By measuring the places that underwent processing treatment through microscopic observation and modeling them as a conductor that pierces through the lamination, it is possible to

evaluate the iron loss. Fig. 8 shows an example that models eddy currents conducting through the lamination.

By using FEA in this way and combining it with the production process, it becomes possible to quantitatively verify and analyze the influence that deviation from the cataloged values exerts on the output characteristics.

By analyzing the amount that it contributes to the degradation and verification of each process, it becomes possible to study both estimates of the amount of leeway during the design stage and improvements in operations that make large contributions.

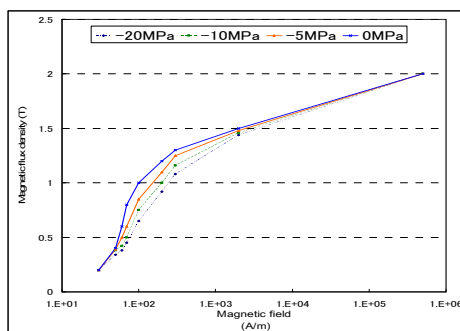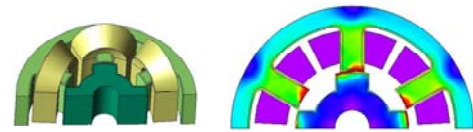Fig. 5 An example of the production process flow

Fig. 6 A comparison graph of the magnetic properties before and after processing
Degradation stands out in the region where saturation increases

Parts Degraded From Punching Processing

Fig. 7 Iron loss density distribution that accounts for production degradation The loss increase from punching in the tips of the tooth parts is remarkable.
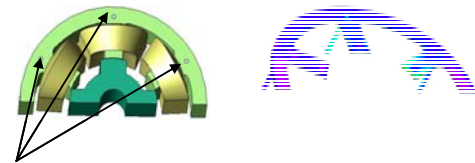
Crimping

Fig. 8 An image of eddy currents between laminations caused by punching or crimping

Fig. 9 A process flow, including improvements from the flow in Fig. 5

Usage in the Operation Process

Harmonic loss, vibration, and noise while the motor is running are all problems that occur in the operation stage.

Even if there are no problems in the body of the product itself, it is not rare for problems to occur after it has been mounted. Generally, when a problem occurs at the operation stage it takes quite a few man-hours to fix, so they need to be avoided as much as possible. This is why verification in advance through simulation is indispensible.

Below are concrete causes and phenomena that occur during operation. (Fig. 10)

- Magnetic coupling with the surrounding parts: Leakage reactance, stray loss
- Control waveform harmonies: Harmony iron loss, magnet eddy current loss
- Electromagnetic excitation force and machine resonance: Vibration, noise

The number of cases in which, due to miniaturization and density growth, motors have to be restricted to a limited space has started to increase. Because of this, a part of the magnetic flux that should pass through the main circuit magnetically couples with the surrounding parts such as the case, causing leakage reactance and stray loss. The impedance and loss initiated by the leakage flux depend strongly on the environment in which the motor is placed, so it becomes a case that is extremely difficult to anticipate at the design stage. For example, a reluctance motor uses inductance that changes into a rotation direction and generates torque. This is when the magnetic flux, which is generated in the axial direction, separates from the core, which is the main circuit, and becomes a cause of leakage reactance and stray loss. (Fig. 11)

Even complicated problems like this can be quantitatively evaluated with FEA. With a leakage flux problem, by modeling the surrounding conductors, including the cases, it is possible to confirm the entire magnetic circuit. At the same time with regard to stray loss as well, by looking at the distribution and not just the value it is possible to confirm the correlation with the magnetic circuit. It becomes possible to evaluate this result and the embedded environment, including the motor, with a simulation.

When the motor is activated, the PWM control method is widely used. The characteristic of this method is its high energy efficiency, but it uses a square wave that is controlled by an on/off switch, so time harmonic components appear. These time harmonic components induce harmonic iron loss and magnet eddy current loss in the core and magnet. In general time harmonic components have a high frequency compared to space harmonic components like slot harmonics and they produce a complicated distribution, so quantitative evaluations are not easy.

With FEA, a quantitative evaluation becomes possible through a coupled analysis with the control simulator by entering the current waveform, including time harmonic components dependent on the PWM controls. (Fig. 12)

Another problem when the motor is running that is just as important as loss is vibration and noise. These are phenomenon that relate directly to the five senses, so they are brought up as problems for when the motor is running. The main cause behind the phenomena of motor noise and vibration is electromagnetic excitation force. It is thought that the vibrations and noise that can actually be felt are often transferred from resonance with the motor's eigenvalue, which includes the surrounding environment as well.

In FEA through electromagnetic field analysis, by calculating the electromagnetic forces generated in the stator and carrying out vibrational and acoustic analysis with this as the excitation force, it becomes possible to evaluate the electromagnetic vibration and noise. Through analysis, one can find out how to control vibration and noise as well as make countermeasures to take out frequencies in the range of hearing that become problems, instead of simply evaluating the sound pressure and frequency of vibration that occurs. (Fig. 13, 14)

It is often necessary to evaluate the environment that the motor is embedded in when it comes to problems in the operation stage, so evaluations have to include the surrounding environment and not just the motor itself. Because of this, there are many necessary targets for simultaneous evaluations, and until now the only method was evaluation via testing of a real machine.

FEA (JMAG) is making evaluations and improvements during operation through desktop simulation possible by supporting a switch to large

scale analysis and coupling with other simulations such as control simulations.

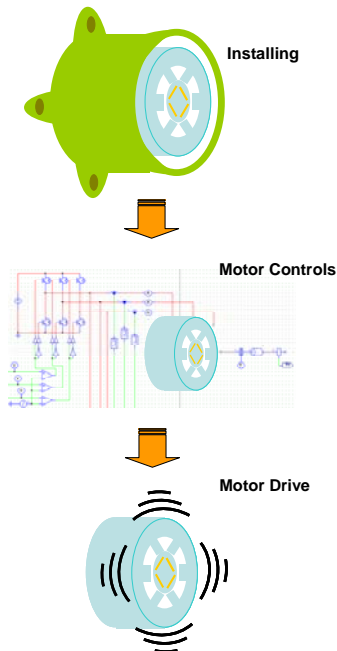

Installing

Motor Controls

Motor Drive

Fig. 10 An example of the flow in the operation process
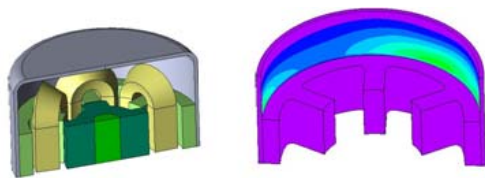Motor incorporation, drive, vibration, and noise

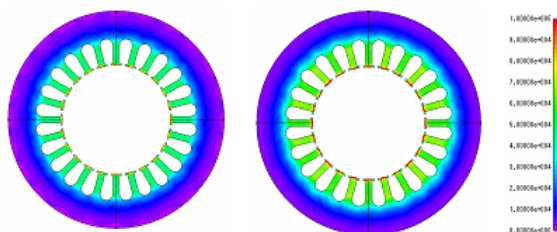
Fig. 11 Stray load loss distribution in an SRM

Fig. 12 Stator harmonic iron loss distribution
during PWM control (Left side)
The right side, whose units are W/m3 , is iron loss distribution in a sine
wave drive for the purpose of comparison
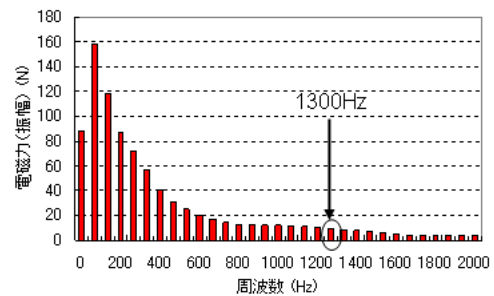
Fig. 13 Electromagnetic vibration frequency distribution
(Vibrational analysis of a JAC138 SR motor)
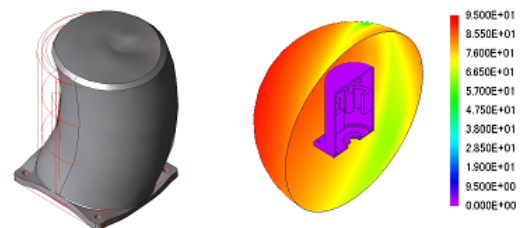
Fig. 14 A contour plot of the eigenvalues
and electromagnetic vibration
The units for the image on the right are dB
(Vibrational analysis of a JAC138 SR motor)

Installing

Stray loss evaluations and case geometry studies

Avoiding resonance through changes in the installation conditions

Motor Controls

Motor Drive

Contribution analysis of the loss

Contribution analysis for vibration and noise

Fig. 15 The flow after improvements from
Fig. 11 have been added (A comparison with Fig. 10)

In closing

In this issue we have looked at products from the viewpoint of their development processes in terms of design, production, and operation. I introduced proposals for simulations that apply FEA mainly to both electromagnetic field analysis and problems initiated by electromagnetic phenomena in each phase.
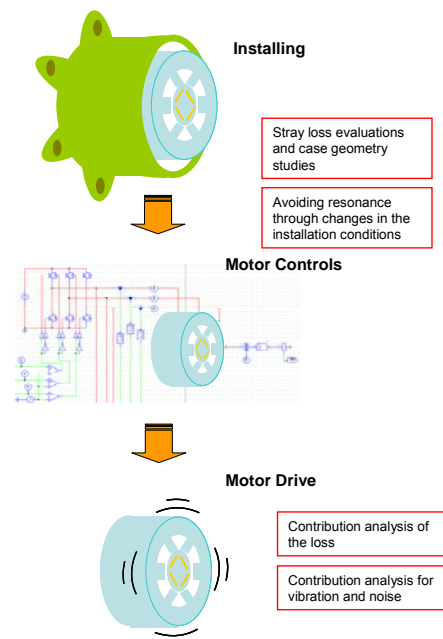
Using FEA technology, which keeps the product development process in mind, makes it possible to achieve simultaneous building-in of product quality, in addition to shortening development lead time thanks to doing away with test production.

The contents of this presentation are no more than a small part of FEA's total usage method. There are also ways of using FEA that broaden one's viewpoint from product development and look at the entire life cycle of the product. FEA is also effective for verification in the unfortunate event of an accident or defect, and recently, from a reliability engineering standpoint, they have started using simulations, including FEA, in accident analysis. I would like to introduce this in written format at a later time.

As an author, it would be an honor if this issue provided the opportunity for you to undertake the task of improving the current design process.

Fully Mastering JMAG Part 3

Evaluating Results and Viewing Models from A to Z

Have you mastered JMAG?

JMAG continues to evolve with each passing day. There may be functions in JMAG that are unknown even to those who are already using it. There are also most likely some useful procedures that are not well known yet. Why don't we aim at making operations more efficient by becoming familiar with new functions and procedures that we don't know about?

In this series, I would like to introduce "Things that we should know" in JMAG.

Overview

JMAG supports results evaluations through a variety of post functions. The reason for this is that it reduces the effort that goes into organizing results as much as possible, and we wanted our clients to be able to create shapes for better design proposals quickly.

By all means, use this as an opportunity to take advantage of JMAG's post function, which can multilaterally evaluate and analyze results.

A Convenient Viewing Method for Confirming the Amount of Distribution

I would like to introduce a useful function for confirming the distribution amounts that are output in JMAG in contour plots and vectors.

Cut-Plane

It can handle the physical phenomena that occur inside of an appliance because it is a simulation.

With JMAG, by creating cut-plane of the model in a location of your choosing, you can confirm results in parts that you cannot see. There are two types of cut planes: A "Cut Plane," which you can create as you wish, and a "Cylindrical Plane," which creates a plane of the cylindrical area (See Fig. 1). It is also possible to use them in combination. It is easy to switch between hiding and displaying the cut plane, and to display it by itself, as well.

The steps for creating a cut plane are as follows:

1. Right-click on [Cut Planes] under [Model] in the [Treeview] tab.
2. Click on [New Cut Plane].
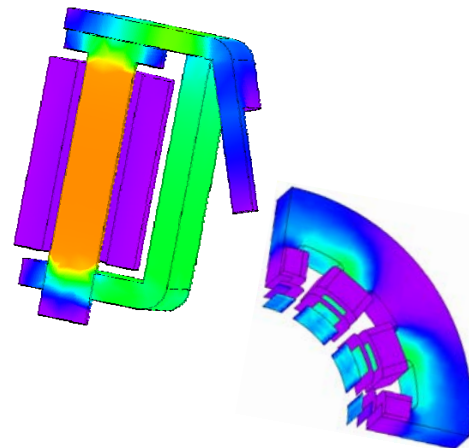3. Enter a title, specify a location for the cut plane, select a display type, and click [OK].

Fig. 1 Cut plane display (Above: Cut plane, below: Cut cylinder)

Model Copy

If you want to display the results analyzed from a partial model in a full model, use the Model Copy function.

In JMAG you can copy contour plots and vectors (See Fig. 2). There are two types of copies: "Mirror Copy" and "Rotation Copy." The model copy settings are applicable to all of the cases that were created by parametric analysis.

By carrying out the copy settings by following the steps below and clicking the [Model Copy Display] button, you can display the copy.

1. Right-click [Model Copy] in the [Treeview] tab and select [Edit Model Copy].
2. Select the part to copy.
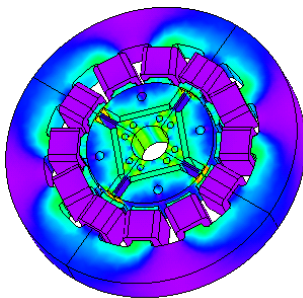3. Specify the copy type.
4. Click [OK].

Fig. 2 A full model display via model copy.

Multiview

If you want to carry out factorial diagnosis while comparing with different diagnosis results, use the multiview function.

With JMAG, you can split the model view window into several windows and display them (See Fig. 3). Thanks to this, as with iron loss analysis and vibrational analysis, studies and factor comprehension become easy.
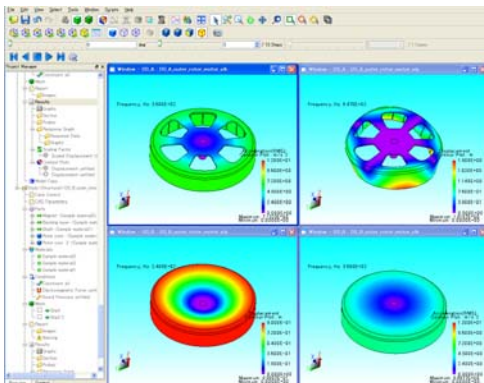
Fig. 3 Vibrational analysis factor comprehension using Multiview

Animation

If you want to display each step and each phase of the analysis results in succession, use the animation display.

In JMAG, you can display animations of contour plots and vectors. For transient response analysis you can confirm each step, and for frequency response analysis you can confirm each phase. The settings for playing speed and steps to use it are also simple. You can also export the animation to a file.

It takes just a single click to run and import it. For the animation, click the "Play" button on the animation control bar, and to import it click [Export Animation] in the [File] menu.

Graph Conversion in the Graph Manager

In JMAG it is possible to display several types of graphs, such as history graphs and section graphs, but it is also possible to display graph conversions instead of simple graphs.

Graph conversions are carried out in the Graph Manager. By using the Graph Manager you can confirm point sequence data, in addition to performing more basic tasks such as combining graphs and freely matching several of them up for a comparison.

I would like to introduce the convenient way of using the Graph Manager.

Fourier Transform

To carry out analysis of the frequency components of magnetic flux density and electromagnetic force, use the Fourier Transform function.

JMAG's Fourier Transform function uses frequency spline interpolation. By adding data, you can use point sequences from results other than those obtained in JMAG (See Fig. 4).

The steps for Fourier Transform are as follows:

1. Choose the data set that carries out the Fourier Transform in the Graph Manager.
2. Click on [Transform] and select [Fourier Transform].
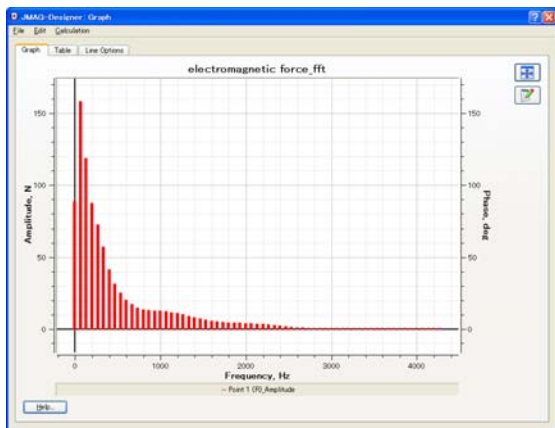3. Specify the display method and scope and click [OK].

Fig. 4 Analysis of the frequency components of the electromagnetic force in the tips of the teeth of an SR motor.

Combining Graphs

To confirm the correlation of similar physical quantities such as flux linkage and current value or X and Y components in magnetic flux density, combine the graphs.

You can select the items to determine the parameters of the X and Y axes from several data sets and create a new data set (See Fig. 5).

The steps for combining graphs are as follows:

1. Select the data set to use as the X-axis from the Data Manager.
2. Select the data set to use as the Y-axis while holding down the [Ctrl] key.
3. Click [Transform] and select [Combine].
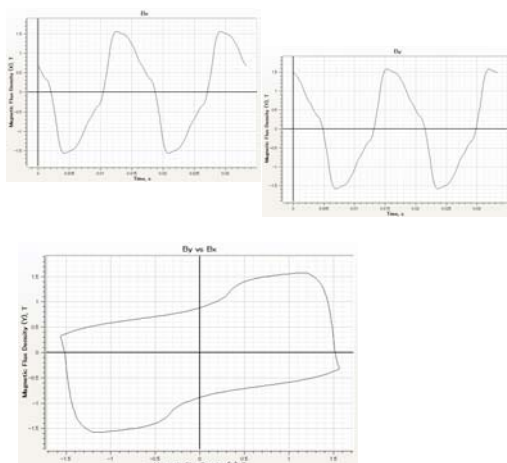4. Carry out the axis settings and mapping, and click [OK].

Fig. 5 Confirmation of a rotating magnetic field via a combined graph. (Top: Magnetic flux density X components. Middle: Magnetic flux density Y components. Bottom: Rotating magnetic field via waveform combination)

A Wide Variety of Graph Displays

It is also possible to select various graph displays and options from history graphs that display the histories of point sequence data. I would like to introduce a multifaceted evaluation method and a display method that makes things easier to see.

Skew Graphs

Skew occurs when the motor stator or the magnet is tilted at an angle in the direction of the axle in order to suppress torque pulsation. A skew graph is a function that expresses the skew effects by superimposing the 2D analysis results. (See Fig. 6). We integrate physical quantity graphs that were obtained when moving models without skew by using the specified method. The output items that it supports are: Torque, current, voltage, and electromagnetic force.

The steps for creating a skew graph are as follows:

1. Right-click [History Graph] under [Analysis Results] in the treeview, select the output parameters and display the graph.
2. Select [Skew Graph] under [Calculation] in the [Graph] dialog box.
3. Set the angle for the skew angle and for a single revolution.
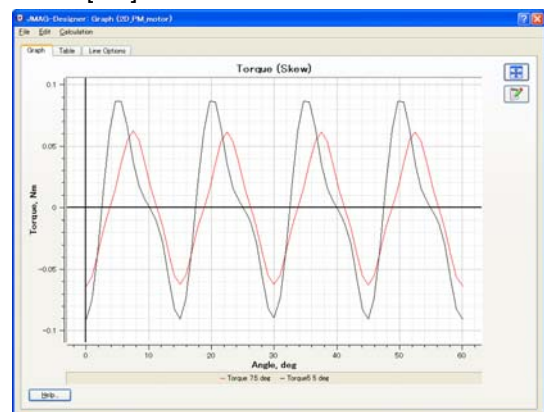4. Click [OK].

Fig. 6 It is possible to confirm the presence of skew due to changes in torque in the graph.

Response Graph

To combine the response values output from several cases of parametric analysis into a single graph, use the response graph. By doing this, it is possible to easily confirm changes in the response values of evaluation items against design variables.

Comparisons that process the results of average values, max./min. values, and intensity are simple as well, so it is also possible to achieve N-T curve renderings within JMAG, (See Fig. 7).

The steps for creating a response graph are as follows:

1. Display the graph of the response value that you wish to confirm.
2. Select [Response Graph Data] from [Calculation] under the [Graph] dialogue box, and define the title and calculation method.
3. Register the response values in the [Table] dialog box.
4. Right-click on [Graph] under [Analysis Results] > [Response Graph] and define values for the X-axis and Y-axis in the [Response Graph] dialog box.
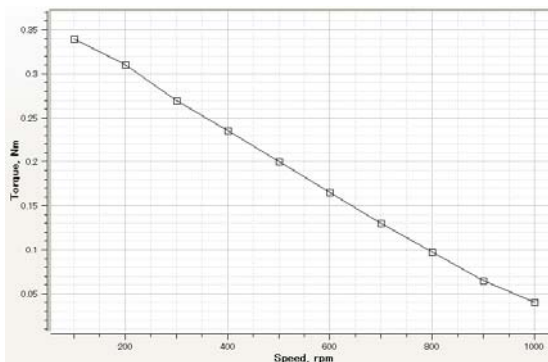5. Click [OK].

Fig. 7 An N-T curve showing a calculation of the average torque values from several cases obtained through parametric analysis and displays them combined into a single graph.

Graph Options for Averages and Intersection Displays

With JMAG, it is possible to find out average values and values of intersections with reference lines on a graph without using spreadsheet software.

To make values of averages and intensities appear in a graph, simply click "On" in the checkboxes for [Average] and [Intensity] in the [Line Options] tab. And by specifying the reference line the intersection coordinates will appear on the graph, as well (See Fig. 8).

It is also simple to set things like line symbols and titles for history graphs.

The confirmation methods for values of intersections that use reference lines are as follows:

1. Click the [Edit] button in the [Graph] tab.
2. Click "On" in the [Reference Line] check boxes under the X-axis or Y-axis in the [Graph Properties] dialog box and enter values.
3. Click [Apply] or [OK].
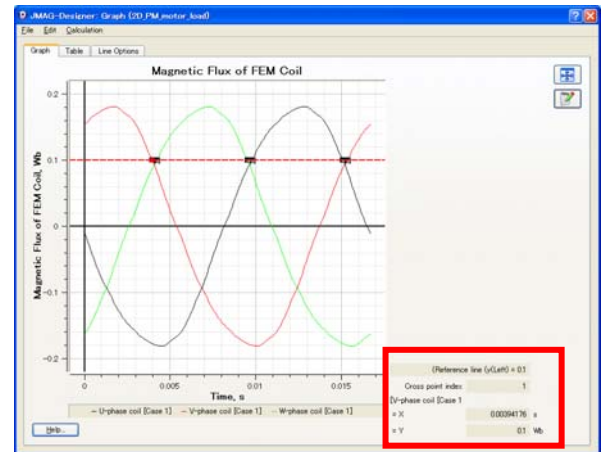
Fig. 8 The coordinates for the intersection with the reference line appear in the lower right.

Analysis Reports

The process does not end when the results from electromagnetic field analysis have been obtained. There are many things that one should do post analysis, such as comparing analysis results and creating reports that include the analysis settings.

With JMAG, it is possible to confirm analysis settings and results in a single report (See Fig. 9), one can also response graphs and design variables for each case when carrying out parametric analysis. There is also a message browser that allows a person to confirm messages that are output when the analysis ends, as well as solver reports that display models in addition to the convergence of, and time taken for, calculations. Use it according to your objective.

The steps for setting output items for reports and for displaying reports are as follows:

■ Steps for setting output items:
1. Right click [Report] in the treeview.
2. Select [Properties] and display the [Report Properties] dialog box.
3. Select "On" in the check boxes for items that are going to be output from the column to the report.
4. Click [OK].

■ Steps for displaying a report.
1. Right click [Report] in the treeview.
2. Select [Case Report].
3. A report is created based on the contents set in the [Report Properties] dialog box, and it is displayed in the graphics window.

Analysis Report **JMAG-Designer**

Report Created 2011/11/10 09:53:23

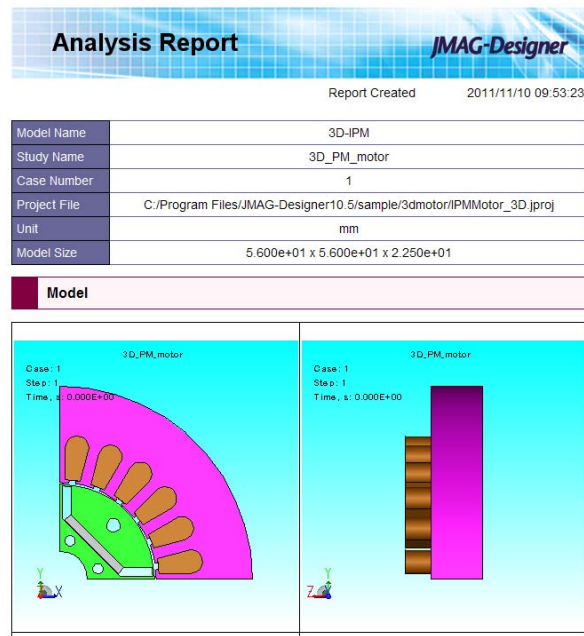| Model Name	3D-IPM
Study Name	3D_PM_motor
Case Number	1
Project File	C:/Program Files/JMAG-Designer10.5/sample/3dmotor/IPMMotor_3D.jproj
Unit	mm
Model Size	5.600e+01 x 5.600e+01 x 2.250e+01

Model

Fig. 9 An analysis report

Model Display Changes Via Keyboard and Mouse Operation

It is necessary to change the model display by rotating, expanding, and shrinking it when setting the materials and conditions. It is possible to change the model display by using the tool button, but in JMAG, one can change the model display by operating the keyboard and mouse alone. Whether you use the tool button or operate the mouse and keyboard is your preference, but this will allow a person to reduce their number of clicks, so by all means give it a try.

The method for changing a model display by using the keyboard and mouse is a follows:

Zoom
Rotate the mouse wheel back and forth.

Rotating It Relative to the Center of the Graphics Window
Drag it while pressing down on the mouse wheel.

Rotating It Relative to a Point in the Graphics Window

Press down on the mouse wheel on the location that you want to make the center of rotation and drag it while holding down the [Shift] button.

Rotating It Relative to the Center of the Model
Drag it while pressing down the mouse wheel and holding down the [Ctrl] key on the keyboard.

Panning
Drag it while pressing down the mouse wheel and the right mouse button.

Shortcut Keys That are Actually Useful

We have prepared various shortcut keys for JMAG operations, as well. I would like to introduce a part of the shortcut keys for JMAG-Designer (See Table 1). See the JMAG Users' Manual for more information.

Table 1 JMAG-Designer's shortcut keys.

Expand the treeview	*
Close the treeview	¥
Open active functions and close inactive functions in the treeview	/
Zoom in on the Circuit Editor Display	[Ctrl] + ;
Zoom out of the circuit editor display	[Ctrl] + -

In Closing

I have taken this opportunity to introduce several result display methods as well as useful model display methods. The explanations of the operation methods were long, and there may be some who have doubts about whether they will lead to more efficient operations, but learning simple methods is a shortcut to reducing time and cost. It would be wonderful if everyone could learn these more convenient functions and operation methods, getting to be able to use JMAG more effectively.

Next time I plan to introduce an A to Z for calculations. Be sure not to miss it.

Mini Corner

How Do I Fix Problems That I Am Having With JMAG?

Has everyone here ever experienced a problem when using JMAG? What do you do in those situations? You may be using independent methods such as asking a JMAG user nearby, asking customer support, just thinking about it, or maybe even giving up.

We here at JMAG provide various types of support services to help solve any problems that you may be experiencing. I would like to introduce support services that you should know for every situation when using JMAG.

Problems when you are just starting to use JMAG

You have assembled a usage environment for JMAG. So, what should you do next?

We have prepared a "Self Learning System" (Referred to from here on as "SLS") for those just starting to use JMAG. This makes it possible to learn the way of thinking behind modeling and the conditions while getting experience in the basic analyses in JMAG. The procedure for setting up SLS is as follows:

Start Menu > JMAG-Designer > Documents > Self Learning System
JMAG Menu bar > Help > Self Learning System
JMAG Website > Support > Self Learning System

We are also conducting seminars for beginners for those who would like to learn from an instructor instead of doing it on their own. See the JMAG Website for more information on the contents and schedule.

JMAG Website: http://www.jmag-international.com/
JMAG Support inquiries: jmag-support@sci.jsol.co.jp

Fully Mastering JMAG

An Introduction to JMAG Technical Support

- Accounting for the magnetic hysteresis characteristics -

We, support members, are continuously working on early solutions to the problems we received so that you can conduct your tasks much smoother. In this series, I would like to introduce the scenes in which JMAG technical support service supports our customers while communicating our customers and support members.

This time I would like to introduce the case that one of our support member offered a solution for the problem that cannot work around with the standard features.

Mr. A: Has worked on JMAG for three months, putting effort into actuator analysis
Mr. B: Mr. A's boss. He ordered Mr. A to conduct search how close results they can obtain to actual measurements using JMAG.
Support: JMAG technical support contact person

The deadline for Mr. A's JMAG analysis result report is approaching, but a problem has occurred with the analysis result so he is conferring with his boss.

Mr. A	The values of electromagnetic forces are OK, but response characteristics do not match. What should I do? (*1)
Mr. B	The values of electromagnetic force match to each other. So response characteristics should do as well. Do you account for hysteresis? (*2)
Mr. A	No. I do not. I don't know how to account for hysteresis. I found no descriptions about it on the JMAG manual.
Mr. B	Contact JMAG support and learn how to do that, and search it!

Mr. A decided to inquire his question to JMAG support via e-mail.

Mr. A	I performed actuator analysis, but the response characteristic does not match with the actual measurement. I think that is because I do not account hysteresis. Please tell me how to account for hysteresis.
Support	I see. It takes calculation time when you perform a calculation that accounts for hysteresis. Before that, please let me check if you are accounting for eddy currents. For example, if it is a lump of material then the effect from eddy currents is large, and it has effects on the response characteristics as well. (*3)
Mr. A	Really? This time I use just a structural material. OK, I will check the eddy current.

Mr. A performed an analysis accounting for eddy currents.

Mr. A	Oh! I got almost the same measurement with the actual measurement after accounting for eddy currents!
Mr. B	Accounting for eddy currents result in matching them with each other even without accounting for hysteresis. Um-hum To make it sure, please check how much the influence of remanent magnetization is. (*4)
Mr. A	The contact person of the support said that it takes calculation time for accounting for hysteresis... I will consult with the support as to the details.

Mr. A contacted the support again.

Mr. A	I obtained a result that is close to actual measurement after accounting for eddy current. Does this mean no remanent magnetization influenced this analysis? How can I check the degree of remanent magnetization influence?
Support	You obtained the result close to actual measurement. That's good. You have three choices of the methods to accounting for the magnetic hysteresis, and I will suggest the most appropriate one. There are some easy methods (*5) to account for the hysteresis, but they do not account for the remanent magnetization. So you cannot apply them for this time's analysis. Also, concerning the method (*6) that keeps a log of the operating point of the magnetizing properties, some other data is required for some of those methods, so it will take rather long time. You are in a hurry, so I will suggest the method that easily estimates the degree of the influence of remanent magnetization.
Mr. A	A simplified method is enough. I would like to know the degree of the influence, so please tell me the concrete operation procedure.
Support	I see. I will explain that. Refer to the column for the details.

- After that, Mr. A indicated that the influence of remanent magnetization is small and Mr. B accepted the conclusion.

In Closing

The above mentioning is just an example, but JMAG support members are proficient in the restrictions on how to use or applicable scopes of JMAG. So, we can suggest some techniques that are not described in the manuals. Even if you think what you desired to do using JMAG is impossible, please contact JMAG support and inquire about it. We will suggest creative analysis methods. **J**

The following is a collection of explanation by JMAG support members.
*1. The things that can be a problem for actuators are the response characteristics for the electromagnetic force and applied voltage in each of the moving parts.
*2. If the values of electromagnetic forces match, it is assumed that transient phenomenon is not correctly reflected. In such case, what to focus on is rather a factor arise from transient such as eddy current influences than whether the magnetic hysteresis characteristics is correctly reflected.
*3. Usually magnetic steel sheets are not used at moving parts of the actuator, and there is high possibility of large eddy current generation.
*4. Actually, magnetizing properties have hysteresis properties, so it is necessary to check the influence to the result.
*5. These are methods that calculate hysteresis loss from the magnetic flux changes, and this is used for the iron loss calculation.
*6. Normal magnetic field analysis uses direct current properties, so creating a user subroutine is necessary to keep a log of the operating points of the magnetizing properties.

▌ [Column]: In order to accounting for remanent magnetization

"Remanent magnetization" refers to a situation in which the magnetization of an object that has gone through external excitation does not return to zero even after the cause of said excitation has disappeared. To express the remanent magnetization it is required not only the information on where the operating point currently is but on the log that records the track of the operating point. In order to handle this phenomena accurately on the current version JMAG, the only method is creating a user subroutine. Creating a subroutine requires related knowledge and it will be a hard and time-consuming task such as programming.

Then, this is a simplified method but I will introduce an accounting method of the remanent magnetization characteristics using the magnetization analysis function. With this method, assuming that the status with remanent magnetization is a permanent magnet, perform the analysis with defining the magnetic material as a magnet in the middle of the analysis. I will divide this analysis into two parts, where Step 1 is analysis with the external excitation status ON, and Step 2 is analysis with the external excitation status OFF. In step 1 we carry out analysis of ordinary initial magnetizing properties, and in step 2 we apply remnant magnetization to the object based on the magnetization field distribution of the final results of step 1. Using JMAG's magnetization analysis function enables you to decide the magnetization from the magnetization field distribution result.

Please be note that what you can account for is only the remanent magnetization when exciting once, and cannot do the remanent magnetization when repeating exciting status.

Event Information

JMAG Users Conference 2011

We have one month left until this year's JMAG Users Conference. Just like with JMAG, we upgrade the Users Conference every year, as well. I would like to tell everyone about the attraction of JMAG Users Conference 2011 through an introduction of the variety of projects that we have planned.

JMAG Users Conference 2011
Conference Outline
Host   : JSOL Corporation
Dates   : Wednesday December 7 – Thursday December 8, 2011
Venue   : Tokyo Conference Center – Shinagawa
Enrollment Limit   : 300
URL   : http://www.jmag-international.com/event/conference2011/

We will have the usual presentations by both people working in the forefront of various fields and technical partner companies, but in addition to that we will host section meetings for small groups of people to exchange technical ideas and information.

An Overall Picture of the Users Conference

We at the JSOL Corporation would like to provide a plan for the Users Conference that gives our customers an opportunity to communicate with each other.

In order to allow everybody to enjoy it without feeling a gap in skill level, we have prepared a wealth of contents for everyone, from those who are skilled with JMAG to those who have started using it recently, to those who are attending the conference for the first time, to be able to participate at ease. This year we will host 5 projects.

1. Presentations
There will be presentations of interest to everybody, covering such topics as motors, analysis system construction, and operation streamlining. This year we are also planning presentations by technical partner companies.

2. Section meetings
We expanded the poster exhibition by the JMAG engineers, which we had done until last year, into section meetings, which we will hold instead. This should turn out to be a technical exchange that satisfies everyone.

3. JMAG Seminars
In these seminars, the JMAG engineers will introduce the latest solutions. The engineers, who are experts in JMAG, will reveal tricks that they have acquired to master it easily, as well as operation streamlining methods. We have prepared various other contents in addition to these, as well.

4. Simulation Park
We will reopen the Simulation Park, which got a good response last year as people had fun with JMAG by looking, touching, and experiencing it. This year we decided to go for a museum atmosphere, so everyone can look at JMAG's history along with the history of simulation in general.

5. Exhibition
The exhibition area is a place for collaboration between JMAG and each exhibitor. There will be exhibitions by various companies that are relevant to everyone's business operations, such as test production and design consultation, measurements,

The 2010 Simulation Park: In front you can see the interactive mesh generation process, "Get a Feel for Automesh."
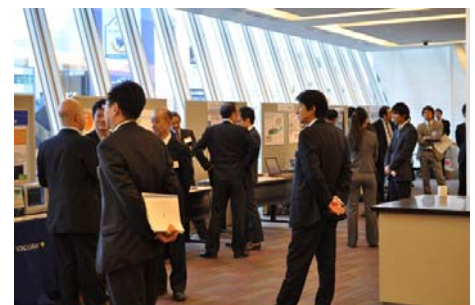
The design for the 2010

optimization systems, hardware and software vendors, and also the material manufacturers that are provided in the materials database.

The section meetings, seminars, and presentation program will be introduced on the next page, so by all means read it through and attend the Users Conference.

We look forward to seeing you there.

Section Meeting Introduction

As with the poster exhibition, we used a wide variety of themes as our subject matter for the section meetings, making this a place where small groups can communicate through technical and information exchanges.

The JMAG engineers will act as facilitators so that everyone can talk freely about things like the direction where analysis technology is heading and their requests for features in JMAG. This should be useful for everyone to share beneficial information and make connections.

Each section meeting will hold up to 20 people, so please apply early.

Themes

1 Let's Talk About Motor Design

Participants can talk about their personal preferences and tastes as motor designers.

2 Hopes for Future Functions and Services in Induction Heating Analysis

Participants can discuss function development and services in the induction heating analysis field that they would like to see in future versions of JMAG.

3 What Role Can JMAG Play in the Power Electronics Field?

Participants can discuss the role and functions that will be sought for in JMAG in the power electronics field.

4 Let's Try Multiphysics Analysis.

Participants can discuss achieving multiphysics analysis and what shape it should take.

5 What Exactly is "A Really Good Mesh Generation Function" in Electromagnetic Field Analysis?

Participants can have a heated exchange regarding elementary mesh generation to special mesh generation technology.

6 Motor Models in Motor Drive System Development

Participants can discuss the next step for JMAG-RT while deliberating exactly what a good motor model is.

7 The Latest Trends in Solver High Speed Technology and JMAG's Approach

Participants can discuss next generation solvers while resolving their doubts about solvers and gaining knowledge.

8 Are You Making Full Use of Your Important Results?

Participants can debate regarding the usage values that will be expected of the results, and the results processing and visualization technologies that will make them a reality.

9 Moving to JMAG-Designer With You, Who Still Cannot Live Without JMAG-Studio

JMAG Seminars

In these seminars, the JMAG engineers will introduce the latest solutions. We have prepared a range of contents, from usage methods and operation streamlining to the differences between JMAG-Studio and JMAG-Designer.

Themes

"Fully Mastering JMAG-Designer: –Supporting Streamlining of Design Operations"	Geometry Modeling With JMAG-Designer
An Introduction of JMAG-Designer's Signature Features and New Functions in V. 11	How to Use the RT-Viewer
"A JMAG-Designer Course for JMAG-Studio Users" – The Differences Between JMAG-Studio and JMAG-Designer	What is LCR? The Phenomenon and the Basics Behind It (Basic Version)
Practical JMAG-Designer Script Course	Evaluating LCR Through Analysis (Practical Version)

Presentation Program: Wednesday December 7, Thursday December 8

We will host presentations by people working in the forefront of various fields.

Wednesday December 7: First Day of the JMAG Users Conference	
Registration (Starts at 8:50)	
Opening Ceremony	
Development Planning of JMAG I Dr. Takashi Yamada, JSOL Corp.	
Let Us Promote Analysis of Electromagnetism Dr. Noboru Kikuchi, TOYOTA Central Research and Development Laboratories, Inc.	
Global Cases and Coupling Analysis Session	
Electric Drives for Off-Road Mobile Equipment John Deere, Mr. Jim Shoemaker	
Technical Exchange Session (Lunch)	
Multiscale Thermal and NVH Models for EV/HEV Integration of an SR-based Drivetrain using JMAG coupled with Virtual.Lab Acoustics LMS International Simulation Division, Mr. De Langhe Koen	
Researches on the Behavior of Vibration and Noise of an IPM Motor with JMAG and LMS CHINA FAW GROUP CORPORATION Dr. Zeng Jinling	
Vibration and Noise Analysis of the Motor for Electric Vehicle Mr. Takayuki Miyakawa, Vehicle Performance Engineering Department, Nissan Motor Co., LTD	
To Be Announced	
Technical Exchange Session	
Analysis System Construction Session	Induction Heating Session
TBA University of Wisconsin-Madison Brooklin, Mr. J. Gore	A System of Coordination With Analysis Engineers and the Successes That Follow Mr. Norihide Fujiyama, KOYO THERMO SYSTEMS CO., LTD
A Case Example of JMAG-RT Application in an Electrical Automotive MBD Mr. Kei Yonemori, MAZDA Motor Corporation	Using Simulations to Develop the Autogenic Alloy Remelting Process Mr. Tomoji Osada, NIPPON THERMODYNAMICS Co., Ltd.
JMAG-RT Application in Motor Control ECU Quality Verification Mr. Yoshinori Takeuchi, DENSO CORPORATION	The Effect of Magnetic Properties on the Accuracy of Induction Heating Simulation Analysis Mr. Hiroshi Yuki, Advanced Technology R&D Center, NTN Corporation
To Be Announced	
Close (18:35)	

Thursday December 8: Second Day of the JMAG Users Conference	
Registration (Starts at 8:30)	

Motor Session	Transformer Session
Demagnetization Analysis Method Using Dy Diffused Magnets and the Most Suitable Dy Diffusion Methods and Their Effects for Motor Applications Mr. Mitsutoshi Natsumeda, Hitachi Metals Ltd.	The Magnetic Simulation Using JMAG and Simpleware Dr. Yosuke Iijima, Taiyo Yuden Co., Ltd.
A Vibration Analysis Using Numerical Results of Electromagnetic Analysis of the IPM Motor (D-model of IEEJ) Mr. Takushi Fujioka, FUJITSU GENERAL LIMITED	A Comparison Study Between the Actual Measurement of a Reactor's DC Superposition Characteristics and a JMAG Simulation Mr. Kouhei Ueda, TABUCHI ELECTRIC CO., LTD.
A Case of Coupled Analysis of JMAG-RT and Circuit Simulator Dr. Hideki Ohguchi, Fuji Electric Co., Ltd.	Developing Iron Loss Analysis Methods for In-Vehicle Power Transformers Mr. Masato Kabetani, Electronics Division Engineering Department, Toyota Industries Corporation
Eddy-Current Rotor Position Sensor Mr. Seiji Shimizu, SUMIDA Electric Co., Ltd.	JSOL Corp.

Technical Exchange Session (Lunch)	

Motor Session	Operation Streamlining Session
Valuable Variable Characteristics Machines (MATRIX motor and CMMF motor) Prof. Kan Akatsu, Electric Engineering, Shibaura Institute of Technology	Magnetic Shield Design Optimization in HDD Writer Mr. Kenkichi Anagawa, TDK Corporation
Voltage Boost Type Drive Circuit Without Additional Reactor for Switched Reluctance Motor Dr. Nobukazu Hoshi, Department of Electrical Engineering, Faculty of Science and Technology, Tokyo University of Science	Simplifying JMAG Analysis With CATIA Models Ph.D. Hisashi Yajima, SMC Corporation
Development of a Ferrite Permanent Magnet Axial Gap Motor with Segmented Rotor Structure Mr. Masatsugu Takemoto, Associate Professor, Graduate School of Information Science and Technology, Hokkaido University	Development of Bicycle Generator Hub Dynamo Using JMAG Mr. Takeshi Fujiwara, SHIMANO INC.

| Technical Exchange Session	
Designers and In-house Distribution Session	
Development and Design of a Loudspeaker Using JMAG-Designer Mr. Yoshihide Toyoshima, Onkyo Corporation	
Expanding and Utilizing JMAG-Bus for Developing Motor Systems Mr. Takehiro Miyoshi, Technology Research Division 9, Honda R&D Co., Ltd.	
Development Planning of JMAG II Dr. Takashi Yamada, JSOL Corp.	
Closing Ceremony (17:20)	

Event Report

JMAG is opening events both in Japan and overseas. Take a look at JMAG's activity.

LMS Conference Japan 2011

Conference Outline

Host   : LMS Japan K.K.
Dates   : Wednesday October 18, 2011
Venue   : Tokyo Conference Center - Shinagawa
URL   : http://www.lmsjapan.com/lmsconferences/japan
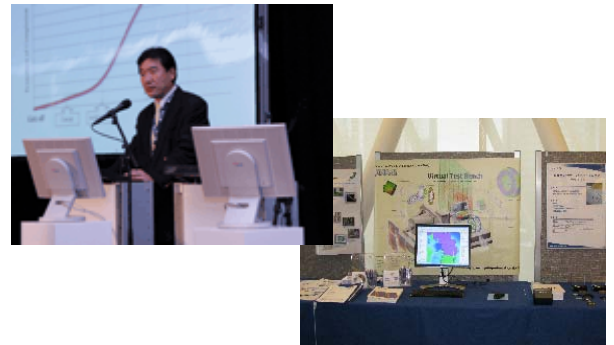
At LMS Conference Japan 2011(In Shinagawa), JSOL's Mr. Sakashita gave a presentation on the subject of, "Motor Noise Vibrational Analysis With Coupling Between LMS Virtual,Lab and JMAG."
We also exhibited JMAG in front of the venue, and introduced JMAG to those who are doing sound and vibrational analysis. They actively traded opinions regarding vibrational analysis that inputs the electromagnetic force. We are planning on further strengthening coupling functions with LMS Virtual.Lab from now on. This is something that everyone using JMAG can look forward to.

IEEE Energy Conversion Congress and Exposition 2011（ECCE 2011）

Conference Outline

Host   : IEEE
Dates   : Saturday September 17 - Thursday September 22, 2011
Venue   : HYATT REGENCY PHOENIX & PHOENIX CONVENTION CENTER
              IN PHOENIX, ARIZONA (America)
URL   : http://www.ecce2011.org/

Powersys Solutions, JMAG's distributor, made a presentation at the conference held by IEEE.
At the Industrial Seminar JSOL hosted a 30 minute seminar and cocktail reception with the theme of, "JMAG Industrial Seminar & Cocktail Reception supported by JSOL Corporation and Powersys, Inc."

At the exhibition booth, we introduced JMAG's features and carried out a demonstration of JMAG-Express and JMAG-RT Viewer.