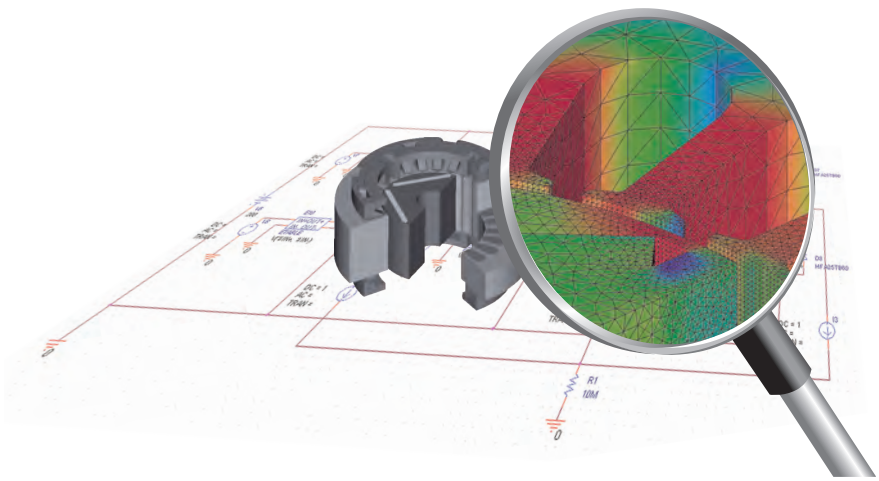
Simulation Technology for Electromechanical Design

JMAG®

# JMAG News Letter

November,2009



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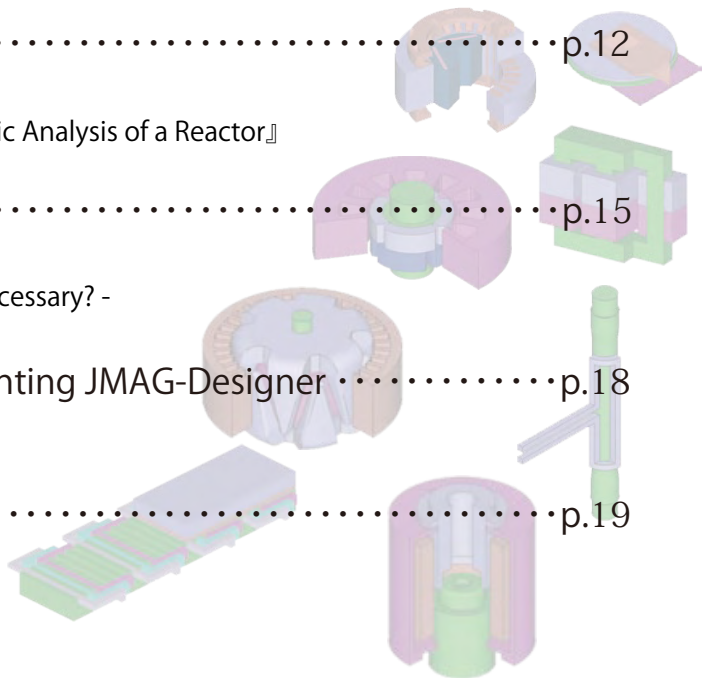

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Implementing JMAG

# NIDEC CORPORATION

## Supporting the Success of New Businesses

**The Nidec Corporation, a top manufacturer of small precision motors used in devices such as hard disk drives and CD-ROM drives, entered the automotive market with a mid-size motor for power steering in 2000. The tool that facilitated their growth and success in a market the Nidec Corporation had little experience or knowledge was JMAG, an electromagnetic field analysis software from the JSOL Corporation. Less than 10 years have passed and the Nidec Corporation has grown to hold roughly 10% of the market share. Mr. Hitoshi Inoue, head of development for the Nidec Corporation, and Mr. Nakaba Kataoka discuss the merits of implementing the JMAG system.**

NIDEC Corporation
Shiga Technical Center
Vice President
Mr. Hitoshi Inoue

NIDEC Corporation
Shiga Technical Center
Research & Development Dept.1
General Manager
Mr. Nakaba Kataoka

## JMAG Supports Growth Entering New Markets

**- Why did you decided to enter the market for power steering and what was the current market situation?**

**Mr. Inoue** There are three major types of power steering; "hydraulic systems" which uses the engine's output, "hydraulic-electric systems" where the motor output assists the hydraulic pressure, and " electric systems" which use an electric motor. We decided to enter the market with a motor for hydraulic-electric power steering in 1995. Our first product was used in the "Peugeot 307" in August 2008. Amazingly this vehicle earned the European "Car of the Year" award, increasing our sales to provide us with a powerful foothold in the power steering market.
Currently, we lead in hydraulic-electric type power steering and hold approximately 10% of the market share. Our power steering has been implemented in vehicles from manufacturers such as Peugeot, Citroen, Ford, Nissan, and Renaud.

The power steering market, especially the electric types, is expected to grow drastically in the field of automotive components. Only an electric type motor can be implemented when the engine of hybrid automobiles stops at idle and the demand for precise steering and fuel efficiency grows. We are focusing all of our effort into the development of fully electric motor prototypes as we expect the demand to increase.

**- What were the reasons you decided to implement the JMAG system?**

**Mr. Inoue** Entering the competitive ring for components mounted on vehicles with a motor for power steering was quite challenging for us. We had experience in designing continuously variable transmissions and reduction gears, but we had never designed motors for power steering. As a vital safety device that protects the lives of the driver and passengers, power steering needs to be viable in severe climates from -40 to 120 degrees Celsius. The severity of conditions for motors we where designing at the time was from -10 to 40 degrees Celsius. I mean, we had no idea what kind of characteristics to expect from a motor at 120 degrees Celsius. The major factor to secure when designing these types of components is reliability. Simulation and analysis software was vital in supporting us throughout the design process. Mr. Kataoka was asked to evaluate a variety of analysis software because we knew, even at that time, it would be indispensable.

**Kataoka** We had already been using analysis software provided by a different company, but we needed the tools specializing in design that JMAG offered to catch up and move past rival manufactures. In 1996, we benchmarked analysis software from 4 different companies, but JMAG was the software that met the specifications we desired in an analysis software.

First, the usability was fantastic. Next, the accuracy of the software when comparing analysis results and the actual measurements obtained after building a prototype were almost identical. The designers were able to use this software practically, reducing the number of prototypes that need to be made. We were confident that we could take on this new market using JMAG because we could reduce the number of prototypes. JMAG was evaluated so highly inside our company, that it was the only software we wanted to implement.

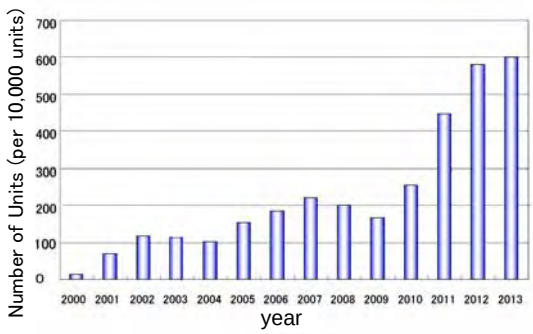



Fig. 1. Nidec Motor Sales for Power Steering

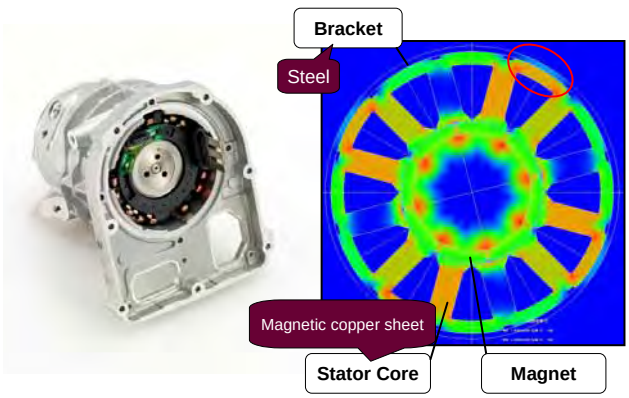



Fig. 2.Nidec Motor for Power Steering

## Adhering to Development Costs while Increasing Speed

### What did you think about JMAG after you started using it?

**Kataoka** Even after evaluating the performance and actually using JMAG, I was surprised. We were able to reduce the number of prototypes, the amount of time, and the cost because of how closely the results matched the actual measurements. Basically, we were able to adhere to strict costs and increase the speed of development making it easier for us to step into this new market.

### - How are you currently using JMAG?

**Kataoka** Mainly, we simulate specialized components, and components with complicated geometry. For example, as the temperature of a magnet in a motor raises and the current increases, the magnetic force is reduced by demagnetization. The analysis results we obtain are invaluable in miniaturizing our designs by reducing demagnetization as much as possible. We can perfect the designs to smooth the heaviness of the steering when the motor losses torque as well as hone the geometrical design of position sensors in motors, such as a resolver. The resolver rotor has a multi-pole design that offers extremely high-precision.

The requests of the automotive manufacturers get more and more demanding every year. Without simulation software like JMAG, we could not meet the request our customers have for the motors used in power steering, or improve balance between reliable and consistent performance for all of our product designs. You could even say that without analysis through simulation software, we would be expected to meet unattainable requirements. JMAG is a tool that allows us to develop more efficient parts that are smaller and lighter even as the development schedules get shorter each year.

**Inoue** Some of the specifications and sizes our customers request are unrealistic, but explaining why is a difficult proposition. But using results from the JMAG simulation our designers can have confidence going to our customers and proposing, "We cannot achieve these characteristics at this size, but we can at this size."

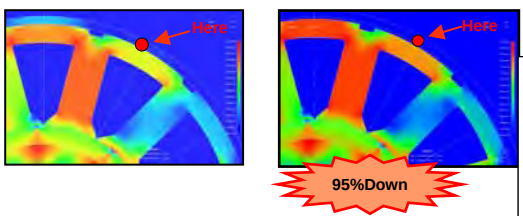
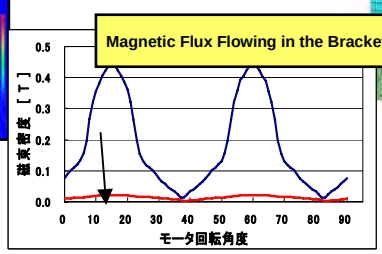



Fig. 3. Reduction in Lost Torque



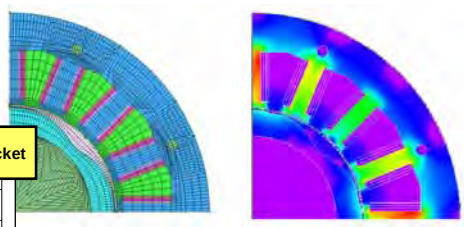



Fig. 4. Internal Resolver Development

The most important aspect about using JMAG is that the results obtained with the simulation can actually be realized. The analysis results have to be accurate because the output provided by the design division is what the product becomes. JMAG is great at doing this. I think when Mr. Okamoto said, "designers are able to use this software practically," this is exactly what he meant.


## Flexible Software Allows Innovative Development

**- How would you evaluate the support JSOL has offered since implementing JMAG.**

**Kataoka** We are very grateful for the support we have received. The JSOL Corporation has a specialized support team that patiently handled all of our questions. For example, they created various tools as well as solved any flaws that we found. This support helped us vastly. As JMAG began being used throughout Nidec, I feel as though the support was enhanced to meet our growing need.

There are specialized analyses for motors to assist in design, such as analyses for demagnetization and variations in torque. Calculating this phenomena by hand was difficult, but JMAG allows us a tool to obtain analysis results automatically with a single operation. Through the innovation of the GUI, the conditions settings that used to take half a day to enter can now be done in ten minutes.

The amount of time to obtain the results from the analysis has also been vastly reduced by the ease of generating and dividing the mesh through an auto mesh feature that was implemented.

**- What areas do you feel JMAG needs to be enhanced?**

**Kataoka** The amount of time for motor development requested by our customers has been reduced from 4 years when we entered the market to 2 and half years. There are many ways we are upgrading the development process to meet these requests, innovating development, reducing the number of prototypes, and reducing the amount of time required for the design process. JMAG is a vital part of these enhancements.

To remain strong in a competitive market, further innovation that reduces the amount of time required for an analysis as well as the ability to link to the 3D CAD data are necessary. Currently, an analysis of 3D data distributed to multiple computers takes three to four days. I would like to see the speed and the accuracy of the calculation improved even more. Currently linking to 3D CAD data is supported, but I want to be able to modify the data in the CAD software and have that data automatically reflected in the analysis software.

## Strengthening Their Position in the Motor Market

**- How do you plan to use JMAG in the Future?**

**Inoue** JMAG is a tool that makes it possible for designers to discover problems that occur from design to prototype through simulations they can run independently. American manufacturers break development into groups for analysis, design, and prototypes which often causes misunderstandings as well as errors in data between each party. But I think a concurrent type of development can be achieved by using JMAG.

JMAG will be a large part of our development process in the future. The popularity of motors is based on the maturity of the economy and culture.The number of motors being used in vehicles will increase. Furthermore, the importance of motors as a key drive train type device will most likely expand with the growing awareness of the products effects on the environment, such as energy efficiency.

We are also innovating various motor technology for hybrid vehicles as we aim to achieve EV (electric vehicles) motor technology. Magnetic field analysis is vital to facilitate this goal. We plan to increase the areas JMAG is being fully implemented, and I believe that JMAG will open doors for us to new opportunities.

**- What does the Nidec Corporation dream for the future?**

**Inoue** We always say, ″contribute to environmental conservation by reducing CO2 emissions by converting automobiles, ships, and airplanes that currently run on fuel to an electric system.″ The Nidec Corporation is striving to develop high-output motors. We competed in the F5B Championships, known as the F1 of radio controlled airplanes. The estimated performance of the motor developed by the Motor Engineering Research Laboratory installed in these planes achieved a power to weight ratio of 8kW/kg. This is a 30 percent increase from the standard F1 engine at 6kW/kg. Team Nidec, using planes powered by Nidec motors, swept the top three places of the 2008 Japan Championships, for the second year in a row. This motor technology will be implemented in hybrid vehicles and electric vehicles and most likely be adapted for electric ships and airplanes in the future.


▲Top 3 Two Years Running!


▲Motor and ECL for the F5B

Nidec
All for dreams

日本電産株式会社

Chairman of the Board and CEO Shigenobu Nagamori

Established: July 23, 1973

Capital: ¥66,551,220,790 (March 31, 2009)

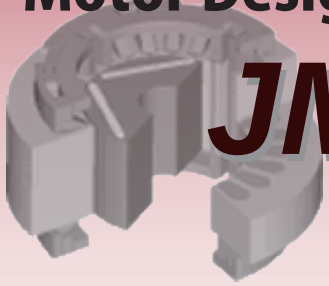
Business Overview

The Nidec Corporation aims to be the world's #1 manufacturer of comprehensive drive technology based on the motto, "for everything that spins and moves." Since the Nidec Corporation's establishment in Kyoto to manufacture and sell small precision AC motors, they have secured their position as a brushless DC motor manufacturer (motors driven by conductors switching electric poles), and furthered their position as the top small precision motor manufacture for hard disk drives, multimedia devices (CD-ROMs, DVDs, BD), and office equipment. The Nidec Corporation is also proud to be one of the major share holders for small precisions fan motors used in various home appliances.
The Shiga Technical Center develops various motors for automobiles, OA/IT, and fans as well as strives to support commercial production and quality assurance.

http://www.nidec.co.jp/

Try it now

## Motor Designing Tool

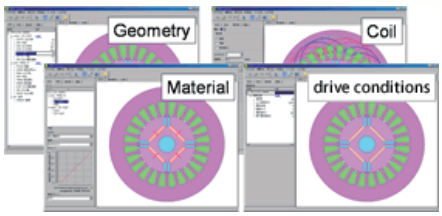


# JMAG-Express

## for Rotating Machines

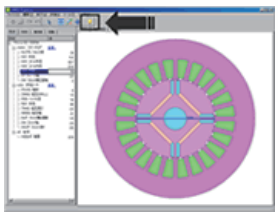
- JMAG-Express instantly extracts characteristics of the PM motors and inducution Machines being designed.
- It is very quick and easy to satisfy the needs of busy design engineers.
- The simulation engine is based on JMAG FEA technology, yet no FEA knowledge is required.

### Step1



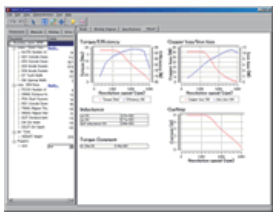

Enter the Specifications

### Step2



Click

### Step3



Output the Fundamental Characteristics

**Output:**

Torque, Iron Loss,Copper Loss, Efficiency,Induced Voltage

**Support for Induction Machines Coming Nov.12,2009**

- Templates are frequently updated on our website exclusively for JMAG-Express users.
- Your own templates can even be created using JMAG-Designer.

The module can be downloaded from here

**www.jmag-international.com/express/**

**jmag-express@sci.jsol.co.jp**

# JMAG Version 10.0
# - Using JMAG as a Design and Evaluation Tool -

## ●JMAG for Designing and Evaluating Devices

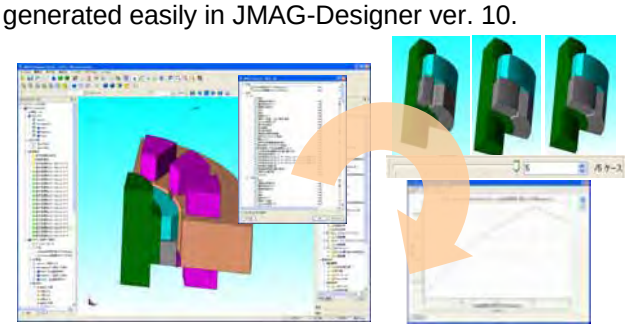
JMAG ver. 10 was released on June 8, 2009. This version of JMAG has been developed with a focus on **streamlining the workflow required to perform analyses**. The speed with which an analysis can be performed is vital when designing and evaluating results. A vast amount of designs need to be evaluated by editing dimensions to attain the highest level of quality. This means that the number of designs that can be evaluated is directly connected to the quality of the design. New and improved functions have been implemented into JMAG ver. 10 to provide the most efficient design and evaluation process. This article introduces the major functions version 10 has to offer, that include but are not limited to, parametric analyses, analysis templates, as well as a scripting function.

## ● Investigating a Multitude of Designs with Parametric Analyses

Investigating the effects of design variables on the performance of a device is a vital part of the design and evaluation process. A multitude of varialbes can be simulated in JMAG by running a series of analyses that encompass a wide range of parameters (parametric analysis).

A series of operations for the parametric analyses can be performed directly from the general users interface in JMAG-Designer ver. 10. Variables for a parameter analysis can be selected by displaying **a list of settings** from the dimensions of the geometry to the settings specified to generate the mesh. The **data for each case** is automatically generated for a range of variables specified for a setting. Furthermore, the geometry of a model can be edited and displayed easily by simply moving a slider bar.

The analysis results need to be evaluated after multiple cases are evaluated with a parametric analysis. Generally, a **response graph** is drawn with the variables on the vertical axis and the output on the horizontal axis, but the same response graph can be generated easily in JMAG-Designer ver. 10.

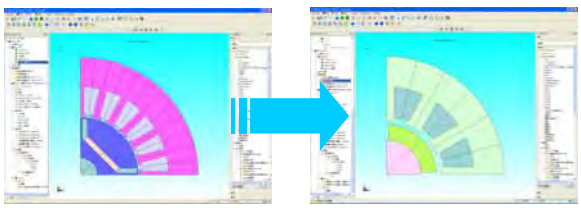


Response Graph of Geometry and Results based on Selected Parameters (Parametric Analysis)

## ● Standardizing Analyses with Analysis Templates

Knowledge about the material and condition settings required for an analysis is not the same as the knowledge required to design and evaluate a device. For this reason, standardizing the knowledge required to perform an analyses is vital.

Therefore, a new analysis template function has been added to JMAG-Designer v10. An analysis template saves **all of the settings, except for geometry,** used to perform an analysis. These settings, such as materials, conditions, and analysis result settings, are saved when a template is exported from one model and then imported for another model. Analysis templates provide an invaluable educational tool that can be used to efficiently pass on the knowledge acquired by an experienced user to a novice user.



Apply an Analysis Template for an IPM Motor to an SPM Motor

## ● Automating the Analysis Process with Scripts

The analysis process in JMAG can be automated by standardizing settings that are often specified to evaluate designs with an analysis. These operations can be automated by writing and executing operations with a script.

JMAG-Designer supports VBscript, JScript, Python, and universal script languages which are compatible when linking to another analysis system. In addition, a **function to record script commands while operations are performed** has been implemented into JMAG-Designer ver. 10.

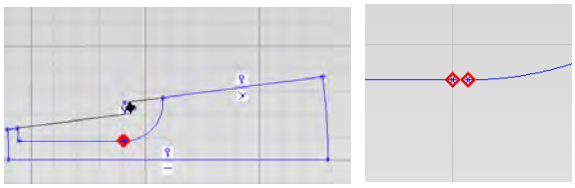
The functions that have been introduced above focus on the design and evaluation process. In the sections that follow lets look at the new and improved modeling and analysis functions.

### ● Crisp Diagrams using Cut and Paste: Geometry Editor

New editing functions have been added to the Geometry Editor in JMAG-Designer ver. 10 that support both 2D and 3D geometry. For example, **Sketch Copy**. Sketches that are created for each part can be used to create a sketch for a different part of the model. Furthermore, a sketch or solid can be copied or moved to a specific position by creating **reference points, lines, or planes**.

Another function has been implemented to resolve one of the major problems that occurs when creating geometry. **IGES or DXF** files imported to JMAG as 2D data in Geometry Editor are sometimes imported with an open polygon caused by the compatibility of the CAD systems. When these files are imported, areas that are not connected can be found easily by **highlighting the floating vertex**.

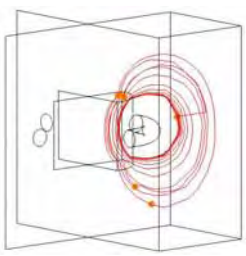
These are some of the vital basic functions that have been enhanced in this version of JMAG.



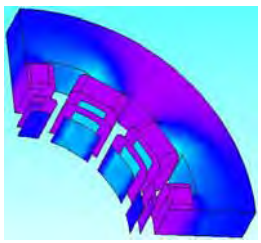
Highlighted Floating Vertex

### ● Displaying Results using Flux Lines and Cylinder Cut-Planes for 3D Models

Two new functions to display results have been implemented into JMAG-Designer ver. 10. These functions can display results for 3D models using flux lines and cylinder cut-planes. A cylinder cut-plane is especially advantageous when displaying the magnetic flux density distribution inside the teeth of a motor. The analysis results can be evaluated from various angles by integrating cut-planes and cylinder cut-planes.



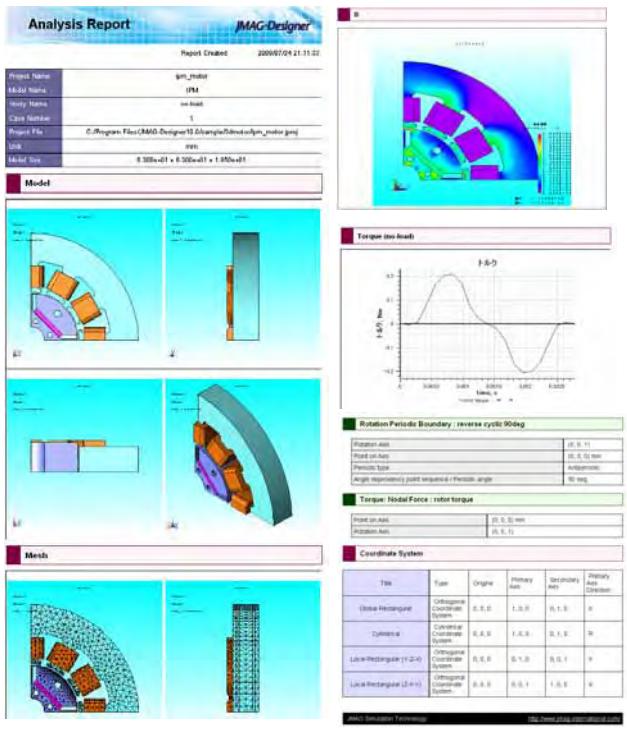
Flux Lines for a 3D Model



Cylinder Cut-Plane

### ●Organizing and Sharing Analysis Results Instantly: Generating Analysis Reports

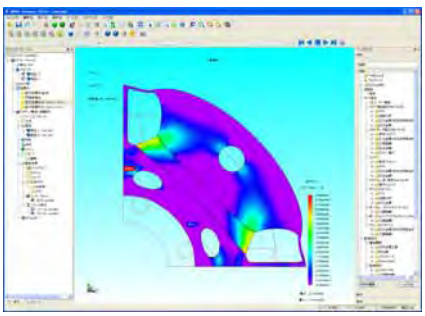
Results can be discussed and evaluated using a function to generate analysis reports quickly and easily from the results that are obtained with an analysis. **Distribution results, including geometry, vectors, and contours as well as graphs can be automatically inserted into a report.**The results can be organized into a report to share with colleagues and groups with the click of a button.

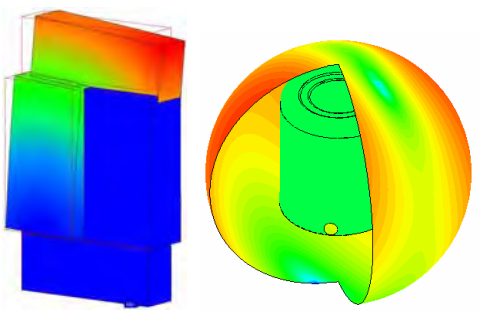



Analysis Report including the Geometry, Mesh, Distribution, and a Graph

## ●Improved Interface: Structural Analysis

JMAG-Designer ver. 10 now supports structural analyses. The structural analysis has not just been migrated from JMAG-Studio, rather, the interface for the structural analysis has been vastly innovated. The original interface for the structural analysis was complicated compared to the other analysis types in JMAG-Studio, such as the magnetic field analysis. However, the strength of JMAG to **perform a structural analysis based on the electromagnetic force calculated with a magnetic field analysis** has been combined with a simple to operate interface in JMAG-Designer. The structural analysis which in the past has required a fair amount of analysis know-how is now easier to use than ever before in JMAG-Designer.





Structural Analysis in JMAG-Designer

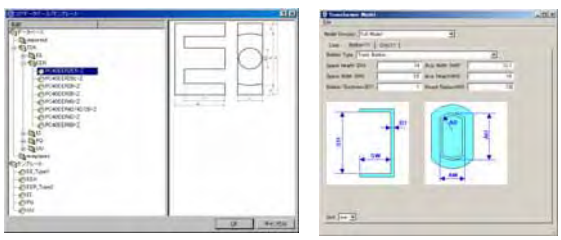
## ●Analysis Interface Specialized for the Design and Evaluation of Transformers

An interface geared towards designing and evaluating transformers and reactors has been implemented into JMAG-Designer ver. 10. The first step for an analysis is simply selecting the geometry to create from a **template database**. The database includes magnetic characteristics of ferrite cores, such as TDK and Hitachi Metals, as well as data for iron loss characteristics. Furthermore, the geometry can be created by simply **specifying the settings for the bobbin and core provide on the screens specific to the core and bobbin settings**.

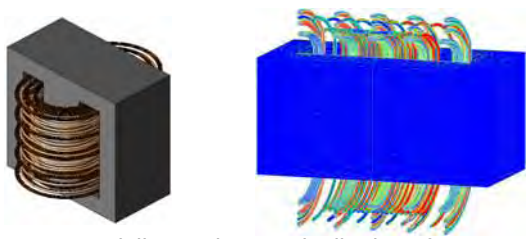
One more advantage of this new analysis interface for transformers and reactors is the calculation used for an analysis. The main goals of an analysis for transformers and reactors is to obtain the inductance and losses.These results can be obtained directly by using this specialized interface.

Losses that account for the skin effect and proximity effect are vital when analyzing a device such as a high frequency transformer. Each wire inside of the coil needs to be modeled to obtain these results requiring a vast amount of time for any analysis. However, **the losses accounting for the skin/proximity effect of the wires** can be calculated quickly by applying an independent approximate calculation algorithm that has been implemented into this specialized interface.

Note: The transformer modeling tool requires a separate license.



Core Template Database and Bobbin Settings



Modeling and Loss Distribution of Litz Wire

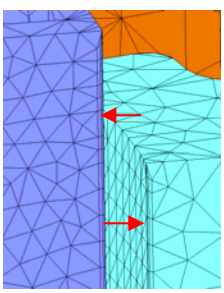
The solver for the magnetic field analysis as well as the function to generate mesh has also been improved in JMAG-Designer.

## ● Improving Accuracy while Maintaining Speed: Semi Auto Mesh Function

A semi auto mesh function was implement in JMAG-Designer version 5 (the previous version). In addition to the auto mesh function that is used to generate a high-quality mesh, the semi auto mesh function is used to generate mesh based on the element sizes specified by the user to reduce the time required to generate mesh. The time required to generate the mesh can be reduced greatly by using the semi auto mesh function. However, the quality of the mesh was difficult to control if the element size of the mesh was to large.

The semi auto mesh function has been enhanced to generate a higher quality of by re-generating the mesh with the appropriate element size based on the geometry of a model. Naturally, the fundamental purpose of the auto mesh function to **generate high quality mesh quickly** has been maintained.

A mesh to simulate the skin effect has also been added. **Mesh to simulate the skin effect can be generated for 2D models or for specified areas, such as the faces of a solid**. Furthermore, errors caused by variations in the mesh have been reduced by copying the mesh after **specifying a parent and child relation**.



Mesh to simulate the skin effect generated for only the specified faces

## ● Specifying the Deterioration of the Magnetic Properties: Magnetic Field Analysis

The speed of the solver has been improved for magnetic field analyses. In addition to a faster solver, the magnetization characteristics can now be calculated in JMAG ver. 10. One of these features has increased the **accuracy when calculating nonlinear magnetic properties** using a frequency response analysis. There were limitations to the accuracy of a frequency response analysis when the magnetic saturation was strong, however, the accuracy of these analyses have been improved in version 10. A **function to adjust the magnetic properties of materials** has also been implemented. The deterioration of materials can now be modeled by applying correction coefficients to the magnetic properties of magnetic materials and permanent magnets. This function can also be applied to materials in the material database to visualize the effects of manufactured deterioration.

## ●Using JMAG-Studio

Although this article has focused on introducing the functions that have been added and improved in JMAG-Designer, the solver and mesh functions described above have been implemented in JMAG-Studio as well as JMAG-Designer. The output files for both JMAG-Designer and JMAG-Studio are bilaterally compatible, and both systems can be run on the same computer. Even though the quality of JMAG-Studio will continue to improve in the future, please don't hesitate to try JMAG-Designer which offers a new type of framework for analysis technology.

# JMAG Application Catalog

## Efficiency Analysis of an IPM Motor

The Application Notes guide users inexperienced in analysis software, or experienced users that want to explore new fields using simulations, through a smooth analysis process.
Here is an introduction for two of our newest examples, "Efficiency Analysis of an IPM Motor" and "Superimposed Direct Current Characteristic Analysis of a Reactor."

IPM motors use not only magnetic torque produced by a permanent magnet and the rotating magnetic field but also reluctance torque produced by the inductance difference between the d-axis and the q-axis. So, they are highly efficient motor with high torque. The current phase angle $\beta$, at which torque and efficiency are maximized, varies with rotation speed and torque. So, the current phase angle $\beta$ needs to be taken into account for designing high efficient motor. This note presents the use of magnetic field analysis to obtain the efficiency of an IPM motor at each current phase with the rotation speed of 1800 rpm and the current amplitude of 4.0 Ampere when the motor is driven by sinusoidal current.

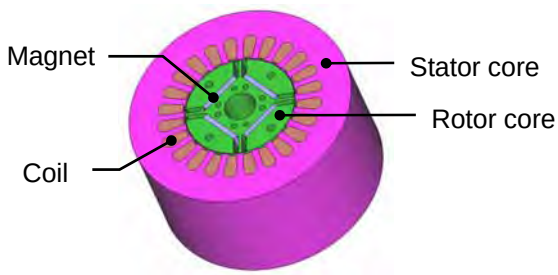



Figure1 Application

**Efficiency Characteristics**

Efficiency characteristics are obtained by changing the rotation speed, amount of current, and current phase, and then obtained characteristics can be used to create an efficiency map.
As shown in the efficiency graph, the maximum efficiency of 90.7 % is obtained at $\beta$ =30 degrees.

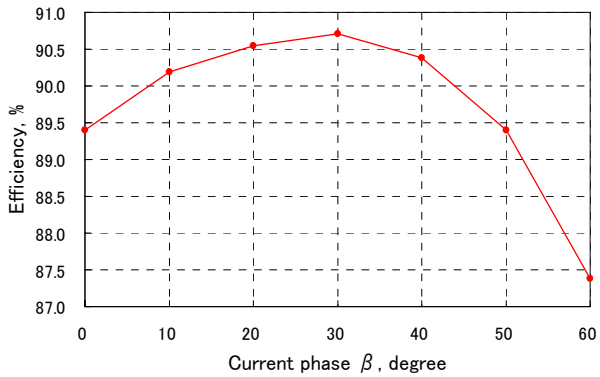



Figure2
Efficiency Characteristics of Each Current Phase
at Rotation Speed 1800 rpm and Current Amplitude 4.0 A

**Losses at Each Current Phase/ Magnetic Flux Density Distribution**

By adjusting the current phase, the magnetic flux density of the stator can be smaller and the iron loss can be reduced.

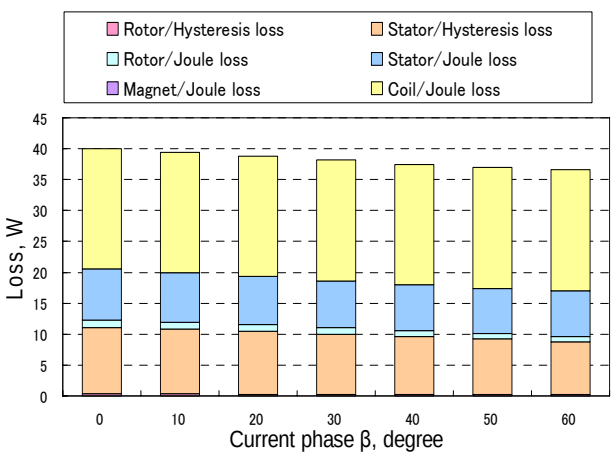



Figure3 Losses at Each Current Phase

# JMAG Application Catalog

## Efficiency Analysis of an IPM Motor

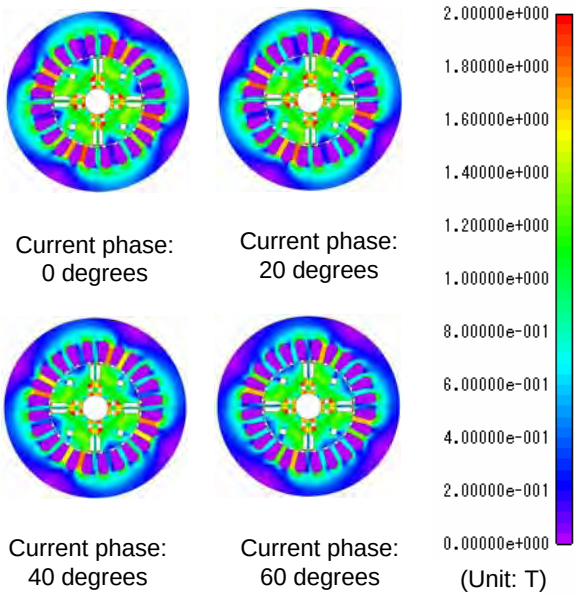



Figure 4 Magnetic Flux Density Distribution

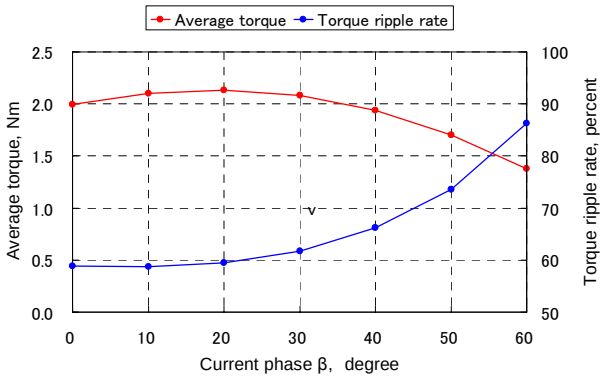



Figure 6
Average Torque and Torque Ripple Rate at Each Current Phase

**Torque Waveform**

While, the average torque may be reduced, and the torque ripple, the cause of the noise, may increase. Therefore, the current phase needs to be determined by taking into account the effect of torque ripple, as well as the importance of high efficiency

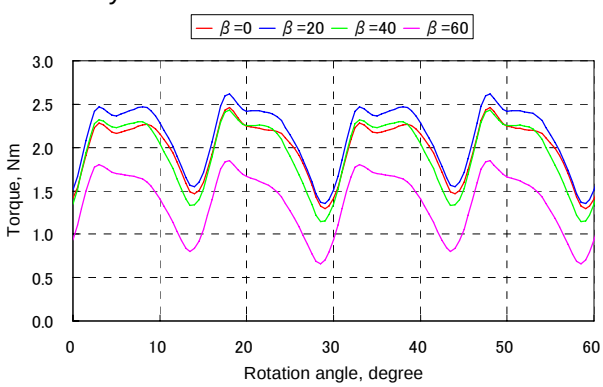



Figure 5 Torque Waveform

# JMAG Application Catalog

## Superimposed Direct Current Characteristic Analysis of a Reactor

A high-frequency reactor, used in equipment such as DC-DC converters, has a high-frequency current accompanying the switching direct current. The performance of a reactor is evaluated by a stable inductance in a wide direct current region.
The gap that is designed to prevent magnetic saturation from the core largely affects the inductance. The gap is a vital parameter of the reactor's design.
This example analyzes the superimposed direct current characteristics of a high frequency reactor.

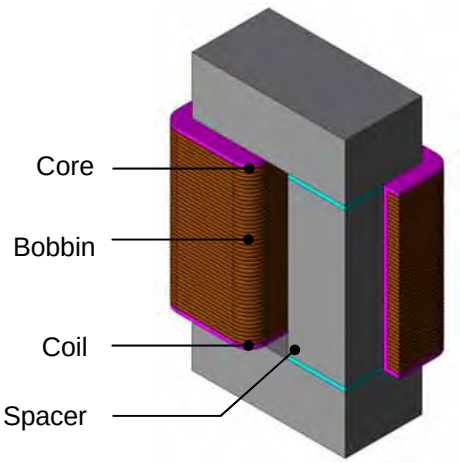



Figure1 Application

**Superimposed Direct Current Characteristics**

The superimposed direct current characteristics when the width of the gap is changed are indicated in Figure2. The magnetic flux density distribution of the core is indicated in Figure3.
The inductance decreases more rapidly as the direct current increases as indicated in Figure2. This is caused by magnetic saturation as indicated in Figure3. The sensitivity of the inductance for the current variation decreases because the magnetic resistance of the magnetic circuit is transferred by the gap as it gets wider.

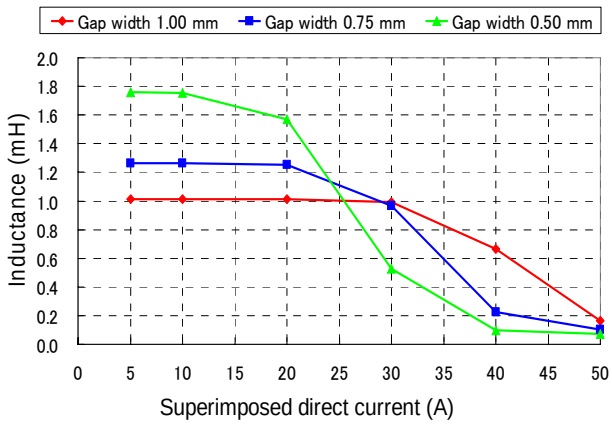



Figure2 Superimposed direct current characteristics

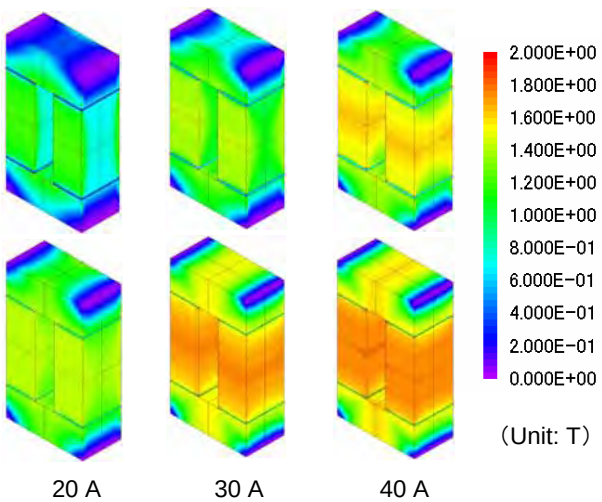
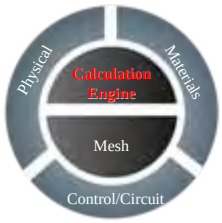



Figure3
Magnetic flux density distribution
(top: gap width: 1.0 mm; bottom: gap width 0.5 mm)

# Technical Report Vol.1




## A Powerful Simulation Engine
## - Why is a high-speed calculation engine necessary? -

In recent years, the needs of engineers are diversifying as computer aided engineering (CAE) tools are applied more regularly when designing electromagnetic devices. JMAG answers the diversifying needs of our users by enhancing technical development and functionality.

This technical report introduces the scope of JMAG's technological development. For this first issue, we raise the question of why a high-speed calculation engine is necessary and address the various ways a matrix solver has been integrated into JMAG.

CAE's role has vastly changed in the last 10 years following the expansion of CAE. Three dimensional analysis is becoming more common which has lead to an increasing number of elements that need to be evaluated (see Fig. 1). For this reason, high speed capabilities of the calculation engine have become an essential part of the technology.

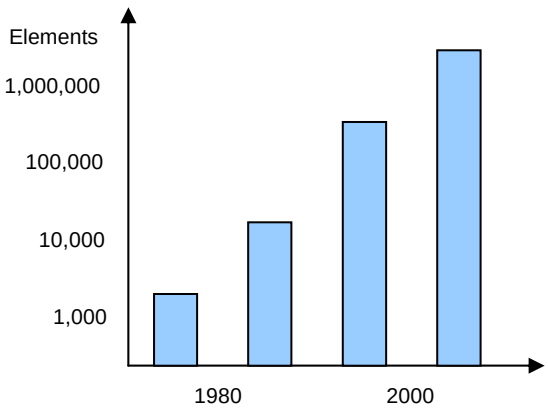



Fig. 1. Increasing Number of Elements

As previously mentioned, the needs of engineers utilizing CAE tools has diversified. At the very least, CAE tools support the analysis operations of users whom demand a program which can easily and efficiently evaluate a variety of calculations. Furthermore, as each day passes, more and more users require the ability to analyze phenomena in greater detail. To provide software to meet these requirements functionality is important, but developing a high-speed calculation engine is vital.

### ●Usability

As users around CAE have most likely noticed, JMAG provides a variety of functions.

One example is the ability to use CAD models designed in CAD systems for analyses. A precise CAD geometry model created using a CAD system can be used easily via the functions to link JMAG to a CAD system. However, the number of elements required increases dramatically to accurately evaluate a model with complicated geometry.

This is why JMAG provides an automatic mesh generation function that allows users with little to no experience generating mesh the ability to generate mesh appropriate for an analysis. A high quality mesh can be generated based on the model's geometry and internal design, such as the gap. However, because generating only the minimum number of elements necessary with the auto mesh function is difficult, an experienced user that can control how the mesh is generated manually is advantageous.

### ●Calculating a Variety of Parameters Efficiently

" I want to increase reliability of my designs by investigating a number of parameters." Many designers desire the same ability. JMAG provides a parametric calculation function that allows users a method to automatically calculate a large number of design possibilities efficiently.

### ●Analyzing Designs in Greater Detail

Invisible phenomena, such as magnetic flux density distribution, can be analyzed because JMAG is a computer aided engineering tool. Naturally, designers want to evaluate the physical phenomena inside their designs accurately. JMAG not only provides a wide range of modeling methods for geometry, but also simulates physical phenomena that include material properties, heat, and the structural makeup of a design.

Innovations to handle a large number of elements and calculation parameters as well as increasing the scale of the analyses are necessary to fulfill the diverse needs of our users. This is what drives us as we continue to develop a high-speed calculation engine.

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## ●Quintupling the Speed Yearly

JMAG has been developed to provide a tool that can drastically reduce costs and increase efficiency throughout the design process via high-speed analyses for a variety of different analysis targets.

JMAG utilizes a wide range of ingenuity to achieve the high-speed analyses that it offers. The main innovations focus on improving the algorithms and calculation processes as well as implementing a function for parallel computing. The amount of time required for an analysis in version 9.1 has been reduced to 1/5 the amount of time required in version 8.3, as indicated in Fig. 1. Although the time required depends on the type of analysis, JMAG has successfully quintupled the analyses over 4 years.

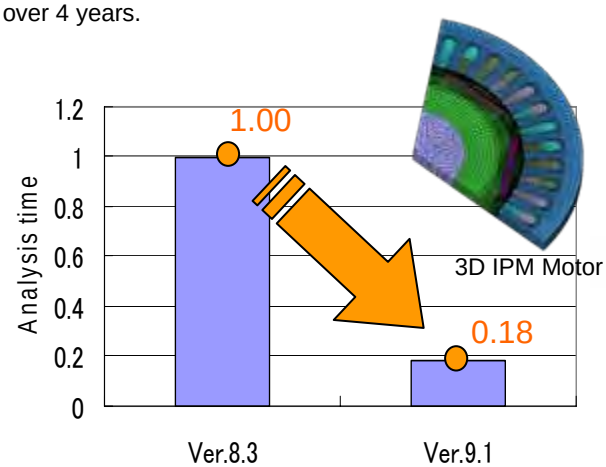



Fig. 1. Time Require for an Analysis in JMAG by Version [1]

## ●If It's Not Fast, It's Not Worth Using

Why is the speed of JMAG such a large part of the development process? Speed is vital to meet the demands designers face each day.

The number of designers using CAE tools is increasing as the performance analysis software offers grows. In an extremely competitive product development industry there is constant pressure to reduce the number of prototypes as well as the amount of time for developing a product. Research has shown that the amount of time allotted for design in the automotive industry has decreased by 40% in the last 10 years.

JMAG is implement into the design process to increase efficiency and reduce costs. The speed of the solver is indispensable to meet these demands. Therefore, if the solver is not fast, it is not worth using.

## ●Parallel Computing for the ICCG Calculation Method

JMAG has implemented parallel computing to attain a faster analysis.

Why parallel computing? Parallel computing is used because the matrix solver for linear equations requires the most time for an analysis. Analyses performed using ICCG make up 80% to 90% of the time required for calculations performed based on our internal research. Therefore, JMAG has been designed to perform analyses with ICCG by implementing symmetric multiprocessing (SMP). The speed attained using symmetric multiprocessing is indicated in Fig. 2. Compared to an analysis that uses a single processor, an analysis that is distributed over eight processors offers 3 to 4 times the speed. Furthermore, these results were obtained using computers with two Intel® Xeon 5500 Quad Core CPUs.

## ●Robust Parallel Solver

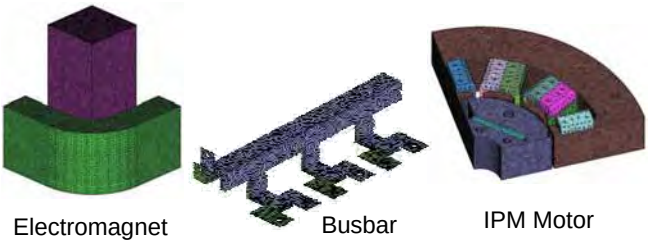
The robust parallel solver JMAG offers is vital for both the hardware and the solver. How was this robust solver realized? Let's take a look at three factors that influence the development of the solver:

### (1) Optimum Performance on Various Hardware

Unfortunately, the performance of parallel computing differs according to the hardware that is used. How can a high level of performance be accomplished on an assortment of hardware? A vast amount of trial and error with a lot of fine tuning is required.

The parallel computing function implemented in JMAG was tested on a wide variety of the latest hardware with the cooperation of the hardware vendors. A lecture the Sumisho Computer Systems Corporation presented at the JMAG Users Conference 2008 regarding the present and future state of multi-core processors used the ICCG solver in JMAG as their example.

The hardware JSOL used to test and refine the solver in JMAG is indicated in Fig. 3. Seven out of nine of the CPUs that could effect parallel computing had already been tested with JMAG.



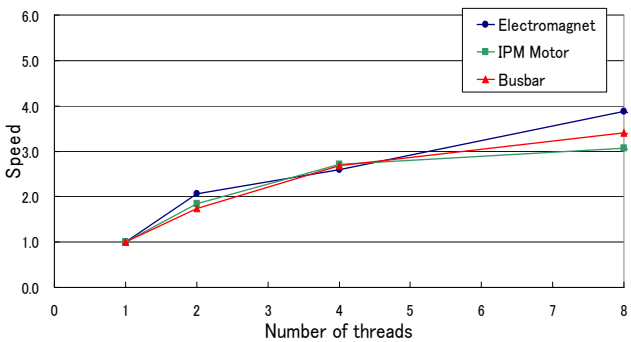




Fig. 2. Speed Achieved with Parallel Computing
(top: analysis model; bottom: comparative speed)

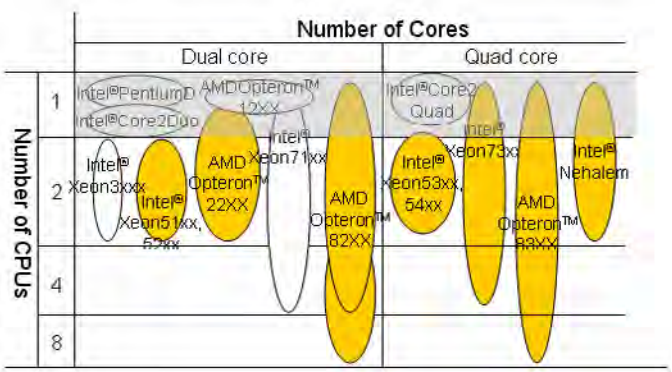



Fig. 3. Hardware Tested for Parallel Calculation

## (2) Focusing on Solver Stability

Regardless of how fast an analysis can be performed using parallel computing, the analysis is useless without the ability to obtain accurate results. This is why the primary focus for the development of JMAG is stability.

Various measures have been researched and tested to achieve a materix solver in JMAG that provides the highest level of convergence.

A wide range of tests have been performed to successfully develop a high-speed solver that uses parallel computing while maintaining stability. JMAG provides a faster solver for a variety of analyses from static to transient and frequency response analyses that can be performed for a wide range of analysis targets that include motors, magnetic heads, busbars, and magnets.

## (3) Applying Algorithms Accounting for the Number of Threads

The algorithm used for parallel computing depends on the number of threads (number of cores) used. For example, the performance of an algorithm that offers a vast amount of speed for a small number of threads decreases when the number of threads exceeds a certain point. For this reason, it is necessary to select an algorithm based on the environment that will be used.

Presently, the maximum number of threads supported for multi-cores is 8. Therefore, JMAG applies algorithms specifically for this size of parallel computing.

## ●Parallel Computing and Hardware Innovation

Technology for parallel computing is influenced by innovations in multi-core hardware. Recently, hardware that applies parallel computing has been introduced to the market as manufacturers such as Intel® and AMD continue to revolutionize multi-core computer processors. Software developers are currently focused more on utilizing multi-core parallel computing because increases in the clock speed of the CPU environment can no longer be expected.

## ●Increasing the Speed of JMAG

In the future, innovations for multi-core computer processors will continue to be a vital part of implementing further innovation into JMAG.

This innovation is not only being applied to further development of a parallel solver, but also to increase the speed of analyses performed on a single processor. CAE tools do not make the products. However, JMAG aims to provide the fastest magnetic field analysis solver to assist our users in designing the highest quality of products possible.

The next edition will introduce how the mesh generation engine has been enhanced to meet the diverse needs our users have.

[1] : From the JMAG Users Conference 2008 Poster Session
[2] : From our internal research

# For Anyone Considering Implementing JMAG-Designer

A 30-day free trial is available for customers considering implementing JMAG-Designer.
Don't hesitate to take advantage of this opportunity to see how easy JMAG-Designer is to use as well as try the various services that are offered.

**30-Day Free Trial**

A free 30-day trial license is offered to those who would like to try JMAG-Designer. All of the various services that are offered for JMAG can be used during this evaluation period. This opportunity allows you to try the sophisticated pre-processor and the high-speed analysis solver.

## The Services Provided During the Trial Period

### 1 The JMAG Application Catalog

This comprehensive application catalog contains a wide range of example analyses that introduces the vast number of applications and analysis functions that JMAG-Designer has to offer.

### 2 The Self Learning System (SLS) Practice Mode

The Self Learning System provides an optimum learning environment that guides users through the various procedures for a variety of applications from creating analysis models to specifying the necessary parameters.

### 3 Tutorials for Each Function

These PDF tutorials are an invaluable resource packed with information about the functions and adaptive mesh options that can be used in JMAG-Designer. Sample data is also provided with each tutorial.


For more information about how to take advantage of this free trial, refer to the following URL:

**http://www.jmag-international.com/evaluation/**

# List of Distributors

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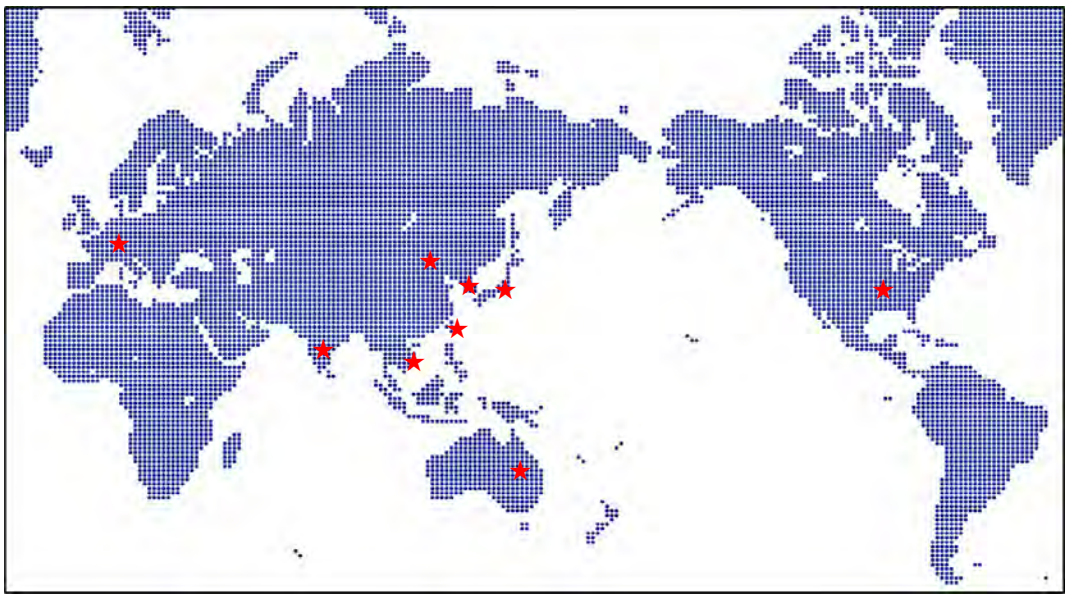

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