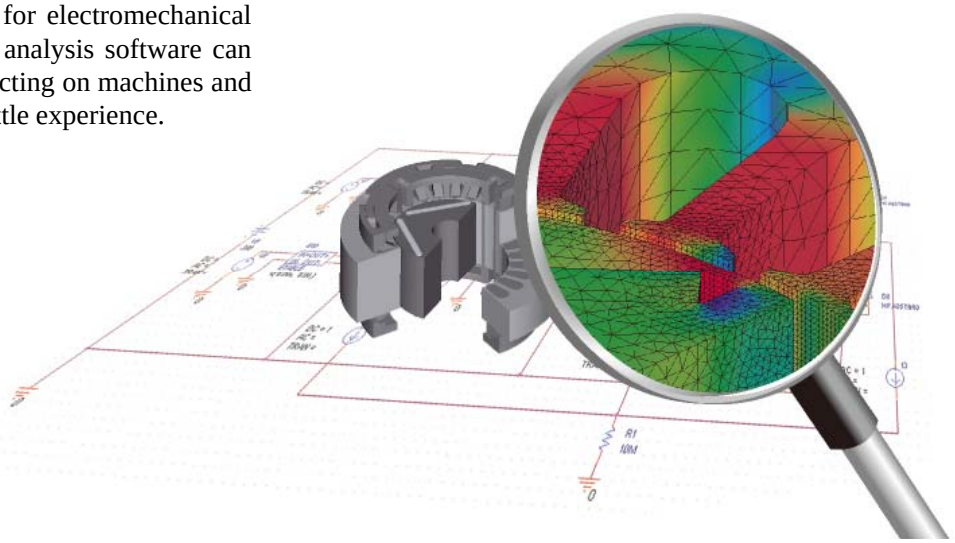
Simulation Technology for Electromechanical Design

JMAG

JMAG News Letter

Jan. 2011

JMAG is a comprehensive software suite for electromechanical design and development. This high speed analysis software can capture the complex physical phenomena acting on machines and obtain highly accurate results easily with little experience.



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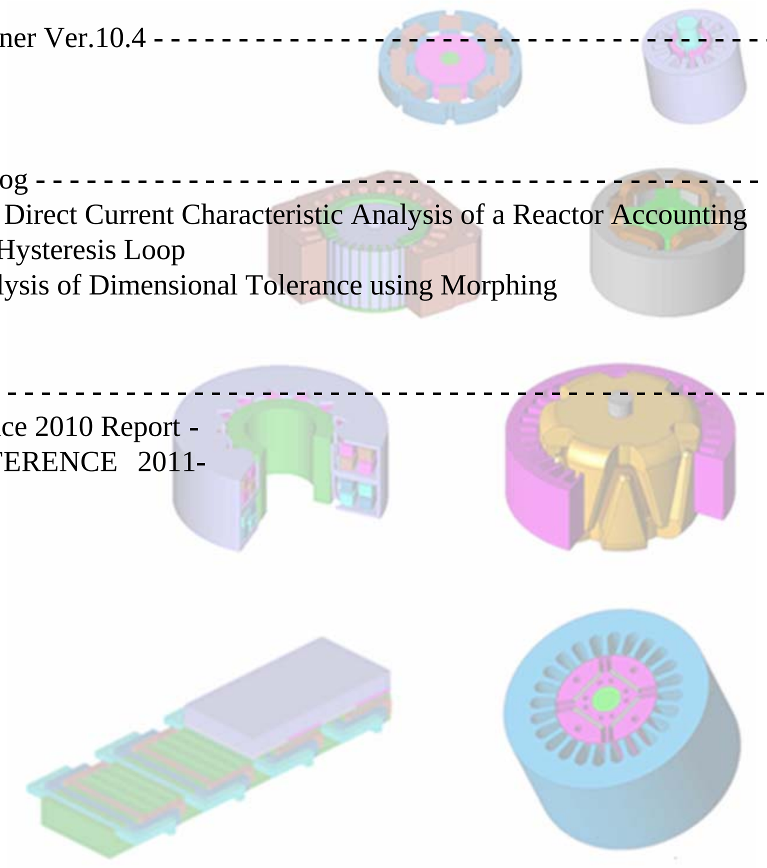

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JMAG News Letter January Edition

This edition of the JMAG News Letter features JMAG-Designer Ver. 10.4.

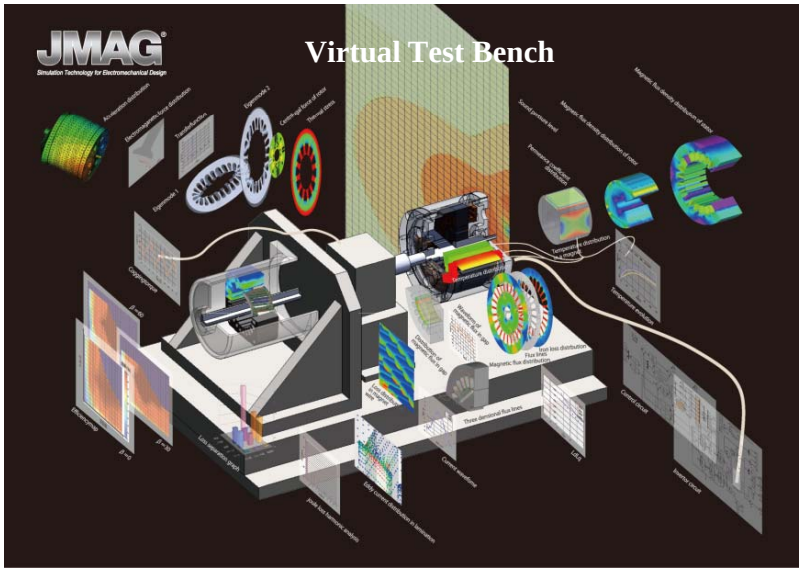
The new features of JMAG-Designer Ver. 10.4, which was released December 7, 2010, are introduced in addition to the benefits of using JMAG-Designer and the know-how required to use the software from our users with hands-on experience using JMAG-Designer.

The latest version of JMAG-Designer has evolved to provide a comprehensive analysis software which is easy to use for those experienced or inexperienced in computer aided engineering (CAE). These new features are introduced alongside some of the prominent ways they can be used.

In this edition, Professor Kan Akatsu from the M&A Energy Conversion Lab. at Shibaura Institute of Technology provides his insights in Implementing JMAG. The M&A Energy Conversion Lab. actively researches ways to achieve even more highly efficient motor systems as well as motors providing added value which will offer a competitive edge in in the international market while they aim to reduce CO_2 emissions 50% by 2050. In this interview, Prof. Kan Akatsu talks about his paper "A New Control Method for Torque Ripple Compensation of Permanent Magnet Motors" a well as his expectations for JMAG in the future.

We hope you enjoy this edition of the JMAG News Letter.

Engineering Technology Division
JSOL Corporation

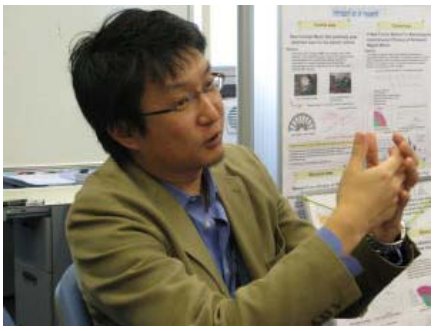


Implementing JMAG

Shibaura Institute of Technology Kan Akatsu M&E Energy Conversion Lab.

Tackling Next Generation Motor Development using JMAG

The evolution of technology for motors and control systems has been tremendous. The progress of development is driven around an environmental axis which has provided motors that can cut the world's power consumption in half and brought us electric vehicles. Electromagnetic field analysis software is becoming a tool indispensable in designing and evaluating the performance of these types of products. Prof. Akatsu uses the electromagnetic field analysis software, "JMAG," for his M&E Energy Conservation Lab. at Shibaura Institute of Technology which is known for its achievements reducing torque ripple in permanent magnet motors and he is an executive member of several technical committees in The Institute of Electrical Engineers of Japan. In this interview, Prof. Akatsu discusses motor development and electromagnetic field analysis software.



Associate Professor Kan Akatsu
Department of Electrical Engineering
Shibaura Institute of Technology

- It seems interest in motor and control systems is growing as hybrid vehicles that combine engines and electric motors are becoming the standard while electric vehicles approach commercial viability.

Prof. Akatsu Motors are thought of as a very mature technology, but their technological innovation continues today. Currently, motor and control systems continue to advance, especially to address environmental issues.

Although this statistic is not very well known, 57% of the power in Japan is consumed by electric motors. This includes all of the motors built into compressors, pumps, and various other equipment. Motors that have power usage efficiency of less than 30%, or "power wasting motors" make up more than a hand full of the motors that are used. Motors controlled by inverters are said to have a usage efficiency of roughly 16% to 17%.

It is estimated that the world's $C0_2$ emissions could be reduced by 7% if motors just in Japan were replaced by the most efficient products in the market today.

This means that highly efficient, small, low cost, and high performance motor systems need to be adopted around the world when considering the environmental burden.

Interest in electric vehicles is growing and the technological progress of motor systems, which is at the heart of these vehicles, is advancing rapidly. For example, motors for automobiles require high torque at low speeds, such as when starting a car on a hill. However, motors only capable of producing large torque would be too powerful and pointless under normal driving conditions. Additionally, because these motors need to be installed inside the vehicle, small yet powerful motors are desired.

These challenges drive a new type of research in motor electronics that needs to unify the development of the materials and structure of motors with the development of the control.

- Among the increasing demands of today, you use the leading edge magnetic field analysis software "JMAG" for your research.

Prof. Akatsu JMAG is used as a design tool as well as a tool to examine our theories. As an example, we investigate the effects of nonlinear characteristics using simulation after creating a linear design. We also examine whether the theories we are considering for a new motor are actually valid, which relates to the numerical models we create JMAG is also used to create control models by deriving the control parameters of the motor.

Linear models are no longer used in the design of control systems. Therefore, results from magnetic field and circuit simulations using JMAG-RT are implemented in real-time control simulations.

JMAG is a vital tool that is taught to the students working in my lab. The students address specific production challenges of motors, which deepens their understanding as they attempt the inductance calculations[*1], iron loss calculations[*2], and output curve calculations[*3] used in the manufacturing process.

*1 Inductance = A property caused by variations of current becoming induced electromotive force in coils, etc. Inductance is also referred to as induction coefficient.
*2 Iron loss calculation = The amount of electric energy lost when current is applied to the core of a motor wound with coil and magnetized. The efficiency of motors worsens as iron loss increases.
*3 Output curve calculation = Variations of output (power) for motors

Evaluating High Torque & Reducing Torque Ripple with JMAG

- Prof. Akatsu, you presented "A New Control Method for Torque Ripple Compensation of Permanent Magnet Motors" at the JMAG Users Conference in December 2010. Could you please summarize this research for our readers?

Prof. Akatsu When aiming to gain higher torque which provides more powerful motors, the trade-offs related to the torque ripple[*4] always need to be considered. To solve this problem, development that is “collaborative between the motor design and control“ is required to increase the average torque in the motor design and limit the torque ripple in the control. We use JMAG in this type of development.

More specifically, we measured the torque ripple instantly by deriving numerical models encompassing the torque ripple. Then, we are able to reduce the torque ripple by applying a current using a current command to eliminate the torque ripple that we obtained.

Formulating the equation for the torque ripple was extremely difficult, but we were able to create a model matching the calculation results in JMAG and the actual results that we measured. Analyses allowed us to further our research because we know that the torque ripple results obtained in JMAG match those measured in the prototype.

- Were you able to realize your objective of a high torque design through collaborative motor design and control development?

Prof. Akatsu JMAG is suited to generate these types of numerical models. Knowing the results in JMAG match the actual phenomena allows us more freedom in designs at the design stage.

In the past, the person making the motor and the person controlling the motor were different. There were many people developing control methods that believed "the motor works just like the numerical model." However, in the real world, this is not true.

Collaboration between the people making the motors and those controlling the motor is made possible by the highly accurate torque ripple models generated in JMAG.

*4 Torque ripple = Pulses of torque (force) produced when the motor rotates. The torque ripple that occurs causes noise and vibrations and may worsen controllability.

*5 Switched reluctance motor (SRM) = A motor that rotates using the difference in electrical resistance between the stator and the rotor. Even though switched reluctance motors have superior heat resistance due to a simple structure compared to rotating magnetic field type motors that have permanent magnets embedded into the rotor, there application into electric automobiles has been deemed difficult because the usage efficiency of torque and energy is low making miniaturization difficult. However, there has been some success in small, high output SR motor development.

- How will your research be expanded based on the testing results?

Prof. Akatsu There are two directions I plan to expand my research. First, we have been able to control the torque ripple and the vibrations caused by the torque ripple in testing, but I would like to apply the same techniques to a larger motor with nonlinear characteristics, such as a switched reluctance motor (SRM)[*5], which is a motor that does not use permanent magnets.

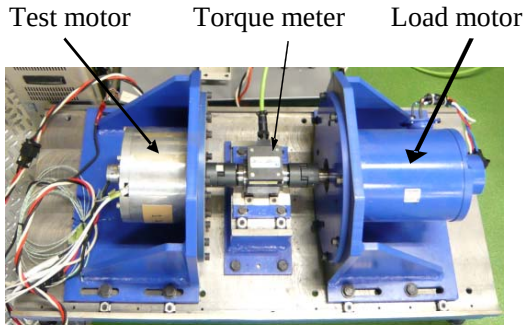
I also plan to utilize JMAG in the actual controller. I want to use JMAG to provided feedback to the controller in real time by being able to fully trust the torque ripple calculated for the numerical model derived in JMAG. I am confident that this will happen within the next 10 years.

(JMAG Users Conference 2010) Simulation Park

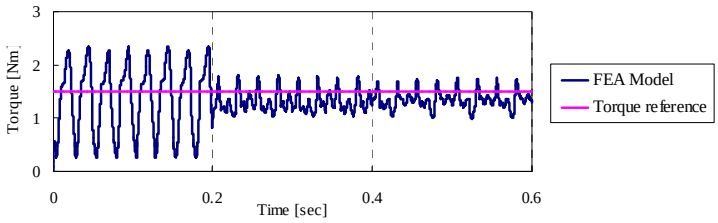
"A New Control Method for Torque Ripple Compensation of Permanent Magnet Motors" video

Available on the JMAG website (only Japanese) at:

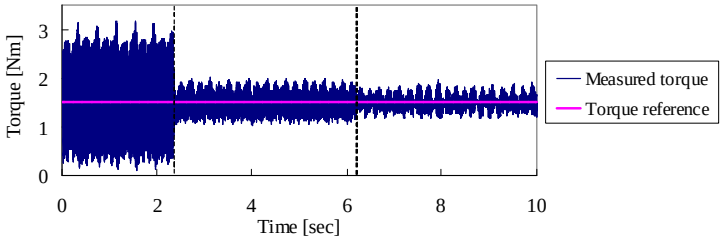
http://www.jmag-international.com/jp/conference2010/sim_park.html



Appearance of the equipments



Torque ripple control (simulation results)



Torque ripple control (actual results)

Related Papers:

• Noriya Nakao and Kan Akatsu, “A New Control Method for Torque Ripple Compensation of Permanent Magnet Motors”, The 2010 International Power Electronics Conference –ECCE ASIA- (IPEC2010), 23P3-38, Sapporo, June, 2010/06/28
• Noriya Nakao and Kan Akatsu, “A New Control Method for Torque Ripple Compensation of Permanent Magnet Motors”, 2010 Annual Conference of I.E.E. of Japan, Industry Applications Society 1-16

Evolving Motor Technology and Analysis Software

- How do you think the introduction of magnetic field analysis software has affected the development of motor technology?

Prof. Akatsu It is no coincidence that the introduction of permanent magnet motors in the early 1990's and viable analyses using the finite element method coincide.

It could be said that the needs and innovation have created a cycled development. Each progressing mutually from the others' success.

There was a time when development was all about solving equations for the control. Motors with new structures or new methods of control can’t be discovered by repetitively solving equations, and if they could, it would take a vast amount of time. The "Prius" hybrid*6 and other electric vehicles would not be around today without analysis software using the finite element method.

There is bilateral development where this type of software promotes advances in motor technology which in turn filters back to the software’s own innovation. This cycle of innovation will continue into the future.

- Based on your experience with JMAG, where do you think JMAG’s strengths are?

Prof. Akatsu JMAG has supported development engineers since its release. Engineers needed a tool like JMAG and they were waiting patiently for its release.

I started using JMAG in 2000 for a research center of an automotive manufacturer when I was asked to compare the magnetic field analysis results of the various software that were available. Any misgivings about the analysis accuracy were due to a lack of understanding about how to use the software as a tool as well as the limited number of analysis examples that combined data comparing the analysis results to actual data. However, the more analysis experience that was accumulated, the more trust JMAG gained.

Another reason that JMAG earned as much confidence as it did was the support provided by JSOL. The user friendly technical perspective they offered builds a strong foundation of trust. The support team is very fast in responding to any trouble or questions that we run into. They are on top of the problem right after we contact them. I am very grateful for this support, and I don't think it is going to far to say it is unacceptable that other companies are not keeping pace with this kind of support.

*6 Prius is a registered trademark of the Toyota Motor Corporation.

Understanding the "Logic" of Results Obtained in JMAG Brings Technological Reform Reducing Post-processing

How would you like your students to use JMAG?

Prof. Akatsu I would like them to consider the results they obtain until they are convinced of the accuracy. They need to know intuitively that the analysis results are a simulation. An analysis, no matter how advanced the software, will not provide any answers if the analysis is not setup correctly. They need to use the software with this always in the back of their minds.

Even in "the 5 rules" I have put in place at my lab., I have included "always consider the fundamental principles." They need to measure the results and then investigate whether or not they have obtained the right answer. This type of approach is important.

- What would you like to see improve in JMAG for your research in the future?

Prof. Akatsu First I would like to see more ways to utilize the analysis results effectively.

For example, Professor Katsumi Yamazaki's (Chiba Institute of Technology) method for isolating the magnetic flux produced by the magnets and the magnetic flux produced by the armature windings suggests a new way of using analysis results. This means that the "analysis results" are not just taken as is, but rather evaluated by "breaking down" and analyzing those results. If the contents and logic behind the results is understood, the areas that need to be focused on, including problems that may occur at the next stage, can be grasped. Maybe it should even be called a "post-processing breakdown."

The plots to display the magnetic flux density distribution by frequency are very advantageous. I am sure this type of freedom in post-processing will determine the value of analysis tools in the future. I would also like an established method to simulate the charge and spin of magnetic fields (spintronics) to capture in what way electromagnetic fields are produced, something that is still not fully understood.

Nevertheless, JMAG is indispensable for companies in Japan and the rest of the world to develop motors viable in extremely competitive industrial markets. Permanent magnets are wonderful, but we relay on China for the rare-earth materials. This is where the concept of a high-performance SRM comes from. SRM do not require magnets and allow us to conserve natural resources.

Even further motor development expanding added value can be expected, from motors that cannot be reverse engineered to motors exhibiting two opposing characteristics, or motors with built-in inverters. JMAG is also in the background supporting these advancements by promoting a more collaborative development.

Student's Perspective

Freshman Noriya Nakao
Electrical Engineering and Computer Science Graduate Program
Shibaura Institute of Technology

I feel that JMAG is a very advanced analysis tool, but, at the same time, I feel it takes a certain amount of engineering experience. For example, to set windings, someone with no experience would not be able to visualize how to specify the various settings. Often, the user doesn't realize they have made a mistake until after the results have been obtained.

This problem might stem from the difficulty of switching from thinking about things 2-dimensionally to thinking about them 3-dimensionally. In other words, the real "power" of JMAG is its ability to grow as a tool as the user gains more experience.

SHIBAURA INSTITUTE OF TECHNOLOGY

Research Overview

Associate Professor Kan Akatsu
Department of Electrical Engineering
Shibaura Institute of Technology

The M&E Energy Conservation Lab. was established in 2009 at the Toyosu campus of the Shibaura Institute of Technology. Their research focuses on the primary challenges for higher efficiency and performance of motors and generators. The M&A Energy Conservation Lab.'s mission is to "contribute to reducing CO_2 emissions 50% through engineering by 2050."

Associate Professor Kan Akatsu received his Ph.D in electrical engineering from Yokohama National University before joining the Nissan Research Center. In 2003, he joined the department of Electrical and Electric Engineering at Tokyo University of Agriculture and Technology from 2003 to March 2009 until accepting a position as an associate professor in the Department of Electrical Engineering at Shibaura Institute of Technology. Kan Akatsu specializes in electromechanical energy conservation, power electronics, and control engineering. He is also a member of the Institute of Electrical Engineers Japan and various other societies.

http://www.sic.shibaura-it.ac.jp/~akatsu/english/index_e.html

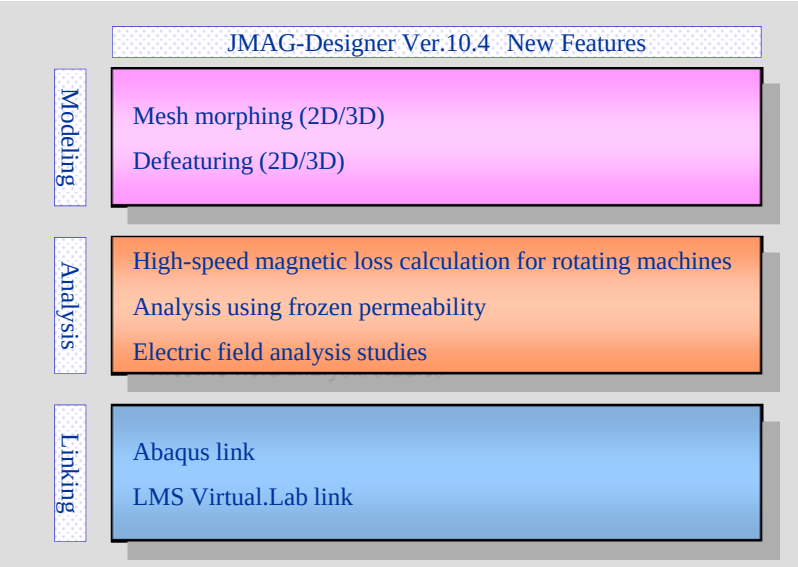
Introducing JMAG-Designer Ver. 10.4

- Simple to be Precise -

JMAG-Designer Ver. 10.4 was released December 7, 2010. The latest version has evolved by combining the know-how of the most experienced engineers to provide a comprehensive analysis software which is easy to use for anyone experienced or inexperienced in computer aided engineering (CAE).

This article introduces the latest features that have been implemented into JMAG-Designer 10.4 along side primary examples of how to use the new modeling, analysis, and linking features.

Let's start by taking a look at the new modeling features that are available.



Modeling

Defeaturing

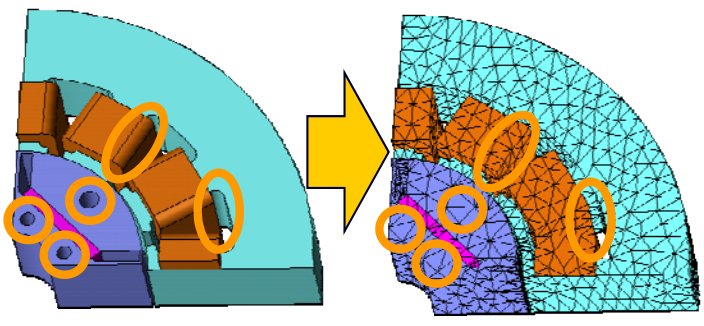
Simplifying geometry appropriate to satisfy the objective of an analysis while reducing the scale of the model greatly illustrates the know-how required for modeling. However, the new defeaturing capabilities implemented into JMAG-Designer Ver. 10.4 allow users to simplify the geometry of models by automatically removing fillets, chamfers, and holes when generating mesh.

Almost all of the parts utilized for electromechanical machines take advantage of fillets and chamfers (features) to round corners and prevent injury to users as well as the chipping of the parts themselves. These types of features cause the mesh to become dense, increasing the number of elements when the mesh is generated, because of the extremely small area these features make up compared to the entire model. Furthermore, they have very little affect on the analysis results. These types of unnecessary features need to be removed from the geometry to limit the number of elements, and in turn, limit the calculation time and memory that is required.

However, CAD software has been the only way to edit the geometry of models. Therefore, editing models also required an a vast amount of time and effort, especially for models without any feature information, because the geometry had to be re-modeled from scratch.

This cumbersome defeaturing process has now been automated in JMAG-Designer Ver.10.4 Defeaturing can be specified as an option for generating mesh. Fillets and holes to remove can be filtered by simply setting the their dimensions. CAD geometry no longer needs to be re-modeled to reduce the number of elements because the geometry of the mesh model can be simplified without ever touching the CAD model itself.

*Defeaturing requires a separate license.

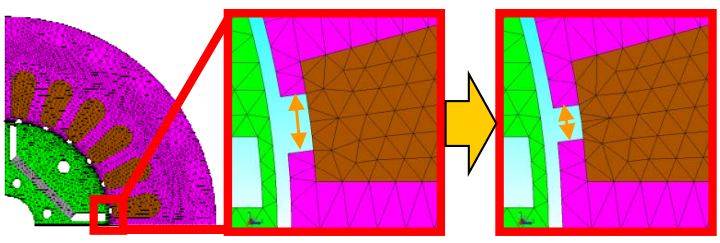


Deleting fillets and unnecessary holes using defeaturing

Mesh Morphing

The mesh morphing feature implemented into JMAG-Designer Ver. 10.4 allows the geometry of mesh models to be directly manipulated. Small changes to geometry can be emphasized and evaluated in the analysis results using the mesh morphing feature because, the differences in the mesh caused by these small geometrical modifications is minimal which limits mesh noise in the results. In addition, there is no need to return to the CAD system to edit geometry because morphing can be specified right in the graphical user interface of JMAG-Designer, just like defeaturing. The topology of mesh is maintained after the geometry is modified by moving the position of nodes in the mesh to change the geometry. The mesh quality does not deteriorate because the position of the nodes inside of the entire part to modify are automatically optimized as the specified area is deformed. Modifications to the geometry can be finely tuned via settings to constrain the geometry and connections, rather than just simply displacing edges or faces.

The mesh morphing feature is effective for tolerance analysis. A tolerance analysis requires analyses for multiple models that have differing geometry to examine the effects of the dimensional or geometrical tolerance of products after assembly. The mesh models used for the analyses differ, even if the geometry is almost the same, because the mesh is generated for each model. Therefore, clearly determining whether the differences in the results are caused by the changes in geometry or the differing mesh becomes difficult. Anyone who has performed tolerance analyses has experience manually generating mesh so that the mesh topology for each model is the same reducing the effects of differing mesh. Mesh models that maintain the mesh topology without the time and hassle of editing the model geometry and re-generating mesh can be done with the mesh morphing feature.

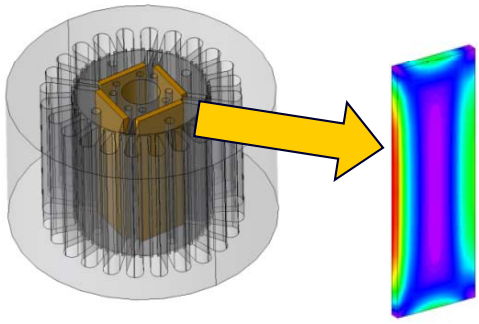


Changing the width of teeth using the mesh morphing feature

Analysis Features

Rapidly Calculate the Magnet Loss of Rotating Machines

The speed of the magnetic field analysis solver continually increases. High speed calculation for eddy current analyses of magnets in IPM and SPM motors has been implemented into JMAG-Designer Ver. 10.4.



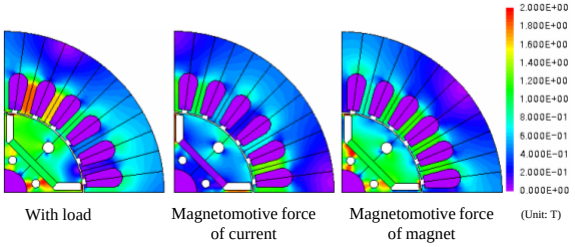
Loss distribution caused by eddy currents produced in magnets

3D analyses have to be performed to account for the three dimensional phenomena of eddy currents flowing in magnets. Furthermore, a large number of steps need to be evaluated to shorten the time interval to avoid problems of time harmonic related components of PWM, etc. A high speed 3D analysis can be performed by referring to the magnetic flux distribution of the gap obtained in advance using 2D analysis. Eddy current loss calculations that once took 8 hours using conventional methods can now be performed in 12 minutes, including the time required to run a first stage analysis (varies by analysis model).

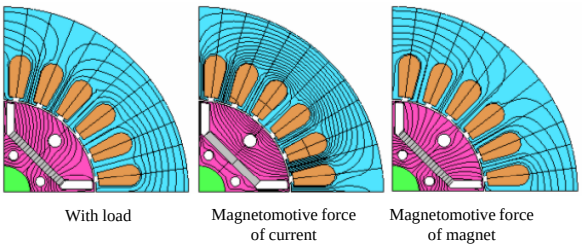
The high-speed loss calculation for rotation machines is suited for anyone who has been forced to avoid these types of analyses due to time constraints, even though the results could be invaluable.

Analysis Accounting for Permeability Distribution

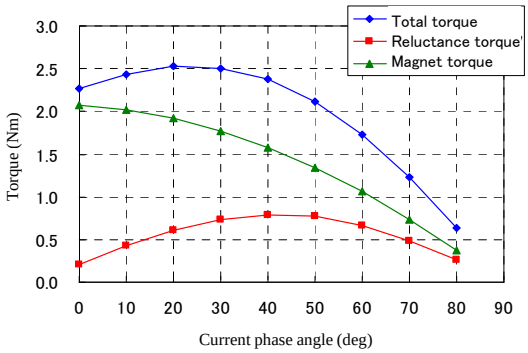
Features have also been implemented to provide even more precise analyses. Analyses can now be preformed by fixing, or freezing the magnetic characteristics of materials in JMAG-Designer 10.4 The two main applications for this feature are, evaluating the magnetic flux density distribution and flux lines by isolating each of their magnetomotive forces, and isolating and evaluate the magnetic flux distribution and flux lines of the magnet and the load current separately in load analyses of motors using permanent magnets. The magnetic flux for motors using permanent magnets can be broadly divided into the flux produced by the permanent magnets and the flux produced by the load current. The magnetic flux that is obtained separately and added together is larger than the results of an analysis evaluating both the magnet and load current because the magnetic saturation is not taken into account. However, JMAG-Designer Ver. 10.4 allows the operating points of an analysis evaluating both magnets and load current to be obtained in advance to evaluate the magnetic flux density distribution and flux lines separately utilizing the frozen permeability in an analysis.



Isolated magnetic flux distribution

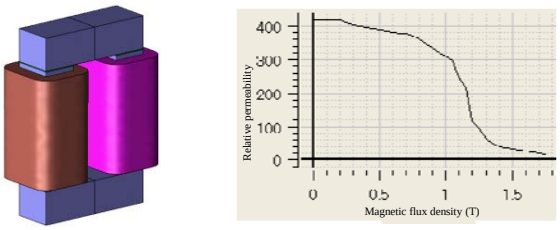


Flux lines of the isolated magnetic flux



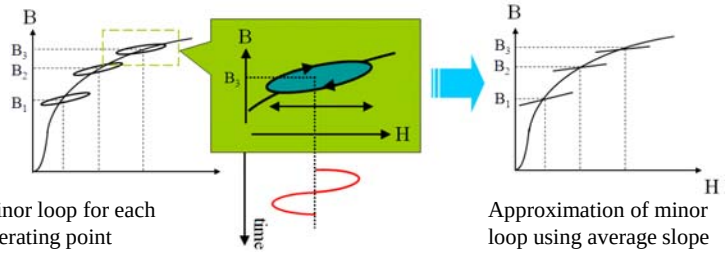
Flux lines of the isolated magnetic flux

Additionally, a superimposed direct current characteristic analysis can also be performed. In transformers and reactors that have direct current superimposed on the driving current, the magnetization properties of the direct current for the inductance are smaller than the values that are measured because the magnetic flux in the primary magnetic pathways stops varying in the saturation region. The superimposed direct current characteristics can be evaluated in JMAG-Designer 10.4 by obtaining the operating points of the direct current components, and then analyzing the alternating current components using the frozen permeability. Even greater analysis accuracy can be attained by artificially reproducing the minor loop of hysteresis if the magnetic flux density/minor loop permeability properties are available.



Magnetic flux density versus relative permeability

*Provided by Tabuchi Electric Co., LTD.



Small amplitude signal of superimposed direct current

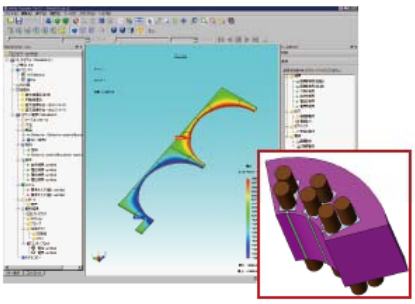
Analysis using magnetic flux density versus relative permeability

Electric Field Analysis

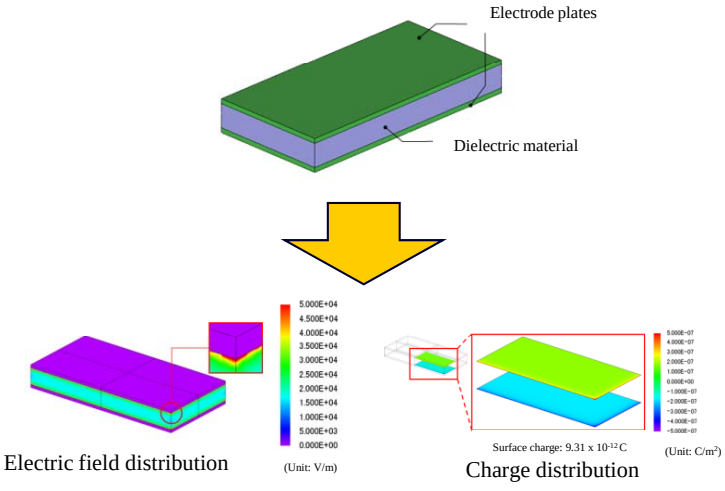
Electric field and current distribution analyses can now be performed in JMAG-Designer Ver. 10.4.
Those who have been using JMAG-Studio to perform electric field analyses can now take advantage of the rich pre/post processing features and usability of JMAG-Designer.

The capacitance of capacitors and the effects of motor stray capacitance and coil geometry on the current distribution can be analyzed and evaluated. The reliability and lifespan of motors that axial voltage occurs deteriorates if a PWM inverter power supply is used. Axial voltage is produced by the stray capacitance of motors. The reliability of motors is improved by understanding the stray capacitance via electric field analysis and investigating ways to prevent it.

Analyses accounting for the heat sources of capacitors and the temperature dependency of electric properties can also be performed by coupling magnetic and thermal analyses. Don't hesitate to take advantage of all these new analysis features.



Electric field analysis of wire in slots



Capacitance analysis of a capacitor

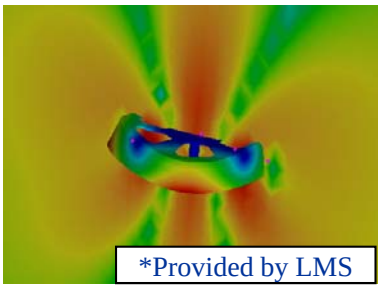
Linking Features

Realizing Multilateral Evaluation Through Links to Third-party Software

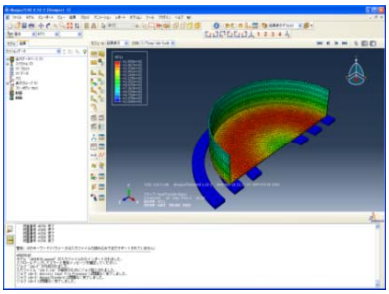
The development of electromechanical equipment today demands designs that are able to establish bilateral trade-offs yet satisfy the requirements from electromagnetic, thermal, and structural points of view. JMAG offers an optimal analysis environment to examine machine designs from multiple perspectives via a link to the structural/thermal analysis CAE software Abaqus.

Magnetic field phenomena obtained in JMAG can be utilized as input to the structural/thermal analyses in Abaqus. The results obtained in a structural analysis in Abaqus can also be utilized as input to the magnetic field analysis in JMAG.

A comprehensive vibration analysis can be achieved by applying the electromagnetic force obtained in JMAG to LMS Virtual.Lab.



Noise analysis using LMS Virtual.Lab



Induction heating analysis (IH) by linking JMAG-Abaqus

In Summary

This article has introduced the latest features in JMAG-Designer Ver. 10.4. Don't hesitate to try all of the new and easy to use features that are now available in JMAG-Designer Ver. 10.4.

JMAG Application Catalog

The Application Notes guide users inexperienced in analysis software or experienced users that want to explore new fields of simulations through a smooth simulation process.

In this issue of the JMAG News Letter, two of our newest examples are highlighted; " Superimposed Direct Current Characteristic Analysis of a Reactor Accounting for the Minor Hysteresis Loop" and "Influence Analysis of Dimensional Tolerance using Morphing "

JAC158 Superimposed Direct Current Characteristic Analysis of a Reactor Accounting for the Minor Hysteresis Loop

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 superimposed with alternating current components.

The initial magnetization curve is typically used for the magnetization properties of electromagnetic steel sheet in the magnetic field analysis, but the operating points are on the miner loops of the hysteresis curve when a high-frequency alternating current component is superimposed on the direct current component. (Fig. 1)

Differences in the superimposed direct current characteristics become apparent when the minor loops differ significantly from the initial magnetization curve. In this case, the inductance needs to be obtained by taking into account the minor loop.

This example presents the use of a magnetic field analysis to obtain the superimposed direct current characteristics of a high-frequency reactor accounting for the minor hysteresis loop by using the frozen permeability condition.

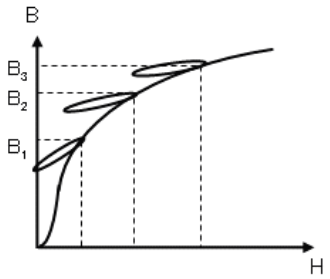


Fig. 1. Minor loop for each operating point

Superimposed direct current characteristics

The superimposed direct current characteristics are indicated in Fig. 2 and the magnetic flux density distribution of the core is indicated in Fig. 3.

The inductance decreases more rapidly as the direct current increases as indicated in Fig. 2. This is caused by magnetic saturation as indicated in Fig. 3.

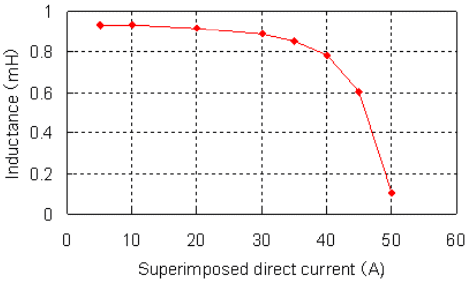
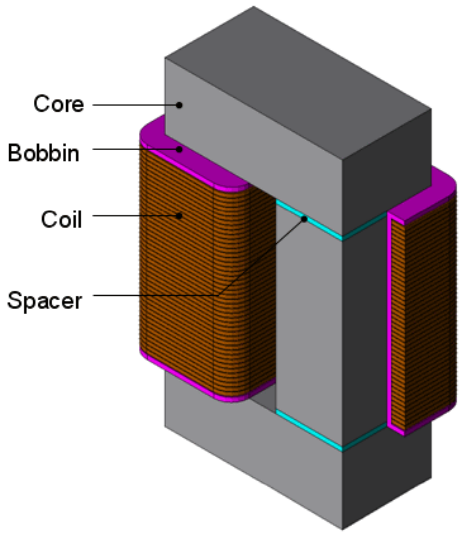


Fig. 2. Superimposed direct current characteristics



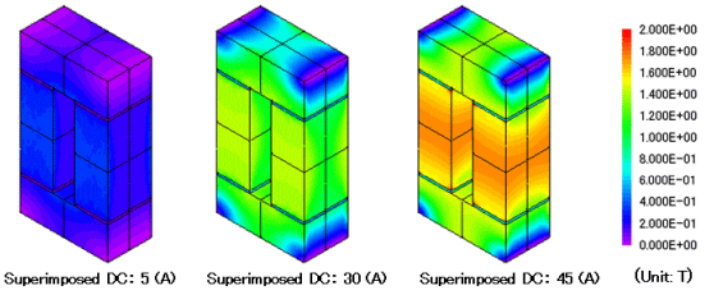
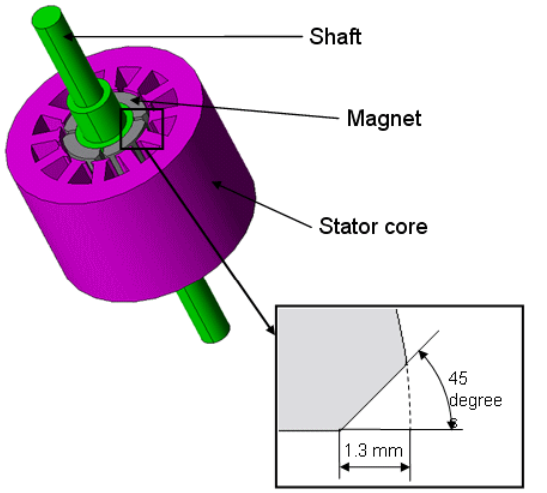


Fig. 3. Magnetic flux density distribution(excited by direct current)

JAC159 Influence Analysis of Dimensional Tolerance using Morphing

The angle of the magnets in SPM motors use a fillet or chamfer. However, the fillet and chamfer of each product that is manufactured varies because to completely fabricate the same fillet or chamfer is difficult in the manufacturing process. Therefore, the dimensional tolerance is set so the motor performance is not affected by these variations.

This example presents the use of a magnetic field analysis to compare whether the cogging torque of the SPM motor is influenced by changing geometry in the tolerance range assuming the dimensional tolerance of the chamfer is }0.4 mm.



Geometry of magnet chamfer

Cogging torque

The cogging torque waveform is indicated in Fig. 1 and the frequency components of the cogging torque are indicated in Fig. 2. The position of the peak value shifts as the dimensions of the chamfer change, but the peak value remains almost the same, as indicated in Fig. 1. The variations of the fundamental frequency of 360 Hz are smaller than the harmonic components, as indicated by the frequency components in Fig. 2.
Therefore, the variations of the geometry in the tolerance range of the chamfer only affect the cogging torque minimally.

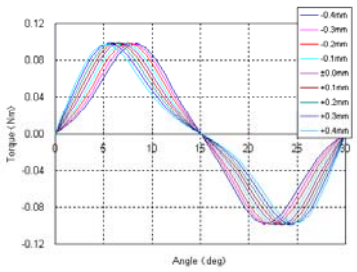


Fig. 1. Cogging torque

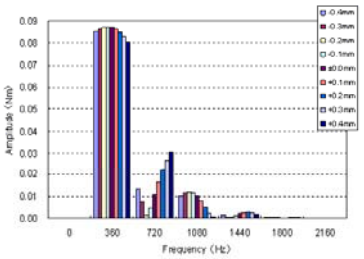


Fig. 2. Frequency components of cogging torque

Back EMF

The back EMF waveform is indicated in Fig. 3 and the frequency components of the back EMF are indicated in Fig. 4. The value of the back EMF is almost the same even when the dimensions of the chamfer are changed, as indicated in Fig. 3. The variations of the fundamental frequency of 60 Hz are smaller than the harmonic components, as indicated by the frequency components in Fig. 4.
Therefore, the influence of the chamfer tolerance is minimal.

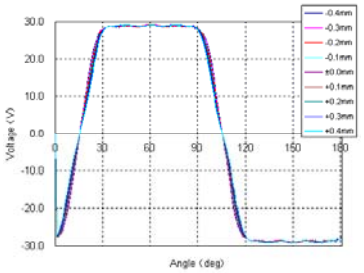


Fig. 3. Back EMF

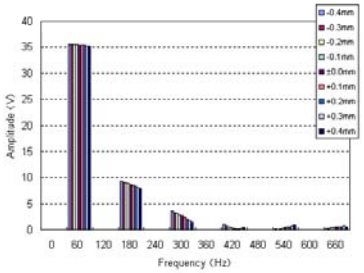


Fig. 4. Frequency component of back EMF

Over 120 analysis examples for JMAG
are available on our website at:
http://www.jmag-international.com/catalog/index.html

JMAG Users Conference 2010 Report

JMAG Users Conference 2010
Special Session
New Motors -Innovating Mature Machines-
Dates: December 9 and December 10, 2010 Venue: Tokyo Conference Center

The 17th Annual JMAG Users Conference 2010 was held at the Tokyo Conference Center on December 9 & 10, 2010. The conference ended in a great success with more than 420 participates.

We would like to share deepest thanks to everyone who attended as well as to the presenters and the exhibitors for their participation in the conference.

The JMAG Users Conference 2010 was made up of lectures presenting JMAG's role in their cutting-edge research, JMAG seminars introducing the latest JMAG solutions, poster sessions presenting by the JSOL engineers, exhibitions by a wide-range of companies, and a simulation park offering hands-on experience in simulation technology.

The conference focused on communicating technical information in a fun format that every participant from our most experienced users to those new to simulation technology could enjoy by providing high quality yet easily accessible content.

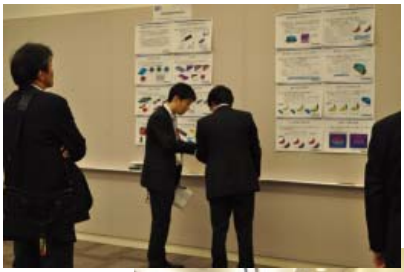
This issue of the JMAG News Letter takes a look back at the JMAG Users Conference 2010, including the thoughts of those that attended the presentations, poster sessions, and the simulation park.

● Presentations

Lectures at the forefront of research in various fields presented their findings and their analysis results as well as offering pointers for future development.

Zi-Qiang Zhu, professor at the University of Sheffield which leads the world in PM motor development, took the podium for the keynote presentation of our special session themed, “New Motors.” Those that attended Prof. Zhu‘s presentation noted that; “It was interesting to consider that new materials could be found from old motors,” “I learned a lot that will help me in my own research,” and "This really helped me understand the development of new motors."

Those that attended many of the other presentations that were held told us; "The insight into the development done at other manufacturers was great," "There are many things I can use in my work," and "It was nice to know that I am not alone in many of the struggles I face in my work."



● Poster Session

A poster session was hosted by the JMAG engineers.

These poster sessions provide a wonderful venue for technical exchange with our engineers that rarely get a chance to talk directly with our users. Many of those that attended the poster session told us that they learned of a feature they didn't know was available while finding new ways to approach their own development.

We have published the posters on the JMAG-International website for users in response to overwhelming demand for the opportunity to have more time to review the posters in more detail.

● Exhibitions

A record number of 24 companies, including the material manufacturers that provide technological information to JMAG, exhibited at this year's conference.

JMAG-Designer Ver. 10.4, released the day before the JMAG Users Conference, was also on display at the JSOL booth.

A lively and casual technological exchanged of information between the participants and exhibitors took place as they enjoyed their lunch while looking at the many different exhibits that were available.

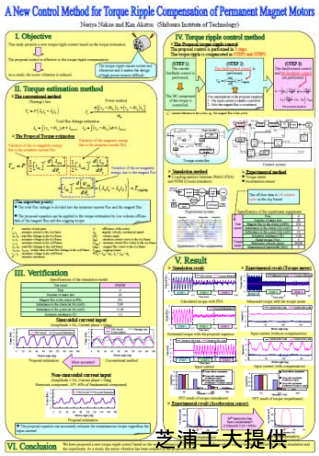
We would like to thank all of the exhibitors for their participation.

● Simulation Park

This year, those not acquainted with simulation technology, or those just starting, were offered a place to experience the technology in a hands-on manner.

Hokkaido University was kind enough to arrange a 3D display where flux lines could be visualized 3-dimensionally.

Furthermore, Professor Kan Akatsu from the Shibaura Institute of Technology described motor control using JMAG as an observer. There was also a wide-range of contents to experience magnetic field analysis from the principles of FEM to JMAG for the iPad.




Provided by Hokkaido University

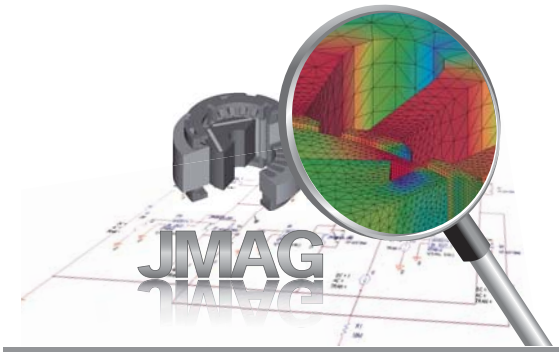

Introducing the principles of FEM

We hope everyone that attended the JMAG Users Conference 2010 enjoyed the presentations, various seminars, exhibitions, as well as the simulation park.

We also hope that the information we have provided here has offered a glimpse of the JMAG Users Conference to all those who were unable to attend. We look forward to seeing each of you at the conference next year.

JMAG Users Conference 2010 homepage:

http://www.jmag-international.com/event/conference2010/

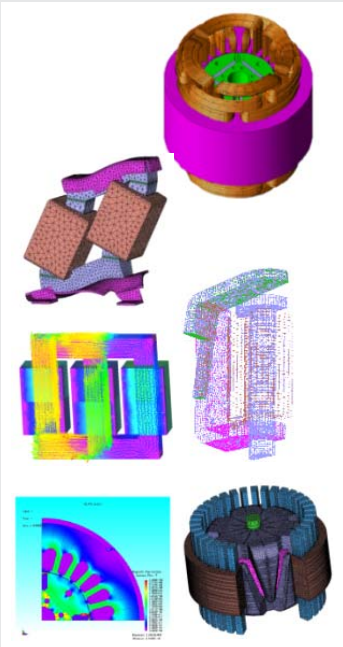


JMAG®
Simulation Technology for Electromechanical Design

JUNE 28th, 2011
FRANKFURT/MAIN, GERMANY

JMAG USERS CONFERENCE 2011

ORGANISED BY POWERSYS



POWERSYS is pleased to announce the second European JMAG Users Conference. It will be held in Frankfurt/Main, GERMANY on JUNE 28th, 2011.
This one-day Users Conference will focus on JMAG simulation software for electromechanical design and its fields of applications.

It will also give you the opportunity to share your experience with other users and discover the new features of JMAG-Designer version 10.4.

Topics discussed will include:
>> Structural analysis
>> Thermal analysis
>> Noise analysis
>> Coupled analysis

This is an opportunity to network with peers, industrial and academic actors involved in these fields of application. It also be the chance to learn about the latest technology advancements and performance improvements of JMAG.

The objectives of the Users Conference will be:
- Presentation of JMAG's latest developments
- End-user simulation studies presentations
- Exchanges around simulation topics
- Evolution of the software
- Future requirements with the developers

The event will include:
- Users presentations,
- Posters

Intended audience:
This Users Conference is intended for people who deal with motor design studies:
- Novice to advanced JMAG users
- Those who wish to discover the help JMAG could provide them

Who Should Attend:
- Design Engineers and Development Managers wishing to discover JMAG
- Engineering Managers, Electrical Motors Development Managers
- Electromechanical Engineers

This conference will be held in English. All written supports will be in English.

JMAG's Applications flieds:
- Electrical motors,
- Transformers,
- Magnetic elements,
- Sensors,
- Capacitors,
- Busbars, ...

Contributions:
You wish to share your applications ?

Take part in:
- Oral presentation,
- Poster presentation

>> please contact us!
jmagconference@powersys.fr

powersys solutions

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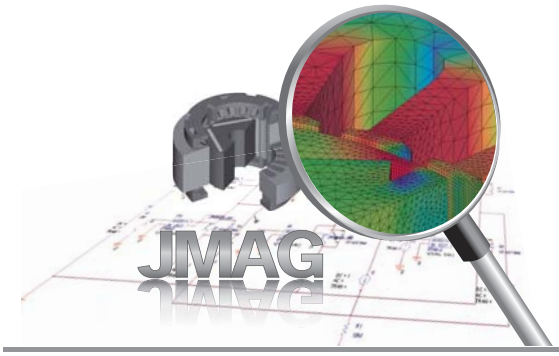

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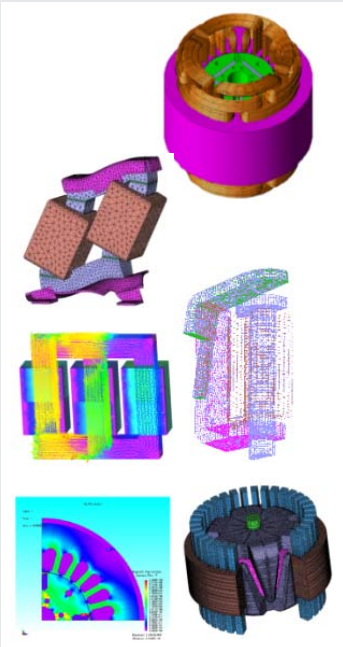


Participation:
- FREE (including lunch)
- The number of seats is limited

>> Please let us know as soon as possible if you are interested by this event.

Registration:

You can take part as:
>> A speaker : sharing an oral-presentation,
>> A poster presenter,
>> A listener

Please fill-in the form on the following link:
http://www.powersys-solutions.com/usersconference_registration.php

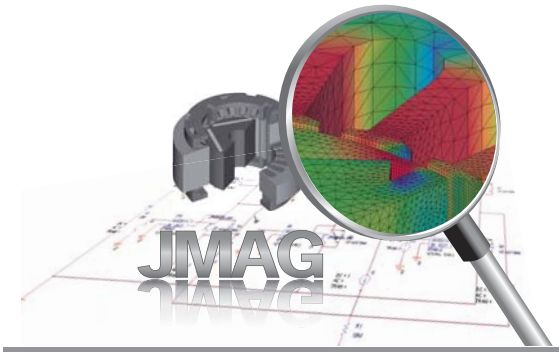
JMAG's Applications flieds:
- Electrical motors,
- Transformers,
- Magnetic elements,
- Sensors,
- Capacitors,
- Busbars, ...

DEADLINES:

DATES	PAPERS PRESENTATION	POSTERS PRESENTATION
15/02/11	ABSTRACT SUBMISSION	
28/02/11		ABSTRACT SUBMISSION
31/03/11	ABSTRACT ACCEPTANCE NOTIFICATION	
30/04/11	AUTHORS REGISTRATION	
13/05/11	FINAL SUBMISSION	
28/06/11	JMAG USERS CONFERENCE	

CONTACT FOR INFORMATION:

JMAG European Users Conference 2011
jmagconference@powersys.fr
Tel : +33 (0)4 42 61 02 29



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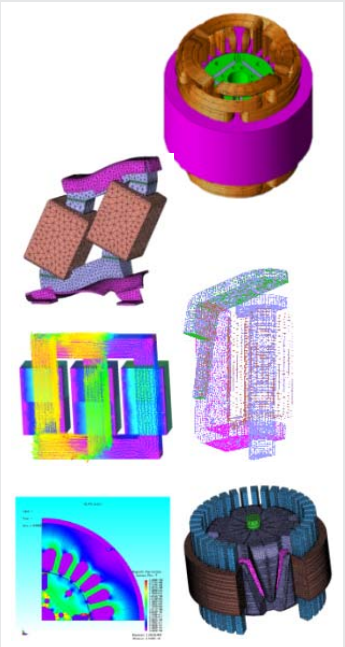

JMAG's Applications flieds:
- Electrical motors,
- Transformers,
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- Sensors,
- Capacitors,
- Busbars, ...

Place: The **JMAG Users Conference** will be held in:

STEIGENBERGER AIRPORT HOTEL

Unterschweinstiege 16
60549 FRANKFURT/MAIN
GERMANY

PHONE +49 69 6975-0

TOLL-FREE BOOKING HOTLINE: 00800 – 78468357
RESERVATION DEPARTMENT: 0049 69 6975 2426
http://www.steigenberger.com/en/Frankfurt_Airport

ROOMS RESERVATION:
For early booking, please click on the following link:
http://www.steigenberger.com/en/Frankfurt_Airport/booking/selection#content

Toll-free booking hotline: 00800 – 78468357
Please mention you wil attend the JMAG USERS CONFERENCE when making the reservation.

EASY CONNECTIONS : The hotel is only 900m away from FRANKFURT RHINE-MAIN AIRPORT

TRAIN
Take the **STEIGENBERGER AIRPORT HOTEL airport shuttle** from the Frankfurt-Airport train station to the hotel.
This **24-hours shuttle service** departs at Terminal 1 exit A1 and at Terminal 2 exit D/E at 15-minutes intervals from the hotel.

CAR
* Input GPS: Unterschweinstiege
* Parking available next to the hotel 2.50 Euros per hour - 18,50 Euros per day (*changes in prices are up to the car park operator).*
ARRIVAL: http://www.steigenberger.com/en/Frankfurt_Airport/arrivals

FLIGHT
Take the **STEIGENBERGER AIRPORT HOTEL airport shuttle.**
This **24-hours shuttle service** departs at Terminal 1 exit A1 and at Terminal 2 exit D/E at 15-minutes intervals from the hotel.

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