Electromagnetic Know-How

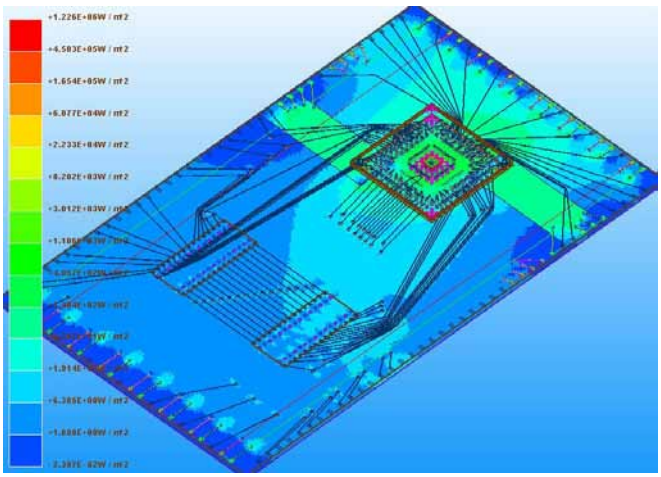
No Shortage of Software Options in PT/Motion Control Market

Matthew Jaster, Associate Editor

Finite Element Analysis (FEA) software can be used for a variety of mechanical engineering tasks, including injection molding simulation of plastic parts, analysis of aerospace components, impact and crash analysis of automobiles and the electromagnetic analysis of motors, actuators, transformers and sensors—aka the power transmission/motion control crowd. Because this market is flooded with software variations, it can be difficult to decide what features and capabilities best suit a given manufacturing operation. *PTE* has attempted to answer the "who, what, where, why and how" of electromagnetic software solutions in today's power transmission/motion control industry:

ANSYS Maxwell

ANSYS Maxwell is electromagnetic field simulation software for engineers tasked with designing and analyzing 3-D and 2-D electromagnetic and electromechanical devices such as motors, actuators, transformers, sensors and coils. *Maxwell* uses the accurate finite element method to solve static, frequency-domain and time-varying electromagnetic and electric fields. "Engineers throughout the world use *Maxwell* to simulate these devices and accurately predict force, torque, capacitance, resistance, flux density and other electromagnetic quantities that are critical to predicting a design's performance," says H. Mark Ravenstahl, director of product marketing, electronic business unit, at ANSYS. "*Maxwell* enables engineering teams to anticipate a device's performance before building a physical prototype, thus accelerating the design process and reducing development cost."



ANSYS solutions incorporate tools for an end-to-end electronics product solution, from chip to package and board design.

Maxwell is only one part of the *ANSYS* solution for motion control/power transmission. Although it is suitable for accurately solving electromagnetic fields critical to the performance of motors, actuators, transformers and sensors, there are also thermal and mechanical forces that must be taken into account. Moreover, these devices are integrated with power electronic circuits and control technology to create the synergistic, physical systems. "The *ANSYS* software portfolio includes *ANSYS Mechanical* for thermal and structural analysis and *ANSYS Fluent* to solve computational fluid dynamics (CFD). Each can be coupled to *Maxwell* to perform in-depth multi-physics studies of a device including electromagnetic-thermal-structural," Ravenstahl says.

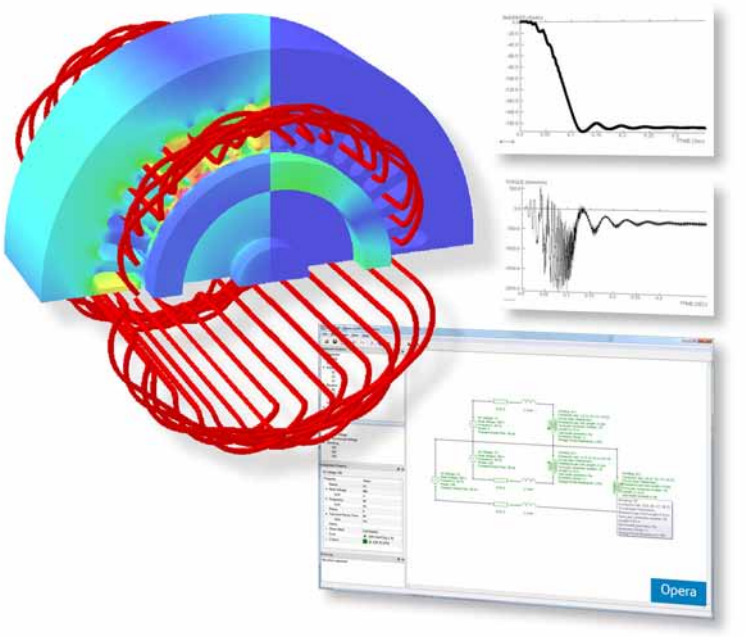
In addition, *ANSYS Simplorer* allows companies to solve motion control/power transmission system challenges with the requisite interoperability of components and circuits from the initial design stage. "This powerful multi-domain, multi-technology approach to design captures the underlying physics that governs a component's behavior, allowing engineers to accurately model, simulate and validate the component, circuit and system level performance required for a successful system design," he says.

Since the acquisition of Ansoft Corporation in 2008, *Maxwell* has been integrated to *ANSYS* technologies for structural and fluid dynamics simulations, which greatly expand the range of multiphysics simulations engineers can perform. "With these comprehensive multiphysics solutions, engineers can readily evaluate stresses, as well as assess the reliability of devices undergoing forces such as shock and vibration. They can also better understand phenomena such as heat flow and study various cooling strategies. All of this can be accomplished while also optimizing the design of electromechanical components. These various simulations can be tied together

within the *ANSYS Workbench* framework for a smooth exchange of data between field solvers and design tools and also with *ANSYS Engineering Knowledge Manager (EKM)* software for managing simulation data. This unified approach coupled with our breadth of engineering solutions and depth of multiphysics technologies gives development teams the tools they need to be successful in a competitive environment," Ravenstahl says.

Currently, mobile computing technologies are being evaluated at ANSYS by product management teams to determine if they have a role in electromagnetic and multiphysics designs. "Because simulation technologies have high computational demands, it would be quite a feat to have this technology running on a mobile phone or tablet in the near future," Ravenstahl says. "Cloud technology has promise of shared resources; however, due to concerns with Internet security, many customers are not interested in exposing sensitive engineering data to such solutions. Of greater concern to our customers is the ability to solve larger simulations in the least amount of time."

ANSYS has worked with its customers to develop high-performance computing (HPC) solutions to enable engineers to fully utilize existing clusters to achieve the fastest simulation solution time possible. The ANSYS HPC solutions ensure customers can optimize their designs by considering more alternatives and deliver them to market fast. "ANSYS will focus on continual development of its individual electromagnetic, fluid dynamics and mechanical products as well as the interoperability between the disciplines," Ravenstahl says. "Simultaneously, research and development efforts will focus at the systems level to provide customers with innovative multi-technology, multi-domain solutions that will deliver a competitive advantage and help them achieve their business goals." For more information, visit *www.ansys.com*.



Machines Environment **creates, analyzes and optimizes rotating machines (courtesy of Cobham).**

Machines Environment

The electrical *Machines Environment* is a graphical dialog-driven interface to Cobham's *Opera* FEA multi-physics software suite which provides an easy-to-use process for rapidly creating, analyzing and optimizing rotating machines. "It is a virtual design and test environment that is as accurate as conventional prototyping but which is extremely versatile, faster and more cost-effective than the conventional method," says Nigel Atkinson, business development manager at Cobham Technical Services. "It can be used to investigate many design variants that would otherwise be prohibitive in both time and expense. The environment captures the knowledge of our own electrical machine experts. It uses a series of templates, which allow the user to build and analyze designs of a wide range of industry-standard machine types that can be tested under real-life conditions, including fault conditions."

Atkinson continues, "The interface is written in the *Opera* scripting language and can easily be modified by the user to include any special or proprietary features. The process for making modifications is well documented. It enables users to customize or configure the environment to suit their needs, such as adding tests or producing documentation required by local processes. The *Machines Environment* is one of several application-specific environments for *Opera*. Another is the *Transformer* and *Reactor Environment*."

Cobham recently integrated the *Opera Optimizer* tool into the two-dimensional version of the *Machines Environment* software, allowing designers to specify multiple goals and constraints and to automatically hone in on global-optimal designs. The three-dimensional version has been upgraded with additional solution schemes such as dynamic machine analysis.

"*Opera* is a multi-physics FEA suite and circuit solver. It is bi-directionally integrated with both the Windows interface and Linux shared library API which means it can be linked to most third party software with similar interfacing capability," Atkinson says. "For example, we have customers using *Opera* with third party PLM and CFD packages. Specifically, there is a bi-directional link to the *Mathcad Simulink* product and to CD-Adapco's *Speed* program."

Mobile technology is currently not a priority with the *Machines Environment* software, but that could change, according to Atkinson. "There is little or no technological barrier to this relatively new technology, but only limited interest at present, though this may change in the future. FEA is relatively computationally intensive, so any implementation with mobile technology will need to take this into account. Most users currently run the software on a standard laptop or desktop, but some use larger multi-processor computers. The software can be installed for network or stand-alone use."

Immediate plans for *Opera* are to extend its multi-physics capability by extending the stress solver to include modes of

vibration. *Machines Environment* will be extended to allow co-simulation of the electromagnetic, thermal and stress/vibration solvers. This will allow engineers to analyze both the electrical and mechanical characteristics of the machine. "We have recently begun a three-year research program with Jaguar Land-Rover and Ricardo (U.K.) to address the need for improved electric drives for the automotive industry," Atkinson says. "This work is supported by the U.K. government's Technology Strategy Board and will lead to further enhancements and extensions to the *Machines Environment*."

For more information, visit *www.cobham.com*.

Speed 2012

Speed software allows users to design electric machines such as induction motors (polyphase/1-phase); brushless permanent-magnet motors (square wave/sine wave); DC brush motors; switched reluctance motors; and synchronous reluctance motors. Many of the new features in *Speed* are intended for generators as well. With over 1,500 customers using *Speed* for more than 20 years, they are among the leading manufacturers, designers, developers and users of electric machines.

Dr. Tim Miller, originator of *Speed* and now a consultant to CD-Adapco, commented, "While this is a great development for *Speed* and all our customers, we're wasting no time in making a complete new release of all the *Speed* software and its documentation. One compelling reason why we've joined forces with CD-Adapco is to make *Speed* even better." Miller continued, "An early sign of *Speed's* progress is the intense collaboration to share geometry and other design parameters with *Star-CCM+* (the CFD program of CD-Adapco). Another is the development of a 3-D electromagnetic solver in *Star-CCM+*. And a third is the intense training activity that *Speed* is running—two or three times the previous level."

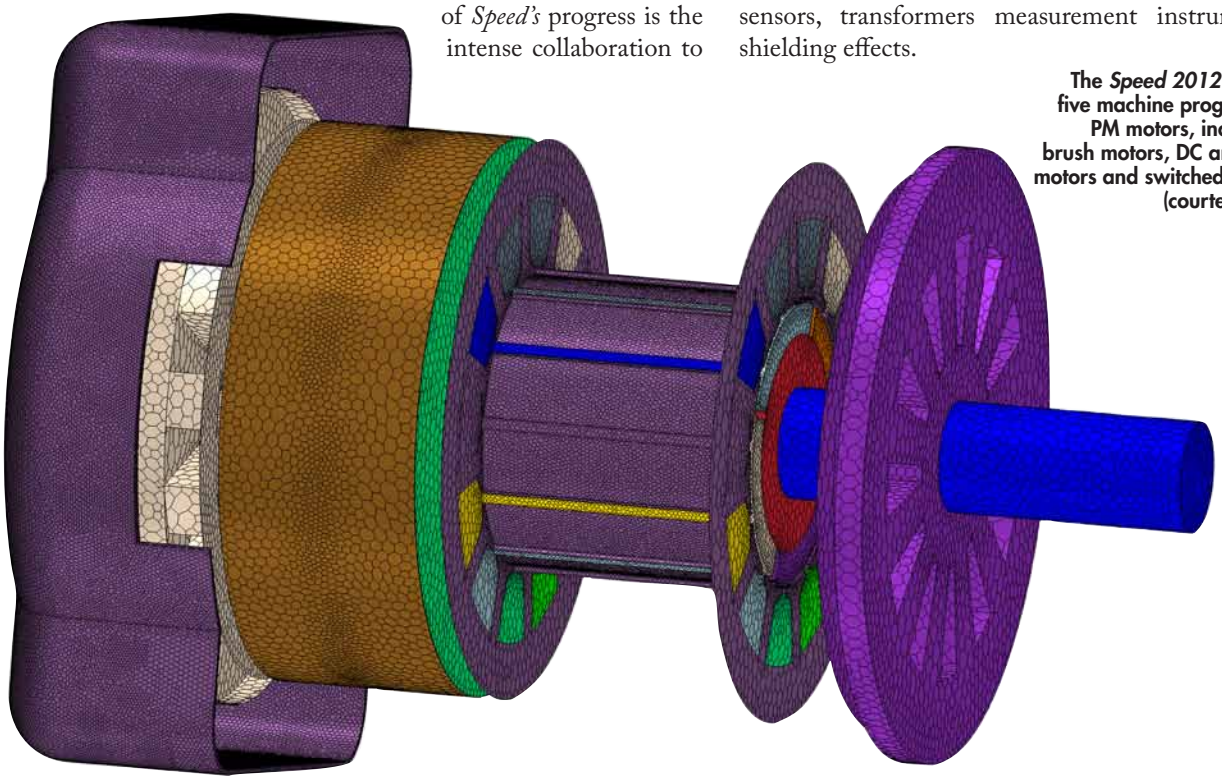
Speed offers several features for automotive, refrigeration, aerospace and industrial applications. "It's a specialized analysis tool for the design of electric machines such as motors, generators and alternators including the drive with inverters and their control," says Markus Anders, electrical machine sector manager, at CD-Adapco.

The *Speed 2012* release consists of five machine programs for brushless PM motors, induction motors, DC brush motors, DC and AC wound field motors and switched reluctance motors. These programs are available with a floating license system using *FlexNet Publisher* and a link that was established to *Star-CCM+* to exchange the data needed from *Speed* to *Star-CCM+* to set up the CFD 3-D model and run an advanced thermal calculation of the entire electrical machine.

"Today more and more individual software is merging like *Speed* and *Star-CCM+* to have a software chain from achievable designs to highly sophisticated simulation to get deep inside in the magnetic or thermal behavior of the electrical machine," Anders says. For more information, visit *www.cd-adapco.com*.

Additional Options

Software packages from CST and Electro Magnetic Works offer similar software expertise. *CST EM Studio* (*www.cst.com*) is dedicated to the simulation of static and low-frequency devices. Embedded in the same user friendly *CST Design Environment*, *CST EMS* features a variety of solver modules to tackle electrostatics, magnetostatics, current flow, low frequency and even stationary temperature problems. Applications include: actuators, brakes, EMC, generators, motors, sensors, transformers measurement instrumentation, and shielding effects.



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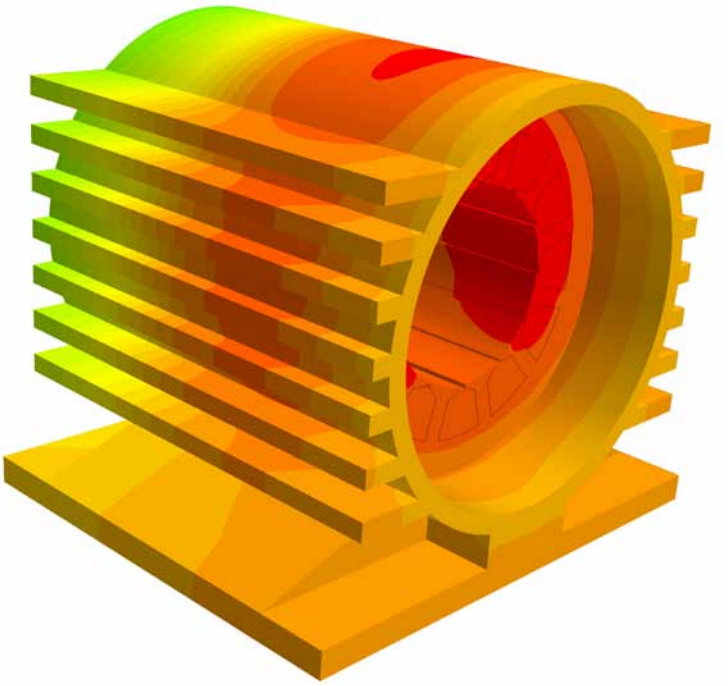
EMS (*www.emworks.com*) is a 3-D electromagnetic field simulator software suite, based on the powerful finite element method. Currently, it is the only electromagnetic add-in to *SolidWorks*. *EMS* is Gold Certified by SolidWorks and targets four main areas: electromechanical, electromagnetic, power electronics, and electromagnetic behavior. Each of its five modules—*Electrostatic*, *Conduction*, *Magnetostatic*, *AC-Magnetic* and *Transient*—has a built-in, fully integrated thermal solver. *EMS* empowers the designer to compute electric, magnetic, mechanical, and thermal parameters including force, torque, magnetic flux density, magnetic field, electric field, electric flux, current flow, eddy current, inductance, capacitance, resistance, flux linkage, core loss, saturation, induced voltage, force density, power loss, temperature, temperature gradient, heat flux and more.

The many software design options available in this field make it necessary to examine brochures, training videos, publications, testimonials and case studies to get a better idea of what's currently available on the market. To be sure, this is another area of software development that is constantly evolving. "There is increasing interest in, and use of, FEA for electrical machine design. This has been driven by the increasing performance of computers and similarly the increasing capability of FEA. The current situation is that electrical machines can be fully and accurately characterized using FEA for most situations. This includes testing the machine with its power supply and mechanical load," Atkinson says. "Coupled simulations allow the electrical, mechanical and thermal behavior to be investigated. With this level of realism and validated accuracy, FEA is becoming accepted as an integral part of the design process. It is more cost effective and quicker to evaluate a virtual machine than it is to build and test a prototype."



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