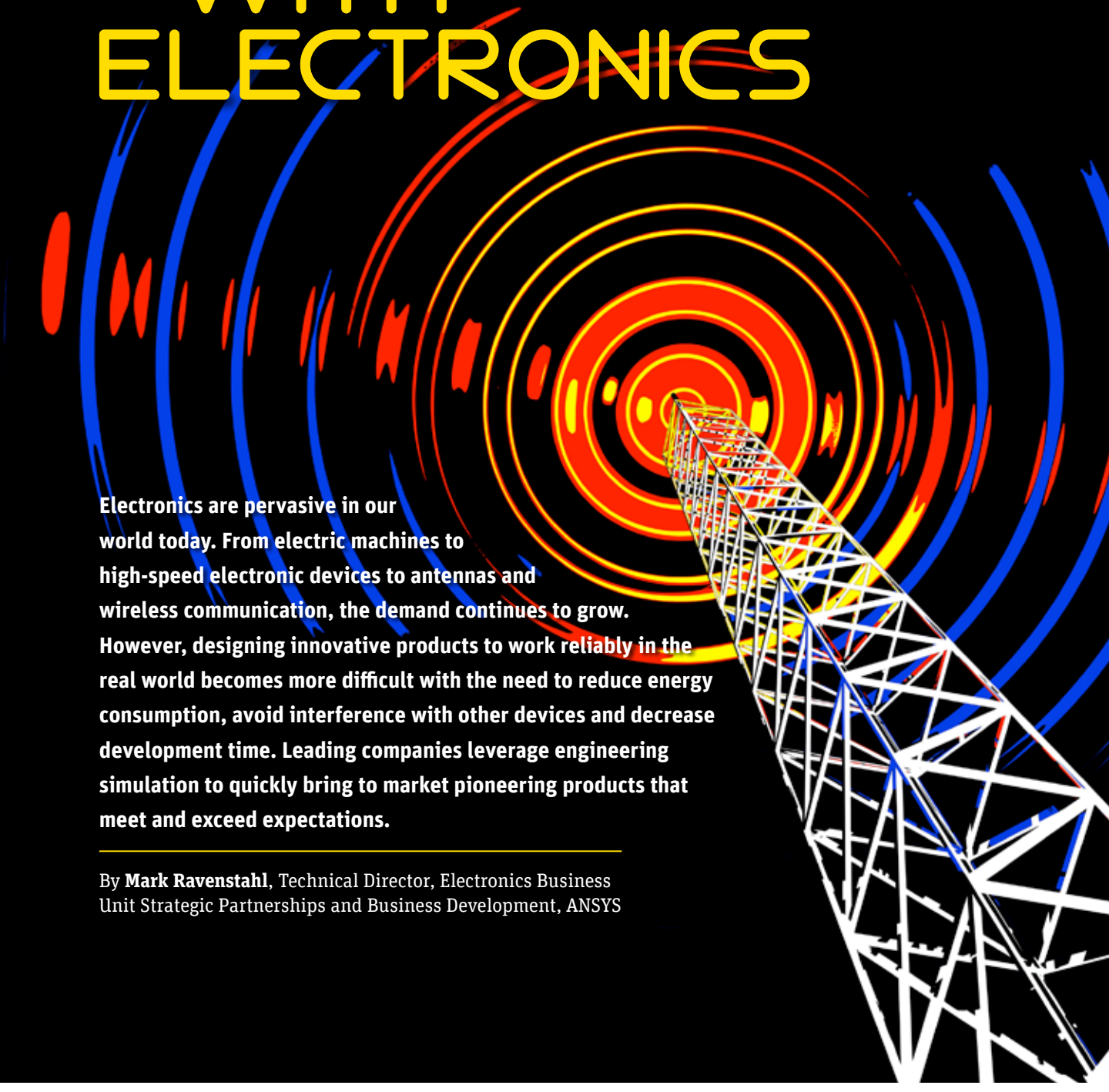
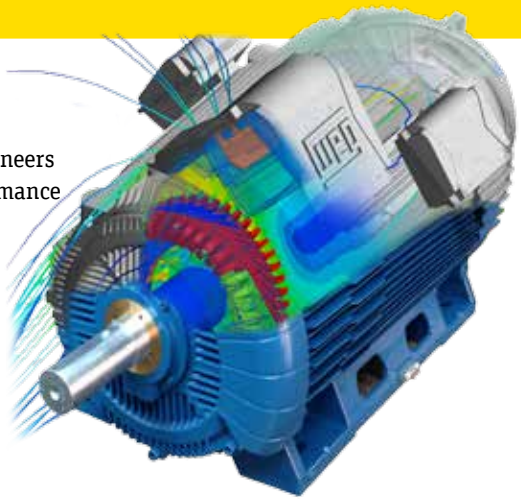
DRIVING INNOVATION WITH ELECTRONICS



Electronics are pervasive in our world today. From electric machines to high-speed electronic devices to antennas and wireless communication, the demand continues to grow. However, designing innovative products to work reliably in the real world becomes more difficult with the need to reduce energy consumption, avoid interference with other devices and decrease development time. Leading companies leverage engineering simulation to quickly bring to market pioneering products that meet and exceed expectations.

By **Mark Ravenstahl**, Technical Director, Electronics Business Unit Strategic Partnerships and Business Development, ANSYS

HIGH-PERFORMANCE ELECTRONICS drive some of the most remarkable innovations in every industry. Trailblazing inventions such as advanced driver assistance systems (ADAS), the Internet of Things (IoT), 5G communications, hybrid propulsion and others require advanced electromagnetic field simulation so that leading organizations can design, optimize and deliver products quickly to market. Engineers need to evaluate the effects of system density as radio frequency (RF) and wireless communications components are integrated into compact packages to meet smaller footprint requirements while improving power efficiency. Electrification of cars, planes and ships requires pushing industrial components such as electric machines and electronics beyond their traditional limits by leveraging new ways of thinking and design.



An electric machine from WEG demonstrates how virtual design leads to real innovation. Using ANSYS simulation, WEG delivered best-in-class energy efficiency, exceptionally low noise and bearing life over 100,000 hours.

With accurate simulation, engineers can predict the detailed performance of their designs and deliver innovative products. ANSYS supports the delivery of cutting-edge products with powerful innovations, including an integrated platform, best-in-class single physics and comprehensive multiphysics to push the envelope of computer simulation to new heights. Our most recent electromagnetic software innovations for electric machines, high-speed electronics and RF/wireless communications continue to help engineers reach functionality and reliability goals on schedule.

Electric Machine Design

Electric motors account for two-thirds of the world's industrial electricity consumption, which is equivalent to 28 percent of the world's total electricity consumption, according to a study by ABB [1]. That is a massive amount of energy considering that the world devours electrical energy at close to 24,000 terawatt-hours per year [2]. Improving motor efficiency by 1 percent would save the equivalent of 81 million tanker trucks of gasoline each carrying 9,000 gallons of fuel. That's enough eighteen-wheelers to go halfway around the Earth if placed bumper to bumper. Clearly this energy savings is worth exploring. ANSYS simulation software helps electric machine designers optimize their designs and improve energy efficiency.

ANSYS Innovation:
Comprehensive Multiphysics Workflow

To improve motor efficiency, ANSYS Maxwell software carries out rigorous performance calculations for the machine, including the motion-induced effects caused by linear translational and rotational motion, advanced hysteresis analysis, demagnetization of permanent magnets and other critical electromagnetic machine parameters. Maxwell shares the same CAD source with and can be coupled to ANSYS Mechanical, ANSYS Fluent or ANSYS Icepak through the ANSYS Workbench platform to perform stress, thermal, CFD and acoustic analyses. These multiphysics capabilities are required for a detailed analysis of the full spectrum of factors that influence electric machine efficiency. For example, losses calculated by Maxwell can be used

Robust Electric Machine Design Through Multiphysics
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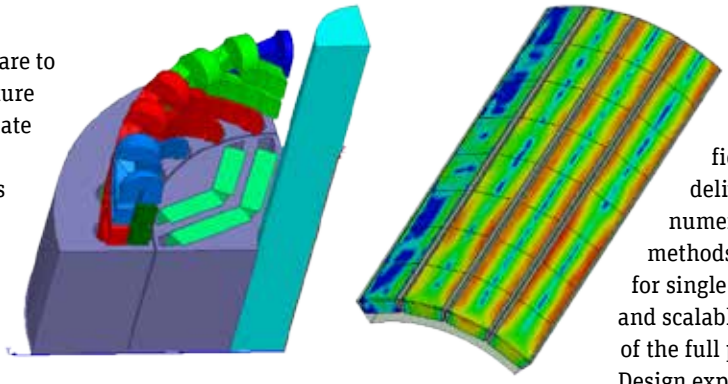
as inputs to CFD software to calculate the temperature distribution and evaluate cooling strategies. Electromagnetic forces and torque calculated in Maxwell can be input to ANSYS Mechanical to analyze deformations and further assess potential vibrations. This depth of multiphysics analysis is unique to the ANSYS platform and can lead to machine designs that significantly decrease power consumption.



End effects Subdivided magnets

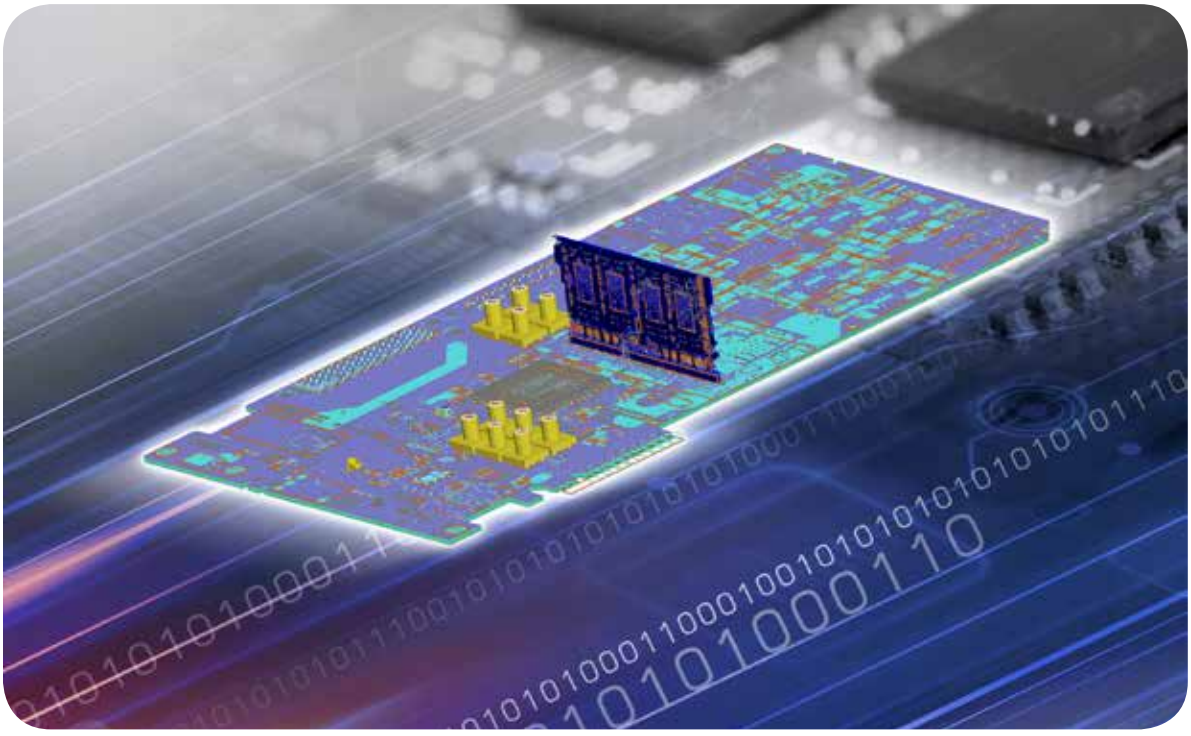
Electric machine 3-D effects have significant impact on end-product performance.

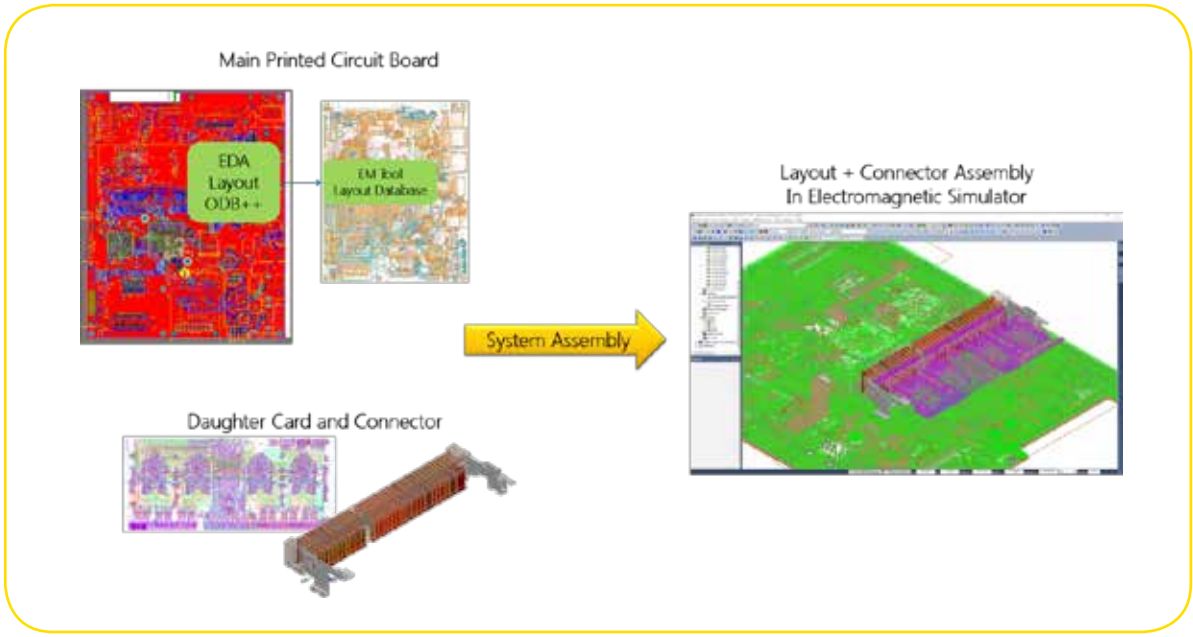
to simulate more and larger models both faster and with higher fidelity. ANSYS software delivers groundbreaking numerical solvers and HPC methods that are optimized for single multicore machines and scalable to take advantage of the full power of a cluster. Design exploration using parametric analysis is highly accelerated when scaled across a cluster. Motor dimensions, drive currents, speed, torque load and any other simulation parameter can be evaluated at numerous design points and solved simultaneously on multiple cores. The new time decomposition

"Electrification of cars, planes and ships requires pushing industrial components such as electric machines and electronics beyond their traditional limits by leveraging new ways of thinking and design."

ANSYS Innovation: High-Performance Computing

One of the most significant advancements in the field of engineering simulation is high-performance computing (HPC). Organizations are now leveraging tens, hundreds or even thousands of computer nodes method (TDM) within ANSYS Maxwell takes advantage of modern compute clusters. TDM delivers the computational capacity and speed needed to perform the full transient electromagnetic field simulations required for electric motors, planar magnetics and





Three-dimensional layout with integrated system assembly for a laptop computer that combines a main printed circuit board layout coupled with an edge connector and a daughter card

power transformers. This enables engineers to solve all time steps simultaneously instead of sequentially, while distributing the time steps across multiple cores, networked computers and compute clusters. TDM makes full 3-D simulation possible during the design phase so that details such as winding end effect or subdivided magnets commonly used in electric machines can be explored and considered in a matter of hours. The result is a phenomenal increase in simulation capacity and speed that allows engineering design teams to explore many more options early in the development process to reduce power consumption and meet other specifications.

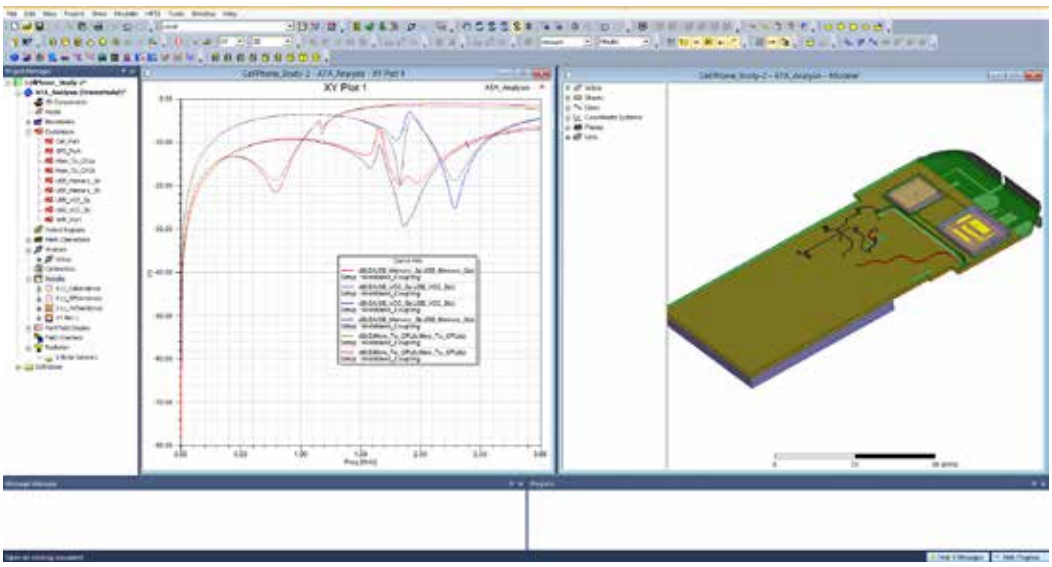
High-Speed Electronics

Automated electronics design has evolved since the days when IC design was controlled by the capabilities of the lithographic manufacturing process. Once layout and design could be considered together, electronic signaling speeds increased and signal integrity challenged electrical engineers with short signal rise time, transmission line effects and crosstalk. This required electromagnetic modeling. With today's tight packaging densities, fast signaling and high frequencies, tools for layout and electromagnetics must be employed jointly to obtain optimal performance and reliability. Circuit and system analysis is now part of the broader EM assembly solution rather than the driver of it. Transient circuit analysis can be run directly from the layout so electrical engineers can virtually assemble a digital electronic system with IC packages, printed circuit boards, connectors and cables, and then perform analysis of that system to leverage appropriate technology.

ANSYS Innovation: Assembly Modeling, 3-D Components and Automation

Electrical engineers have long used schematic-based design to connect models for printed circuit boards, IC packages and components. This works well for relatively simple designs, but becomes tedious and error-prone for larger, more complex designs. If the engineer misses just one point-to-point connection for a single node, the simulation results will be incorrect. Layout-driven assembly is a superior method because it eliminates the need to create a schematic by assembling actual 3-D models of individual components. The layout-based environment is designed to prepare a model for advanced 3-D electromagnetic simulation by instantly making all electrical connections the moment the component is placed on the board. This streamlines the geometry setup so that the engineer can launch a full electrical circuit simulation from the layout.

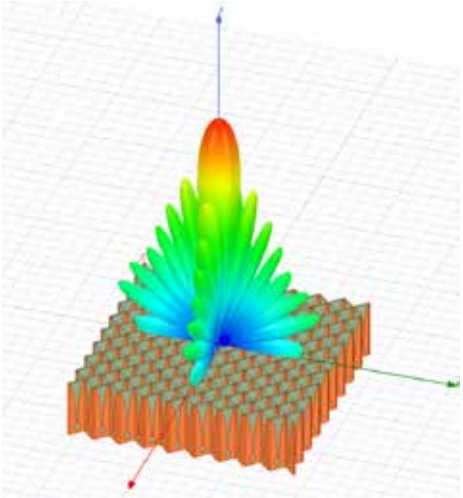
ANSYS HFSS: Layout-Driven Assembly in ANSYS Electronics Desktop
ansys.com/electronics-desktop



Simulation of a smartphone in ANSYS HFSS. Coupling among antennas and components across the frequency spectrum is shown on the left and the 3-D geometry is shown on the right. HFSS predicts the installed antenna performance, and coupling among antennas and signals on the PCB, across a broad range of frequencies.

RF and Wireless

Antennas are critical for excellent wireless device performance and essential to delivering innovations like the IoT, autonomous driving and more. In our modern wireless world, devices have multiple antennas for various radio services and multiple input, multiple output (MIMO) processing, and must operate in the vicinity of other electronic devices in large, complex electromagnetic environments such as an office, home or automobile. The latest ANSYS product innovations assist industry leaders in designing reliable antennas, no matter what the size or end application.



ANSYS Innovation: Antenna Synthesis and Installed Antenna Performance

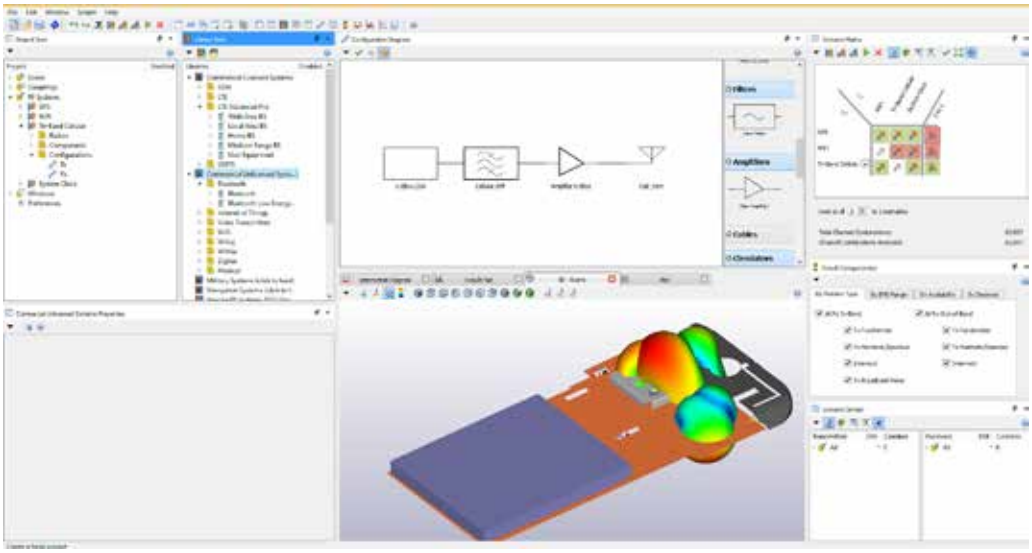
ANSYS HFSS high-frequency electromagnetic software streamlines synthesis, setup and analysis of antenna designs. It allows every engineer, including those without antenna expertise, to create and optimize antenna designs and integration. ANSYS HFSS SBR+, a powerful, shooting and bouncing ray (SBR) electromagnetic field solver option for HFSS, delivers installed performance analysis for antennas mounted to electrically large platforms. Antenna designs created individually in HFSS can be digitally placed on an electrically large platform and rapidly solved as an array using HFSS SBR+. This powerful combination enables analysis of installed performance and antenna placement optimization.

ANSYS Innovation: RF Co-Site Prediction

As the number of wireless devices increases and the spectrum in which they operate remains the same, these communication systems are more likely to interfere with each other and degrade the performance of neighboring systems. The ANSYS RF Option now includes ANSYS EMIT, the industry-leading software for predicting RF co-site and EMI interference of multiple radio transmitters and receivers.

Platform and antenna coupling information from HFSS is automatically transferred to EMIT through a powerful link. Using libraries

Maxwell Time Decomposition Methods Accelerate Simulation of Transient Electromagnetic Fields
ansys.com/time-decomposition



ANSYS EMIT is a unique RF interference tool that can evaluate system performance in complex RF environments. The EMIT desktop shown here includes the HFSS model, radio circuits and a unique scenario matrix in the upper right corner. The red squares in the scenario matrix indicate several RFI issues that must be addressed, while green squares show no problems present.

and behavioral models of radio circuit elements in EMIT, designers can quickly configure RF systems to model their performance under real-world operating conditions. This includes interference from other radios and unintentional emissions from the phone's circuitry. The software provides the tools to diagnose complex issues like intermodulation products.

While simulation was once the sole domain of experts and used mainly for verification, advanced automation features allow more simulation by the product development team up front in the development process to quickly evaluate design changes.

> *"The ANSYS RF Option now includes ANSYS EMIT, the industry-leading software for predicting RF co-site and EMI interference of multiple radio transmitters and receivers."*

The precise path of all interference is revealed in the interaction diagram to help identify causes of problems. Once identified, mitigation measures can be simulated to gauge their effectiveness, ultimately enabling an interference-free design as indicated by the scenario matrix.

Future

Future electronic product innovations will be far-reaching and apply to a broad array of industries. Delivering these innovations requires a platform on which engineers can simulate and design entire electrical and electronic products while including all the necessary physics and system effects. This could include the minute details of a complex integrated circuit or even a full product, like an automobile.

ANSYS electromagnetics products simulate not only the electromagnetic behavior of a motor, a circuit board or an antenna, but digitally place it in its operating environment so that you can determine real-world performance, even with interference with other arrays. ANSYS delivers products that drive innovation.

References

[1] ABB, High-efficiency motors: "Haze Killers," August 2017. abb.com

[2] Enerdata, Global Energy Statistical Yearbook 2017, August 2017. yearbook.enerdata.net