



ANALYSIS SOFTWARE GOES BEYOND ELEMENTAL

Don't guess at product optimization and manufacturability. There's plenty of analysis software to help ensure it.

By Lawrence S. Gould / Contributing Editor / lsg@LSGould.com

Pick an industry. Pick an application. Pick a material, even those that used to be considered exotic. There are dozens of computer-aided and finite element analysis software (CAE and FEA) packages for each of those domains to help product designers, engineers, and managers figure out whether their products meet design specifications, customer needs, and real-world usage. Better, these software programs are suitable both for hard-core and casual users of analysis software.

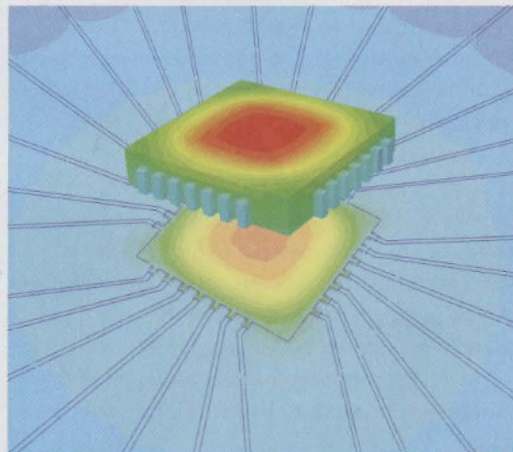
It's a mechatronic world

Many products today combine mechanical devices with sophisticated electronics. Analyzing these multi-domain electromechanical systems is facilitated by software that can handle such mechatronic systems. For example, Simplorer from Ansys, Inc. (ansys.com). Version 8.0, the latest, has a new user interface to help engineers

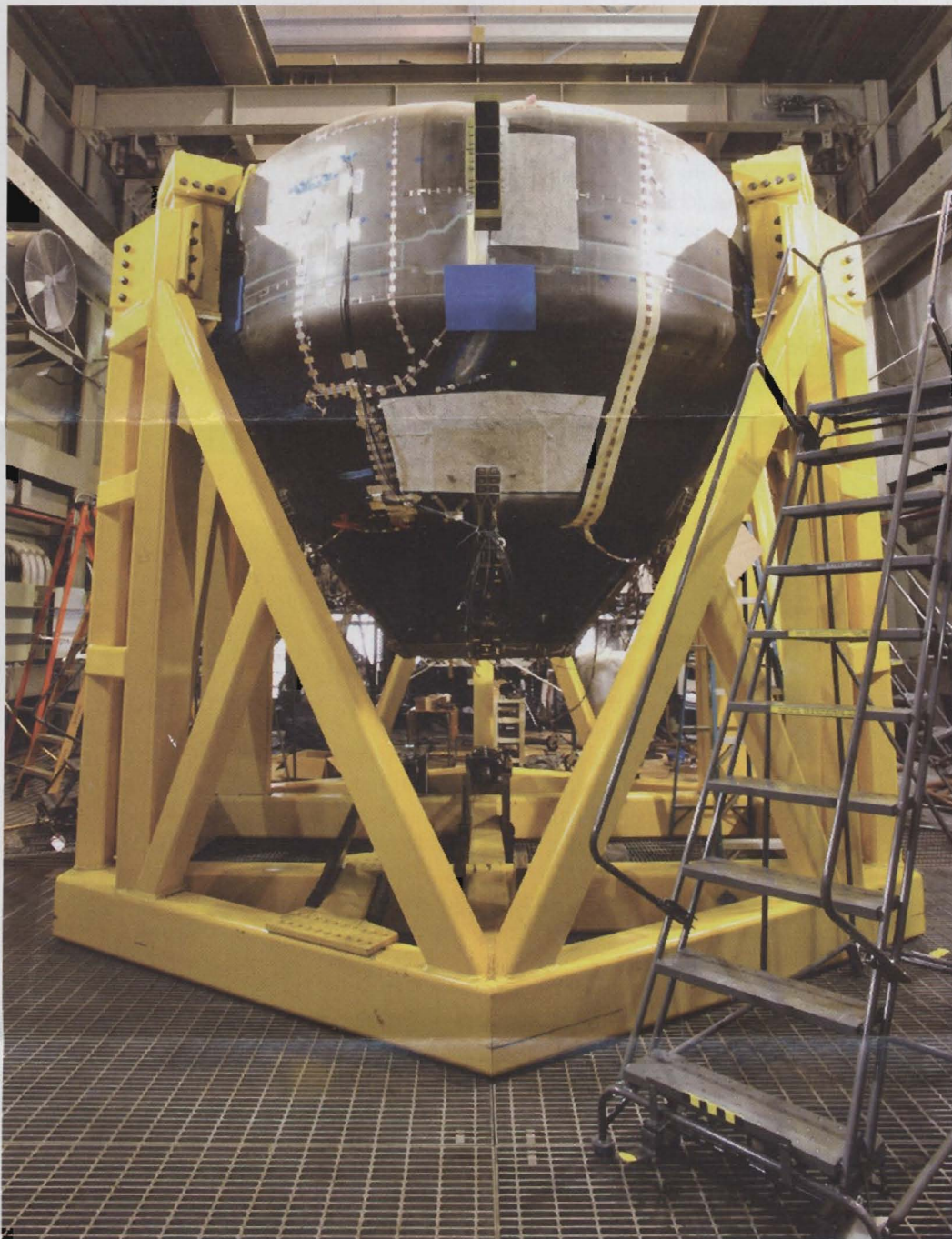
simultaneously use multiple modeling techniques involving circuits, block diagrams, state machines, equations, and modeling techniques in managing modeling data and executing simulations. New tools let engineers create average and dynamic models of power semiconductor devices and in building DC-to-DC converter models.

Focusing on the electronics, ICEpak, also from Ansys, applies fluid dynamics to electronics thermal management. The latest release, 12.0, simulates the thermal energy dissipation in electronic devices at the component, printed circuit board (PCB), and system levels. A new PCB trace Joule heating modeling capability improves the accuracy of thermal simulations of PCBs. Two new meshing technologies—automatic multilevel and Cartesian hex-dominant meshing—improve the smoothness, quality, curvature and proximity capturing, and speed in meshing complex geometries. The software can automatically generate highly accurate, conformal meshes to represent the true shape of electronic components and heat transfer (conduction, convection, and radiation) for both steady-state and transient thermal flow simulations. All of this helps improve design performance, reduce the need for physical prototypes, and speeds time-to-market.

With Simplorer, engineers can extract thermal models from the transient parametric sweeps calculated with Icepak. This new capability lets Simplorer calculate the transient temperature anywhere in an electronic system; this system-level modeling approach helps engineers quickly evaluate the thermal transient response of the electronic components.



This display from Ansys Icepak shows the temperature contours on a micro lead frame plastic quad package in a natural convection chamber. Traces are modeled for increasing the accuracy of electronics thermal management. [PHOTO COURTESY OF ANSYS INC.]



Dimensioning is clear in SolidWorks. The software can automatically place dimensions, rearranging existing dimensions as necessary.

[PHOTO COURTESY OF DASSAULT SYSTÈMES SOLIDWORKS CORP.]

Other Ansys products have been updated in the past year. The latest version of Ansys AQWA has a new hydrodynamic diffraction analysis system. With its own meshing capabilities, this software program lets engineers manage the entire analysis of multibody wave diffraction and radiation, from model setup to post processing. The latest release of Ansys Emag, a software package for electronic design analysis, includes a

new family of 3D solid elements for low-frequency electromagnetic simulation, specifically for modeling magnetostatic, quasistatic time harmonic, and quasistatic time-transient magnetic fields.

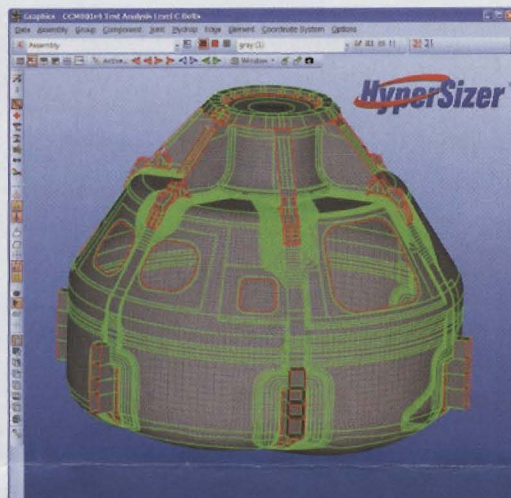
Composite materials for the down-to-earth HyperSizer from Collier Research Corp. (hypersizer.com) is an analysis and design software

product for composite materials, with a particular focus on aerospace applications (HyperSizer's roots stretch from NASA Langley Research Center). But composite technology—design and manufacture—has matured to the point where increasing numbers of industries are using composites in their product designs. Three that come to mind are boating, light rail, and wind power, all of which can benefit from this technology.

HyperSizer begins where FEA ends. It verifies structural integrity, predicts potential failures for all loads, determines optimal weight combinations, and, in an interesting twist of terminology, identifies “negative margins-of-safety.” It does this by running through millions of candidate dimensions and laminates in just minutes. HyperSizer takes imported finite element models (FEM) from computer-aided design (CAD), FEM, and FEA programs, along with the corresponding FEA-computed loads. A designer then selects composite materials from the HyperSizer's database, or creates custom layups, using an interactive, graphical module for managing metals, foams, honeycomb cores, ply tape, and fabrics. From that, HyperSizer performs the failure analyses. It considers flat and cylindrical buckling, local buckling, post buckling, and crippling for panel and beams, at the fiber, matrix, ply, and laminate levels. HyperSizer can size such structural elements as flange width, facesheet thickness, and stiffener spacing. It can also optimize panel/beam concept, cross-sectional dimensions, and the combinations of materials, panels, and ply layups.

All of this leads to stronger, lighter, and manufacturable products, as well as less time spent bouncing between FEM and conventional strength and integrity analysis. As required, HyperSizer will display ply counts, percentages, and drop-offs; generate discrete laminates (including layup rules, tolerances, ply angle percents and thickness) for every component in an assembly; and determine assembly edge forces and cross-section properties, among other aspects of composite design. The software will also generate a variety of documentation, including Microsoft Word-based stress reports, margins-of-safety stress reports for certification, and PDF-based methods documentation.

The latest version of HyperSizer includes a new series of laminate composite failure methods to account for damage tolerance effects



Here's NASA's Ares V space launch vehicle in a text fixture. The vehicle has a composite shroud. During flight, the shroud separates into four petals to release a lunar lander. Colors in the computer display show where HyperSizer has optimally “sized” the panels' cross-sectional dimensions and layups to the computed loads from an FEA program. This analysis helped reduce structural weight, establish margins of safety, and create certification documentation of airworthiness. (PHOTO COURTESY OF COLLIER RESEARCH CORPORATION)

such as compression after impact, tension after impact, and barely visible damage. A new method for managing composite material correction factors accounts for temperature, thickness, open hole diameter, percent 45 plies, and angle minus load number. This information can be plotted as functions of any independent variable (temperature, thickness, etc.). A new “Detail Analysis” form offers the Bolted Joint Stress Field Method (BJSFM), giving designers full control over BJSFM inputs and the ability to see the applicable factors and output data. One of the major enhancements to this program is in the failure tab. Designers can now choose to display margins of safety either at the controlling load case or display the minimum margin for each failure mode for all load cases.

Another program for analyzing composites is NEi Fusion 2.0 from NEi Software (NEiSoftware.com). NEi Fusion is a combination Nastran FEA solver and 3D modeler powered by the SolidWorks solids modelers from Dassault Systèmes SolidWorks Corp. (solidworks.com). The 2.0 version can analyze hyperelastic and orthotropic composite materials. It also has several new types of modal and heat transfer analyses, element types, and load capabilities. This analyst

software is aimed at the “in-CAD” FEA market, namely for analysts who prefer a pre-post tool with a 3D CAD orientation and CAD/FEA model associativity.

That said, there’s still a lot of work being done in metal—and in the analysis of metal applications. NEi Software has added an explicit dynamics program to its product line-up. NEi Explicit solves “nonlinear impact problems that involve large deformations with complex contact and motion.” Think crashes, metal forming, drop tests, and ballistics. (NEi Explicit is also useful for solving static problems with millions of degrees of freedom.) This dynamics program is completely integrated with NEi Nastran FEA software.

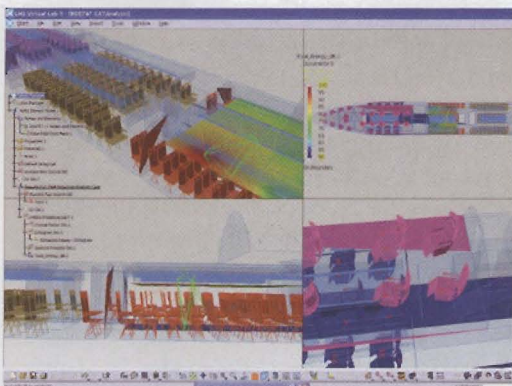
Simulation begets analysis

New analysis tools are still being introduced to handle new applications in new or burgeoning industries. For wind turbine manufactures, LMS International (lmsinternational.com) has a new feature in its LMS Virtual.Lab product called Motion Aerodyn Wind Loads. This feature solves problems in using third-party software for aero-elastic wind load modeling, varying the associated load runs, and automating pre/post processing. Aerodyn Wind Loads lets analysts reliably predict transient dynamic loads and use them as input to determine fatigue life and radiated noise—from within LMS Virtual.Lab. Here’s how the subroutine fits in. Virtual.Lab can determine blade and structural flexibility and wind behavior, and it can incorporate other aspects of wind turbines, such as gearboxes, bearings, and controls. The Aerodyn subroutine

computes the wind loads for Virtual.Lab Motion based on wind information, blade orientation, and speed. The results show precise blade-wind interaction and load cascading.

LMS has also been updating several of its dedicated software packages. The latest version of the company’s acoustic simulation software, LMS Virtual.Lab Acoustics, has new ray tracing technology for following sound waves as they propagate, reflect and diffract throughout a space. This technology can handle audible frequencies up to 20 kHz, a frequency band not always feasible using standard finite and boundary element modeling (BEM) because the size of the models is huge. Ray tracing can be used for numerous interior applications, such as planes, trains, road vehicles, concert halls, even train stations, as well high-frequency exterior acoustics applications, such as high-speed train or high-way-noise shielding. There’s a new time-domain BEM solver, a time-based method for simulating acoustic problems. Plus, a new inverse numerical acoustics tool helps determine realistic vibration sources for better noise and vibration system optimization. LMS Virtual.Lab Aero-Acoustics Rev 9 adds features such as conservative mapping for more accurate predictions, analysis of quadruples noise sources based on computational fluid dynamics, and more ways to analyze flow-induced noise. LMS Virtual.Lab Durability has a new feature for analyzing the effect of changing temperatures on fatigue behavior in exhaust systems, turbocharges, and even individual engine parts.

Lots of analysis software products exist for the “in-CAE” market. That is, dedicated analysis products have been adapted to work seamlessly within third-party products, thereby providing more-detailed analysis and simulation. This is not new. What’s new is the increasing numbers of analysis software and vendors doing this. The result is a more “have-it-your-way,” mix-’n-match CAE/FEA/simulation world. For instance, LMS and Ansys have worked together to adapt four LMS Virtual.Lab products to extend the simulation capabilities of the Ansys Structural Simulation product. The four are the aforementioned Acoustics and Durability, plus Motion (for building dynamic, multibody models of complex mechanical systems), and Correlation (for quickly comparing and validating test-based and virtual component models). **TC**



New ray tracing technology in LMS Virtual.Lab Acoustics handles the full frequency range of audible sound for optimizing, say, aircraft interiors. [PHOTO COURTESY OF LMS INTERNATIONAL]