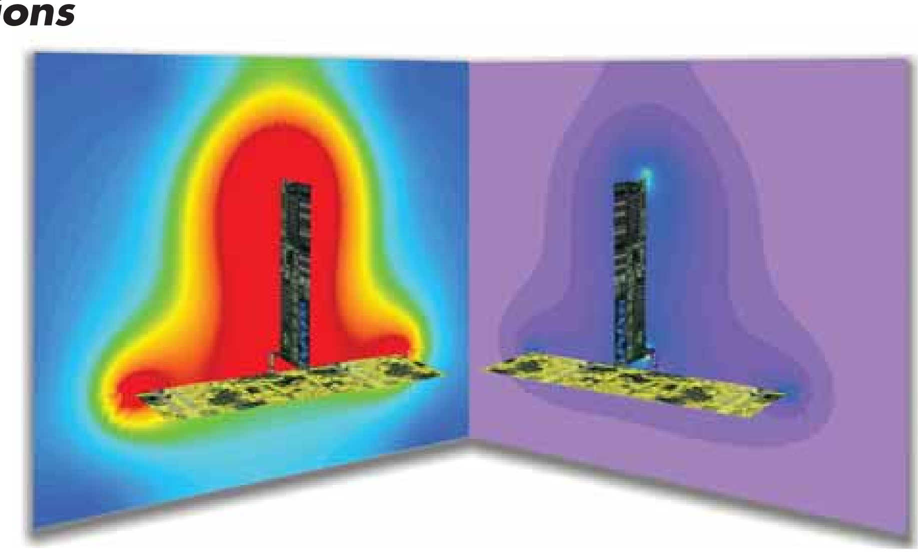
Computers in engineering

Predicting EMC emissions

Recent research has indicated that electromagnetic emissions from interface cards can be reduced by simple changes in grounding arrangements. Stuart Charles of **E-Mead Consulting** performed a simulation study on paddleboard cards connected to the backplane of an equipment enclosure through connector pins. The study focused on modeling the effectiveness of the grounding pins using the concepts of partial inductance to determine electromagnetic compatibility (EMC).

Charles used the FLO/EMC simulation software from **Flomerics** to investigate the impact of grounding, bonding, and inductance in real-world designs that could not be analyzed easily by pure mathematics. In the basic arrangement that Charles studied, he showed that simply changing from one to four grounding pins in a coaxial topography reduced emissions by more than 20 dB.



In this example, changing from one to four grounding pins reduced emissions by more than 20 dB.

"The results of this research study are equally applicable to daughterboards as paddleboards," said Charles. "It's often necessary to pass a clock signal in the 10- to 50-MHz range to one of these boards, with one pin typically carrying the clock signal and the connector ground pins carrying the return. The L/di/dt voltage drop across the connector ground pins excites the paddleboard and associated cable. This assembly then acts like an aerial that can potentially radiate beyond **FCC** [Federal Communications Commission] Class A limits."

The study began by using the concepts of partial self and mutual inductance to demonstrate the correlation between radiated emissions and the RF voltage drop across the ground pins. Charles started with a typical daughterboard that had a 20-MHz clock routed from the motherboard. He calculated the partial self and mutual inductance of combinations of parallel conductors with the distance between them of less than their length and between 10 and 100 times their radius. He then used the partial inductance concept to compute the net inductance of the ground wires or pins.

FLO/EMC was then used to model the effectiveness of a variety of grounding pin configurations. The advantage of FLO/EMC over an approach based on first principles is that the software is capable of modeling complex geometries, and that it determines the real-world quantitative impact of grounding arrangements without requiring the user to solve a complicated mathematical analysis.

Using tools such as FLO/EMC makes it possible to identify EMC design issues early in the design cycle, well before physical prototypes are built. The simulation tool uses the Transmission Line Matrix method for solving Maxwell's equations, solving for all frequencies of interest in a single calculation and therefore capturing the full broadband response of the system in one simulation cycle.

In his study, Charles used FLO/EMC to simulate five different grounding configurations: a reference design with a single ground pin; models 2 and 3 that both have two ground pins; model 4 with a three-ground-pin arrangement; and model 5 that has four ground pins. When Charles compared the different grounding configurations, the simulation showed major differences between them from an EMC standpoint. Models 2, 3, 4, and 5 generated 7, 9, 13, and 20 dB, respectively, less emissions than the reference design. The test results matched the theoretical calculations very closely.

David Alexander

New tool for all

Today's manufacturers are under pressure to innovate new products with high reliability. This demand requires virtual product development (VPD) tools that represent the physical world, which in turn necessitates multi-physics (multi-discipline) analysis. Almost all products are subjected to varying degrees of linear and nonlinear multi-discipline stresses such as structural, thermal, dynamic, crash, and buckling. While integrated point solutions can provide multi-discipline analysis, they struggle to provide the accuracy of simultaneous, coupled multi-discipline simulation.

To meet this demand, **MSC.Software** has developed MD Nastran—the MD stands for multi-discipline. Accurate representation of the complex interactions between key disciplines ensures an accurate simulation of the physical phenomena. Even with recent advances in modelers, computing power, and automated capabilities, discipline specialists still manually simulate the complex inter-discipline interactions as discrete analysis steps. Assessing large volumes of analysis data to determine how to hand off results from one discipline to another is tedious, subject to human error, and often is nonrepeatable.

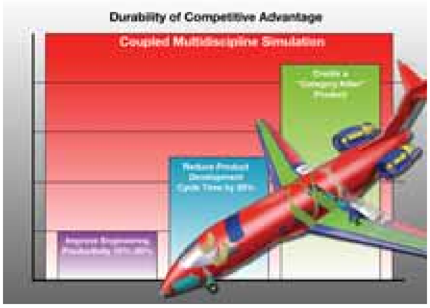
MD Nastran connects the disciplines so the information is live, and they are in an open-loop environment. Whether it is linear, nonlinear, motion, CFD, or explicit dynamics, working together implies they provide correct engineering and mechanical feedback to each other at exactly the right time.

Ten years ago, modeling rivets in an aircraft FE wing model was not even a consideration; today it is commonplace. More sophisticated and complex simulation models with unbounded model and analysis data set size increasingly have become a necessity. At the other end of the life cycle, engineers simulate entire vehicle systems prior to manufacturing.

MD Nastran solves a common or single model for multi-discipline analysis. An FE model can be loaded and conditioned to study various disciplines. The type of disciplines that must interact with each other guide and determine whether analysis is simultaneous, integrated, staggered, or loosely coupled. Note that one model used across all simulations means extractions are made from the model to make a representation of the system that can accommodate the simulation under given constraints and loads.

Where optimization is required, MD Nastran makes optimization loops available. For example, a point solution may rely solely on shape or topology optimization. MD Nastran uses variability optimization (stochastics), allowing an investigation of the robustness of the overall system.

Taking into account inter-discipline simulations places an even greater burden on computational resources. To this end, MD Nastran continues the activities



MSC.Software has launched a new tool for multi-discipline analysis: MD Nastran.

in high-performance computing established by its predecessor products with its port to true 64-bit processors, continued investment in solver optimization, SMP/DMP (shared memory parallel/distributed memory parallel) support, and enhancements to superelement techniques for complex model management and optimization.

David Alexander

Virtual manufacturing of aero engines

Volvo Aero is coordinating a new European Union (EU) project, VERDI, in which 16 European engine manufacturers, institutes, and universities will collaborate on the virtual simulation of the manufacturing process. VERDI stands for Virtual Engineering for Robust manufacturing with Design Integration. The aim of the program is to develop engineering technologies to improve European aeronautics by manufacturing aero engine components of the highest quality.

"We will be able to test all stages of the development in a virtual environment," said Torbjörn Kvist, VERDI Project Manager at Volvo Aero. The four-year program has total budget of €6.4 million, including €4.5 million in funding from the EU.

Virtual simulation means that with the help of CAE at an early stage, it will be possible to see how the components are affected during manufacture. Engine manufacturers will save development time, enabling them to manufacture engines for their customers at reduced cost.

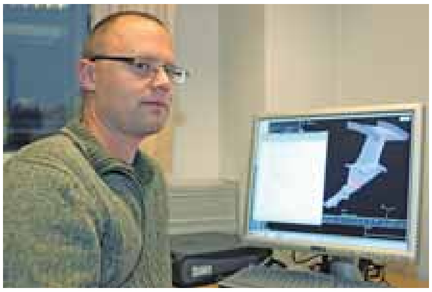
"We will also become more sensitive to customers' needs when we can develop new products more quickly, and it will become easier and less expensive for us to make any necessary changes," said Kvist.

Volvo Aero is coordinating the project and has an important contribution to make because of the company's extensive simulation experience. Volvo Aero has used advanced weld simulations since the early 1990s. The program will create an overall simulation tool through contributions of VERDI partners' expertise in different areas, such as simulated milling or sheet-metal stamping.

"All the participants are not experts in every field of manufacturing simulation. Each partner will contribute their piece of the puzzle," said Kvist.

Through simulation, it will be possible to see in the concept phase what happens to the final component when it is manufactured. VERDI then goes one step further. It creates a digital model of the components so that the engineers can see how the material is affected by the different manufacturing stages.

Simulation saves precious manufacturing time as well as the environment. There will be fewer physical tests and therefore less scrap. It will also be possible to design lighter engines that use less fuel because the material is used more optimally.



Volvo Aero's Torbjörn Kvist is the coordinator for the European Union's VERDI project, which coordinates collaboration among 16 partners to develop virtual simulation of the manufacturing process.

VERDI's partners are: Volvo Aero, **Rolls-Royce**, **MTU Aero Engines**, **Aachen University of Technology**, **Universität Karlsruhe**, **ITP**, **CIMNE**, **Luleå University of Technology**, **Trollhättan/Uddevalla University**, **Avio**, **EnginSoft**, **Politecnico di Torino**, **CENAERO**, **Techspace Aero**, the **University of Nottingham**, and **AICIA**.

David Alexander