BY HOWARD JOHNSON, PhD

EM-simulation software

Bruce Archambeault, PhD, distinguished engineer at IBM, IEEE fellow, and the author of the *EMI/EMC Computational Modeling Handbook*, responds to my questions about EM (electromagnetic)-simulation software.

I've heard you say that measurements may be a great emotional comfort to the user but sometimes provide little usable information. Please explain.

A Too many engineers just accept whatever they see on a measurement device as gospel. In reality, every measurement provides ample opportunity for mistakes. Your probe may load down the circuit, you may fail to use an appropriate reference connection—that is, ground connection—or fail to account for a changing antenna factor when operating near a metal floor. I firmly believe that measurements are important, but you must question everything—both measurements and simulations—to ensure correctness.

Let's say I'm designing a differential via. What kind of simulation tools might I need?

A That [answer] depends on the frequency range for your signal and the physical size of the vias. Below a few gigabits per second on a board of normal thickness—60 to 100 mils—a 3-D quasistatic field solver provides adequate values for simulating the circuit as a simple LRC lumped-element object. If you move to higher frequencies and thicker backplanes, the quasistatic assumptions break down. There you should use 3-D, full-wave tools to build S-parameter models for the vias and plug them into a Spice simulator that accepts S-parameter models.

What must a user know to obtain accurate answers from a full-wave-simulator tool?

A Every tool gives accurate answers to the questions you put to it, but there is a catch. You must know what questions to ask. A basic understanding of physics and electromagnetics on your part is required. Lacking that understanding, no tool can create useful models, but every tool will give impressive-looking answers. That's the pitfall. Let me emphasize that you must also understand a range of modeling techniques and the limitations of each. There are many techniques. Each excels in some areas, not in others. For example, the MOM [method-of-moments] technique excels when calculating emissions from long wires but performs poorly when calculating the effectiveness of shields. The FDTD [finite-difference-time-domain] and FIT [finite-integration-technique] algorithms perform well for shielding but not for long wires.

The relatively new PEEC [partial-element-equivalent-circuit] technique works well for many PCB [printed-circuit-board] simulations. It can work in both time and frequency domains. It is a full-wave-analysis technique that can do, among other things, power-plane analysis. It is unique in that it allows lumped elements, such as capacitors, resistors, and inductors, to be easily added to the full-wave simulation without adding a significant computational burden, as happens for some of the other techniques.

Will computers ever replace the need for an understanding of basic physics?

A When I was in school, my EM professor once said, "All the world is an analog stage, in which 'digital' plays only bit parts." That [idea] seems even truer today as we face the age of 'microwave digital' circuits. To be effective at those frequencies, you must understand high-frequency effects.

Certainly, software tools help. I use full-wave tools for analysis of complex electromagnetic structures and simple rule checkers to make sure the physical-layout designer followed my established rules. But beyond that, the basic design rests on my knowledge of EM. Some so-called expert system manufacturers will imply that their tools can be used by someone who does not know anything about engineering and physics fundamentals, but, in my experience, that [implication] is not true. Any person who wishes to design very-high-speed circuits must understand basic EM. Otherwise, he is designing blindfolded. EDN

The advanced electromagnetic-simulation tools that Archambeault creates for IBM are available through Moss Bay EDA at bruce@mossbayEDA.com.

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