Computational Electro-Magnetics in Commercial EMC Design

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In preparation for this article I looked back at my first involvement with ACES. In 1989 I attended my first ACES conference; and, as an EMC engineer, the idea of actually using computational methods to help in product design efforts seemed remote but intriguing. The following year I presented my first paper at ACES with the goal of highlighting the needs of commercial EMC designers in the hope that some of the available expertise could be focused in this direction. While there have been significant strides in this direction, there is still a way to go, and today we have the benefit of faster and more readily available computers. In light of the needs of the EMC engineer and today's updated techniques and technologies, I am again bringing this question to the ACES community.

In radar cross section, antenna calculations, and other applications of CEM, very precise answers are sought and an error of 0.1dB can have significance. EMC engineers, on the other hand, would have been, and still are, ecstatic to get an answer within 6dB. As stated in my 1990 ACES paper, 6dB, that is +100% / -50%, ***is*** accuracy to an EMC engineer. This was not my first technical presentation but it was probably the one that produced the most curious results in those attending. While there were some understanding nods, there were a lot more surprised faces, and I got the impression I was almost considered heretic by some.

Modeling is not used regularly by most EMC engineers. Rather, it is reserved only for the cases where established design rules fall short, and to address specific, well-defined problems. One difficulty resulting from occasional use is the trouble in becoming comfortable and competent in using what can be very complex computational tools.

EMC regulations cover the frequency range of 9 kHz to 40 GHz; however, only a portion of this range really requires help through modeling. Below 100 MHz, while some specific questions will be raised, modeling is usually in the form of circuit simulations and parameter extraction. EMC design rules and past experience both work well at these lower frequencies. The upper frequency bound is constantly rising due to increasing switching rates, and today it is rare for an EMC engineer to have serious concerns above 10 GHz. This leaves just a two-decade region where the need for modeling is greatest. EMC concerns are often broadband in nature, and so time-domain techniques can be most revealing, showing resonance and coupling effects over the frequency range of interest.

Another key consideration is to understand what EMC engineers are trying to model and why. Partly, models are done to determine specific parameters such as radiated emission levels or coupling coefficients. One area where the use of modeling really is helpful is in the evaluation of multiple "what if" scenarios, comparing apertures in shields and comparing emissions based on location of a particular component. While comparison models are usually aimed at solving a particular task, they also have a more general use, namely they enable the engineer to gain a better insight into the physics of the problem.

A great many EMC engineers did not select their careers based on their excellence in electromagnetic theory. Rather, EMC engineers are drawn from widely varying fields and so may not have training with any particular emphasis on EMC or even RF in general. It is a relatively recent step forward to have engineers actually trained as EMC engineers at college. Over the past decade or so, the use of CEM has grown greatly in the area of EMC, and this is in great part due to the training activities provided by ACES and the IEEE. Refinement of the computation techniques and ever increasing CPU power has also played a role.

Given the state of our computer resources and the developments in CEM, are better ways now possible for EMC modeling? Not being one to break with tradition, I would again like to challenge the ACES community to think about some of these situations that are unique to commercial EMC design engineers. Are there techniques that can, at the expense of some accuracy, provide solutions using less computer resources or in much less time? Can simplifications be made to an implementation, making a technique easier to use? Along the way, can these tools help provide engineers with EM or CEM training so that their skills can grow? If you have insight to any of these questions, the EMC community looks forward to hearing from you.