Why We Need to Educate and Train EM Engineers and Scientists?

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ABSTRACT

Antenna engineering has emerged during the last five decades from what was considered an art to a true science. Responsible for its success has been the introduction and technological advances of new radiating elements and complex communication systems with multiple, versatile, intriguing, convenient, and astonishing system functions. In addition, when some novel material structures are integrated with such elements and systems they result in some unique and exciting characteristics which typically have numerous applications that have captured the attention and imagination of engineers and scientists. Excitement has also been created by the introduction and advancement of low-frequency and high-frequency asymptotic methods, which have been instrumental in analyzing many previously intractable problems. A major factor in the immense success of antenna technology, which has contributed significantly to the advancements of wireless mobile communications, has been the advances in computer architectures and numerical computational methods. Today electromagnetic system modeling and simulation can be performed using a variety of analytical, numerical and computational methods, such as IE/MoM, FDTD, FEM, GTD/UTD, just to name a few. In addition, there are a plethora of personal and commercial full-wave simulators, based on such methods, which can be used to perform the modeling and simulations. For example, such simulators have played a major role in the design and development of advanced low-radar visibility targets, such as the stealth bomber and fighter, and in the fast paced advancement of mobile units, such as the cell phone. One of the first questions that we need to pose is: Why we need to educate and train EM engineers and scientists with BS, MS and PhD degrees, especially when the CEM resources, hardware and software, are so advanced?

Antenna elements have basic radiation characteristics when they radiate in an infinite medium or when placed on basic structures, such as infinite ground planes. In practice, however, these elements are mounted on complex structural environments, such as finite ground planes, truncated cones and cylinders, mobile wireless devices, electronic packages, ground based vehicles, and airborne platforms (such as airplanes, helicopters, etc.). The integration of materials to the design often increases the complexity, although usually improves the performance. Once the antenna system has been modeled and simulated, how do we know or decide that the data obtained are representative of the system that we have modeled? One answer the question is to perform measurements, which are usually expensive, time consuming and may require specialized facility and instrumentation. Besides, we use the computational methods and full-wave electromagnetics solvers for their versatility and to avoid costly and time consuming experiments. One of the alternatives is to attempt to shed some physical interpretation on the data obtained through simulations, which most often requires understanding of the fundamental and advanced principles of electromagnetics. While GTD/UTD shed more physical inside into the modeling, they are limited by the types of structures, constituent parameters, and geometrical complexity. Full-wave

simulators, such as those based on IE/MoM, FDTD and FEM, are more versatile for simulations and animations, although are usually limited by physical insight, interpretation and electrical size.

In this presentation I will address and answer some of the questions as to why we need to educate and train EM engineers and scientists, which I think it is even more important today than in the past because the electromagnetic environment is much more complex and the systems functions are much more demanding. Based on my own personal experience, basic antenna and guided structures will be modeled and simulated when mounted on complex structures, and I will attempt to provide, based on basic electromagnetic and physics principles, some physical insight and interpretation of the altered radiation and propagation characteristics, such as resonant frequency, impedance, amplitude pattern, and transmission coefficient, as compared to when such radiators are placed on basic structures.

While antenna technology has made giant strides and has attained a major level of maturity, it still faces many new challenges and opportunities. Computational electromagnetics, using supercomputing and parallel computing, offer refreshing opportunities and will model even more complex electromagnetic interactions. Innovative antenna designs, for smart antenna systems, multifunction (input and/or output), multi-frequency, wide band, and reconfigurable applications, are welcomed and always should remain an elusive objective.