



Electromagnetic Education – Development of Models and Measurement Validation

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The study of electromagnetics is of fundamental importance to engineers working with RF systems. Many engineers find the theory and application of the theory to be challenging. Importantly, engineers need insight into the development of good analytical models require subsequent validation with experimental measurements. The challenge at the academic level is to teach the theory in such a way that leads to the needed insight. This insight can often be developed with good case studies.

It is also noted that a good background in electromagnetic theory necessarily includes an understanding of measurement techniques. Armed with such knowledge, an engineer has the background to question the accuracy of the measured data given disagreement with analytical predictions.

A academic case study compares electromagnetic models to data considers the measurement of the radiation pattern of an antenna in the far-field (i.e., in the Fraunhofer zone). Engineers are taught criteria that ensures far-field measurements. For example, the distance to the far-field is generally presumed to be given by the Raleigh condition: $r > 2 D^2 / \lambda$. For this condition, D is the largest linear dimension of the antenna while λ is the wavelength of the carrier frequency. This far-field criteria is not suitable for the measurement of antennas with ultra-low sidelobes. In this case, the analytical models may predict sidelobe levels that exist but require more measurement distance to be detectable.

Electrically small antennas (small relative to wavelength) require knowledge of other far-field criteria (i.e., the geometrical and electrical conditions). Again, an RF engineer need a proper understanding of the associated electromagnetic theory before proceeding to measurements.

This presentation will examine this and other case studies and emphasize how they can be used to increase the quality of metrology in the university academic curricula.