The Lives of Subjects – Evolution and Education

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Introduction

In the previous *Perspectives in CEM* entitled "A new modelling army?" it was suggested that approaching and understanding of electromagnetics through mathematics as a first line of attack may not be the most appropriate way for us to approach the education of university and college students these days. It recommended that a more pragmatic approach, and one that will touch more of the lives of more students, would be to start with modelling and simulation in order to develop a sense of understanding about what actually goes on in electromagnetic systems and then develop the mathematics to deepen this understanding for those able to cope with the non-trivial nature of the analysis. This would lead to a highly granular grouping of 'creators' and 'implementers'.

Comments

There were a number of comments received on this subject and, possibly to a mixture of relief and the chagrin of the author, there was virtually no dissent on the main thrust of the article. The comments are encapsulated under the following headings.

Context

In the original article, an analogy with one instance of the engineering profession was used. However, it was pointed out that the 'class system' undertones do nothing to support discussion and detract from the exposition and interpretation. This is a well made point and it was certainly not the intention to support a division of the profession. A better analogy would, perhaps, have reinforced the idea that people with different natural abilities, skills and interests will perform different tasks; none of which being better or worse than the others but all being different and equally valuable.

Breadth

If more people manage to grasp electromagnetics and the opacity that is a hallmark of the subject to a great many engineers dissipates, then more wide ranging discussions about EM and subjects such as EMC can be had within the design teams. The potential benefit of this is better understanding of EM issues by groups of people with, hitherto, a poor appreciation of the subject, and hence an increased probability of better, more robust, product design.

Experimentation and measurement

There is virtually no mention of experiment and measurement in the article. One element of an undergraduate curriculum that helps to reinforce concepts is laboratory work. The result is that students will find substantial benefit from being able to model a system, in order to see how fields and charges behave; to experiment in order to understand what the simulation means in the physical world and then to perform the analysis in order to develop a deeper more profound understanding of the electromagnetics involved.

Subject Life Cycle

The life cycle of electromagnetics was more specifically considered as a factor. Consider the amount of change that has occurred in computational electromagnetics in the last quarter of a century. Two of the most profound are:

- 32 kbytes of storage for a personal computer was seen as extravagant, yet now 1Gbyte of RAM in a personal computer is seen as nothing more than reasonable.
- The number of methods from which to choose has grown, the number of commercial packages has increased manifold and CEM is seen as another tool available to the designer.

Effectively, the basic components of CEM have seen a period of growth and maturity with other aspects of the subject taking over this mantle of growth. When viewed this way, it can be seen that the life-cycle of CEM is not very different to other technologies, such as semiconductor devices. The result of this is that as the subject itself evolves, the methods of teaching, research and scholarship also need to evolve. Consider the analogy with semiconductors: transistors (etc.) are everyday components of circuit design, and while understanding the physics can help, it is not essential to good circuit design. As the subject develops, and the knowledge base increases, the reliance on specialist knowledge is reduced because that specialist knowledge is captured in books, articles, papers, design guides and is therefore readily available to anyone who wants to undertake some design or analysis.

Thus, an understanding of the mathematics of electromagnetics may help in the production of good designs, but with the quality of modelling packages available today, knowing how to apply the rules and understanding fields as entities will be much more use. Perhaps, above all, using CEM packages underpinned by experimentation and theory is only 50% of the battle, the remaining 50% is encouraging students to make use of the vast body of knowledge captured in books, articles, papers, tutorials, on-line resources and to contribute to this global knowledge base.

Knowledge and Wisdom

It seems that the evolution of computational electromagnetics as a subject in its own right has resulted in a detailed understanding of the mathematics now being subservient to experience, well formulated design practice and skills at researching a global knowledge base. It has been suggested[1] that wisdom (knowledge with insight) sits above knowledge (information with meaning) which sits above information (data with context) which sits above data (the observations). As educators, we should be encouraging the pursuit of wisdom and the key may very well not be teaching modelling or theory specifically but teaching innovation, design methodology and developing research skills.

[1] Based on Skyrme, D. and Amidon, D., (1997) *Creating the knowledge based business*, Business Intelligence, London