Education News

■ K.C. Gupta

Articles Invited for Education News Column

We invite MTT-S members, RF and microwave educators, and other readers of this magazine to contribute to this column. Objectives of Education News include presentation of education-related activities of the MTT-S, issues related to education and continuing education of microwave and RF engineers, brief tutorial articles/comments related to RF and microwave educational topics, and technology-aided microwave and RF educational development tools. Please contact Prof. K.C. Gupta (k.c.gupta@ieee.org) with your ideas, proposals, and suggestions for contributions to or comment on the reports in "Education News."

Welcome to another appearance of Education News in *IEEE Microwave Magazine*. In this issue, we start with an important announcement about the IEEE Microwave Education Fund that is being created at the IEEE Foundation level. This is followed by an interesting, thought-provoking essay by Jim Rautio, titled "In Defense of Uselessness." This essay presents a refreshing view on a topic that has confronted academic researchers for a long time. The "Education News" department will consider publication of any reactions, rebuttals, or further thoughts on this topic. Also, in this issue we include a call for applications for MTT-S Undergraduate/Pregraduate Scholarships for 2004, an update on the 2004 MTT-S Undergraduate Fellowships, and a preview of the 2004 RF and Microwave Education Forum to be held at this year's International Microwave Symposium (IMS 2004).

K.C. Gupta is with the University of Colorado, Campus Box 425, Boulder, CO 80309 USA, +1 303 492 7489, k.c.gupta@ieee.org.

IEEE Microwave Education Fund

An IEEE Microwave Education Fund has been established within the IEEE Foundation for supporting educational activities in the microwave field. To enhance future educational activities in the microwave field, sources of financial support are being sought through this announcement and other activities in the near future.

Donations are being sought from individuals, companies, and corporations, and any amount can be accepted. Since the Fund is for charitable purposes, the contributions are tax deductible. The money will be deposited with the IEEE Foundation through the IEEE Development Office in Piscataway, New Jersey.

Provisions have been made to create a named award with sufficient funds and for a specified duration. Provisions have also been made to recognize specified individuals or organizations in the presentation of an educational aid.

The winners of these educational aids will be determined by the Education Committee of the IEEE MTT-S. This information will be forwarded to the IEEE Foundation Board for funds dispersal.

Additional information can be obtained from Ms. Karen Galuchie, IEEE Development Operations Manager in Piscataway, New Jersey, k.galuchie@ieee.org, +1 732 562 3860. Information can also be obtained from the MTT Web site. The key contact at the MTT-S level is Dr. Kiyo Tomiyasu, k.tomiyasu@ieee.org.

In Defense of Uselessness

I was feeling pretty good about a paper I had just presented [1] demonstrating a dynamic range exceeding 120 dB for a

method of moments (MoM) electromagnetic (EM) analysis of a fairly complicated circuit. I had even taken care to point out that tiny noise ripples at 120 dB down were consistent with a numerical noise floor 155 dB down. "Pretty neat!," I thought to myself.

Then came The Question. It was from a good friend, a well-known and capable professor. He asked me privately, after the presentation, "Why would anyone ever need results with such a large dynamic range, you can't even measure that far down." Wow! I had not thought to ask that question. We engineers really like doing things that are useful. This fellow was suggesting that my work was useless. What's more, it was a reasonable and fair question to ask!

Not having considered this question before, I did not have a good answer. Within an hour, however, I had talked with an experienced filter designer. He told me that their filters are typically specified for stop band rejection down to 80 dB. Looking at it from the analysis point of view, we typically trust results down to about 20 dB above the noise floor. A noise floor at –100 dB works nicely. Since many EM analyses cannot push any where near that far down, maybe my work might be useful after all!

This causes me to wonder: Is the 80-dB typical stop band specification forced by measurement limitations? Perhaps. Would communication systems engineers be able to take advantage of a stop band rejection of more than 100 dB? Maybe. Would circuit designers be able to design it? The difficulty would be increased many times with insufficient analysis dynamic range, or worse yet, unknown dynamic range.

This is an odd defense of uselessness. I spend my time searching for justification that my own work is actually useful when someone suggests it is useless. That is exactly the reason I think uselessness should be defended: We don't always see usefulness in advance. Roger Harrington related to me (as described earlier in this publication [2]) how his work on MoM was considered useless because a computer could not invert even a 100 × 100 matrix; the magnetic tape would wear out going back and forth.

Three years into my work with MoM (19 June 1986, 2:35 p.m., Meadowbrook Lodge, Blue Mountain Lake, New York), a prominent microwave designer told me that all this numerical EM stuff was useless academic research with no practical application. I clearly recall the sinking feeling I had as I realized he was right. After all, the best I could do was to invert a 100 × 100 matrix in about an hour and then only by using hand-coded assembly language. What kind of practical circuit could I do with only 100 subsections? Nothing! Maybe I should just drop all this really neat, but useless, EM stuff and get real. The answer is clear today: We can use lower upper decomposition (LUD) to invert 30,000 × 30,000 matrices in about an hour, and numerical electromagnetics is a required part of modern high-frequency design. Fortunately, I decided to ignore that early (and accurate) designation of uselessness.

In these—and many other—cases, uselessness is an accurate designation upon the start of a major piece of work. The people telling Roger Harrington that his work was useless were absolutely correct. The people saying my work was useless knew exactly what they were talking about. My work on EM dynamic range and quantitative accuracy (it is incredibly difficult to get papers published on this topic!) is also correctly described as useless, at least for now, for some people.

Why do we creators of useless research continue to work so hard? When Roger Harrington did the calculations for his classic text on EM theory [3] in the mid 1960s using an advanced, state-of-the-art electromechanical calculator, it was really neat. When I got my first MoM matrix successfully filled and inverted, it was really neat. When I saw my first analysis showing a dynamic range pushing all the way down to 180 dB, it was really neat. We do it because we love it. We do it because it is really neat. Usefulness is an afterthought.

But we are engineers; usefulness is important. If something is useless, that might be OK, as long as there is a chance, someday, that it might be useful. So we do have to keep an eye on usefulness, and if some course of our endeavors really starts to look like it will never be useful (e.g., pig perfume [4]), then it is important to be realistic, cut our losses, and get on with life. We have all had our failures, and, like losing lottery tickets, we tend not to publicize them. When we strike out, it is important to realize it as quickly as possible, shake it off, and get on with the game.

What about these people who take ideas whose greatness still lies in the future and blithely call them useless? Are these people useless, ignorant morons? I don't think so. In fact, these people are basically just like the rest of us. I'll go even further: These people *are* us. Any one of us can and have pointed to a future great idea and called it useless. It happens. The downside is we might kill a future great idea with our quick callous of judgment. It's like a car running down a small child; as the parents cry over the small coffin, we wonder what might have been.

When I am talking with researchers or reviewing papers, I try to drive carefully. I will never condemn a new EM analysis because it is slow or inaccurate. Someday it might grow up to be fast and accurate. However, if someone claims an analysis is fast when it is really slow, or accurate but they give no quantitative indication of error, I point it out. I always try to give the child a chance to grow and to gently but firmly direct attention to areas that need work.

As long as it feels "really neat" and there is at least some remote potential for future usefulness, let's drive carefully and refrain from using "uselessness" as a reason to discard someone's work. But perhaps some might feel this advice is itself useless. They might be correct. But I hope they will consider carefully reading this essay a second time, because it is they for whom I write.

References

[1] J. C. Rautio, "Testing limits of algorithms associated with high frequency planar electromagnetic analysis," in *Proc. European Microwave Conf. Dig.*, Munich, Germany, 2003, pp. 463–466.

[2] J. C. Rautio, "Planar electromagnetic analysis," *IEEE Microwave Mag.*, vol. 4, pp. 35–41, Mar. 2003.

[3] R.F. Harrington, *Time-Harmonic Electromagnetic Fields*. New York: McGraw-Hill, 1961.

[4] M. Golio, "Continuing adventures of Bo Cambert and Leary McFly," *IEEE Microwave Mag.*, vol. 3, p. 144, June 2002.

James C. Rautio

2004 MTT-S Undergraduate/Pregraduate Scholarships

Applications are currently being accepted for the 2004 MTT-S Undergraduate/Pregraduate Scholarships. The application deadline is 1 May 2004. A detailed announcement appears on page 101. Details are also available from the IEEE MTT-S Web page, http://www.mtt.org. Click on "Awards > Undergraduate Scholarships," or contact Prof. Sanjay Raman at sraman@vt.edu. Prof. Raman chairs the Undergraduate Scholarships Subcommittee of the MTT-S Education Committee.

Update on MTT-S Graduate Fellowships

The deadline for the 2004 MTT-S Graduate Fellowships was 30 November 2003. The applications are currently being processed, and the awards will be announced soon. Details of the MTT-S Graduate Fellowship program are also available from the IEEE MTT-S Web page, http://www.mtt.org. Click on "Awards" or "Education," and then click on "Graduate Fellowships." Alternatively, please contact Dr. Aditya Gupta at a.gupta@ieee.org. Dr. Gupta chairs the Graduate Fellowships Subcommittee of the MTT-S Education Committee.

RF & Microwave Education Forum

IMS 2004, Fort Worth, Texas, USA
Tuesday, 8 June, 12:00–1:15 p.m.

The Education Committee of the IEEE MTT-S has sponsored an RF and Microwave Education Forum almost annually since 1998. The forum, held during IMS, is an annual gathering of educators from around the world who have professional interest in RF and microwave engineering. It provides an opportunity for meeting, and networking with, colleagues having common interests and serves as a venue for discussing topics of current interest to the educators in this field, examining innovative ideas related to education, and sharing information. A different theme is selected each year for the Forum to focus the discussion and allow an in-depth deliberation despite the short duration.

The theme of this year's education forum, organized by Prof. Madhu S. Gupta of San Diego State University, is "Convergence of Analog IC and Microwave Design?" Historically, microwave circuit design differed significantly from analog circuit design in a variety of ways, such as the type, number, manner of use, and description of active devices employed, and the design objectives, tools, and emphasis. This difference was reflected in, and in turn justified, the different educational emphasis in the respective curricula—while microwave engineers worked with distributed elements and Maxwell's equations, the analog circuit designers worried about voltage references and current mirrors. This situation has changed greatly in recent years. One reason is economic: the need to design for large volume and cost-sensitive civilian markets requires attention to cost; elimination of individualized tweeking and tuning; design robustness to accommodate manufacturing tolerances; and the use of standard processes in place of custom tools components and designs. The other reason is technological: as waveguide circuits got replaced successively by planar circuits, hybrid circuits by monolithic ones, two terminal active devices by three terminal ones, and "exotic" devices by silicon devices, so also have the design methods. On the other side, analog designs have also evolved as the active devices attained higher cut-off frequencies, circuits required higher bandwidth and speeds, devices required more extensive models accounting for parasitics, and the behavior of interconnects required careful modeling due to concerns about delay and reflection.

We have now arrived at a stage where designers, carrying out mixed signal designs, routinely cross any vestiges of boundaries between the RF and analog domains. Moreover, the imperfections (of linearity, delays, matching, synchronization, etc.) in the designed circuits are increasingly compensated for by DSP and digital control devices, rather than by microwave techniques that suffer from higher complexity, cost, and tolerance sensitivity. Finally, the efficiency of modern design tools has greatly decreased the need for large design teams. All indications are that, in the future, the industry will need microwave engineers who are broadly trained not only in microwave engineering, but also in analog design, digital signal processing, and wireless communication technologies. The curricular implications of this change in our industry have not yet permeated through the educational system, as evidenced by the continuing traditional teaching of microwave design courses, by the appearance of new textbooks that do a better job of explaining older design approaches, and by the narrow focus of training.

Future educational programs will face multiple challenges, mentioned above, in their mission. Microwave educators might find it increasingly difficult to maintain a distinct identity and justify a distinct training path for designers in the future. This has implications on the design of microwave curricula and syllabi, the textbook content, the mathematical background required to understand the optimization methods, and the advising of students regarding the breadth of preparation required for a successful career in the field.

This forum will present brief remarks by invited speakers who will delineate the issues, present insightful perspectives, propose innovative approaches to address the changes, and share the experience based on their own efforts in this regard. In addition, attendees are also invited to participate in the discussion and share their observations; those who wish to address the gathering briefly are urged to bring an overhead transparency summarizing the gist of their remarks.

For efficient use of discussion time, the forum attendees will be provided boxed lunches. Although there is no formal registration for this event, an e-mail confirmation of interest in attending the Forum will help the organizers to be better prepared for it. Please direct all inquiries and communications regarding the 2004 Forum to its organizer, Prof. Madhu S. Gupta, at m.gupta@ieee.org.