

Guest Editorial

About This Special Issue

THIS Special Issue on “RF and Microwave Tutorials” is a new experiment in the publication for this TRANSACTIONS. It differs from the traditional issues and special issues of this TRANSACTIONS in two ways: 1) this is the first time that an issue has been devoted entirely to tutorial papers and 2) this is also the first time that this TRANSACTIONS has published papers that include some electronic content to embellish the printed material, thereby requiring an electronic copy of the material to be distributed along with the printed version. The electronic version is contained on a CD-ROM accompanying the printed copy of this TRANSACTIONS. This editorial briefly summarizes the motivation, genesis, and logistics of this Special Issue and, in addition, the guest editors’ thoughts on the potential significance of what has been accomplished in this Special Issue, as well as what might develop from it in the future.

Philosophical Underpinnings of This Special Issue

Historically, the IEEE Microwave Theory and Techniques Society (IEEE MTT-S) has been recognized as the premier organization engaged in the dissemination of technical information in its discipline, through the means of its publications and conferences. This, however, is not the only role of a professional society. Many professional organizations engage in a variety of other service activities as well—including education, certification, networking, public service, maintenance of discipline and self-policing, and representing membership interest (for example, in legislative and corporate settings). We envisage an expanding role for the IEEE MTT-S in the future in the arena of continuing technical education. Our expectation is based on several observations, of which the following three are the most significant:

- current evolution from an industrial to a knowledge-based society;
- increased globalization of professional activities;
- development of market forces in the education field.

Firstly, we are today evolving further into a post-industrial knowledge-based society. In this emerging knowledge-based society, the generation of wealth and resources depends upon creation and applications of new knowledge. Thus, the society is becoming more dependent on our higher education system to create knowledge, educate people, and provide everyone with learning resources throughout their lives. This emphasis on lifelong learning (to use continuously evolving knowledge and technology) has made the “continuing education” much more significant. Secondly, enhanced communication and travel have lead to internationalization of commerce, wherein no country is any longer self-sufficient or self-sustaining. National economies and many companies are truly international, and dependent on other nations and other people. Education must enable all students to appreciate the unique contributions to

human culture that come from other traditions so that they are able to communicate, work, live, and thrive in multicultural settings. Traditionally universities have enjoyed a monopoly in higher education because of their geographical location and controlled accreditation of programs for awarding degrees. A recent upsurge in information technology has, however, eliminated the barriers of distance and time. This has created a competition from for-profit education providers and virtual universities.

Changing Scenario of Continuing Education and Lifelong Learning

A number of new themes are being recognized as being crucial for continuing and higher education in this century. Among these are: 1) learner-centeredness; 2) affordability; 3) need for lifelong learning; 4) need to address diverse populations; and 5) need for intelligent and adaptive learning environments. First of all, in rapidly changing workplace patterns of today, there is a need to acquire new skills and advanced education throughout one’s life. The concept of an abrupt end to education at the completion of college studies is disappearing. Undergraduate, graduate, professional-education, on-the-job training, and continuing education are thus merging to form a continuum of lifelong learning experience. Traditionally, the university/college faculty have determined the curricula in the conventional system of higher education. That system needs to become more responsive to the learning needs of “students” (which includes all of us!). When serving the student needs is viewed as the primary objective, we shift focus from a teacher-to learner-centered style of higher education. Technology is now available to replace monologue style professorial lectures with plug-and-play type interactive learning experiences. Both the educators and learners will welcome Web-based and CD-ROM-based tutorials as they become available to meet this rapidly growing demand for continuing education and lifelong learning. In summary then, we have a confluence of: 1) rapid technological development; 2) increased recognition of need for continuing education; 3) development of alternative delivery systems; and 4) expanding role of nonuniversity institutions in education and training.

Genesis of This Special Issue

These changes in the educational scene are of relevance not only to the universities, but also the professional organizations like the IEEE and its constituent societies, which will have to examine the needs of their members, and help them to cope with this emerging need for lifelong learning and continuing education. During the past three years, the Administrative Committee (AdCom) of the IEEE MTT-S has been discussing ways to help its members with their continuing education and lifelong learning needs. This effort has resulted in a steady increase in the number of tutorial workshops and short courses offered each year at the IEEE MTT-S International Microwave Symposia. The IEEE MTT-S also has plans for bringing tutorial workshops to its local chapters throughout the world. Another suggestion

that has been discussed is a Web-based periodical publication for making RF and microwave tutorials conveniently available to IEEE MTT-S members and other subscribers. As a part of those deliberations, and as an initial experiment with publishing tutorial material that takes advantage of the electronic medium, it was considered prudent to bring out a Special Issue of this TRANSACTIONS. This Special Issue is a result of those deliberations. Summaries of some of these discussions within the IEEE MTT-S, in summary form, are available in the Education News column of the issues of the *IEEE Microwave Magazine* for the past three years.

Motivations for and Purpose of This Special Issue

The principal motivations for conceiving this TRANSACTIONS' Special Issue on "RF and Microwave Tutorials" can be summarized as follows.

- 1) *Increasing the Availability of Tutorial Papers:* One of our goals has been to encourage the preparation, and increase the availability, of tutorial papers in the field of microwave theory and techniques. The dearth of articles in the pages of this TRANSACTIONS that are accessible to large numbers of nonexpert readers has long been lamented. It was commented on a quarter of a century ago by Marion Hines, an eminent member of the society, in his evaluation of this TRANSACTIONS [1]; it has periodically led to attempts and efforts by past editors to attract such papers [2]; and it has been considered sufficiently important for the appointment of more than one Associate Editor for Reviews and Tutorials from 1993 to 1998.¹ Despite these efforts, such papers continue to be in short supply. This shortage could possibly stem from the large commitment of time required to prepare tutorial papers, the preoccupation of researchers with communicating their specialized work to a small community of specialists, the misperception in some circles that the writing of tutorial papers is somehow a lesser accomplishment than an original research report, and other similar reasons. It was our hope that a special issue, specifically dedicated to tutorials, will prompt contributors to prepare and submit additional such papers.
- 2) *Broadening the Range of Published Materials:* The IEEE MTT-S is already the world's largest and the most highly regarded publisher of research papers in the field of microwave and RF engineering. However, the publication output of the IEEE MTT-S is unidimensional—it consists almost exclusively of printed text (broadly defined to include the accompanying mathematical, graphical, and tabular material). Over the past 50 years of its life span, there has been little change in the nature of publication in this TRANSACTIONS despite the explosive growth of electronic forms of publication and engineers' reliance on them. Even though archiving, distribution, information retrieval, and access to this TRANSACTIONS have become electronic, the TRANSACTIONS and the form of its content (hardcopy print-only material) has remained the same. (Only very recently, "indexing" of the paper has introduced hypertext and links that allow

the reader of the text to access other information sources, such as cited papers; but the form of primary information remains text-only). This Special Issue is the first attempt by this TRANSACTIONS to go beyond text-only publication, and may be viewed as a small step in exploring a wider variety of forms that its publications might take in the future. Thus, a second goal of this Special Issue has been to experiment with the publication of a broader range of types of materials beyond the traditional print-only hardcopy journals by the IEEE MTT-S, both to learn from the process, and to prepare for the prospects of such publication in the future.

- 3) *Roles for the IEEE MTT-S:* A third purpose of this Special Issue is to explore new services and roles for the IEEE MTT-S that may add value to its membership, specifically in the continuing education arena. This Special Issue exemplifies several such roles for the IEEE MTT-S. One is as the originator of new and innovative forms of technical information dissemination with the aid of electronic means. A second is as the provider of technical information for continuing education in its discipline. A third is as a catalyst in encouraging the development of new ways of meeting the professional development/renewal needs of its membership.

Planning for this Special Issue

Consistent with the above goals, the intended purpose of this Special Issue was to publish tutorial papers that will assist the readers in maintaining and updating technical skills, enhancing professional competence in newly emerging areas, and continuing lifelong learning, and professional development. The topical scope of this Special Issue was intentionally kept broad and included materials for learning concepts, techniques, and skills from the entire field of RF and microwave engineering at various levels such as devices, circuits, modules, subsystems, and systems. The emphasis of the solicited papers has not been on the presentation of new results, but rather on expository and tutorial writing at a level accessible to nonspecialists, from both emerging and established areas of technology. The types of solicited papers, which were listed in the announcement for this Special Issue, included the following:

- 1) papers that elucidate difficult concepts, make recent progress comprehensible, organize disparate bits of information into a cohesive framework, and aid in understanding;
- 2) papers that significantly advance the quality and state-of-the-art in the expository and tutorial material currently available on their specific subject matter;
- 3) short tutorial features on new developments in the RF and microwave field, addressing significant recent research/developments on specific topics within RF and microwave engineering;
- 4) reviews of other available tutorials, websites, books, software, and journal papers of tutorial nature in RF and microwave field;
- 5) papers and items dealing with virtual experiments and virtual laboratories;
- 6) papers on alternative forms of presentation of a topic (distinct from what is generally available);
- 7) illustrative examples for explaining a known theorem, principle, algorithm, principle, or concept;

¹Inside front covers of the IEEE TRANSACTIONS ON MICROWAVE THEORY AND TECHNIQUES, 1993–1998.

- 8) clarifications of typical misunderstandings (particularly those found in print).

Preparation of This Special Issue

Solicitation for the papers for this Special Issue began in October 2001. Prospective authors were invited to submit proposals prior to submitting their contributions, and to contact one of the guest editors to discuss the proposed papers. More than 40 proposals/papers were received and, following a review of the proposals, a number of these authors were encouraged to prepare full papers. Thirty completed manuscripts were received and reviewed. The review process included a consideration of both the technical, as well as the expositional qualities of the papers. Selected manuscripts were revised by authors and were reviewed again. This long process finally converged to the 13 papers that are published in this Special Issue. The guest editors would like to thank all of the authors for their patience while waiting for the reviews and for their cooperation in meeting various deadlines for the print and electronic versions of this Special Issue. Our grateful thanks also go to the large number of reviewers who evaluated the papers not only for their technical contents, but also for their usefulness as tutorial papers. Although these reviewers must remain anonymous, they are the most crucial and valuable element of the process, as in any scientific and technical research journal.

Role Played by Electronic Content

The variety of formats in which technical information can be presented in electronic media is exemplified by the set of papers comprising this Special Issue. These range from the traditional “text-only” tutorial papers to those that include substantial non-text “electronic content.” The electronic content can enhance a print-only paper in a number of ways, and at several different degrees of interactivity.

- 1) Perhaps the lowest level of electronic supplement to a text-only paper is a slide- or transparency-style presentation, possibly with audio clips, which gives the paper the appearance of an oral presentation or a conference paper. In addition, it helps organize information in “bullet” form and, thus, helps focus attention on the crucial issues and their inter-relationships. Papers by Zhang *et al.* and Thomas are examples of this genre.
- 2) In print media, the gray scale of a halftone photograph is sometimes used to represent an additional variable in graphical form, as are color graphics, which have occasionally used color to convey an intensity or magnitude of a variable, when necessary. An electronic version of a manuscript can present additional dimensions very effectively in a number of alternative ways, such as through a complex three-dimensional plot observed from different perspectives, thus adding the ability to include another dimension to the graphical communication.
- 3) The lowest level of “live” feature is the inclusion of simulations and animations in which the information in the paper is supplemented with graphics that are time varying. The time scale can be used in a variety of ways: to display time variation of information, show the effect of variation of some parameter through time displacement, or include animation. An example is the article by Harris *et al.* in

this Special Issue in which the sweeping of a frequency window can be presented graphically in this manner. Of course, in this particular case, the reader needs to run the MATLAB code (attached to the paper) for observing this feature.

- 4) The first level of reader-control of graphically displayed information is in allowing the user to choose the variable values or settings employed in graphics. Such graphics can be either stationary or animated, but the distinguishing feature is that the user can set the values of parameters and control information. One example of this occurs in the paper by Georgieva and Tam in this Special Issue.
- 5) The usefulness of tutorial papers can be enhanced by added computational modules (say, by using Java applets), wherein specific design parameters for obtaining design information may be inserted, and the design results obtained instantaneously. The papers by Cidronali *et al.* and Gupta *et al.* on “RF and Microwave Network Characterization” are such examples.

Some of the other features that are useful for interactive graphics, although not exemplified by any of the papers in this Special Issue, are as follows:

- still higher level of interactivity is one in which the reader selects not just the variable values, but also options (possibly from a menu) that control the task performed, or the functionality of the graphical display;
- software used to simulate or compute the graphics need not be limited to the generation of graphics; in general, it can serve to provide input to a computer-aided design, simulation, analysis, layout, or modeling software, and, thus, perform other tasks of engineering interest.

Future Needs

The paper on the use of concept maps for tutorials by K. C. Gupta *et al.* brings out an IEEE MTT-S membership need and, hence, a potential future role for the IEEE MTT-S. Development of skills in a given field requires significant investment of time from a learner. Experience shows that only a part of this investment is directed toward acquiring the specific skills or a knowledge of a specialized subject, which was the intended goal of learning; a good deal of the effort goes into learning much unrelated material, which may be valuable in itself, but is not essential for the specific desired goal. As a result, learning is not particularly rapid or efficient. The learning process, and the investment of time and effort, can be made more efficient if the exact prerequisites, required for learning exactly the desired subject, could be identified in advance so that the learner could follow the most direct path to the goal. In the past, this professional responsibility had fallen, by necessity, on textbook authors, who select the topics encountered along the route of learning, and ensure that all prerequisites are included. The authors, however, must design their books to be of value to a large cross section of readers, and not for the narrow goal of a single learner at a particular time. Consequently, some other means of acquiring the required prerequisite without necessarily subjecting the learner to a large overhead load of learning numerous ancillary topics should be available. This implies modularity of instructional material, exact specification of hierarchical relationships between the modules, and a means of charting the course of a journey

through a large set of modules. Clearly, both a computer and a subject-matter expert are essential to planning and navigating through the learning process. Herein lies a possible new role for the IEEE MTT-S.

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with continuing education in microwave engineering through the teaching of short courses in advanced technology, authoring a number of extensive review papers, and editorial work. His research is in the areas of microwave devices, RF integrated circuits, low-noise technology, and CAD.

Dr. Gupta has served on the IEEE Microwave Theory and Techniques Society's (IEEE MTT-S) Administrative Committee (AdCom), Technical Committees, a Standards Committee, and Speakers' Bureau, and also as Chapter chairman of the Boston and Chicago Chapters. In addition, he has been a member of the Editorial Board of the IEEE TRANSACTIONS ON MICROWAVE THEORY AND TECHNIQUES, the editor-in-chief of *IEEE Microwave and Guided Wave Letters* (from 1998 to 2000), and is the editor of the *IEEE Microwave Magazine* (beginning with 2003).