Guest Editorial

RECENT advances in microwave computer-aided design (CAD) technology, the availability of powerful PC's, workstations, and massively parallel systems, suggest the feasibility of interfacing electromagnetic (EM) simulations into optimization systems or CAD frameworks for direct application of powerful optimizers. With fast, robust, commercial EM simulators increasingly available, microwave engineers are already pushing the frontiers beyond traditional uses of EM simulators. The new thrust is to integrate EM simulations directly into the linear/nonlinear circuit design process in a manner transparent to the designer.

The previous Special Issue of the IEEE TRANSACTIONS ON MICROWAVE THEORY AND TECHNIQUES for which I was Guest Editor (vol. 40, no. 7, July 1992) had a broader focus: process-oriented microwave CAD and modeling. This present Special Issue addresses expectations of using EM simulations as effective tools in an automated design environment. Expectations for this have been raised, in part by myself, based on the considerable and excellent work currently in progress. This emerging design technology is expected to be a cornerstone of future integrated CAD systems.

In the call for papers, novel theoretical contributions as well as practical applications and software implementational aspects were encouraged, including: 1) design with tolerances and yield-driven design using EM simulators; 2) implementable adjoint parameter sensitivity computations; 3) automatic layout optimization with EM validation; 4) techniques for capturing and automating parameterization of two-dimensional (2-D) and three-dimensional (3-D) geometries; 5) novel parameterized geometrical model primitives; 6) scalable models for optimization; 7) space-mapping optimization; 8) quasi-global modeling of EM simulated subcircuits and devices; 9) parameter extraction methodologies for companion modeling; 10) novel techniques for numerical, geometrical, and EM decomposition; 11) optimization strategies for complex and irregular shapes; 12) active device physical/EM simulation and optimization; 13) use of supercomputers, massively parallel and heterogeneous workstations; 14) novel software architectures for EM optimization environments; 15) use of databases and automated table look-up for EM simulations; 16) multidimensional response approximation and effective interpolation techniques; 17) exploitation of meshing, simulation accuracy, and simulation speed; 18) techniques for inverse electromagnetic problems; 19) visualization for automated EM design; 20) mixed analytical, empirical, and numerical EM simulation and optimization; 21) merging of linear/nonlinear circuit theoretic and field-theoretic simulations; 22) asymptotic waveform techniques applied to EM simulations; 23) optimization techniques for chip compaction; 24) optimization in the frequency, time, and mixed domains; and 25) applications to filters, multiplexers, antennas, waveguides, monolithic microwave integrated circuits (MMIC's), interconnects, etc.

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I am fortunate to be able to include three invited papers dealing with optimization-related subjects. The first is by Veluswami, Nakhla, and Zhang, one of the foremost groups in high-speed/high-frequency (HF) circuit design. It deals with the application of neural network modeling to EM-based CAD and optimization. The second invited paper, by Jain and Onno, documents the authors' expertise in state-of-the-art industrial applications of commercial EM simulators. The third invited paper is a very comprehensive survey of Professor Arndt's approach to design of waveguide components using EM building blocks. This approach offers both high speed and high accuracy.

Contributed papers deal with decomposition, space mapping, adjoint sensitivity computations, neural networks, and a variety of relevant numerical, geometrical, and computational techniques for improving the effectiveness of EM-field solvers in design automation. I am particularly pleased by the contributions reporting implementation by industry. I also note that most of the papers originate in the North American continent.

Ye and Mansour present a novel technique stimulated by the recent space-mapping technique (also discussed within the pages of this issue) for filter design. Their technique, similar to space mapping, enjoys the accuracy of a full-wave simulator and the speed of a circuit simulator. Waveguide to microstrip optimization is addressed by Lee and Itoh. The use of finite-difference time domain (FDTD) within an optimization loop is described by Miazga and Gwarek, while MMIC element modeling employing neural networks is studied by Creech *et al*. Device–wave interaction is handled by an algorithm merging FDTD with packaged nonlinear active components, in an excellent example of what I believe may be a future trend for dealing with highly integrated systems, including electromagnetic compatibility(EMC)/electromagnetic interference (EMI) effects. Data interpolation and extrapolation over a frequency band exploiting singular value decomposition is described by Adve *et al*. This is particularly useful for fast frequency sweeps. A finite-element modal frequency method is offered by Brauer and Lizalek. Alos and Guglielmi present an interesting filter design technique using an EM solver.

The Bonani *et al*. paper, while appearing somewhat disjoint from the rest of the papers, does address optimization-oriented physics-based design of devices and circuits. The boundary between this and traditional EM simulation is likely to become fuzzy in the future.

After working for so long in the area of adjoint network sensitivity evaluation myself, I am particularly pleased to see the paper by Mongiardo and Ravanelli dealing with the application of adjoint networks to the design of radiating structures.

As this Special Issue shows, numerical methods of EM field-theory practitioners and those of circuit-theory practitioners are now substantially intertwined. The bond between the various computational modules is also increasingly being further strengthened through modeling practices which ensure effective sensitivity information transfer.

One of the best examples of practical hands-on use of EM simulators in microwave design is exemplified by an outstanding short course recently delivered by Dan Swanson of Watkins-Johnson, CA. Results from his studies and runs of several popular field solvers, from 2-D to 3-D, are presented by Swanson, including implementation of optimization technology [1].

Defining and shaping this new collection of papers has been challenging. It offered me a new opportunity to interact with an outstanding group of researchers and innovators. My long-time collaborators Dr. R. M. Biernacki and Dr. S. H. Chen of Optimization Systems Associates, (OSA), Ont., Canada, helped me in many ways. Apart from their contributions to the reviewing process they provided comments on the Issue's technical focus and content. Administrative coordination was cheerfully assumed by my assistant, Joan Tripp, of OSA.

My thanks go to many tireless authors and reviewers, and also to Dr. Robert J. Trew, Editor, for his enthusiasm and support. Through the strict, but fair, review process we have all aspired to, I believe we have all contributed to the success of this Special Issue.

The alphabetical listing of reviewers used for this IEEE TRANSACTIONS ON MICROWAVE THEORY AND TECHNIQUES, vol. 45, no. 5, May 1997 follows.

F. Arndt
R. M. Biernacki
J. Bornemann
A. C. Cangellaris
G. Carrer
V. A. Monaco
M. Mongiardo
A. Morini
T. Mukherjee
R. A. Nicolaides
M. Celuch-Marcysiak
K. Chang
S. H. Chen
R. C. Compton
G. L. Creech
D. de Zutter
M. Dionigi
S. M. El-Ghazaly
F. Filicori
O. Fordham
G. Gatti
S. F. Ghosh
M. Guglielmi
V. F. Hanna
R. J. Harrington
W. J. R. Hoefer
T. S. Horng
B. Houshmand
R. H. Jansen
L. P. B. Katehi
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C. M. Snowden
M. I. Sobhy
R. Sorrentino
M. A. Styblinski
D. G. Swanson, Jr.
A. Taflove
R. J. Trew
V. K. Tripathi
R. Vahldieck
Q. Wang
I. Wolff
T. Ytterdal
K. A. Zaki
Q.-J. Zhang

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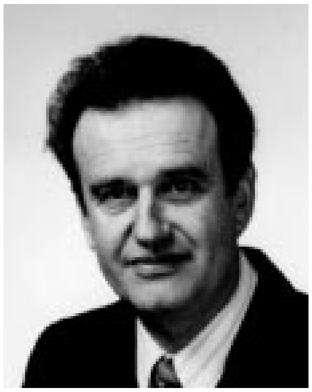
REFERENCES

[1] D. G. Swanson, Jr., "EM field simulators made practical," Besser Associates, Los Altos, CA, Jan. 20–21, 1997.



John W. Bandler (S'66–M'66–SM'74–F'78) was born in Jerusalem, Israel, on November 9, 1941. He studied at Imperial College of Science and Technology, London, U.K., from 1960 to 1966. He received the B.Sc. (Eng.), Ph.D., and D.Sc. (Eng.) degrees from the University of London, London, U.K., in 1963, 1967, and 1976, respectively.

He joined Mullard Research Laboratories, Redhill, Surrey, England, in 1966. From 1967 to 1969 he was a Post-Doctoral Fellow and Sessional Lecturer at the University of Manitoba, Winnipeg, Canada. He joined McMaster University, Hamilton, Ont., Canada, in 1969, where he is currently Professor of Electrical and Computer Engineering. Dr. Bandler has served as Chairman of the Department of Electrical Engineering and Dean of the Faculty of Engineering. He currently directs research in the Simulation Optimization Systems Research Laboratory. He is President of Optimization Systems Associates Inc. (OSA), which he founded in 1983. OSA implemented a first-generation yield-driven microwave CAD capability for Raytheon in 1985, followed by further innovations in linear and nonlinear microwave CAD technology for the Raytheon/Texas Instruments Joint Venture MIMIC Program. OSA introduced the CAE systems RoMPE in 1988, HarPE in 1989, OSA90 and OSA90/hope in 1991, Empipe in 1992, Empipe3D, and Sonnet's ***empath*** in 1996. Dr. Bandler has contributed to *Modern Filter Theory and Design*, Wiley-Interscience, 1973 and *Analog Methods for Computer-aided Analysis and Diagnosis*, Marcel Dekker, Inc., 1988. He has published more than 290 papers, four of which appear in *Computer-Aided Filter Design*, IEEE Press, 1973, one in each of *Microwave Integrated Circuits*, Artech House, 1975, *Low-Noise Microwave Transistors and Amplifiers*, IEEE Press, 1981, *Microwave Integrated Circuits*, 2nd Ed., Artech House, 1985, *Statistical Design of Integrated Circuits*, IEEE Press, 1987, and *Analog Fault Diagnosis*, IEEE Press, 1987. He has pioneered contributions in simulation, sensitivity analysis, and optimization of linear and nonlinear circuits, statistical design centering, design with tolerances and postproduction tuning, yield-driven design optimization, fault diagnosis of analog circuits, optimal load flow in power systems, GaAs device statistical modeling, and parameter extraction.

Dr. Bandler was an Associate Editor of the IEEE TRANSACTIONS ON MICROWAVE THEORY AND TECHNIQUES (1969–1974), and has continued serving as a member of the Editorial Board. He was Guest Editor of the Special Issue on Computer-Oriented Microwave Practices of the IEEE TRANSACTIONS ON MICROWAVE THEORY AND TECHNIQUES (March 1974) and Guest Co-Editor with Rolf H. Jansen of the Special Issue on Process-Oriented Microwave CAD and Modeling of the IEEE TRANSACTIONS ON MICROWAVE THEORY AND TECHNIQUES (July 1992). He was Guest Editor, Special Issue on Optimization-Oriented Microwave CAD, *International Journal of Microwave and Millimeterwave Computer-Aided Engineering*, 1997. He joined the Editorial Boards of the International Journal of Numerical Modeling in 1987, and the International Journal of Microwave and Millimeterwave Computer-Aided Engineering in 1989. Dr. Bandler is a Fellow of the Royal Society of Canada, a Fellow of the Institute of Electrical and Electronics Engineers, a Fellow of the Institution of Electrical Engineers (Great Britain), a member of the Association of Professional Engineers of the Province of Ontario (Canada), a member of the MIT Electromagnetics Academy, and a member of the Micronet Network of Centres of Excellence. He received the Automatic Radio Frequency Techniques Group (ARFTG) Automated Measurements Career Award in 1994.