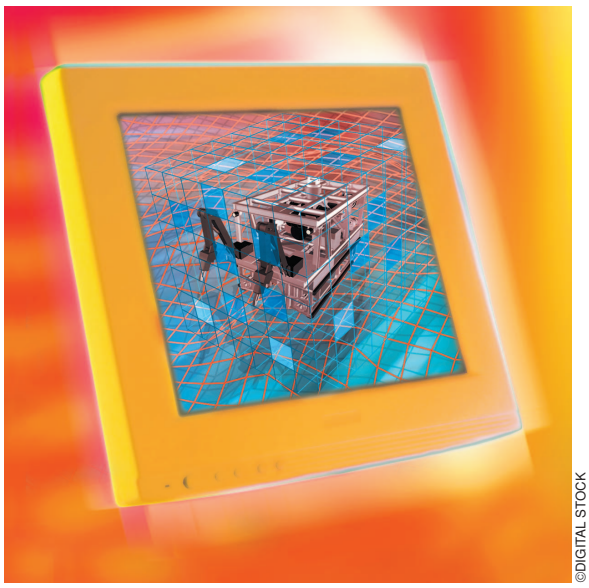
From the Guest Editor's Desk

Electromagnetic Software in Microwave Engineering

■ **Natalia K. Nikolova**

This issue of the *IEEE Microwave Magazine* is dedicated to electromagnetic software in microwave engineering. Computer-based analysis is at the core of modern simulation tools, and it has revolutionized engineering design, even more so in microwave engineering where these tools allow us to "see" the electromagnetic field and its effects such as current and charge distributions. Cosimulation and multiphysics simulation have grown remarkably in the last decade to provide designers with unprecedented insight into the interaction of the electromagnetic field with circuits, thermal flow, and mechanical motion. In the span of more than 35 years, simulation software has evolved into a variety of complex packages equipped with sophisticated layout and visualization modules. The numerical engines employ computational methods whose efficiency and versatility have improved greatly since their time of inception, mostly in the 1970s. Such packages, now commercially available, have allowed designers to leave behind the drawing board and the look-up tables and to shortcut through several stages of expensive prototyping and manual tuning. Recent advances in applied optimization have found their way into microwave design software. Automated parameterization is now available in practically all commercial packages and it enables iterative optimization procedures. It is not uncommon in modern design practices to leave to the computer fully automated tasks such as final tuning, tolerance, or yield analyses.



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The issue contains a record number of articles: seven features and six application notes. They cover a wide spectrum of topics ranging from comprehensive reviews to novel developments in the microwave software technology.

Yu et al. (ComDev International) share experience in using three-dimensional (3-D) electromagnetic field simulators to design passive microwave devices—resonators, an orthomode transducer, broad-band (low-pass) filters, narrow-band combline and dielectric-resonator filters, and a coaxial T-switch. Comparisons and discussions make this article highly engaging reading and a valuable source of technical tips and hints.

The electromagnetic software industry also shares its knowledge and opinions on the latest developments. Weiland et al. (Computer Simulation Technology, CST) bridge academic and industrial views on electromagnetic simulation with broad overview of time- and frequency-domain methods employed in contemporary commercial packages, their applicability ranges, and

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their pros and cons. The discussion is abundantly supported by examples. The reader will enjoy and benefit from the "tips and tricks" offered in this technical yet friendly reading.

Jakobus et al. (EM Software & Systems, EMSS) guide the reader through the newest features in a method-of-moments (MoM) simulation tool. Examples ranging from microstrip and dielectric-resonator filters to helix antennas and frequency selective surfaces (FSS) convince the microwave engineer that MoM-based techniques have evolved into powerful and versatile simulation tools which can handle very complex heterogeneous structures through clever and highly efficient hybridization approaches.

New methodologies for planar design are presented by Rautio. Hear the captivating story of one of the pioneers in the microwave software industry, learn through his experiences from times when electromagnetic software was making its entry into industrial design, and make the most of the new technology of calibrated ports.

Williams and Rousselle (Ansoft Corp.) make a compelling case for electromagnetics-based mixed system design and demonstrate new software capabilities, which allow engineers to design entire end-to-end microwave systems. In a design example of an active phased array mounted on an aircraft, they explore the powerful capabilities of electromagnetic field simulation which is tightly and bidirectionally coupled to nonlinear circuit analysis.

Contributors from academia provide overviews of topics which may define new directions for the microwave software industry. Koziel et al. review the state-of-the-art of space mapping methodologies and place them contextually into the history of design optimization and modeling of microwave circuits. Prof. So introduces the method of weighted residuals (MWR), which unifies the electromagnetic modeling approaches and classifies them according to the choice of expansion and testing functions as well as the computed physical quantities. The MWR is viewed as the foundation for building an object-oriented software framework for computational electromagnetics.

The application notes discuss particular software features applied to various microwave design problems. Zheng and Wan (Zeland Software, Inc.) discuss the full-wave simulation of radio-frequency integrated-circuit (RFIC) passive devices from industrial layouts. Penney (Remcom Inc.) discusses the Rotman lens design using time-domain simulation. Celuch and Gwarek (Warsaw University of Technology, QWED Sp. z o.o.) discuss symmetries and how they are used in the vector two-dimensional (V2-D) method to reduce the 3-D geometry to a rigorous 2-D model. Design examples demonstrate the V2-D method in action through an implementation in a highly efficient body of revolution finite-difference time-domain (BOR FDTD) analysis engine. Kolundzija and Sumic (University of Belgrade, WIPL-D d.o.o.) discuss "smart reduction" techniques in MoM-based commercial software, which allow for drastic reduction of computational resources required by electrically large and complex radiation and scattering problems. Arndt (University of Bremen, MiG, Microwave Innovation Group) introduces novel state-of-the-art hybrid simulation technology for fast electromagnetic design solutions. Remarkable efficiency and optimization capabilities are demonstrated through high-complexity waveguide and antenna design examples. Johns (CST of America) outlines an efficient compact source approach to analyzing antenna performance where the effects of the environment are taken into account.