Computer-aided design for optoelectronic systems: introduction to the feature issue

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Welcome to the first special issue of *Applied Optics* on computer-aided design for optoelectronic systems. This special issue stemmed from our realization of the need for dialogue between optoelectronic system designers and computer-aided-design developers, as well as from the realization that various research groups are developing or, in some instances, have already developed and commercialized such tools. Our goal for this special issue is to enhance this type of dialogue by showing to the optoelectronic system design community the current state of optoelectronic computer-aided-design tools. © 1998 Optical Society of America

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In recent years developments in optoelectronic (OE) technologies have made them practical for use in computing and communications systems. In some instances these technologies have now been inserted in commercial products. It is, however, still difficult and time consuming for engineers who design and build such systems to evaluate effectively how OE devices can be used to make components and how these components can be integrated to build systems. This has been due to the lack of available tools for the design, analysis, and simulation of systems that integrate OE technologies. These tools are themselves hard to develop because OE systems are by nature heterogeneous, combining various technologies such as electronic circuits and OE devices, as well as optical and micro-optical components. Furthermore, systems based on OE technologies are assembled with packaging techniques for which mechanical or thermal analysis and evaluation tools are not generally available. There are commercially available optical system design tools, both for lens design and waveguide analysis. However, there currently is no tool, or set of tools, that spans all the technologies required for OE system design. This is in sharp contrast to the state of electronic design automation tools, which are extensive and have, over the past few years, fueled the exponential growth of the semiconductor-based industry.

System-level OE design tools should enable designers to simulate their designs, perform trade-off analyses among various technological and architectural solutions, and potentially provide feedback to materials and device engineers to get improved components that match specific system requirements. A feature of such tools would be the ability to predict and project accurately and quickly system performance such as power consumption, speed, bit-error rate, weight, volume, cost, etc. In addition, OE design tools could also enable automatic synthesis of some parts of the system: electronic, OE, or optic. Finally, these tools must provide a good balance between accuracy and run time.

Each of the ten papers presented in this special issue addresses some aspect of these requirements. We hope that readers, and in particular, system designers, will react to these papers and respond by interacting with the growing OE design tool community.

The first two papers describe three complete software tools, each of which has a set of particular application strengths. COMSIS is dedicated to the simulation and the analysis of integrated optical networks and, in their paper, the authors introduce some new models for the network components. GOLD and OPALS, described in the second paper, are two complementary tools addressing the same application area as COMSIS: OPALS is dedicated to device-level simula-

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tions, while GOLD is meant for dynamic network analysis.

The second group of papers presents software tools in development that have goals of broader application, although the tools themselves are incomplete. Each of the three introduces a different philosophy in their approach. The SPICE-based system and Chatoyant are built on existing simulating frameworks and are extended into the OE domain. Both of them, in their current states, are geared toward free-space optical interconnection applications. In contrast, HADLOP was built from scratch for the architectural-level modeling of all kinds of OE systems.

Each of the papers in the third group solves a particular design problem. The first paper describes OASIS, which is a design and analysis tool for parallel optical memories, and emphasizes the need for accurately modeling noise and cross-talk sources in such systems to design appropriate coding schemes. The second paper concentrates on the timing analysis of free-space systems. The third paper represents an example of the other side of the dialogue, in which a device engineer has developed a device model in a form that could be used directly in any of several computer-aided-design (CAD) tools. The fourth paper gives an example of how an existing electronic CAD tool can be extended to include constraints specific to OE systems. Finally, the last paper deals with a very different but important aspect of any system design methodology—cost. Increasingly, economic factors drive system design more than advances in technology do. In many cases the success of a new technology will first depend on its economic feasibility. Thus providing the ability to evaluate the cost and the reliability of specific systems on the basis of new technologies might prove critical.

Of course, ten papers cannot span the entire state of OE CAD tools. However, we hope that they are representative of research and development efforts to the extent that readers will be able to react with comments to guide CAD developers in their goal to produce useful design automation tools.

To further the opportunity for collaborations between OE CAD tool developers and users, we are collecting WWW pointers to these projects. Please contact us by e-mail if you would like to be included in our lists: steve@ee.pitt.edu or philippe@celece.ucsd.edu. We also hope to continue the dialogue at the 1999 Optical Society of America Topical Meeting on Optical Computing (OC '99).