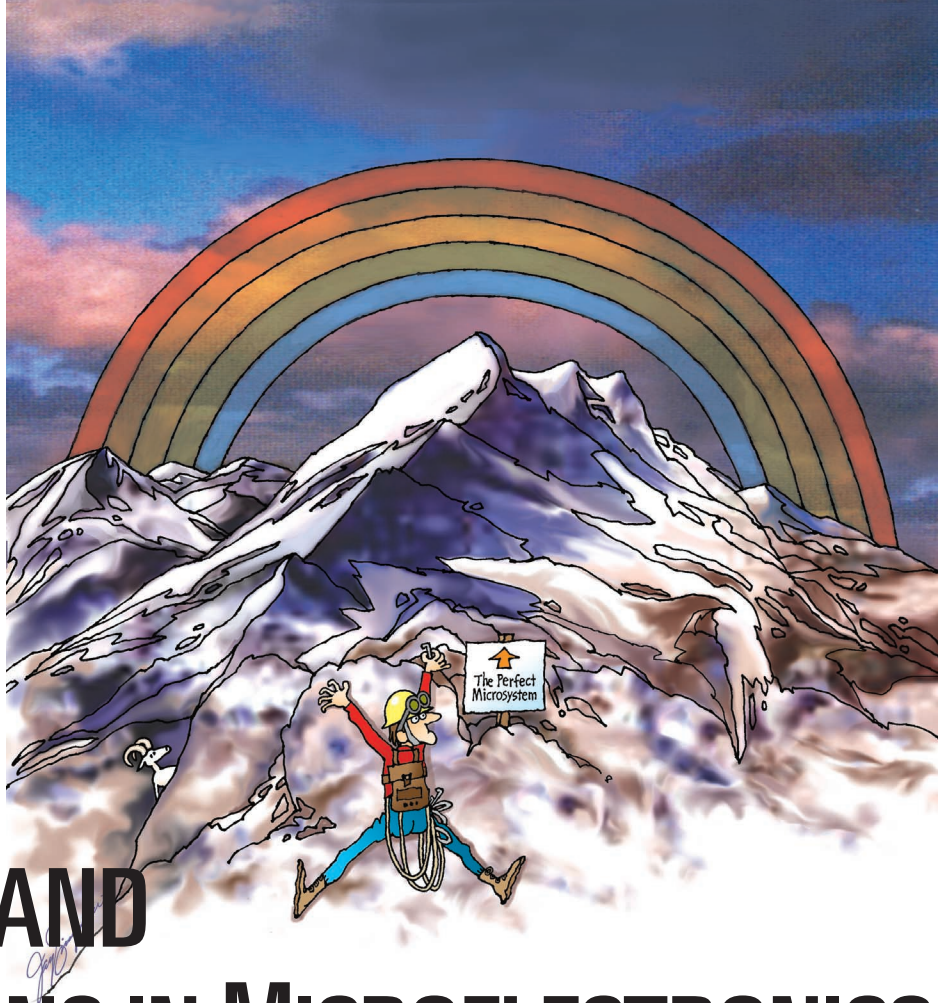


GUEST
EDITORS'
INTRODUCTION:

TRENDS AND DIRECTIONS IN MICROELECTRONICS



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..... In summer 2001, a workshop called “Electronics in the 21st Century: Trends and Challenges,” sponsored by the Special Interest Program Madess II of the Council of National Research (CNR), took place in Rome. Antonio Paoletti, the project’s scientific director, chaired the event. The goal was to assess the state of the art in electronics at the edge of the nanometer era. The speakers covered a wide spectrum of topics, including system design; automotive electronics; embedded-system networks; optoelectronics and nanotechnology; microelectromechanical systems (MEMS); and telecommunications applications. The speakers were (in order of presentation) Alberto Sangiovanni-Vincentelli, Richard Newton, Theo Claasen, Hugo DeMan, Jan Rabaey, Fabio Romeo, Jim Meindl, David Eaglesham, Eric Ippen, Jeff Bokor, Richard Muller, and Bruno Murari.

This issue contains a subset of the contributions from that workshop, devoted to exploring the main aspects of system on a chip (SOC) use in modern electronics, from market challenges, system-level design issues, and

interconnect problems, to the huge possibilities presented by the use of MEMS.

Moore’s law provides the opportunity for unparalleled computing, communication and storage power in almost any aspect of everyday life. As Theo Claasen points out, although the perceived utility of this growth follows a logarithmic law, the exponential nature of Moore’s law still results in an unprecedented increase in the empowerment of people. In mankind’s history, comparable “revolutions”—advancements enabled by a growth in technology—have arisen from inventions like the printing press and steam engine. Just as in those cases, exploitation of technology requires the appropriate sociological and economic environment; the ability to design and create; solutions to difficult technological challenges; and the interfacing of the technology’s core with an existing environment. In the steam engine’s case, these interfaces were to an environment that included mines, railways, factories, and rivers. So any new technology must deal with complex and heterogeneous environments; advanced micro-

electronics is no different.

The article by Alberto Sangiovanni-Vincentelli uses the automotive electronics domain as a paradigm for the complex commercial, engineering, supply, and production structure the electronic industry must use to invent, design, produce, and sell value in the form of software, hardware, and MEMS. This article focuses on the notion of a platform as the articulation point between top-down and bottom-up design. This paradigm enables sharing platform implementations among a variety of application designers, and applications among a variety of platform implementers.

Theo Claesen offers a broad overview of the system-level design challenges that industry must solve to design SOCs with millions of gates successfully. Claesen explains that a separation of concerns between functionality and architecture enables tradeoff analysis at the highest possible level. He also advocates platforms as a means to enable silicon reuse, while standards for intellectual-property (IP) interchange—often in-house, at least so far—enable design reuse for both hardware and software. Finally, he sees black-box testing as essential for true exchange of IPs. However, testing must stop relying on traditional quiescent-current measurement techniques because their effectiveness is diminishing with CMOS process scaling.

James Meindl illustrates several ways of attacking an essential issue for the next technology nodes, those from 90 nm to 22 nm: the increasing importance of interconnect delay and power. Global interconnect architectures (including on-chip networking aspects) and physical wiring design rules (dictating different width and thickness for different layers) are essential to limit the otherwise exponential increase in wire delays versus active-element delays. In the future, 3D structures will also alleviate the wiring congestion problem, and thus reduce the effect of interconnects on delay and power.

Finally, Bruno Murari discusses how to interface electronic systems with the external world in a much more efficient manner than what is done today. These efficient interfaces rely on sensors, actuators, antennas, and other discrete electronic components. Today, designers not only have the choice of fabricating these components as fluidic, inertial,

RF, optical, and mechanical systems, but they can also use MEMS to realize substantial fabrication and deployment cost savings.

After reading this issue, we hope you will have a clearer idea of the great opportunities that lie ahead, and of the amazing difficulties that those of us working in microelectronics must overcome, to deliver on the promise of these advances. Key to this task will be the development of platform-based design and the separation of concerns on the design side. New interconnect architectures and the use of MEMS will be essential on the implementation side. MICRO

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