

## FOREWORD

This theme issue contains the lectures presented at a recent workshop on “Visions Of Nonlinear Science In The 21st Century”, held in Sevilla, Spain, on June 26, 1996. This workshop was organized as a Distinguished Plenary Lecture Session to honor Professor Leon O. Chua on the occasion of his 60th birthday. In recognition of his numerous contributions to the broad field of nonlinear science, we hoped that this series of authoritative and visionary lectures by eminent scientists would provide the most appropriate birthday present. This workshop was organized by the Spanish National Microelectronics Center through its Institute of Microelectronics of Sevilla, and co-sponsored by the Circuits and Systems Society of the Institute of Electrical and Electronic Engineers, Inc., and by the Office of Naval Research. It was sandwiched between two conferences (one immediately before June 26, and the other immediately after this date), namely, the Fourth International Workshop on Cellular Neural Networks and their Applications (CNNA-96) and the Workshop on Nonlinear Dynamics of Electronic Systems (NDES-96), both held in Sevilla immediately before and after the 26th of June.

Traditionally these two workshops have been independently scheduled at different seasons of the year even though there is considerable overlap among their participants. In order to provide an opportunity for attendees from these two separate workshops to attend the above cited plenary lectures by eminent scientists (including Nobel Laureate Ilya Prigogine). The respective organizers of these two workshops had decided to schedule them so that they overlapped with the plenary session. In organizing the distinguished lecture session, we had to consider three issues. The first one was what to offer. After much deliberation, we opted for a visionary workshop that would peer into the next century. Our plan was to invite a few eminent scientists, who have made major contributions in different areas of nonlinear science or technology, to deliver a formal lecture on their visions of the great challenges and possible payoffs from nonlinear science, mathematics and technology, for the 21st century. We believe that the thoughtful ideas and positions to be advocated by these distinguished lecturers will help to identify important but tractable research directions in nonlinear science, and to provide leadership and inspiration to future generations of researchers for

solving many fundamental problems from such multidisciplinary areas as neural networks, artificial intelligence, nanotechnology, nonlinear dynamics, nonlinear mathematics, self organization, complexity, artificial life, etc. Our main objective in this workshop was to identify some of the most fundamental and significant problems which are tractable and economically feasible, and whose solutions are likely to have major impact in industry as well as economy in the 21st century and beyond. The second issue that we had to address was who to invite? After much consultation, we narrowed it down to a short list which included the authors from this theme issue. We wish to take this opportunity to thank them for accepting our invitations, and for their truly outstanding, inspiring, and visionary lectures.

The third issue to consider was deciding upon the target audience of the lectures. Of course, the majority of the audience would have been scientists and engineers. However, we also recognized that much of the visions to be projected by the speakers would most likely call for generations of young blood in the coming decades. Consequently, we decided to also invite students. After these three issues were resolved, we began applying for the financial support necessary for organizing this workshop. We wish therefore to take this opportunity to acknowledge with deep gratitude the support we have received from several organizations, including the Spanish National and Regional Research Agencies, the National Research Council and the University of Sevilla.

The workshop was a great success. Besides the technical presentations, which were far beyond our expectations in terms of quality, the attendance was impressive: There were more than 150 scientists and several hundred students in the audience. I hope all of these students will take advantage of this privileged day and that most of them will remember, in the future, the concepts discussed at this seminar, and contribute to enhance them, remembering, at the same time, the celebration of the anniversary such an extraordinary scientist. Following a hardworking day, a magnificent banquet was held in a romantic setting — an old moorish-style villa surrounded by renaissance gardens, and accompanied by enchanting music and colorful flamenco dancers. The banquet provided the atmosphere for learning the human side of a great scientist. Many friends and former students of Prof. Chua recounted thoughtful anecdotes and fond memories of days gone by. The atmosphere was warm and joyful, especially when Prof. Chua's family described, to the audience' delight, a poignant portrait of Prof. Chua as a husband and a father. His diversity in life was further enhanced by Prof. Mira's thoughtful testimony of Prof. Chua's superb wine cellar, and his penchant for vertical and horizontal tasting of fine wines. We close this editorial with a tribute to Prof. Chua's contributions to science and engineering

during the past three decades. Among his many fundamental contributions, perhaps the most significant was his creation of an axiomatic foundation for nonlinear circuit theory where a logically consistent hierarchy of nonlinear circuit elements is defined in terms of a nonlinear constitutive relation between a conjugate pair of circuit variables. This highly original approach was instrumental in clarifying the intrinsic nature of many nonlinear devices as well as in the systematic discovery of fundamental and higher-order circuit elements, including memristors, mutators, and other algebraic elements. In particular, Chua's 1969 seminal book on Introduction to Nonlinear Network Theory (a classic and essential reference worldwide) is based entirely on this axiomatic approach and the two classic Kirchhoff laws. This book, together with his seminal publications on the qualitative theory of dynamic nonlinear circuits in the early seventies, have provided a solid foundation of nonlinear circuit theory, and have stimulated intense worldwide research activities. These worldwide efforts have spawned new research directions. One such area on chaos and nonlinear dynamics was stimulated by his invention of Chua's Circuit. This is an area that has evolved into its own identity with an annual international workshop (NDES). Another area, which also evolved into an independent discipline is Cellular Neural Networks, which he invented in 1987. This area is the subject of a bi-annual international workshop. From a historical perspective, it is interesting to point out that Chua's 1964 Ph.D. thesis already contained an in-depth mathematical formulation and analysis of strongly nonlinear circuits with multiple solutions, which implies bifurcations! There were very few publications in engineering and even in science in 1964 which involved nonlinearities. Chua's dissertation was the first to stress the importance of facing the nonlinearity head on, and not to avoid it by linearization. As a tribute to Prof. Chua's legacy to science, we remark that he has always been a strong advocate of mathematical rigor as an essential standard and element in the discipline of nonlinear science, even though he has also emphasized the crucial importance of physical interpretations and experimental confirmations.

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