APPLIED SYSTEMS AND CYBERNETICS

Edited by G.E. LASKER

VOLUME 2
Systems Concepts, Models and Methodology

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Proceedings of the International Congress on Applied Systems Research and Cybernetics

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Proceedings of the International Congress on Applied Systems Research and Cybernetics
edited by Dr. George Lasker

VOLUME I:	THE QUALITY OF LIFE: SYSTEMS APPROACHES
VOLUME II:	SYSTEMS CONCEPTS, MODELS and METHODOLOGY
VOLUME III:	HUMAN SYSTEMS, SOCIOCYBERNETICS, MANAGEMENT and ORGANIZATIONS
VOLUME IV:	SYSTEMS RESEARCH IN HEALTH CARE, BIOCYBERNETICS and ECOLOGY
VOLUME V:	SYSTEMS APPROACHES IN COMPUTER SCIENCE and MATHEMATICS
VOLUME VI:	FUZZY SETS and FUZZY SYSTEMS, POSSIBILITY THEORY and SPECIAL TOPICS IN SYSTEMS RESEARCH

All papers submitted for the presentation at the Congress and for the subsequent publication in the Proceedings have been reviewed, first on the basis of extended abstracts and then on the basis of final manuscripts. The authors submitted camera-ready copies and their papers appear here essentially as we received them. Inclusion of the paper in the Proceedings in no way constitutes the endorcement by the Congress Council of the authors' views and opinions.

THE INTERNATIONAL CONGRESS

ON

APPLIED SYSTEMS RESEARCH AND CYBERNETICS

held

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PREFACE

The Proceedings contain a selection of papers presented at the International Congress on Applied Systems and Cybernetics, which was held December 12-16, 1980 at the Acapulco Convention Center in Acapulco, Mexico. The papers cover a large variety of subject areas and describe current trends and advances in the application of Systems Science and Cybernetics to many different fields.

The interdisciplinary oriented Congress provided a forum for presenting and discussing scientific works in the areas of applied systems research, cybernetics and several other fields. More than 1200 scientists, engineers and professionals from 42 countries presented in parallel sessions over a five-day period nearly 1000 scientific papers.

Since the main theme of the Congress was: THE QUALITY OF LIFE AND HOW TO IMPROVE IT, a large number of papers that have been included in the Proceedings deal with Quality of Life related issues. The papers examine how systems research and cybernetics should be used to help us solve various technical, socio-political, ecological, and other problems that we are facing at present and prepare us for the challenges of the future. Many papers also examine how modern sciences can more effectively utilize systems methodology in order to improve the quality of human life in our society, to promote individual freedom, social justice, civilized discourse, peace, and the dignity of man. Topical coverage of these Proceedings clearly reflect and confirm a newly emerging trend in the evolution of Systems Science and Cybernetics, characterized by a shift from the value-free sciences in the past towards value-oriented sciences at present and in the future. In my opinion, it is through this evolution that Systems Science and Cybernetics will acquire a new important human and spiritual dimension, which will tremendously expand the domain and the scope of research activities of these two sciences in the years to come.

The Congress Proceedings are divided into six volumes. Each volume covers one or more subject areas that are relevant to the major themes of the Congress.

Volume I is devoted to the Quality of Life issues and also includes the inaugural addresses that were presented at the Opening Session of the Congress. The volume contains papers that present diverse points of view and concepts of quality of life, and

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show how quality of life can be measured and analyzed in various social settings through a variety of methods and approaches. These papers also examine the impact of modern technology and automation on the human environment and on the quality of life. Many of these papers study the effect of the development of personality and the development of knowledge on the quality of life. They also examine how changes in man and the human society affect the quality of life. Some papers explore the quality of life in terms of the quality of social interaction and participation, and in terms of quality of education. Quality of life is also explored here in the context of social values, beliefs, ethics, lifestyles and basic needs.

Several papers in this volume present cross-national and cross-cultural analysis of the quality of life in the U.S.A., Canada, France and elsewhere. These papers examine the effect that income, energy consumption, economic growth, transportation and other factors have on the perception of well-being.

One set of papers studies the quality of life from the political perspective. Another set of papers examines the quality of life in the context of law from a human rights perspective.

A special section of the volume is devoted to the quality of work life from the systems point of view. The volume also examines the contribution of sports to the quality of life and analyzes the quality of life in the context of human kinetics. The concluding section of the volume studies the impact of emerging technologies and communication systems on the quality of human life in the future.

Volume II of the Proceedings focuses on the conceptual and methodological foundation of General Systems Theory and Applied Systems Research. The current thinking in Systems Science and Cybernetics is reflected in the content of the first few introductory sections of the volume. These introductory sections primarily deal with new systems concepts, models and theories of general systems. Some of these concepts are further explored in the section on the epistemological issues in Systems Science and Cybernetics.

Several papers in the subsequent two sections are devoted to the issues of human behavior modeling and to human learning systems. The papers contained in the following sections are devoted to Decision Systems and Decision Analysis, and to Management of Information Systems. These sections cover a broad spectrum of topics ranging from the theoretical decision systems design to the applied decision systems research.

A special section of the volume is devoted to the Systems Research Methodology. It contains many important contributions to the methodology of systems modeling and systems analysis. Several papers in this section also deal with some theoretical issues of general problem solving. Volume II concludes with a section that

deals with methodological issues of systems reliability and maintenance analysis.

Volume III of the Proceedings is devoted to studies of Human Systems, Sociocybernetics and Psychocybernetics. The first section of this volume deals with Philosophic and Policy Issues in Institutional Articulation, and with modeling and analyzing various human systems and institutions. The second section on Management and Organization in Human Systems includes a large variety of papers that examine different approaches to human systems management and study the problem of managerial efficiency. Some of these papers also examine problems related to the activities and functioning of organizations.

The third section of Volume III is devoted to Sociocybernetics. It contains papers that deal primarily with theoretical and philosophical issues of sociocybernetics. Some of these papers also examine sociocybernetics in relationship to the quality of life. The next section, devoted to Psychocybernetics and Behavioral Science, presents several important papers that introduce new systems models of personality. Some papers in this section also examine the developmental changes in the evolution of the individual person.

The following section on Social Interaction and Human Development is closely related to its predecessor. This section contains some excellent papers on the analysis of human evolution and examines in great detail various behavior contingencies in social interaction. This section also presents new developments in conversation theory and addresses the issues of time and dualities in self-reflective dialogical systems.

The subsequent section on Human Service-Delivery Systems contains papers that deal with the planning, organization and functioning of various human service-delivery systems and examines the effect of various information systems on the quality of social work. Several papers of this section also study self-service trends in our society and explore the information needs and infrastructure design in social welfare.

The following section on School Systems and Education presents papers on applied systems research that deal with the application of systems approaches in Educational Environments. The next section contains papers on human values and beliefs. These topics are primarily investigated from a systems perspective and address several important philosophical, ethical, and social issues. Another section on Cross-Cultural Perceptions presents a variety of papers dealing with ways of thinking and seeing among peoples of different cultures of the world.

The subsequent section on Social Development and Urbanization examines the processes of migration, urbanization, industralization and social development from a systems point of view. This

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section also examines the factors that determine the success of the community development.

The next section deals with the Behavioral and Systems Approach to Historical Analysis and presents a systems assessment of specific events from ancient and modern history. The final section of Volume III is devoted to Studies of the Future. The papers presented here examine the future scenarios of human evolution and introduce methodologies for forecasting future developments.

Volume IV is devoted to Systems Research in Health Care, Biocybernetics and Ecology. The first section of this volume contains papers that present various concepts of health care and reflect current thinking in this area. The second section introduces various health care systems and models and addresses some issues on managing the long-term health care facility. It also describes a special information system for public health.

The third section on Systems and Cybernetic Models of Nursing contains several papers on systems models of nursing care and on the application of General Systems Theory to nursing. The papers in this section also discuss various concepts of nursing and examine the quality of health care.

The next section on Health Care Systems Analysis contains papers that deal with the application of systems analysis to the design, development, and operation of certain types of health care systems. The following section contains the result of research work in the area of Medical Diagnostics and Therapy. The papers of this section also show how certain statistical methodology and computer-based information systems can aid the physician in his daily diagnostic and therapeutic work.

The subsequent section is devoted to Stress and to the Behavioral Aspects of Health. The papers presented here propose various strategies for stress management and examine the effect of common stressors on daily living. The section also contains an important paper on cybernetic foundations of preventive behavioral health science.

In the next section on Computer-Aided Analysis and Modeling of Biosystems, the authors describe recent advances in modeling and simulation of spatial tumor growth, the computer-assisted chromosome karyotyping and a new approach to constructing agonistic-antagonistic models of biosystems. The following section on Systems Research in Biocybernetics contains papers that investigate special biological systems and processes. Several papers study cybernetic models of neural systems, retinal processes and vertebrate skeletal muscles. This section also examines the control mechanism of fermentation processes from the systems point of view.

A special part of Volume IV is devoted to Systems Research in Ecology. This part consists of the last four sections of the

volume. The first section on ecology deals with Modeling and Simulation of Ecological Systems. The second section deals with Systems Approach to Environmental Quality and contains several important papers on environmental systems analysis. The third section on the Management of Ecological Systems deals primarily with decision-making in ecosystems management. Finally, the last section of the volume is devoted to the Assessment of the Environmental Impact. The papers presented in this section examine the effects of competition and predation on diversity of communities, the role of ecosystems analysis in risk assessment of environmental chemicals, and the large scale environmental impact from oil shale development.

Volume V of the Proceedings examines Systems Approaches in Computer Science and Mathematics and concentrates on several major areas of current systems research in computer science and theoretical and applied mathematics. The first section of the volume is devoted to the studies of National Information Resources and Systems. The papers presented in this section examine various information-based measures of society and study the information as a national economic resource. The presented papers also describe the national information services of certain countries.

The second section on Database Systems contains papers that deal with the design, modeling, analysis and methodologies of integrated database systems. The papers also study the impact of auxiliary information and update operations on database computer architecture and examine the long-term implications of database machine research. The third section on Computers, Microcomputers, and Microprocessors contains papers that deal with various problems of applications of computer- and microprocessors-based systems. The following section on Computer Software technology presents papers that deal with interactive programming, computer-aided graphics and computer security requirements. This section also explores the future of computer software technology and its effects on computer program development.

The next two sections are devoted to Distribution Systems and to Natural and Computer Languages. In the language section, several papers are presented that explore the gap between natural and computer language and that deal with design issues in natural language processing systems. The following section is devoted to Man-Machine Interaction and Communication. It contains papers on man-computer communication by voice, on user interface of computing software, and on other related topics. The subsequent section on Artificial Intelligence and Automata Theory describes a microcomputer based artificial intelligence laboratory, knowledge structures defined through the concepts of general automata and a design of an image generator with an information exchange.

Another section on Information Retrieval contains papers that discuss biblioinformatics retrieval, accessibility of local information retrieval systems, retrieval aspects of the universal relation for attribute-oriented query languages and other related

topics. The subsequent section deals with a System Approach to Word Processing.

The following section of Volume V is devoted to Pattern Recognition and Scene Analysis. This section also deals with automatic interpretation of symbolic data on maps and engineering drawings, visual isolation and recognition of objects by a camera-computer system and with use of a range-finder for three-dimensional scene analysis. The next section on Simulation Methodology incorporates papers that introduce several new simulation systems models, methods and approaches. This section also illustrates how certain simulation techniques can be used for experimental optimization.

The following two sections are devoted to Human Factors, to Computer-Aided Instructional Systems and to Computer Science Education. The papers in these sections deal with human factor issues in office information systems, human production and detection of errors in data systems, user satisfaction and with other related topics. The last section on computer science is devoted to the Application of Computers in the Humanities. This section contains papers on a large variety of topics ranging from computer-aided analysis of novels, through computer-assisted analysis of music to the computerized content analysis of narrative in annual reports.

Four sections of Volume V are devoted to Mathematics. The first mathematics section of the volume deals with Concepts, Models and Techniques of Mathematical Programming. The second section deals with the Methodology of Mathematical Modeling and Control of Large Scale and Distribution Parameter Systems. The third section is devoted to the Theory and Applications of Stochastic Systems and Processes, and the last section of this volume contains papers on Special Mathematical Methods and Models.

Volume VI of the Proceedings is devoted to Fuzzy Sets and Fuzzy Systems, to Possibility Theory and it also covers Special Topics in Systems Research. The first section of the volume deals with New Concepts of non-quantifiable and ill-defined (fuzzy) data and systems. The papers presented here address many important problems in the conceptual foundations of fuzzy set theory. They deal with a mathematical theory of uncertainty, fuzzy experiments and with precision and relevancy of fuzzy sets. They also examine how to cope with ill-defined (fuzzy) problems.

The second section of Volume VI reports on Recent Developments in Fuzzy Set Theory. The papers contained in this section describe recent developments in fuzzy arithmetic and fuzzy topology, fuzzy-lip functions and some other related topics. They also deal with the analysis and synthesis of fuzzy mappings and explore problems of information transmission by a system of fuzzy events. The following two sections of this volume deal with Statistical Analysis of Fuzzy Data and examine different notions of Fuzzy Measures.

The subsequent two sections are devoted to Fuzzy Logic and Fuzzy Relations. The papers in these sections examine fuzzy logic knowledge bases and automated fuzzy reasoning, linguistic approach in fuzzy logic, a fuzzy propositional model of concept structure and various types of fuzzy relations on fuzzy sets. The next section on Fuzzy Systems deals with fuzzy linear models, with optimal control of fuzzy systems and also addresses some problems of modeling of uncertain systems. The following section of Volume VI is devoted to Possibility Theory and its applications. It deals with model semantics in fuzzy set theory, with possibilistic approach to the analysis of evidence and with applications of fuzzy sets and possibility theory to systems management. The subsequent section is devoted to Decision Making. It deals primarily with various aspects of fuzzy decision theory and its applications.

The next section contains papers that are focused on fuzzy set approach to repertory grid analysis. These papers study fuzzy entailment analysis and examine how fuzzy semantics improve precision in the repertory grid. The final section on fuzzy sets presents a variety of papers describing Applications of Fuzzy Set Theory to different fields such as earthquake engineering, ecosystem analysis, computer software design, systems management, etc.

The following part of Volume VI is devoted to Special Topics in Systems Research. The first section of this part presents Descriptive Models of various political systems and processes. The second section deals with Systems Approaches to the Analysis of Socio-economic Development. It presents some important papers on actor-oriented systems theory and on the role of institutional actors in social development. It also addresses several problems of regional economic development. The following section in special topics is devoted to the Modeling of Economic Systems. Several papers presented here introduce various microeconomic and macro-economic models for economic policy analysis.

The subsequent two sections are devoted to the Systems Analysis of Agricultural Development and to the Systems Modeling for Land Use and Resources Planning. The papers in these two sections examine various aspects of agricultural development and present several methods and models for land-use evaluation and land-use planning.

The following section on Modeling of Life Support Systems presents papers that deal with food distribution in relation to government policy. These papers also present systems models for food and nutrition policies, and study the inter-national determinants of nutrition levels. The final section of the volume deals with global socioeconomic problems. In particular, it studies developing countries' capital needs, debt problems and growth prospects. It also examines the role of financial institutions for meeting basic shelter needs and develops the design characteristics of a supporting institution that can effectively deliver affordable

housing to low income target groups.

The wide spectrum of topics covered in these Proceedings indicates that systems research methodology and principles of cybernetics are being applied to an increasingly larger number of disciplines where they are helping us to successfully solve many intricate real-life problems.

However, the most significant contribution of these Proceedings, especially of the papers included in Volume I, is that they help us create greater awareness of the quality of life issues among scientists, engineers and professionals from diverse fields. Hopefully, this will provide a higher motivation and greater inspiration for each of us to get more deeply involved with these issues in our everyday work so that we can make an even greater contribution towards the happiness and well-being of all.

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I would like to take this opportunity to express my thanks to all the participants of the Congress for making this memorable event such a great success and for submitting for publication papers of such an excellent quality. I would also like to express my thanks to all members of the Congress Council, Organizing Committee, Program Committee and Liaison Committee for their kind assistance with the organization of the Congress.

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My special thanks and deep gratitude go also to all my colleagues and friends who organized and chaired a great number of individual Congress Sessions, Panels and Symposia and who reviewed papers that were submitted for presentation at the Congress and for subsequent publication in the Proceedings. These colleagues and friends did a marvelous job and contributed significantly to the success of the Congress. They are: Prof. Ronald Yager who organized the largest Symposium on Fuzzy Sets and Fuzzy Systems; Prof. Jean Echlin who organized a Symposium on Cybernetic Models of Nursing; Prof. Vladimir Slamečka who organized a Symposium on National Information Resources and Systems; Prof. A. K. S. Jardine who organized a Session on Systems Reliability and Maintenance Analysis; Prof. F. A. Shull who organized a Symposium on Managing Human Service Organizations; Prof. R. Perret who organized a Symposium on Modeling and Control of Microbiological Systems; Drs. John A. Busch and Gladys M. Busch who organized a large Symposium on Sociocybernetics; Dr. Stuart Umpleby who organized a Panel on Current Trends in Cybernetics; Prof. James W. Haefner who organized a Symposium on Ecosystems Analysis; Prof. Nancy McDonald who organized a Session on Human Factors in Computer Science; Prof. Jan Kryspin who organized a Symposium on Health Care Systems; Prof. Kan Chen who organized a Session on Decision and Modeling; Prof. Verna Willis who organized a Symposium on Management of Variety in Human Systems; Dr. M. L. Howell who organized a Symposium on Human Kinetics; Prof. Kozma Balkus and Prof. Bruce Grindal who organized a Session on Peace and Quality of Life Through Cultural Development; Prof. Luigi LoGrippo, Prof. Ladislav Matejka and Prof. Richard W. Bailey who organized several Sessions on Computers in the Humanities; Prof. Thomas Casstevens who organized a Symposium on Descriptive Models in Political Science; Dr. Bela H. Banathy who organized a Symposium on Enriching the Quality of Life: A Challenge to Education; Prof. Robert F. Ling who organized a Session on the User Interface of Computing Software; Dr. Barry Smith who organized

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