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# SIMULETTER

# TABLE OF CONTENTS

## MINUTES OF SIGSIM MEETING AT 1984 WINTER
## SIMULATION CONFERENCE

ATTENDING: Osman Balci (Virginia Tech), Gerry Blais (FEDSIM), John Comfort (Florida Int'l. Univ.), Ralph C. Huntsinger (California State Univ., Chico), Richard E. Nance (Virginia Tech), Michael Overstreet (Old Dominion Univ.), Stephen D. Roberts (Regenstrief Institute), Val Silbey (Florida Int'l. Univ.), and Sue Solomon (Eastern Washington Univ.).

Chairman of SIGSIM, Richard E. Nance, called the meeting to order at 8:45 P.M. on November 29, 1984.

1. Secretary/Treasurer, Stephen D. Roberts, reported on the SIGSIM Budget. An almost $8,000 deficit is projected for the FY '85. For SIGSIM to break even and to be financially healthy, a dues increase to $12 during the next fiscal year is inevitable.

2. John Comfort indicated some problems about ACM with regard to the Annual Simulation Symposium.

3. Ralph Huntsinger suggested that SIGSIM activities cover continuous simulation as well. The Chairman invited Huntsinger to submit nominees for an associate editor in the continuous area.

4. Huntsinger also suggested that SIGSIM sponsor professional development seminars before or after the Winter Simulation Conference. Discussions followed. The Chairman agreed to introduce this issue before the WSC Board to assess their response before taking further action.

5. Steve Roberts questioned the objectives of SIGSIM, asking does the group have a clearly defined role in regard to other organizations? Much discussion followed on this topic.

6. The meeting was adjourned at 10:15 P.M.

## INTELLIGENCE IN SIMULATION

## EDITORIAL

This year is the thirtieth anniversary of the first language conceived for simulation of systems modelled as a set of ordinary differential equations.  Selfridge, with all modesty, did even not give a name to his language.

Since the time of Selfridge and the pioners of discrete simulation such as Tocher, Kiviat, and Markowitz, our field went through a series of evolutions.  As expected from the inertia of human intelligence, however, some of the shifts of paradigms were not easily achieved.

Among other achievements in the field, it is currently well accepted to separate models from experimentation specifications, a concept which lead to another practically important concept of "model base."

The importance of the role of system theories in simulation was also established in the 70s.

The synergies of mathematical modelling, experimentation techniques, general system theories, advances in computer and software engineering, and artificial intelligence are being advocated to foster simulation.

For a long time, simulation contributed to the field of artificial intelligence by making possible the cognitive simulation studies.  Now, simulation can benefit from the advances in artificial intelligence (as well as from advances in general system theories, software and computer engineering, and mathematical modelling and experimentation techniques).

The question is not whether or not to have artificial intelligence in simulation, but rather how to have it? at which level? how reliably? how soon? and above all how intelligently?

In 1985, already over half a dozen simulation meetings are announced where artificial intelligence aspect is primordial.

The quotation on the cover of this issue would well summarize an attitude: " ... *unintelligent computerization is not enough.*"

Tuncer I. Ören

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| Data General Desktop <br> Generation Microcomputer | L: 200 $/year | L: 1.000 $ 1st year then <br> 500 $/year |
| IBM SIMULA <br> (OS, VS, VM, MVS, ...) | P: 2.000 $ <br> L: 150 $/month <br> S: 1.000 $ | P: 7.000 $ <br> L: 550 $/month <br> S: 3.500 $ |
| ICL 2900 | P: 1.400 $ | P: 7.000 $ |
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23

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*SIMULATION*

# CONTENTS     *VOLUME 43  :  NUMBER 2  :  AUGUST 1984*

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                        COVER
    Photographs courtesy of The Mount Sinai Medical Center in
    New York.
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Application for membership — Page iii
Guidelines for short technical papers — Inside front cover

# CONTENTS VOLUME 43 : NUMBER 3 : SEPTEMBER 1984

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**COVER**

Maritime simulators. This motion base provides a wide range of roll, pitch and heave for heavy weather shiphandling experience without cargo loss or hull damage. See Feature on page 145.

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**COVER**

In February 1984, Astronaut Bruce McCandless II became the first to fly untethered in space by using the Manned Maneuvering Unit (MMU). The MMU will play a pivotal role in the November 1984 rescue of the Palapa B-2 communications satellite. For details on the MMU, please turn to page 251. (Cover photograph courtesy of Martin Marietta Corporation.)

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# Systems Analysis Modelling Simulation

## Journal of Mathematical Modelling and Simulation in Systems Analysis

# Contents

Volume 1    Number 3                                          1984

# SYSTEMS RESEARCH

## The official journal of the International Federation for Systems Research

# Contents

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# INTERNATIONAL INSTITUTE FOR APPLIED SYSTEMS ANALYSIS
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Robert S. McInnes

IIASA, Publications Department
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## IIASA PUBLICATIONS

The publications listed — with the exception of commercially published books (prefix BK) — are available from the Institute at the prices indicated. Books may be purchased from your regular supplier or, in case of difficulty, directly from the publisher.

IIASA publishes a nontechnical newsletter OPTIONS, conveying information on the Institute's programs and activities. Subscriptions are available free of charge.

## BOOKS

**BK-79-002.** *Performance of Computer Systems. Proceedings of the 4th International Symposium on Modelling and Performance Evaluation of Computer Systems, Vienna, Austria, February 6-8, 1979.* M. Arato, A. Butrimenko, E. Gelenbe, editors. North Holland Publishing Co., Amsterdam, The Netherlands. ISBN 0 444 85332 4

These proceedings are a collection of contributions to computer system performance, selected by the usual refereeing process from papers submitted to the symposium, as well as a few invited papers representing significant novel contributions made during the last year. They represent the thrust and vitality of the subject as well as its capacity to identify important basic problems and major application areas. The main methodological problems appear in the underlying queueing theoretic aspects, in the deterministic analysis of waiting time phenomena, in workload characterization and representation, in the algorithmic aspects of model processing, and in the analysis of measurement data. Major areas for applications are computer architectures, data bases, computer networks, and capacity planning.

The international importance of the area of computer system performance was well reflected at the symposium by participants from 19 countries. The mixture of participants was also evident in the institutions which they represented: 35% from universities, 25% from governmental research organizations, but also 30% from industry and 10% from non-research government bodies. This proves that the area is reaching a stage of maturity where it can contribute directly to progress in practical problems.

Please send your orders and requests for further information to:

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IIASA
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Austria

**BK-79-107.** *Connectivity, Complexity and Catastrophe in Large-Scale Systems.* J.L. Casti. (IIASA INTERNATIONAL SERIES, Vol. 7. Available from John Wiley and Sons Ltd.) ISBN 0 471 27661 8

This book represents an approach to large-scale system modeling that is a challenging synthesis for the systems analyst, the operations research worker, the system theorist, the policy analyst, and the student of social systems.

After pointing out that the mathematical form of a system description dictates the types of questions that can be asked and answered by the model, the author declares that "there is no such thing as a model system: there are many models, each with its own characteristic mathematical features and each capable of addressing a certain subset of important questions about the system and its operation". The book supports this point with examples from a wide spectrum of contexts (such as physics, economic activity, water-resource management, ecology, transportation, and physiology) viewed from the points of view of various models and theories (such as general system theory, control theory, graph theory, linear and nonlinear system theory, and catastrophe theory).

Against this broad background, the book then considers in depth the relations to large-scale systems of the theories of connectivity, complexity, stability, catastrophe, and resilience.

**BK-79-506.** *Methods and Models for Assessing Energy Resources. First IIASA Conference on Energy Resources, May 20-21, 1975.* M. Grenon, editor. (IIASA Proceedings Series, Vol. 5. Available from PERGAMON PRESS.) ISBN 0 08 024443 2

Any long-term energy policy must be based, not on the energy reserves that we will use in the next one or two decades, but on the energy resources that will feed our

energy systems in the next century. Many important decisions have to be made now about those resources. Industry has, for a long time, been interested in estimating energy reserves, which are, to a certain extent, their "energy cashflow". Much less is known about the resources.

Various models and methods have been used to assess long-term resources of coal, oil, gas, and uranium, varying from historical statistics, as promoted by M. King Hubbert, to geological analogy or Monte Carlo simulations. Increasing attention is being paid to these methods, to their limited capacity, to their data requirements, and so forth.

For the first time, a conference convening more than 80 experts from East and West has addressed these methods and their potential applications for assessing world energy resources of coal, petroleum, and uranium. Very active discussions pointed out where progress still has to be made and what the most sound factors are on which to base future methodological developments.

The proceedings of this conference, the first of a series organized by IIASA on energy resources, are a basic contribution to the most important field of world resources.

**BK-80-108.** *Pitfalls of Analysis.* G. Majone, E.S. Quade, editors. (IIASA INTERNATIONAL SERIES, Vol. 8. Available from John Wiley and Sons Ltd.) ISBN 0 471 27746 0

Systems Analysis-or Policy Analysis, as it is sometimes called when public problems are being addressed-aims to deepen our understanding of sociotechnical problems, and to bring about improved solutions to them.

However, the craft of systems analysis is a relatively new one, and its practitioners are still exploring ways to conduct such analyses properly, a task complicated by the necessary use of tools and knowledge from many disciplines and contexts. Any craft learns both by what works and by what fails to work, and systems analysis is no exception. This book contributes to the craft of systems analysis by describing many pitfalls of analysis that will lead to failure, thus helping analysts and users to recognize and avoid them.

**BK-80-109.** *Control and Coordination in Hierarchical Systems.* W. Findeisen, F.N. Bailey, M. Brdys, K. Malinowski, P. Tatjewski, A. Wozniak. (IIASA INTERNATIONAL SERIES, Vol. 9. Available from John Wiley & Sons Ltd.) ISBN 0 471 27742 8

This book presents the applied theory of control and cooordination in hierarchical systems which are those where decision making has been divided in a certain way. It concentrates on various aspects of optimal control in large scale systems and covers a range of topics from multilevel methods for optimizing by interactive feedback procedures to methods for sequential, hierarchical control in large dynamic systems.

**BK-80-510.** *Input-Output Approaches in Global Modeling. Proceedings of the Fifth IIASA Symposium on Global Modeling, September 26-29, 1977.* G. Bruckmann, Editor. (IIASA Proceedings Series, Vol. 9. Available from PERGAMON PRESS.) ISBN 0 08 025863 5

Since 1974, the International Institute for Applied Systems Analysis has been monitoring developments in the field of global modeling. The IIASA conferences on global modeling are intended to serve as a forum for exchanging information among modeling groups. This conference focused on a methodology; the models discussed were all constructed with input-output techniques. The main part of the conference was devoted to the Leontief model, "The Future of the World Economy," and FUGI, Future of Global Interdependence, a model

developed by a group of Japanese scientists. FUGI includes a global input-output model, a global macroeconomic model, and a global metallic resources model, and is published here in full for the first time in English. Reports on other input-output models include a survey of work in the USSR, as well as examples of work in progress in the FRG, the United Kingdom, Poland, and the United States.

**BK-81-202.** *Energy in a Finite World, Vol. 1. Paths to a Sustainable Future. Report by the Energy Systems Program Group of the International Institute for Applied Systems Analysis.* W. Haefele, J. Anderer, A. McDonald, N. Nakicenovic. Published by Ballinger Publishing Co., Cambridge, Mass., USA. ISBN 0 88410 641 1

This volume summarizes the results of a seven-year study conducted at the International Institute for Applied Systems Analysis (IIASA) in Laxenburg, Austria. The work, which involved over 140 scientists from 20 countries, aimed to provide new and critical insights into the international long-term dimensions of the energy problem. Given this objective, the 50-year period from 1980 to 2030 was analyzed in detail, though parts of the study looked even further into the future. Geographically, all countries of the world were included - developed and developing, market and centrally planned economies.

The picture that emerges is one of a world facing, during the 1980-2030 period, what is anticipated to be the steepest ever increase in its population. At the same time, the developing regions of the world, in which most of this population growth will occur, will be trying to close the economic gap separating them from the developed regions. Despite the resultant strains on the world's physical resources, on its institutions, and on human ingenuity, the conclusion is that the physical resources and the human potential exist to provide the energy for a 2030 world that is more prosperous than the world of today while supporting a population double that of 1975. Moreover, if resources are developed judiciously and strategically, the world of 2030 could be at the threshold of a critical and ultimately necessary transition from a global energy system based on depletable fossil fuels to one based on nondepletable, sustainable resources.

The companion volume, *Energy in a Finite World, Vol. 2, A Global Systems Analysis*, also published by Ballinger, presents the study findings in detail, with the references and qualifications typical of a comprehensive scientific work. ER-81-4, *Energy in a Finite World: Executive Summary*, by Alan McDonald, provides a concise summary of the study and is available from IIASA.

**BK-81-203.** *Energy in a Finite World, Vol. 2. A Global Systems Analysis. Report by the Energy Systems Program Group of the International Institute for Applied Systems Analysis.* W. Haefele. Published by Ballinger Publishing Co., Cambridge, Mass., USA. ISBN 0 88410 642 X

This volume presents the results of a seven-year study conducted at the International Institute for Applied Systems Analysis (IIASA) in Laxenburg, Austria. The work, which involved over 140 scientists from 20 countries, aimed to provide new and critical insights into the international long-term dimensions of the energy problem. Given this objective, the 50-year period from 1980 to 2030 was analyzed in detail, though parts of the study looked even further into the future. Geographically, all countries of the world were included - developed and developing, market and centrally planned economies.

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**BK-81-514.** *Modeling of Large-Scale Energy Systems. Proceedings of the IIASA/IFAC Symposium on Modeling of Large-Scale Energy Systems*. W. Haefele, L.K. Kirchmayer, editors. (IIASA Proceedings Series, Vol. 12. Available from PERGAMON Press.) ISBN 0 08 025696 1

The problem of the seventies was energy, and the business of modeling energy systems boomed. As models became more sophisticated, and as the international and intercontinental aspects of the energy problem became clearer, the boundaries of the energy systems being modeled grew to the point where it was useful to distinguish a special category of energy models: those dealing with large-scale energy systems.

Practical experience in building and applying models for large-scale energy systems has been accumulating at a rapid rate in recent years. Thus, to contribute to communicating and assimilating some of the lessons learned in the seventies about modeling large-scale energy systems, the Systems Engineering Committee of IFAC (the International Federation of Automatic Control) and the Energy Systems Program at IIASA organized an international symposium on this subject. This volume contains 43 papers given at the symposium.

**BK-81-515.** *Logistics and Benefits of Using Mathematical Models of Hydrologic and Water Resource Systems*. A.J. Askew, F. Greco, J. Kindler, editors. (IIASA Proceedings Series, Vol. 13. Available from PERGAMON Press.) ISBN 0 08 025662 7

The use of the mathematical models for the simulation, analysis, and control of water resource systems has spread rapidly in recent years. The basic structure and the mathematical formulation of these models have been widely discussed, but relatively little attention has been paid to the operational aspects and logistics of model use.

To stimulate the exchange of ideas, knowledge, and experience about the use of hydrologic and water resource models, this Symposium was convened by the International Institute for Applied Systems Analysis (IIASA) and cosponsored by the World Meteorological Organization (WMO) and the IBM Scientific Center (Pisa). The Symposium concentrated on model identification and use. Logistic issues, such as computer requirements, support staff and data needed, and cost-benefit analysis of the use of models in practical work, were examined in particular detail.

This book contains an introductory chapter on model structure and use, fourteen selected papers from the Symposium, and a summary of the more important points raised during the Symposium discussions.

**BK-81-516.** *Planning for Rare Events: Nuclear Accident Preparedness and Management. Proceedings of an International Workshop, January 28-30, 1980*. J.W. Lathrop, Editor. (IIASA Proceedings Series, Vol.14. Available from PERGAMON PRESS.) ISBN 0 08 028703 4

The nuclear reactor accident at Three Mile Island in 1979 presented several surprises to those concerned with nuclear safety. Some features of the accident have been studied in depth - such as problems with operator training, instrumentation, and mechanisms for learning from past accidents - and have lead to corrective actions. Yet one of the most significant features of TMI has received much less attention: the degree of confusion surrounding the management of the accident, including the confusion marking evacuation decisions.

The accident revealed the severe problems of maintaining an accident management system capable of quickly determining and executing population protection measures. This problem is compounded by the rarity of nuclear accidents; preparedness must be developed and maintained on the basis of scarce experience, without authentic testing, and in spite of the poor incentives presented to many of the individuals involved.

Recognizing the need for a critical look at these problems, the Management and Technology Area of IIASA convened a Workshop on Procedural and Organizational Measures for Accident Management: Nuclear Reactors. It brought together people who had participated in the management of the Three Mile Island accident, as well as people working to maintain preparedness in seventeen countries. This volume contains the twenty-one papers presented at the workshop and a summary of the themes that emerged during the discussions.

**BK-82-001.** *Regional Development Modeling: Theory and Practice*. M. Albegov, A.E. Andersson, F. Snickars, editors. Published by North Holland Publishing Co., Amsterdam, The Netherlands. ISBN 0 444 86473 3

This volume contains a collection of papers presented at IIASA's conference on "Theoretical and Practical Aspects of Regional Development Modelling". Of the 50 papers presented , 26 were selected for publication, in such a way as to strike a balance between theory and application of regional systems analysis. The book is divided into seven parts. After an introduction, the second and third parts contain overviews of current modelling practice and planned economies. In the next two parts, the focus shifts to the theoretical problems encountered in structural and multi-objective analysis of regional systems. The final two sections contain examples of regional development models currently ready for use or in operation and analyze the success of these models in clarifying regional planning and policy problems.

**BK-82-002.** *Multiregional Economic Modeling: Practice and Prospect*. B. Issaev, P. Nijkamp, P. Rietveld, F. Snickars, editors. Published by North Holland Publishing Co., Amsterdam, The Netherlands. ISBN 0 444 86485 7

This volume is the result of a particularly effective research collaboration between IIASA and the Department of Regional Economics at the Free University of Amsterdam. The objective was to provide a survey of current practice in the field of multiregional economic modelling and to review its major development trends. As part of the study 50 different models were reviewed and classified, based on a questionnaire circulated to almost 100 researchers or research institutions active in the field. Thus, the project has brought together existing expertise in the area, using IIASA as a "clearinghouse" for theories, models and application experience, stemming from many different countries, planning systems and modelling traditions. This book will prove useful both as a source of reference and guide to current

applied multiregional economic models, and as a work of structured analysis of the field.

**BK-82-518.** *Managing Technological Accidents: Two Blowouts in the North Sea.* D.W. Fischer, editor. (IIASA Proceedings Series, Vol.16. Available from PERGAMON PRESS.) ISBN 0 08 029346 8

A blowout consists of a sudden and uncontrolled release from a well of large amounts of high-pressure gas or gas-oil and carries with it attendant risks of explosion, fire, and pollution; loss of life, equipment and the hydrocarbon fuel itself are all possible. More generally, a blowout may be characterized as a low-probability, high-risk event which may occur when a complex technological process goes out of control.

Drilling for oil and gas in the hazardous environment of the North Sea has, over the years, given rise to great efforts to improve safety standards and operating procedures. By the mid-70s many observers felt that blowouts in the area were extremely unlikely if not impossible. Nevertheless, 1977 saw two blowouts in the North Sea, one on the *Ekofisk Bravo* platform in the Norwegian sector and the other involving an exploratory well being drilled by the *Maersk Explorer* rig in the Danish sector. The blowouts caused great concern to the general public, to the governments involved, and within the oil industry, and prompted extensive reevaluations of equipment, procedures, and the general philosophy of accident prevention.

The management or prevention of such incidents, whose causes lie at the man-technology interface, was the central theme of a Workshop at IIASA which brought together experts on the environment, representatives of the oil industry, and spokesmen for governments and their associated regulatory bodies. This volume is based on the proceedings of the Workshop and is divided into two main parts: the first is an overview of the blowout problem and the second contains the papers presented by the Workshop participants.

**BK-82-519.** *Mathematical Models for Planning and Controlling Air Quality. Proceedings of an IIASA Workshop.* G. Fronza, P. Melli, editors. (IIASA Proceedings Series, Vol.17. Available from PERGAMON PRESS.) ISBN 0 08 029950 4

Air-quality management problems fall into three main classes: it is difficult to obtain a reliable picture of all the physicochemical processes involved, comprehensive assessments of the costs and benefits of alternative control strategies are not easily made, and the technology for pollution abatement is not yet well established. Various mathematical or formal management models do exist but the overall impact of modeling on decision making has so far been relatively small.

The first aim of the IIASA Workshop on which this volume is based was to bridge the gap between air-quality modeling and management. As described in the ten papers in Part One, Workshop participants examined the goals actually pursued by decision makers, the potential role of mathematical models in air-quality management, and the extent to which modeling has been used in real situations in a number of countries.

The Workshop's second aim, reported in the eight papers in Part Two, was to consider the unusual strategy of real-time emission control. An extended description of the IIASA case study of the Venetian Lagoon area was presented, together with contributions on real-time forecast and control schemes in operation in Japan and Italy.

**BK-83-001.** *Processes and Tools for Decision Support.* H.G. Sol, editor. Published by North-Holland Publishing Co. - Amsterdam, New York, Oxford. ISBN 0-444-86569-1.

The change in description of Decision Support Systems (DSS) from "concept" through "movement" to "bandwagon" clearly illustrates the growing interest in the managerial as well as in the research field for decision support systems in their different manifestations. One may expect that a conference on processes and tools for decision support brings together people from practice and research, whose experiences give insight in the direction the bandwagon is likely to go. This brings us to the question how expertise on processes and tools for decision support can be stored in such a way that one can get advice when developing future DSS. This asks for the definition and construction of a knowledge base, into which the expertise can be brought.

In section 2 of this book, the authors address possible frameworks for such a knowledge base. In section 3 they place the papers presented into the chosen framework. Finally an attempt to make inferences from the contributed papers is made.

**BK-83-002.** *Global International Economic Models.* B.G. Hickman, editor. Published by North-Holland Publishing Co. Amsterdam-New York-Oxford. ISBN 0-444-86718-X.

This volume, which contains selected papers from the Eighth IIASA Global Modeling Conference, surveys the state-of-the-art of global international economic modeling. All 15 models included in the survey feature national or regional disaggregation of the world economy and interdependencies among the various nations and regions. A few are constructed for short-term forecasting, but the primary focus is on long-run models and applications. Macro-economic, input-output, general equilibrium, trade and exchange rate, and several hybrid models are included. A cross-sectional analysis by the editor compares the structures, linkage mechanisms, methodologies, and applications of the various models and concludes with some observations on prospective research trends.

**BK-83-112.** *Mathematical Modeling of Water Quality.* G.T. Orlob, editor. (IIASA INTERNATIONAL SERIES, Vol.12. Available from John Wiley and Sons Ltd.) ISBN 0 471 10031 5.

This book is the first to deal comprehensively with the subject of mathematical modeling of water quality in streams, lakes, and reservoirs. About one third of the book is devoted to model development processes--identification, formulation, parameter estimation, calibration, sensitivity testing, and application--and a thorough review of the mathematical principles and techniques of modeling. Emphasis is placed on well documented models, representative of the current state of the art, to illustrate capabilities and limitations for the simulation of water quality. About two thirds of the book deals with specific applications of models for simulation of water quality in natural water bodies. Topics covered include modeling of temperature, dissolved oxygen and phytoplankton growth in streams, development and application of one-dimensional models of stratified impoundments, two- and three-dimensional modeling of circulation and water quality in large lakes, thermally stratified plumes and cooling ponds, ecology of lakes and reservoirs, modeling of toxic substances, and the use of models in water quality management and decision making.

**BK-83-301.** *Modeling Growing Economies in Equilibrium and Disequilibrium.* A.C. Kelley, W.C. Sanderson, J.G. Williamson, editors. (Published by Duke Press Policy Studies, Durham, N.C. USA.) ISBN 0-8223-0567-4.

The papers in this volume were presented and discussed at a meeting held at IIASA. The meeting's goals were to stimulate interaction and collaboration, and to encourage setting research priorities for the future.

Indeed, it is in this latter area where the meeting appeared to yield some of its greatest benefits. It became clear from the deliberations that much needs to be done to better specify the microfoundations of general equilibrium models. More realistic specifications of "conflict resolution" in resource allocation, in both market and nonmarket economies, need to be developed. Equally importantly, much work is required to explore the role of economic disequilibrium in economic growth and development. "Equilibrium" and "disequilibrium" are positive, not normative concepts; neither view is right or wrong; neither will necessarily yield desired social outcomes at all stages of development, or across all regions. Rather, they yield quite different outcomes, which themselves should be subjects for scientific inquiry. The meeting pointed out the potential for expanding the conceptions of general equilibrium modeling to incorporate elements of disequilibrium analysis, so that this framework may not only be increasingly relevant to Eastern countries, but so that the possibilities of East-West interaction on critical aspects of resource allocation and economic growth can be enhanced.

**BK-83-402.** *Uncertainty and Forecasting of Water Quality.* M.B. Beck, G. van Straten, editors. Published by Springer-Verlag, Berlin, Heidelberg, New York, Tokyo. ISBN 3-540-12419-5.

This book brings together a number of critical discussions on the role of uncertainty in the development and use of mathematical models for water quality management. It covers the application of recursive estimation, time-series analysis, maximum likelihood estimation, and the Group Method of Data Handling (GMDH), to the problem of model identification. It also treats the analysis of prediction-error propagation, real-time forecasting, and the use of Monte Carlo simulation in the generation of speculative hypotheses about system behaviour.

**BK-83-501.** *Operational Gaming--An International Approach.* I. Stahl, editor. Published by Pergamon Press. ISBN 0 08 030870 8.

Operational gaming involves several people interacting in a simulation of a real-world problem for the purpose of aiding decision making, planning or policy implementation.

Contributors to this first book on international aspects of the subject are leading gaming experts from the United States, (including Martin Shubik and Richard Duke), Western Europe, and Japan as well as from the Soviet Union and other socialist countries. It includes such topics as the use of operational gaming in practice in several areas of industry, East-West trade games, the international transfer of gaming technology, the use of gaming for futures research, methods of game construction, taxonomies of gaming and new gaming methods focused on interaction between humans and the computer.

**BK-83-601.** *Forest Sector Models.* R. Seppala, C. Row, A. Morgan, editors. Published by A B Academic Publishers, UK. ISBN 0-90730-08-4.

Forestry and the forestry industry are facing major structural changes. On the production side, the development of processing technology has made the industrial use of wood possible in many new areas; at the same time, wood growing has reached its economic and institutional limits in some old forest areas. As a consequence, a major shift in the global pattern of the supply of wood raw material is taking place.

Over the long term, the consumption pattern of forest products is changing: for traditional products, some countries are reaching saturation level whilst in others a considerable increase in demand is anticipated, and technological innovations are changing the overall demand for different products. These issues pose problems that require a global analysis.

This book, based on the First North American Conference, includes many impressive state-of-the-art papers in terms of current knowledge and econometric models; it covers modelling the forest products industry with emphasis on international trade, and represents an important step in improving the ability to model forest management investment. Part I introduces the Forest Sector Project of IIASA; Part II presents approaches to developing forest sector models; Part III emphasises some of the sub-problems in model development, specifically on the development of realistic long-term supply response estimation capabilities; Part IV covers approaches to modelling demand and international trade components.

## RESEARCH REPORTS

**RR-79-004.** *GEM: An Interactive Simulation Model of the Global Economy.* O. Helmer, L. Blencke. September 1979. 77 pp. $8.50.

One of the aims of the International Institute for Applied Systems Analysis (IIASA) is to develop methods of systems analysis that lend themselves to applications to policy analysis.

Gaming has proved to be an important methodological planning tool in such areas as military and business affairs, but thus far few applications to socioeconomic planning have been attempted. The game described here is a demonstration model, intended to acquaint the reader with the potentialities of this approach as a preanalytical research tool.

The model described here, which is named "GEM" (Global Economic Model), is a six person interactive simulation model (or game) intended to generate intuitive insights into the economic interactions among six world regions over the next 50 years.

**RR-79-005.** *A Normative Model of Rural-Urban Development and Optimal Migration Policy.* R. Kulikowski. October 1979. 45 pp. $6.00.

Agricultural development policies influence patterns of internal migration and population distribution directly and indirectly. The reverse is also true. Hence, a nation's agricultural development policy should be consistent with its population distribution policy. Accordingly, the policy field to be investigated must be extended to include side effects and secondary consequences in these interdependent spheres.

Methodological research and a number of case studies are envisaged to deal with this problem in the Food and Agriculture Program, in the Human Settlements and Services Area, and in the Regional Development Task. This paper is among the first of such studies and should

be regarded as a methodological study to determine whether a computerized regional model can be constructed to improve the planning of rural-urban development, employment, and migration policy.

**RR-79-008.** *The Economic Impact Model.* Yu.D. Kononov, A. Por. October 1979. 77 pp. $8.50.

An initial version of the economic impact model (IMPACT) was developed at the Siberian Power Institute of the Siberian Branch of the USSR Academy of Sciences in Irkutsk. The model was originally designed to study the influence of the development of the energy sector on energy-related sectors of the national economy. Subsequently, the model was brought to IIASA where it was revised to focus on the identification and comparison of long-term regional and global energy strategies in the transition period of 15 to 50 years from now. The possible influence of any given energy strategy on the economy is evaluated in terms of capital investment, manpower, materials, and natural resources that are needed to develop not only the energy supply system (ESS) but also the energy related sectors of the economy.

This report describes IMPACT as it exists at IIASA, explains the computer program, and includes a user guide for implementing this methodology.

**RR-79-011.** *Real-Time Forecasting of Air Pollution Episodes in the Venetian Region. Part I: The Advection-Diffusion Model; Part II: The Kalman Predictor.* E. Runca, P. Melli, A. Spirito, G. Fronza, A. Tonielli. December 1979. 50 pp. $6.00.

The object of this overall research, which has an expected duration of two years is to set up a scheme for predicting ground-level pollutant concentrations for real-time control purposes (i.e. the action to be taken at the emission sources in the presence of forthcoming high pollutant events). The forecasting scheme is described, together with its application to sulphur dioxide pollution in the Venetian lagoon area. The scheme is based on a complex mathematical model to be run on a computer and receiving at the beginning of each interval of time all the information (about the meteorological and emission situation) required for the prediction. The type of control action which should be taken on the basis of such a forecast is the object of this part of the research.

**RR-79-013.** *The Dynamics of Energy Systems and the Logistic Substitution Model.* C. Marchetti, N. Nakicenovic. December 1979. 80 pp. $8.50.

This work is dedicated to the empirical testing and theoretical formulation of an invariant, the logistic learning curve, as it applies to the structural evolution of energy systems and systems related to energy, such as coal mining. The great success of the model in organizing past data, and the insensitivity to major political and economic perturbations of the structures obtained seem to lend great predictive power to this invariant.

**RR-79-015.** *Simulation of Macroeconomic Scenarios to Assess the Energy Demand for India (SIMA).* J.K. Parikh, K.S. Parikh. December 1979. 58 pp. $7.00.

The use of the SIMA model within the energy modeling effort at IIASA reflects the desire to treat the special considerations of developing regions with as much care as possible. In particular, the treatment of economic profile and prospects of one developing country with this econometric model can lead towards a greater understanding of energy requirements in the face of alternative economic scenarios. The alternative paths selected for use with the SIMA model include a greater intensification of agriculture, increasing aid, and

stepped-up investments and exports (to generate high economic growth). The SIMA model focuses on the central issues of capital availability and sources of export earnings for building up the domestic energy sector. Also considered explicitly are the uses of noncommercial energy and the extent and pace of rural electrification characteristic of developing economies.

**RR-80-003.** *On the Scenario Approach to Simulation Modeling for Complex Policy Assessment and Design.* W.B. Clapham, R.F. Pestel, H. Arnaszus. February 1980. 24 pp. Reprinted from Policy Sciences, Vol. 11 (1979). Available for a handling charge of $3.00.

This paper reviews the major issues posed by scenario-based simulation modeling in the policy process, using agricultural policy as an example of a complex decision arena.

**RR-80-004.** *Model Structure Identification from Experimental Data.* M.B. Beck. February 1980. 37 pp. Reprinted from Theoretical Systems Ecology: Advances and Case Studies (E.Halfon, editor). Available for a handling charge of $3.00.

Methods for identifying the structure of dynamic mathematical models for water quality by reference to experimental field data are discussed. The context of the problem of model structure identification is described by briefly reviewing the steps involved in the overall process of system identification. These steps include experimental design; choice of model type; model structure identification; parameter estimation; and verification/validation. Two examples of approaches to solving the problem of model structure identification are presented. The first example is concerned with identifying the structure of a black box (input/output) model for the variations of gas production in the anaerobic digestion process of wastewater treatment. The second example addresses the more difficult problem of identifying the structure of an internally descriptive ("mechanistic") model form.

**RR-80-008.** *Modeling the Dynamics of a System of Metropolitan Areas: A Demoeconomic Approach.* P. Gordon, J. Ledent. March 1980. 12 pp. Reprinted from Environment and Planning A, Vol. 12 (1980). Available for a handling charge of $3.00.

This paper proposes a complete dynamic model of a system of metropolitan areas interacting through economic and demographic links, namely trade and migration respectively. It not only considers interregional effects (through an interregional input-output submodel) but also intraregional effects (through a set of Garin-Lowry submodels). In addition it allows the simultaneous determination of migration rates, labor-force-participation rates, and unemployment rates. Suggestive of the demoeconomic approach, this model also reveals the methodological difficulties that such an approach implies.

**RR-80-009.** *Spatial Structure Relationship in a Forest Insect System: Simulation Models and Analysis.* W.C. Clark. March 1980. 26 pp. Reprinted from Mitteilungen der Schweizerischen Entomologischen Gesellschaft, Vol. 52(1979). Available for handling charge of $3.00.

This paper analyses relationships among dispersal, spatial heterogeneity, and local ecological processes in the spruce budworm (Choristoneura fumiferana Clem.) - boreal forest system of eastern North America. A range of simulation and topological models are developed to reflect various hyotheses concerning those relationships. Model predictions are treated as guides to effective experimental design and efficient allocation of research priorities, rather than as ends in themselves. The analysis demonstrates the shortcomings of studies

treating either dispersal or local processes alone, and argues instead for an integrated approach to spatial structure research in population ecology.

**RR-80-010.** *Essays in Multistate Mathematical Demography.* A. Rogers, editor. May 1980. 138 pp. Reprinted from Environment and Planning A; Vol. 12, No. 5. Available for a handling charge of $3.00.

The papers in this special issue of *Environment and Planning A* were first presented at the session on mathematical demography held at the 1979 Annual Meeting of the Population Association of America in Philadelphia, 26-28 April. They are representative examples of work currently under way in a relatively new branch of mathematical demography becoming known as *multistate demography.* The authors come from diverse backgrounds and represent different countries. Philip Rees is British and a lecturer in the School of Geography at the University of Leeds in England; Jacques Ledent is French and is a research scholar at the International Institute for Applied Systems Analysis in Laxenburg, Austria; Frans Willekens, a Belgian, is Research Director at Mens en Ruimte in Brussels; Kao-Lee Liaw is Canadian and teaches geography at McMaster University in Hamilton, Ontario; and Nathan Keyfitz of the USA, is Andelot Professor of Sociology at Harvard University in Cambridge, Massachusetts.

**RR-80-011.** *Process Models, Equilibrium Structures, and Population Dynamics: On the Formulation and Testing of Realistic Theory in Ecology.* W.C. Clark, C.S. Holling. March 1980. 27 pp. Reprinted from Fortschritte der Zoologie, Vol. 25(1979). Available for a handling charge of $3.00.

This paper addresses problems in the formulation and testing of theory to relate structure and dynamic behaviour in complex natural ecosystems. Detailed studies of spruce budworm-coniferous forest interactions in eastern Canada provide a background for the analysis. We argue that the mixed spatial and temporal scales, low density phenomena, and nonlinear interactions characteristic of most ecosystems severely limit traditional statistical approaches to theory building, while rendering most kinds of observational data irrelevant to theory evaluation and testing. We describe an alternative tradition:

1. Cast the theory as a set of "dynamic life tables", bound together by basic ecological process modules; apply available data and field experience to the parameterization of these modules.

2. Compute the consequences of the resulting theory under a wide range of conditions: quantitatively through numerical simulation and qualitatively through the use of topological manifolds.

3. Employ the manifolds to identify key structure- (as opposed to parameter-) dependent predictions of the theory. Compare these with observation, emphasizing behaviour of the system and its theory in extreme natural or experimental situations.

**RR-80-014.** *Economic-Demographic Simulation Models: A Review of Their Usefulness for Policy Analysis.* W.C. Sanderson. May 1980. 121 pp. $10.00.

This paper assesses the usefulness of economic-demographic simulation models for policy analysis, emphasizing in particular the relevance of the current state of the art for agricultural development planners. A critical review of eight models defines the range of questions that can be answered with particular models, evaluating the reasonableness of their specifications and the probable quality of their performance. Suggestions concerning further research are also provided.

The primary function of economic-demographic simulation models is to ascertain the quantitative importance of indirect effects of changes in the economic or demographic environment. For example, governmental policies concerning credit availability, which have a direct effect on the rate of growth of agricultural productivity, will have an indirect effect on rural population growth and rural to urban migration. A clarification of such interactions between demographic and economic phenomena is an essential ingredient of an enlightened development planning process.

The five "second generation" economic-demographic simulation models reviewed in this paper are the FAO model, the Bachue-Philippines model, the Simon model, the Tempo II model, and the Kelley-Williamson, and Cheetham model. The main conclusion of the review is that although none of these models in their present form can offer reliable advice to agricultural policy makers, they may be useful as aids in teaching government officials about the potential long-run consequences of their decisions. Two third-generation models, the Adelman-Robinson model and the Kelley-Williamson representative developing country (RDC) model are also reviewed. Neither of these two models has a significant demographic component, but they are of interest because future economic-demographic simulation models are likely to be constructed around their fundamental concepts.

**RR-80-021.** *The Impact of Waste Heat Release on Climate: Experiments with a General Circulation Model.* J. Williams, G. Kroemer, A. Gilchrist. April 1980. 14 pp. Reprinted from Journal of Applied Meteorology, Vol. 18(1979). Available for a handling charge of $3.00.

Experiments were made with the Meteorological Office general circulation model (GCM) to investigate the response of the simulated atmospheric circulation to the addition of large amounts of waste heat in localized areas. The concept of large-scale energy parks determined the scenarios selected for the five perturbation experiments. Waste heat totaling 150 TW or 300 TW was added to the sensible heat exchange between the surface and air at energy parks in the Atlantic and Pacific Oceans in four experiments. In a fifth experiment, 300 TW were added to a 10 m deep "ocean box" simulated beneath the energy parks. Forty-day averages of meteorological fields from the five waste heat experiments and from three control cases are compared. Model variability is estimated on the basis of the three control cases. The regional and hemispheric responses of the atmospheric circulation are discussed, with emphasis on the magnitude of the heating rates, surface pressure and 500 mb height changes and temperature changes. The main conclusions that can be drawn are that the model exhibits a nonlinear response to the waste heat input and that, in middle latitudes, the spatial scale of the response is large even though the heat input scale is small.

**RR-80-022.** *Modeling Urbanization and Economic Growth.* A.C. Kelley, J.G. Williamson. May 1980. 93 pp. $8.50.

This past quarter century has witnessed unprecedented economic progress in the Third World. Yet major problems have arisen, some of which are the consequences of the progress itself and may become serious constraints on future development. City growth is one such problem. Pessimists stress the developing countries' inability to cope with the resource and social systems requirement of rapid urban growth, thus prompting the term "over-urbanization". Optimists minimize the negative externalities and view urban growth as the key to raising average labor productivity and living standards. All of this experience has taken place under conditions of "population explosions".

This paper presents a general equilibrium economic-demographic model which highlights various aspects of urbanization. Attention is focused on the determinants and consequences of rural-urban migration, on the resource demands of housing associated with rapid urbanization, on optimal land use between urban and rural activities, and on the allocation of investments to education and labor force training.

The economic model is designed to be "representative" of a large group of developing countries, and it will eventually contain a fully elaborated demographic component. The model will be tested with Third World growth experience since the 1950s. It will then be used to analyze the sources of migration and urbanization, and to explore their interaction with distribution, accumulation and growth.

**RR-80-023.** *DRAM: A Model of Health Care Resource Allocation.* D.J. Hughes, A.P. Wierzbicki. May 1980. 67 pp. $7.00.

The principal aim of health care research at IIASA has been to develop a family of submodels of national health care systems for use by health service planners. The modeling work is proceeding along the lines proposed in the Institute's current Research Plan. It involves the construction of linked submodels dealing with population, disease prevalence, resource need, resource allocation, and resource supply.

This is the second research report on the disaggregated resource allocation sub-model called DRAM. It describes the extension of the Mark 1 version (RR-78-8) to include the distribution of many resources across different modes of care. The earlier assumption that all available resources must be used has been relaxed, and an extensive analytic treatment suggests various methods for estimating the submodel's parameters. Several case studies that use the model are in progress and reports on these applications will be forthcoming.

This paper is an output of a collaboration between two Areas at IIASA. It describes how a health resource allocation model, developed in the Health Care Systems Task of the Human Settlements and Services Area, may be solved by using optimization techniques studied in the Optimization Task of the Systems and Decision Sciences Area.

**RR-80-025.** *The Value of Human Life: A Review of the Models.* J. Linnerooth. June 1980. 26 pp. Reprinted from Economic Inquiry, Vol. 17, 1980. Available for a handling charge of $3.00.

This paper reviews four consumer maximization models where the probability of premature death enters as a variable that is both known to the consumer and under his control. These models generate a number of interesting results with respect to a person's willingness to pay for an increased chance of living. The most useful to the cost-benefit analyst is the derived relationship between this willingness-to-pay value and a person's lifetime earnings, and thus the relationship between the theoretically correct willingness-to-pay approach to the valuation of life-saving programs and the widely-used human-capital approach. However, the conclusions of the reviewed models are in this regard conflicting. Two of the models establish a theoretical basis for investigating the correlation of these two measures; however, this basis is shown to follow from an unrealistic assumption concerning the person's lifetime utility function. The remaining two models, although based upon more realistic assumptions, do not claim to provide theoretical grounds for making such investigations. The conclusion of this review is that in the absence of available data on personal demand for increased survival probability it is impossible to determine the relationship

between the willingness-to-pay and the human-capital approaches to placing a value on human life.

**RR-80-026.** *A Demoeconomic Model of Interregional Growth Rate Differences.* J. Ledent, P. Gordon. June 1980. 16 pp. Reprinted from Geographical Analysis, Vol. 12(1), 1980. Available for a handling charge of $3.00.

Declining rates of national population growth, continuing differential rates of regional economic activity, and shifts in the migration patterns of people and jobs are characteristic empirical aspects of many developed countries. In several instances, they have combined to bring about a relative (and in some cases absolute) population decline of highly urbanized areas, e.g., New York, Tokyo, and Stockholm. In other cases, they have brought about rapid metropolitan growth, e.g., Houston, Miami, and Moscow.

This paper argues for a demoeconomic modeling of multiregional systems. It proposes a model that accounts for interregional growth rate differences by means of an endogenous and simultaneous determination of labor force participation, migration, and unemployment.

**RR-80-028.** *Market Substitution Models and Economic Parameters.* B.I. Spinrad. July 1980. 26 pp. $4.00.

Peterka's model for market penetration rests on pricing assumptions used by centrally planned economies and, on this basis, is not applicable in market economies. It is also a strategic principle rather than a strictly deterministic model, since less favored, as well as more favored, technologies continue to be adopted. Using related strategic principles, this paper explores several models that might be usable in market economies. Test application of models to a synthetic problem simulating market substitution in the electric utility industry favors the "price" model. In this model, the economic attractiveness of a technology is proportional to the inverse of the price that would have to be charged for a product.

**RR-80-031.** *The IIASA Set of Energy Models: Its Design and Application.* P.S. Basile. December 1980. 65 pp. $7.00.

This report describes the set of models for evaluating energy scenarios that has been developed and used by the Energy Systems Program. The model set includes: an accounting-framework type of energy demand model, a dynamic linear programming energy supply and conversion-system model, an input-output model for calculating the impacts of alternative energy scenarios, a macroeconomic model, and an oil-trade gaming model. These models were designed as an integrated set for long-term, global analysis.

**RR-80-035.** *A Demoeconometric Model of Poland and its Application to Counterfactual Simulations.* Z. Pawlowski. September 1980. 77 pp. $8.50.

This paper presents the results of modeling the impact of economic factors in the Polish economy on basic demographic phenomena and in turn, the way these phenomena act on various economic variables, especially those pertaining to employment levels. After a brief exposition of the main characteristic features of the Polish economy, the author explains the method by which the equations of the model are built and presents the estimated structural form of the model. The results are used to obtain the reduced form which is later used for a number of counterfactural simulations. These simulations are based on two scenarios. One of them assumes that during the period covered by sample data, i.e., 1960-1976, Poland was experiencing steady but moderate economic growth. The second scenario was built on the assumption of fast economic growth, cou-

pled with a strong rise in the standard of living. When the counterfactual simulations were performed it was found that the two different economic policies would have had a substantially different impact on such demographic variables as birth rates, death rates, and migrations from rural to urban areas, as well as on employment levels in the three sectors of the national economy considered, namely nonagricultural productive activities, agriculture, and services.

**RR-81-002.** *Mathematical Modelling - A Management Tool for Aquatic Ecosystems?* K. Fedra. March 1981. 18 pp. Reprinted from Helgolaender Meeresuntersuchungen, Vol. 34(1980). Available for a handling charge of $3.00.

In recent years there has been considerable interest in developing models for river and lake ecological systems, much of it directed toward progressively larger and more complex simulation models. However, such a trend causes concern about several important issues. In particular, relatively little attention has been paid to the problems of errors and uncertainty in the field data, of inadequate amount of field data, and of uncertainty about estimates of the model's parameters and about relations among the system's important variables.

One possible approach to model uncertainty is a probabilistic interpretation of model predictions, generated by use of Monte-Carlo techniques. Fuzzy data sets and ranges are used. The resulting model response allows the derivation of measures for model credibility. Probability distributions can be computed for certain system states under (un)certain input conditions, representing the effects of insufficient data and structural uncertainty on model-based predictions. Such analysis indicates that prediction uncertainty increases, not only with the uncertainty in the data, but also with increasing "distance" from the empirical conditions, and with time.

**RR-81-005.** *Economic Evolutions and Their Resilience: A Model.* M. Breitenecker, H.R. Gruemm. April 1981. 38 pp. $5.00.

The model treated in this paper is the latest "societal model" of IIASA's Energy Systems Program. After a brief resume of historical developments, the structure of the model is described. Its structural properties are investigated, and the dynamics inside and outside the slack-free region are determined. Then two parameter sets--one for a typical developed country and one for a typical less developed country--are chosen, and scenario variables are introduced. Using this approach, the authors study the interaction between a developed country and a less developed one under the influence of different oil price levels.

**RR-81-019.** *Some Dangerous Misconceptions Concerning Operational Research and Applied Systems Analysis.* R. Tomlinson. September 1981. 12 pp. Reprinted from the European Journal of Operational Research, Vol.7(2),June(1981). Available for a handling charge of $3.00.

After defining the field of interest as operational research and/or applied systems analysis (ORASA), this paper examines ORASA by describing and then qualifying seven 'near-truths' about the subject; each is sufficiently accurate to be accepted by many ORASA practitioners, but equally each contains the seeds of dangerous misconceptions and distortions if its limitations are not recognized. The seven near-truths and the corresponding qualifications thought necessary may be summarized as follows. 1, "ORASA is problem solving": certainly an important aspect but achievement of understanding is the more fundamental goal. 2, "Models are central to ORASA": what is truly 'central' is complex reality even though the models may be 'essential' to the

process. 3, "Problems can and must be defined (uniquely and invariantly)"; definition is vital but redefinition in the light of increased understanding or the views of different analysts is equally necessary. 4, "Models are partial representations of reality": often the aim, but it is important that the exact meaning and range of validity of the models must be understood by their interpreters and the relationship between models and reality very closely examined. 5, "Tactics and strategy are entirely separate": it is misleading to postulate an absolute qualitative distinction - both overviews and problem-solving applications are needed and successful ORASA analysts must combine the two. 6, "All rigorous thought can be expressed in mathematical terms": rigor is necessary but, given the nature of real-world problems, it is essential to combine 'hard' mathematical analysis with equally valid insight from the 'soft' sciences. 7, "ORASA is a science": scientific in its approach but multidisciplinary and cross-cutting in the expertise on which it draws.

**RR-81-026.** *Uncertainty and Arbitrariness in Ecosystems Modelling: A Lake Modelling Example.* K. Fedra, G. van Straten, M.B. Beck. October 1981. 26 pp. Reprinted from Ecological Modelling, 13 (1981). Available for handling charge of $3.00.

Mathematical models of ecosystems are considerable simplifications of reality, and the data upon which they are based are usually scarce and uncertain. Calibration of large complex models depends upon arbitrary assumptions and choices, and frequently calibration procedures do not deal adequately with the uncertainty in the data describing the system under study. Since much of the uncertainty and arbitrariness in ecological modelling is inevitable, because of both practical as well as theoretical limitations, model-based predictions should at least reveal their dependence on, and sensitivity to, uncertainty and arbitrary assumptions.

This paper proposes a method that explicitly takes in account the uncertainty associated with data for modelling. By reference to a partly qualitative and somewhat vague definition of system behaviour in terms of allowable ranges, an ensemble of acceptable parameter vectors for the model may be identified. This contrasts directly with a more conventional approach to model calibration, in which a quantitative (squared-error) criterion is minimized and through which a supposedly "unique" and "best" set of parameters can be derived. The ensemble of parameter vectors is then used for the simulation of a multitude of future systems behaviour patterns, so that the uncertainty in the initial data and assumptions is preserved, and thus the predicted future systems response can be interpreted in a probabilistic manner.

**RR-82-001.** *Validation and Physical Parametrization of a Gaussian Climatological Model Applied to a Complex Site.* E. Runca, A. Longhetto, G. Bonino. January 1982. 11 pp. Reprinted from Atmospheric Environment, Vol.15, No.5, 1981. Available for a handling charge of $3.00.

Seasonal sulphur-dioxide concentrations have been simulated in a topographically complex-coastal site, by means of a Gaussian type model. The model diffusion equation has been parametrized on the basis of the results from a series of field experiments conducted in the area to characterize the dynamic and thermodynamic properties of the local atmosphere. The validity of the adopted model formulation and physical parametrization has been discussed by comparing simulated and measured concentration values separately for unstable, neutral and stable situations, and by testing the model sensitivity with respect to changes in the parameters used. The analysis has shown that

definition of the model physical parameters as indicated by the field experiments leads to a very satisfactory agreement between the calculated and measured concentrations. Therefore the model can be considered a suitable tool to implement air quality strategies in the area on a climatological basis. The study has been applied to the complex coastal sites of La Spezia, Italy, for the period March 1975 - February 1977.

**RR-82-003.** *An Approach to Distributed Modeling.* A. Umnov, M. Albegov. February 1982. 15 pp. Reprinted from Behavioral Science, volume 26 (1981). Available for a handling charge of $3.00.

The problem of computer linkage of different mathematical models into a whole system in order to investigate their joint behavior with more common criteria and constraints seems to receive more and more consideration. Many works on analyzing the behavior of complex systems are based on building large-scale integrated models and sequentials using decomposition and aggregation procedures. In this report an approach is described which permits the investigation of a set of linked subsystems without explicitly building any integrated model.

This report represents a description of a particular approach which might be referred to as "distributed modeling." It deals with conceptual systems in general, which might be used to model concrete systems at any level. The use of the method is illustrated by the practical application of the development of a system of regional models. This approach, based on the smooth version of the sequential unconstrained minimization techniques (SUMT), can be considered from a mathematical point of view as a realization of the general decomposition scheme.

**RR-82-009.** *A Practical Numerical Algorithm to Compute Steady-State Ground Level Concentration by a K-Model.* E. Runca. March 1982. 10 pp. Reprinted from Atmospheric Environment, volume 16 (1982). Available for a handling charge of $3.00.

A numerical algorithm to compute steady-state ground level concentration from elevated sources by means of a K-model which takes into account the spatial variability of wind and diffusivity and neglects horizontal diffusion is discussed. The boundary value problem to be treated, also for a point source, is always reduced to a two dimensional one and it is solved on an optimized grid. In this way the proposed method is made computationally comparable with the classical Gaussian plume model.

**RR-82-013.** *A Long-Term Macroeconomic Equilibrium Model for the European Community.* H.-H. Rogner. April 1982. 89 pp. $8.50.

MACRO, a highly aggregated, long-term, two-sector general equilibrium model, was developed to examine the energy-economy linkage in the context of the global energy study by the Energy Systems Program Group at IIASA.

This report presents a version of MACRO calibrated for the European Community, focusing on model structure, model validation and testing, and four applications to the EC region over a 50-year planning period. The applications, based on a range of energy supply scenarios, examine such economic questions as the impact of rising energy costs on economic activity, the feasibility of common assumptions about price-induced conservation, and the impact of continued high energy levels of energy imports on the trade balance.

**RR-82-017.** *Models for Analyzing Agricultural Nonpoint-Source Pollution.* D.A. Haith. April 1982. 34 pp. $5.00.

Mathematical models are useful means of analyzing agricultural nonpoint-source pollution. This review summarizes and classifies many of the available chemical transport and planning and management models. Chemical transport models provide estimates of chemical losses from cropland to water bodies; they include continuous simulation, discrete simulation, and functional models. A limited number of transport models have been validated in field studies, but none has been tested extensively. Planning and management models, including regional impact, watershed planning and farm management models, are used to evaluate tradeoffs between environmental and agricultural production objectives. Although these models are in principle the most useful for policy making, their economic components are much better developed than components for predicting water pollution.

**RR-82-026.** *A General Regional Agricultural Model (GRAM) Applied to a Region in Poland.* M. Albegov, J.W. Kacprzyk, W. Orchard-Hays, J.W. Owsinski, A. Straszak. August 1982. 68 pp. $7.00.

The General Regional Agricultural Model (GRAM) described in this report is the product of a case study of regional development in the Upper Notec region of Poland carried out collaboratively by IIASA and the Systems Research Institute in Warsaw, Poland. The purpose of this work was twofold: to assist Polish authorities in planning the development of agriculture in the region, and to create a universal methodology in the form of a model applicable to similar problems and settings in other countries. Thus, the methodological characteristics presented in this report are based on testing and implementing the model in the concrete situation of the Upper Notec region of Poland.

GRAM was developed using the so-called "bottom-up" approach, which consists of orienting the model toward technological interdependencies at the level of the agricultural areas in the region, and including a set of variables and parameters that enable this "bottom" model to be linked with those for other aspects of the regional economy.

The model deals with the following elements: a set of crops, a number of rotation groups; types of agricultural animals, types of livestock products, and feed components in forage; three types of market and three types of land ownership; different crop growing and livestock breeding technologies; and different soil qualities and types of fertilizers according to the contents of the elements. The model incorporates space and can give solutions for a number of regions. Technically GRAM is a large linear programming model with static relations.

The purpose of the model is to derive a detailed specification for a production structure combined with a direct utilization of its products that is optimal for a predefined objective. The model can also be used to indicate essential bottlenecks, resource distribution inconsistencies, and so on. It allows the formulations of multi-objective optimization problems to consider conflicts between different groups of producers. It is solved under constraints in labor, machinery, fertilizers and water availability at annual and two peak levels.

Two types of objective functions are used: monetary (linked with cost-benefit analysis) and physical. Among specific objective for which the model has been solved there are: total net return or net production value from agricultural activities within the region; balance of regional agricultural production in monetary terms; regional agricultural production in terms of nutrition un-

its; regional trade balances in livestock products in monetary terms and nutrition units; and export production in monetary terms. In cooperation with other elements of the regional model system, two types of information are exchanged: dual prices and volume of output.

**RR-82-029.** *Immigration and the Stable Population Model.* T.J. Espenshade, L.F. Bouvier, W.B. Arthur. August 1982. 12 pp. Reprinted from Demography, volume 19(1)(1982). Available for a handling charge of $3.00.

This paper reports on work aimed at extending stable population theory to include immigration. Its central finding is that, as long as fertility is below replacement, a constant number and age distribution of immigrants (with fixed fertility and mortality schedules) lead to a stationary population. Neither the level of the net reproduction rate nor the size of the annual immigration affects this conclusion; a stationary population eventually emerges. How this stationary population is created is studied, as is generational distribution of the constant and annual streams of births and of the total population. It is also shown that immigrants and their early descendants may have fertility well above replacement (as long as later generations adopt and maintain fertility below replacement), and the outcome will still be a long-run stationary population.

**RR-82-037.** *Issues in Model Validation.* A. Lewandowski. November 1982. 14 pp. Reprinted from Angewandte Systemanalyse, volume 3 number 1 (1982). Available for a handling charge of $3.00.

There is a common agreement between mathematical modelers that the validation stage is one of the most important ones in the model-building process. Unfortunately, there exists a gap between the general advices and the modeling practice.

To bridge this gap partially, the author introduces a model taxonomy which is important for the validation practice. On the basis of this taxonomy it would be possible to select the groups of models for which the given validation tools are appropriate. The review of existing ideas dealing with validation models is also presented.

**RR-82-039.** *A Descriptive Model of Choice for Siting Facilities.* H.C. Kunreuther, J.W. Lathrop, J. Linnerooth. November 1982. 20 pp. Reprinted from Behavioral Science, volume 27 number 3 (1982). Available for a handling charge of $3.00.

The siting of facilities for large-scale, novel technologies presents a formidable challenge to political risk management. This paper develops a model for describing the decision process for this type of problem at the level of societal systems. It explicitly considers the role of the relevant interested parties, each of whom brings to the siting debate its own set of objectives and attributes. We have labeled the approach a multiattribute multiparity model (MAMP to distinguish it from prescriptive techniques such as multiattribute utility analysis or decision analysis).

The MAMP model is a natural extension of the burgeoning literature on the key role that limited time, attention, and information processing capabilities play in political decision making when there are uncertain outcomes and likely conflicts among interested parties. The model also highlights the importance of decentralized and sequential decision making and indicates the role that formal risk assessments have played at each stage of the process. We illustrate the application in the context of the decision process associated with a proposed liquefied natural gas terminal in California. The concluding portion of this paper suggests future research needs for improving the credibility of analysis

and facilitating collective action with respect to facility siting problems.

**RR-82-040.** *Reliability, Resiliency, Robustness, and Vulnerability Criteria for Water Resource Systems.* T. Hashimoto, D.P. Loucks, J.R. Stedinger. November 1982. 18 pp. Reprinted from Water Resources Research, volume 18 number 1 (1982). Available for a handling charge of $3.00.

Three criteria for evaluating the possible performance of water resource systems are discussed. These measures describe how likely a system is to fail (reliability), how quickly it recovers from failure (resiliency), and how severe the consequences of failure may be (vulnerability). These criteria can be used to assist in the evaluation and selection of alternative design and operating policies for a wide variety of water resource projects. The performance of a water supply reservoir with a variety of operating policies illustrates their use.

When water resource investments are made there is little assurance that the predicted performance will coincide with the actual performance. Robustness is proposed as a measure of the likelihood that the actual cost of a proposed project will not exceed some fraction of the minimum possible cost of a system designed for the actual conditions that occur in the future. The robustness criterion is illustrated by its application to the planning of water supply systems in southwestern Sweden.

**RR-82-043.** *Recent Developments and Future Perspectives in Nonlinear System Theory.* J.L. Casti. December 1982. 34 pp. Reprinted from SIAM Review 24(3) 1982. Available for a handling charge of $3.00.

Results on controllability, observability and realization of input/output data for linear systems are well-known and extensively covered in a variety of books and papers. What is not so well-known is that substantial progress has been made in recent years on providing similarly detailed results for *nonlinear* processes. This paper represents a survey of the most interesting work on nonlinear systems, together with a discussion of the major obstacles standing in the way of a comprehensive theory of nonlinear systems.

**RR-83-003.** *Topological Methods for Social and Behavioral Systems.* J.L. Casti. February 1983. 27 pp. Reprinted form International Journal of General Systems, volume 8, number 4(1982). Available for a handling charge of $3.00.

Methods based in algebra and geometry are introduced for the mathematical formulation of problems in the social and behavioral sciences. Specifically, the paper introduces the main concepts of singularity theory, catastrophe theory and $q$-analysis for the characterization of the global structure of social systems. Applications in urban land development, electric power generation and international conflict are given to illustrate the methodology. The paper concludes with an outline for a general mathematical theory of surprises, together with a program for investigating the systemic property of resilience. ′

**RR-83-004.** *Modelling the US Federal Spending Process: Overview and Implications.* M.A.H. Dempster, A. Wildavsky. February 1983. 46 pp. Reprinted from The Grants Economy and Collective Consumption; R.C.O. Matthews and G.B. Stafford, editors. London and Basingstoke The Macmillan Press Ltd., pages 267-309. Available for a handling charge of $3.00.

The object of study is the US Federal budget process - an institutional process of increasing prominence in US and world affairs - which is unique in generating quanti-

tative data for scholarly research. The authors first outline their rigorous, but simple, econometric models of how budget decisions are made, coordinated, and implemented and then trace the implications of their high-inertia view of the process for the US economic cycle. They propound a presidential and Congressional ambition model of current and postwar cyclical economic difficulties, including stagflation, in terms of a macroeconomic model of the US economy in which federal governmental expenditure is endogenous. The chapter concludes with speculation on the disastrous consequences for society of the growth of a sluggishly adaptable bureaucratic process operating in a rapidly changing economic and social environment.

**RR-83-007.** *Mathematical Modelling at IIASA.* R.E. Levien, A.P. Wierzbicki, W.B. Arthur. March 1983. 122 pp. Reprinted from Mathematical Modelling, volume 3 number 5(1982). Available for a handling charge of $3.00.

Much of IIASA's research in the first ten years of its existence has been concerned with the analysis of complex systems; some of these have been global in scale, such as the studies of energy or food and agriculture, while others, like the Lake Balaton study or the work on small open economies, have concentrated on individual smaller systems. Mathematical modelling has played an important role in all of these analyses. Not only does this approach provide a simplified representation of real-world systems, allowing the modeller to study and sometimes even predict the behavior of the system, but also it can be used for policy analysis and planning purposes. To support these many and varied applications, IIASA has had to make significant advances in modelling methodology, which have allowed the modelling activities to develop in new directions. In view of IIASA's contributions to the theory and the practice of mathematical modelling, therefore, it is particularly appropriate that a collection of papers by IIASA researchers should have been published as a special issue of *Mathematical Modelling*. These seven papers give some idea of the range of IIASA's modelling activities, but by no means represent the full scope of IIASA's research program. They have been selected for their methodological or practical relevance to the art of mathematical modelling.

**RR-83-008.** *Patterns for Family Migration: Two Methodological Approaches.* L.J. Castro, A. Rogers. March 1983. 21 pp. Reprinted from Environment and Planning A, volume 15 number 2(1983). Available for a handling charge of $3.00.

It is widely recognized that many internal migrations are undertaken by individuals whose moves are dependent on those of others. For example, children migrate with their parents and wives with their husbands. This paper suggests two formulations of family migration that permit the introduction of such family dependencies into the population projection process.

**RR-83-010.** *Forest Monitoring and Harvesting Policies.* J.L. Casti. March 1983. 33 pp. Reprinted from Applied Mathematics and Computation, volume 12 number 1 (1983). Available for a handling charge of $3.00.

This paper considers the problem of what information must be measured in a forest management model in order to generate optimal feedback harvesting policies. Together with this question, the paper also addresses the issue of how LP-based models can be embedded within the dynamic programming framework, so that feedback rather than open-loop decisions can be determined.

The appendix to the paper presents a more general system-theoretic framework within which forest

management may be studied. Issues of surprise, response to unknown disturbances, and robustness of policies are examined and a program for systematically investigating such management questions is outlined.

**RR-83-011.** *Water and Fire: Water Needs of Future Coal Development in the Soviet Union and the United States.* J. Alcamo. April 1983. 43 pp. $6.00.

This report presents estimates of water requirements for future coal use in the USSR and the US. Future levels of coal use were based on scenarios presented by IIASA in *Energy in a Finite World.* As a first step in the analysis, IIASA's coal scenarios were broken down from the scale of "world-region" to the scale of coal-producing region. This exercise revealed that American and Soviet coal targets, which seem feasible when viewed on the "world-region" scale, may be difficult to attain on the coal-region scale due to insufficient coal reserves in some regions.

In the next stage of the analysis, an analytical model was developed, which describes on the coal-region scale the quantity of water required during different stages of coal development from mining to its final conversion to useful energy. Application of this model to each of ten principal coal-producing regions of the US and USSR suggested that roughly 1-2 tons of water will be consumed for every ton-equivalent (tce) of coal-fuel delivered. However, these estimates assume a high degree of water conservation; with less emphasis on conservation perhaps 50% more water will be required.

Water requirements for coal were then compared with competitive water uses in each US coal region, as well as estimates of surface water supply in these regions. It was found that the amount of water needed for coal is small relative to other projected water uses such as agriculture and industry. However, after accounting for competitive water uses, there will probably be little or no water available for coal use during dry years in the Southwest and Northwest regions. Unless significant quantities of water can be stored for these years, coal development will have to displace other water uses in these regions.

Intense water pressure will probably also occur in the Asian-USSR coal region of Ekibastuz, and possibly in Kuznetsk, Kansk-Achinsk, and Tungusska. It is concluded, therefore, that an overall four- or fivefold expansion of coal use in the US and Soviet Union will probably be constrained to some degree by both limited coal reserves and lack of readily available water.

**RR-83-019.** *Trade-off Between Cost and Effectiveness of Control of Nutrient Loading into a Water Body.* I. Bogardi, L. David, L. Duckstein. July 1983. 41 pp. $6.00.

A system consisting of a watershed and a water body is considered, and a methodology is presented for selecting the alternative scheme offering the best compromise between economic activity in the watershed and quality of the water body. The general problem is specified for the system of a watershed and a lake endangered by eutrophication. Both economic activity and eutrophication can be characterized by several criteria. The method is applied to actual data from a subwatershed of Lake Balaton, Hungary, where the economic objective is to minimize the sum of costs and losses for the various control measures and the environmental objective is to minimize the amount of P available for algal growth. Both of these objectives are decomposed into several criteria. The action space consists of six pure strategies, namely, the control of (1) point-source pollution, (2) fertilizer, (3) erosion, (4) land use, (5) runoff control, and (6) sediment yield. These six pure actions lead to the definition of eight mixed alternatives. The phosphorus-loading portion of

the model is run repeatedly with different stochastic input sequences to account for hydrologic uncertainty and the corresponding environmental objective is expressed as the probability "uj" that alternative "j" results in the largest decrease of P-loading. Model parameters are estimated using available data or published tables and graphs. Compromise programming is used to find a trade-off (or satisfactum solution) that balances the two conflicting objectives. In order to facilitate further application of the methodology, several points are discussed such as the relationship between the lake and its catchment, the error in stochastic simulation, the consideration of various uncertainties, the effect of snowmelt, and possible coupling with detailed lake eutrophication models. Finally, a step-by-step summary of the methodology is given to facilitate application of the model to other cases. Multicriterion decision-making techniques are briefly reviewed in the appendix so that cases with more than two objectives may also be approached.

**RR-83-020.** *Water-Quality Modelling: A Comparison of Transport-Oriented and Ecology-Oriented Approaches.* L. Somlyody. August 1983. 28 pp. Reprinted from Ecological Modelling, volume 17(1982). Available for a handling charge of $3.00.

In water-quality modelling several different directions can be distinguished according to the strategy employed and the disciplinary background used for analysis. A precise classification would be difficult to make, but the manifest difference between transport-oriented and ecology-oriented water-quality models creates at least two obvious groups. In the first case, the description of biological and chemical processes is oversimplified, while in the second, the same applies to transport phenomena. Both approaches determine the level of involvement of the respectively less emphasised phenomena by a priori assumptions. This paper discusses this apparent gap and how to overcome it. No overall procedure is given; instead, a framework is suggested which is based on establishing the relative importances of the various subprocesses determining water quality and proceeding to the corresponding model structure. This should allow the proper combination of knowledge gained from theory and observations, and, furthermore, the elaboration of essential modelling steps such as parameter estimation and model identification. To illustrate, two examples are presented - one concerns heavy-metal pollution of a river, the second involves a lake for which the wind-induced interaction between water and sediment was analysed. In the first situation, a one-dimensional, coupled hydrodynamic - water-quality model for three cadmium compartments was adopted. For the second problem, it was necessary to determine the unknown boundary condition at the lake bottom. This latter was achieved by simplifying the governing transport equation into an ordinary differential equation and introducing some simplifying hypotheses. Given data from regular, intensive observations, the calibration, identification, and validation of this model were carried out using the extended Kalman filtering technique.

**RR-83-021.** *Urban Systems Modeling.* P. Korcelli, editor. August 1983. 235 pp. Reprinted from Sistemi Urbani, volume 4(1982). Available for a handling charge of $3.00.

The eight papers included in this volume attempt to address a number of current urban modeling issues. Some contributions focus on problems found on the interface between urban planning and urban modeling, while others propose more efficient computational algorithms. Still other papers take a critical view on methods and approaches which have so far been dominant in the field. On the substantive side, the topics vary from urban transportation systems to housing allo-

cation, the urban environment and general planning theory. The diversity of topics represents an essential condition for further progress to be achieved in urban modeling.

**RR-83-022.** *I. Forecasts for Austrian Agriculture to the Year 2000; II. The Food and Agriculture Model for Austria.* K.M. Ortner. September 1983. 37 pp. $5.00.

In Austrian agriculture substantial technical progress has been achieved since World War II, and this has led to high self-sufficiency ratios for foods, decreasing relative prices for agricultural products, and increased migration of labor out of agriculture. As forecasts, three scenarios were assumed, which differ according to the level of production of agricultural goods desired by policy makers: (1) a continuation of past price trends; (2) a continuation of current self-sufficiency ratios; and (3) increased exports. It appears that developments observed in the past will continue into the future but with modifications that critically depend on the targets of agricultural policies and the measures taken to pursue them. The results also demonstrate that the econometric policy analysis simulation model can provide valuable information and can - with some improvement - become a tool for evaluating agricultural policy alternatives and their outcomes.

**RR-83-027.** *Emergent Novelty and the Modeling of Spatial Processes.* J.L. Casti. December 1983. 12 pp. Reprinted from Kybernetes, volume 12 (1983). Available for a handling charge of $3.00.

In this report we consider the complementary questions: in what sense do local dynamics prescribe global spatial patterns and to what extent does a global pattern impose constraints on local interactions. From the standpoint of results from mathematical system theory, it is argued that a modeling approach starting from observed patterns and passing to local dynamics is vastly to be preferred to proceeding in the opposite direction, the usual approach mimicking the procedure followed in the physical sciences. The report concludes with a discussion on the role of anticipatory decision making and adaptation in the stabilization of certain properties of dynamical spatial processes.

**RR-83-028.** *Environmental Modeling Under Uncertainty: Monte Carlo Simulation.* K. Fedra. November 1983. 83 pp. $8.50.

The study of environmental systems as ecological and physicochemical as well as socioeconomic entities requires a high degree of simplifying formalism. However, a detailed understanding of a systems function and response to various changes for the explicit purpose of systems management and planning still requires fairly complex hypotheses, or models. Such models can hardly be subjected to rigorous tests without the aid of computers. Systems simulation is a powerful tool when subjecting complex hypotheses to critical tests of their logical structure and their performance over the range of plausible input conditions .

Based on a formalized trial-and-error approach using Monte Carlo methods, this report presents and discusses an approach to simulation modeling under uncertainty. An introduction to the causes and implications of the problem, namely uncertainty, and a short formal presentation of the methodology proposed are followed by some more technical remarks on Monte Carlo simulation. Using three different application examples, the author discusses the role of uncertainty in the formal testing of model structures, in parameter estimation, and in prediction. In the last example, the limits of estimation and, with it, prediction are demonstrated. In a comparison of Monte Carlo simulation and alternative approaches to including and evaluating uncertainty in

simulation modeling, the discussion section examines the implications of uncertainty for model application in a broader framework.

## STATUS REPORTS

**SR-79-004.** *Health Care Systems Modeling at IIASA: A Status Report.* P.I. Kitsul. April 1979. 65 pp. Single copies available free of charge.

Governmental policies in all countries strongly influence the medical services available to society. It is therefore essential that decision makers be aware of changing demands and needs for health resources and services. In light of this, the Health Care Systems (HCS) Modeling Task of the Human Settlement and Services (HSS) Area has set a goal of creating a model that will assist national decision makers in formulating policy. This model consists of a number of linked submodels dealing with various related topics from population growth to resource allocation. Some of these submodels have already been tested, and collaborating national research centers have started to implement them with their own data. The resulting experience of the past several years is described in this review, which has been prepared by members of the HCS Modeling group. By sharing our aims and achievements with a wider audience, we hope to facilitate future international collaborative work on this research.

**SR-81-003.** *System and Decision Sciences at IIASA 1973-1980.* A.P. Wierzbicki, H.P. Young. November 1981. 51 pp. Single copies available free of charge.

This report contains a brief history of the past achievements of the System and Decision Sciences Area at IIASA, and a summary of its current and future research directions. There is a comprehensive list of the scientific staff of the Area since 1973, together with a list of their publications; abstracts of the most recent reports and biographies of the scholars working in the Area in 1980 are also included.

## EXECUTIVE REPORTS

**ER-80-002.** *Beware the Pitfalls. A short guide to Avoiding Common Errors in Systems Analysis.* G. Majone, E.S. Quade. May 1980. 27 pp. Single copies available free of charge.

The interest in systems analysis, which is now worldwide, is not hard to understand. Analyzing systems of various kinds has helped to solve some important social, economic, and environmental problems, and it has thrown light on others that must eventually be solved. As an aid to establishing policy, systems analysis has been particularly useful where matters are complex, where objectives conflict, and where future planning is difficult.

Analysts tend to evaluate their studies on technical adequacy; decision makers stress practical results. The editors of *Pitfalls of Analysis* saw both types of standards as important and related. They organized their material to present first some common pitfalls of technical adequacy and then some common pitfalls of effectiveness.

**ER-81-004.** *Energy in a Finite World. Executive Summary. Report by the Energy Systems Program Group.* A. McDonald. May 1981. 76 pp. Single copies available free of charge.

This volume summarizes the results of a seven-year study conducted at the International Institute for Applied Systems Analysis (IIASA) in Laxenburg, Austria. The work, which involved over 140 scientists from 20 countries, aimed to provide new and critical insights into the international long-term dimensions of the energy problem. Given this objective, the 50-year period from 1980 to 2030 was analyzed in detail, though parts of the study looked even further into the future. Geographically, all countries of the world were included - developed and developing, market and centrally planned economies.

The picture that emerges is one of a world facing, during the 1980-2030 period, what is anticipated to be the steepest ever increase in its population. At the same time, the developing regions of the world, in which most of this population growth will occur, will be trying to close the economic gap separating them from the developed regions. Despite the resultant strains on the world's physical resources, on its institutions, and on human ingenuity, the conclusion is that the physical resources and the human potential exist to provide the energy for a 2030 world that is more prosperous than the world of today while supporting a population double that of 1975. Moreover, if resources are developed judiciously and strategically, the world of 2030 could be at the threshold of a critical and ultimately necessary transition from a global energy system based on depletable fossil fuels to one based on nondepletable, sustainable resources.

The companion volume, *Energy in a Finite World, Vol. 2, A Global Systems Analysis,* also published by Ballinger, presents the study findings in detail, with the references and qualifications typical of a comprehensive scientific work. ER-81-4, *Energy in a Finite World: Executive Summary,* by Alan McDonald, provides a concise summary of the study and is available from IIASA.

**ER-81-005.** *Sharing Costs Fairly. A Practical Introduction to Cooperative Game Theory.* H.P. Young, N. Okada, T. Hashimoto. September 1981. 29 pp. Single copies available free of charge.

An IIASA executive report based on an IIASA research report by H.P. Young, N. Okada, and T. Hashimoto, who compare traditional methods of allocating costs of new water facilities with more recently developed methods involving cooperative game theory. Their purpose is to show how these methods work in actual use, and the executive report serves as practical introduction to cooperative game theory.

The authors have investigated an actual water cost allocation case in the Skane region of southern Sweden. The 18 municipalities of the area were combined into six groups. Costs of a water development project there were first allocated by two naive methods -- proportional to population and proportional to use. Then five techniques of cost allocation derived from cooperative game theory were tried -- separable costs/remaining benefits, Shapley value, nucleolus, weak nucleolus, and proportional nucleolus.

The rationale behind each of these methods is explained, and the superiority of the proportional nucleolus in this particular case is demonstrated. The authors note that as a practical matter, however, there are cases when a single numerical criterion such as apportioning costs by population or by use may be preferable to the more complicated game-theory methods.

The executive report also discusses briefly a simple method for allocating costs in such cases as the Skane water development project that is based on bidding, a noncooperative type of game that puts the burden of information gathering on the players themselves.

**ER-81-006.** *Lessons from Major Accidents--A Comparison of the Three Mile Island Nuclear Core Overheat and the North Sea Platform Bravo Blowout.* D.W. Fischer. November 1981. 40 pp. Single copies avaiable free of charge.

In research carried out at IIASA, David Fischer compares the 1977 offshore oil well blowout at Platform Bravo, Norway, with the 1979 nuclear plant overheat at Three Mile Island, US. The glaring need emerging from the comparison, in the author's view, is for a smaller part of total resources devoted to accident prevention and a larger part to accident management after an accident has occurred. He says the root of the problem is excessive optimism bred by "professional mindset" that nothing can go wrong.

The Executive Report details the key managerial events that took place after each accident and shows how similar needs were met at various crisis points during the first days of the developing accidents. From this exposition Fischer then draws general conclusions, including these: Major accidents are not unique, and their similarities offer learning possibilities; accident management should be centralized; all participants in accident management should have predetermined roles; and to assure good, flexible design, accident management must be developed through a dialogue among all key participants.

## COLLABORATIVE PAPERS

**CP-81-S01.** *Large-Scale Linear Programming.* G.B. Dantzig, M.A.H. Dempster, M.J. Kallio, editors. April 1981. 1176 pp. (2 Volumes) $30.00.

During the week of June 2-6, 1980, the System and Decision Sciences Area of the International Institute for Applied Systems Analysis organized a workshop on large-scale linear programming in collaboration with the Systems Optimization Laboratory (SOL) of Stanford University, and co-sponsored by the Mathematical Programming Society (MPS). The participants in the meeting were invited from amongst those who actively contribute to research in large-scale linear programming methodology (including development of algorithms and software).

The first volume of the Proceedings contains five chapters. The first is an historical review by George B. Dantzig of his own and related research in time-staged linear programming problems. Chapter 2 contains five papers which address various techniques for exploiting sparsity and degeneracy in the now standard LU decomposition of the basis used with the simplex algorithm for standard (unstructured) problems. The six papers of Chapter 3 concern aspects of variants of the simplex method which take into account through basis factorization the specific block-angular structure of constraint matrices generated by dynamic and/or stochastic linear programs. In Chapter 4, five papers address extensions of the original Dantzig-Wolfe procedure for utilizing the structure of planning problems by decomposing the original LP into LP subproblems coordinated by a relatively simple LP master problem of a certain type. Chapter 5 contains four papers which constitute a mini-symposium on the now famous Shor-Khachian ellipsoidal method applied to both real and integer linear programs. The first chapter of Volume 2 contains three papers on non-simplex methods for linear programming. The remaining chapters of Volume 2 concern topics of present interest in the field. A bibliography a large-scale linear programming research completes Volume 2.

**CP-82-S06.** *Modeling Agricultural-Environmental Processes in Crop Production.* G.N. Golubev, I.A. Shvytov. November 1982. 277 pp. $14.00.

The most important field-scale environmental effects of dry farming--which can potentially lead to such large-scale environmental impacts as eutrophication, water pollution, and cropland losses--have been identified as soil erosion, nitrogen leaching, and phosphorus and pesticide losses. The work in this field was begun by considering the hydrological and major natural biogeochemical processes, which, through a chain of events, cause these environmental effects. There are many mathematical models describing single processes such as water percolation, runoff, nitrogen mineralization, nitrification, denitrification, phosphorus precipitation and adsorption, evapotranspiration, nutrient uptake, pesticide degradation, etc. Moreover, a few complex models (CREAMS, ARM, ACTMO,etc.) have been developed.

This volume presents papers focusing on: 1.) discussions of the state of the art of developing mathematical models for environmental processes in crop production; 2.) improving the guidelines for completing the IIASA research on mathematical modeling of the environmental effects of agriculture; and 3.) refining the Institute's collaborative work with other organizations. A review of the main points brought out at the meeting concludes the volume.

**CP-82-S07.** *Environmental Aspects in Global Modeling. Proceedings of the 7th IIASA Symposium on Global Modeling.* G. Bruckmann, editor. December 1982. 327 pp. $15.00.

The Seventh Global Modeling Conference concentrated on a key problem that, it was felt, deserved special attention, namely, the role of the environment in global modeling. The purpose of the conference was not so much to look back on what had been achieved (or remained to be done), but rather to examine what should be learnt for future modeling work from past achievements or omissions. It is hoped that the papers presented in this volume will give an overview of the problematique and of possibilities for future advances.

**CP-82-S08.** *Progress in Nondifferentiable Optimization.* E.A. Nurminski, editor. December 1982. 264 pp. $14.00.

This volume grew out of the second meeting on nondifferentiable optimization, a field whose most important applications lie in treating problems of decision-making under uncertainty. Since the first meeting, held in 1977, new results were obtained in the theory of optimality conditions, and there was more understanding of the relationships between various classes of nondifferentiable functions. All of these new developments were discussed at the meeting, the reports presented by the participants covering the theory of generalized differentiability, optimality conditions, and the numerical testing and applications of algorithms. After the meeting the participants prepared extended versions of their contributions; these revised papers form the core of this volume, which also contains a bibliography of over 300 references to published work on nondifferentiable optimization, prepared by the editor.

**CP-82-S12.** *Multiobjective and Stochastic Optimization.* M. Grauer, A. Lewandowski, A.P. Wierzbicki. December 1982. 485 pp. $19.00.

This book is divided into four main sections, the first of which contains five papers dealing with the theoretical aspects of multiobjective and stochastic optimization. The seven papers included in Section II are concerned with those aspects of multiobjective analysis which have a direct relationship to decision making (some papers in Sections III and IV are also linked to decision making or

decision support, although not so directly). Section III contains four papers dealing with uncertainties and multiobjective analysis. The first and last papers in this section also present solution techniques which are illustrated by means of examples. The final section contains papers which concentrate on solution techniques and indicate how they can be applied to practical problems; the software presented in this section can be regarded as a step toward computerized decision support systems. Naturally, some of the papers in other sections also touch on applications of multiobjective and stochastic optimization:

examples are drawn from a wide range of activities, including regional planning, environmental control, wage negotiation and energy planning.

**CP-83-S02.** *Input-Output Modeling: Proceedings of the Third IIASA Task Force Meeting.* M. Grassini, A. Smyshlyaev, editors. July 1983. 581 pp. $24.00.

The papers in this volume fall into two groups: the first deals with the linkage of input-output models and describes several models that are now ready to be linked, while the second concentrates on the analysis of structural change as well as reporting recent developments in the INFORUM group of models. Some of the papers in the first group examine the linkage of seven national models using the INFORUM international trade model, the development of a linked system for modeling the small open economies of the Nordic countries, and the definition of an appropriate international scenario for a single national model. Others discuss problems of disaggregation, the relationship between regional and national models, and the role of input-output models as policy-making tools. The section closes with papers on national models for Poland and Finland and a report describing the price-income block of the advanced US INFORUM model. The second group opens with analyses of factor inputs and of energy-economy interactions. It continues with suggestions on how to develop consistent dynamic input-output models using poor data bases and describes how an input-output model can be used to derive aggregate characteristics of probable future structural change. Further papers are devoted to changes in technical coefficients, the development of effective national models using limited or inconsistent data bases, and estimation techniques. The volume closes with a "system for systems design" for use in input-output related work.

**CP-83-S03.** *Eutrophication of Shallow Lakes: Modeling and Management. The Lake Balaton Case Study.* L. Somlyody, S. Herodek, J. Fischer, editors. August 1983. 377 pp. $16.00.

The phenomenon of eutrophication is more irregular in character and less satisfactorily understood for shallow water bodies than for deep lakes. Research, initiated by IIASA, focussed of Lake Balaton, Hungary, as the subject of a case study. Three main considerations promoted the selection of Lake Balaton: 1) a large amount of data was available, due to Hungarian research activities; 2) the lake possesses the "typical" properties of shallow lakes; and 3) serious economic interests are associated to the solution of the eutrophication problem of Lake Balaton and so several "practical" questions had to be answered in addition to the pure "scientific" issues.

The structure of the research was based on a systems analytical approach which allowed the joint study of scientific and practical issues covering a wide range of different disciplines such as biology, chemistry, physics, hydrology, mathematics, economics, etc. The mathematical models developed in harmony and interaction with data collection and experimental work played a significant role in the project. Several existing methods were adopted for modeling the ecological and

hydrophysical processes as well as water quality management in parallel with establishing new methodologies.

At the completion of the research an expert committee was established in Hungary to elaborate recommendations for the government concerning the revision and modification of existing measures on water quality control and regional development. In January 1983, the Council of Ministers approved the recommendations and made the relevant decisions. Thus, the research results were transferred to decision makers within a very short period, allowing them to bring in scientifically well established new decisions.

**CP-83-S05.** *Proceedings of the Fourth IIASA Task Force Meeting on Input-Output Modeling.* A. Smyshlyaev, editor. December 1983. 335 pp. $15.00.

The Fourth IIASA Task Force Meeting on Input-Output Modeling set out to examine how fully I/O modeling captures the substance of policy issues such as energy conversion problems, changes in consumer behavior patterns, and aspects of foreign trade under new and evolving world market conditions. The 28 papers presented are arranged here in three sections. In the first section, ten papers review the results and lessons of modeling work aimed at understanding structural change in the economies of the United States, the GDR, Nigeria, Japan, Hungary, the Soviet Union, Austria, the FRG, and Italy. The papers in the second section are tied together by their focus on issues related to international trade. The first three comment on the structure of trade for Hungary, Austria, and Italy; the next four are interrelated contributions from the NordHand group of modelers (in Denmark, Finland, Norway, and Sweden); the final paper in the section discusses a model of interdependent structural change within the European Communities. In the third section of the book are ten papers dealing with the empirical analysis of structural change through the examination of interindustry interactions and energy analysis. Four papers open the section by analyzing the changing intermediate coefficients in studies of Poland, Finland, Austria, and Hungary. These are followed by four contributions that explore and extend traditional techniques in studies of the economies of Denmark, the European Community, and Austria as well as a long-term application to project the profitability of ethanol production; the volume ends with papers that discuss factors connected with changes in the structure of industrial production in Italy and Czechoslovakia.

# PROCEEDINGS OF THE SCS COMPUTER SIMULATION CONFERENCES

## (20% DISCOUNT OFF SHOWN LIST PRICE FOR MEMBERS OF AFIPS CONSTITUENT SOCIETIES.)

1984—Proceedings of the 1984 Summer Computer Simulation Conference
July 23-25, 1984, Boston, Massachusetts
Approx. 900 pages, two volumes, softcover, $90.00.

1983—Proceedings of the 1983 Summer Computer Simulation Conference
July 7-11, 1983, Vancouver, B.C., Canada
678 pages, one volume, softcover. $90.00

1982—Proceedings of the 1982 Summer Computer Simulation Conference
July 19-21, 1982, Denver, Colorado
678 pages, one volume, softcover, $50.00

1981—Proceedings of the 1981 Summer Computer Simulation Conference
July 17-21, 1981, Washington, DC
736 pages, one volume, softcover, $50.00

1980—Proceedings of the 1980 Summer Computer Simulation Conference
August 25-27, 1980, Seattle, Washington
752 pages, one volume, softcover, $50.00

1979—Proceedings of the 1979 Summer Computer Simulation Conference
July 16-18, 1979, Toronto, Canada
980 pages, one volume, softcover, $50.00

1978—Proceedings of the 1978 Summer Computer Simulation Conference
July 24-26, 1978, Newport Beach, California
942 pages, softcover, $50.00

1977—Proceedings of the 1977 Summer Computer Simulation Conference
July 14-16, 1977, Chicago, Illinois
932 pages, one volume, softcover, $35.00

1976—Proceedings of the 1976 Summer Computer Simulation Conference
July 12-14, 1976, Washington, DC
1,040 pages, one volume, softcover, $35.00

1976—Proceedings of the 1975 Summer Computer Simulation Conference
July 21-23, 1975, San Francisco, California
1,528 pages, two volumes, softcover, $25.00 set.

1974—Proceedings of the 1974 Summer Computer Simulation Conference
July 9-11, 1974, Houston, Texas
954 pages, two volumes, softcover, $25.00 set.

1973—Proceedings of the 1973 Summer Computer Simulation Conference
July 17-19, 1973, Montreal, Canada
1,300 pages, two volumes, softcover, $20.00 set.

1972—Proceedings of the 1972 Summer Computer Simulation Conference
June 14-16, 1972, San Diego, California
1,500 pages, softcover, two volumes, $20.00 set.

For information, contact:

AFIPS Press
1899 Preston White Drive
Reston, VA 22091
(703) 620-8937

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NOTICE BOARD:

Mr. Larry Latham
SIMCO
24333 Southfield Road
Room 203
Southfield, Michigan 48075

(313) 552-0560

is interested in contacting others
in Detroit area working with continuous
simulation models

## LIST OF EVENTS

Compiled and Edited by

Tuncer I. Ören
Murat Özmızrak

Computer Science Dept.
University of Ottawa
Ottawa, Ontario K1N 9B4
Canada

** indicates new entry
-- indicates an update

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J A N U A R Y
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January 2-4, 1985
**EIGHTEENTH HAWAI INTERNATIONAL CONFERENCE ON SYSTEM SCIENCE**
Honolulu, Hawaii, USA

Topics:  Distributed Processing, Mini-Micro Systems, Interactive Systems, Personal Computing, Data Communication, Graphics, User-Interface Technologies, Software Design Tools and Techniques.
Contact:  Ralph Sprague
University of Hawaii
2404 Maile Way
Honolulu, HI 96822, USA
Phone (808) 948-7430

** January 21-24, 1985
**MATHEMATICAL AND COMPUTATIONAL METHODS IN SEISMIC EXPLORATION AND RESERVOIR MODELLING**
Houston, Texas, USA

Topics:  Methodologies of Statistical and Numerical Analysis, The Numerical Integration of Linear and Nonlinear Partial Differential Equations, Signal Processing.
Contact:  SIAM Meetings Department
1405 Architects Building
117 South 17. Street
Philadelphia, PA 19103, USA

January 24-26, 1985
**COMPUTER SIMULATION IN EMERGENCY PLANNING**
San Diego, California, USA

Topics:  General, Policy, Nuclear, Fire, Spills, Earthquakes, Emergency Medical, Other Natural or Man-Made Emergencies.
Contact:  The Society for Computer Simulation
P.O. Box 2228
La Jolla, California 92038, USA
Phone (619) 459-3888

January 24-26, 1985
**SCS MULTICONFERENCE ON MODELLING AND SIMULATION ON MICROCOMPUTERS AND DISTRIBUTED SIMULATION 1985**
San Diego, California, USA

Topics:  Parallel processing and simulation, Architectures for parallel simulation, Distributed simulation engines, Deadlock detection and prevention, Synchronization and communication, Languages for distributed simulation, Support environments, Emprical studies and results.
Contact:  The Society for Computer Simulation
P.O. Box 2228
La Jolla, California 92038, USA
Phone (619) 459-3888

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F E B R U A R Y
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** February 25-27, 1985
**ARTIFICIAL INTELLIGENCE IN SIMULATION**
University of Ghent, Ghent, Belgium

Topics:  Advanced Information Processing Technologies in Systems Modelling and Simulation, Knowledge Representation in Simulation, Man-Machine Interfaces in Simulation, Question-Answering Systems in Simulation, Expert Systems and Simulation.

Contact:  G.C. Vansteenkiste
E.J.H. Kerckhoffs
University of Ghent
Coupure Links 653
B-9000 Ghent, Belgium
Phone 91-236961
Telex 12754 RUGENT

## MARCH

March 1985
### EIGHTEENTH ANNUAL SIMULATION SYMPOSIUM

March 12-14, 1985
### ACM COMPUTER SCIENCE CONFERENCE
New Orleans, Louisiana, USA

Contact:  Terry M. Walker
Computer Science Department
University of Southwestern Louisiana
P.O. Box 44330
Lafayette, LA 70504, USA
Phone (318) 231-6339

-- March 12-14, 1985
### IFAC/IFORS/IFIP WORKSHOP ON ARTIFICIAL INTELLIGENCE PATTERN RECOGNITION IN ECONOMICS AND MANAGEMENT
Zurich, Switzerland

Topics:  Research and Applications of Artificial Intelligence and Pattern Recognition in the Area of Economic and Management Studies, Banking, and Finance.
Contact:  Prof. L.F. Pau
Battelle Institute
7 route de Drize
CH-1227 Carouge, Switzerland

** March 13-15, 1985
### EIGHTEENTH ANNUAL SIMULATION SYMPOSIUM
Tampa, Florida, USA

Contact:  Prof. John C. Comfort
Department of Mathematical Sciences
Florida University
Miami, Florida 33199, USA
Phone (305) 554-2015

** March 24-29, 1985
### 1985 EASTERN SIMULATION CONFERENCES
Williamsburg, Virginia, USA

Topics:  Artificial Intelligence and Simulation, The Simulation Profession, Simulators, Simulation in ADA.
Contact:  Charles A. Pratt
Executive Director
The Society for Computer Simulation
P.O. Box 2228
La Jolla, CA 92038, USA
Phone (619) 459-3888

** March 26-30, 1985
### 1985 INTERNATIONAL CONFERENCE ON ACOUSTICS, SPEECH, AND SIGNAL PROCESSING
Tampa, Florida, USA

Contact:  Dr. J. Robert Ashley
Sperry Electronic Systems
P.O. Box 4648
Clearwater, Florida 33518, USA
Phone (813) 577-1900

** March 27-29, 1985
### ICS 85: ACM EUROPEAN REGIONAL CONFERENCE
Florence, Italy

Contact:  Giacomo Bucci,
Dipartimento di Informatica e Sistemistica
Universita di Firenze
Via S. Marta 3, 50139 Firenze, Italy

## APRIL

** April 11-12, 1985
### SCOTTSDALE, AGAIN
Scottsdale, Arizona, USA

Contact:  Bob Stratman
R2214, Motorola Government Division
8220 East Roosevelt
P.O. Box 9040
Scottsdale, Arizona 85252, USA
Phone (602) 949-3438

** April 16-18, 1985
### TFAIS 85: THEORETICAL AND FORMAL ASPECTS OF INFORMATION SYSTEMS

Barcelona, Spain

Topics:  Foundation of Information Systems, Information versus Knowledge Representation, Data Models, Behaviour Models, Communication Modelling, Conceptual Models and Languages.
Contact:  Antoni Olive
Facultat d'Informatica
Jordi Girona Salgado, 31
Barcelona 34, Spain
Phone 34-3-2048252 (x294)

## MAY

** May 14-16, 1985
### INTERNATIONAL ADA CONFERENCE
Paris, France

Contact:  J.A.N. Lee
Virginia Polytechnic Institute and State University
Blacksburg, VA 24061, USA
Phone (703) 961-6931

May 21-24, 1985
### 1985 INTELLIGENCIA 1985
Paris, France

Contact:  Charles A. Pratt, SCS
P.O. Box 2228
La Jolla, California 92038, USA
Phone (619) 459-3888

## JUNE

** June 11-14, 1985
IFAC WORKSHOP: CONTROL APPLICATION OF NONLINEAR PROGRAMMING AND OPTIMIZATION
Capri, Italy

Contact: Prof. G. Di Pillo
Dipartimento di Informatica e Sistemistica
Universita di Roma
Via Eudossiana 18
I-00184 Rome, Italy


June 12-24, 1985
FIFTH CONFERENCE ON NONLINEAR FINITE ELEMENT ANALYSIS AND ADINA
Cambridge, Massachusetts, USA

Contact: K.J. Bathe
MIT, 77 Massachusetts Av. Room 3-356
Cambridge, Massachusetts 02139, USA
Phone (617) 253-6645


** June 17-18, 1985
IFAC WORKSHOP ON MODEL ERROR CONCEPTS AND COMPENSATION
Boston, USA

Contact: Prof. R.E. Skelton
Purdue University
Aeronautics & Astronautics
331 Grissom Hall
West Lafayette, IN 47907, USA


** June 17-19, 1985
INTERNATIONAL SYMPOSIUM ON COMPUTER ARCHITECTURE
Boston, USA

Topics: Fifth Generation Architectures, Support for Operating Systems and Languages, Techniques for Fault Tolerance, Supercomputers.
Contact: Dr. Tilak Agerwala
IBM Research
P.O. Box 218
Yorktown Heights, NY 10598, USA


** June 18-20, 1985
SCANDINAVIAN CONFERENCE ON IMAGE ANALYSIS
Trondheim, Norway

Contact: Eric Swane
Automatic Control Division, SINTEF
The Norwegian Institute of Technology
N-7034 Trondheim, Norway
Phone 47-7-594361


** June 25-27, 1985
IFIP/IFAC SYMPOSIUM ON AUTOMATION FOR SAFETY IN SHIPPING AND OFFSHORE PETROLEUM OPERATIONS
Trondheim, Norway

Contact: The Norwegian Society of Automatic Control
Kronprinsens gt. 17
Oslo 2, Norway


** June 25-29, 1985
IFAC SYMPOSIUM ON AUTOMATIC CONTROL IN SPACE
Toulouse, France

Topics: Space Robotics, Shuttle Launch Operations, Control of Tethered Sarellites, Navigation, Comunication, Weather and other Mission-Oriented Satellites.
Contact: Marc J. Pelegrin
Director, ONERA-CERT
B.P. 4025
Toulouse, France

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J U L Y
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** July 3-7, 1985
SEVENTH IFAC/IFORS SYMPOSIUM ON IDENTIFICATION AND SYSTEMS PARAMETER ESTIMATION
University of York, United Kingdom

Topics: Major Aspects of Modelling, Identification and Parameter or State Estimation, Applications in Education, Hardware and Software Implementation of Estimation Techniques.
Contact: Conference Services
Institution of Electrical Engineers
Savoy Place
London WC2R OBL, United Kingdom


** July 9-11, 1985
CONTROL 85
University of Cambridge, United Kingdom

Topics: Computer aided Control System Design, Non-linear Feedback Systems, Optimization, Numerical Methods in System Design, Digital and Computer Control Systems.
Contact: Conference Services
Institution of Electrical Engineers
Savoy Place
London WC2R OBL, United Kingdom


** July 9-11, 1985


IFAC SYMPOSIUM: AUTOMATION FOR MINERAL RESOURCE DEVELOPMENT
Brisbane, Australia

Contact: Prof. Alban J. Lynch
Julius Kruttschnitt Mineral Research Centre
University of Queensland
Isles Road
Indooroopilly, QLD 4068, Australia


July 15-18, 1985
NATIONAL COMPUTER CONFERENCE
Chicago, USA

Contact: AFIPS
1899 Preston White Drive
Reston, VA 22091, USA
Phone (703) 620-8900

**50**

** July 16-19, 1985
SECOND INTERNATIONAL CONFERENCE ON THE
TEACHING OF MATHEMATICAL MODELLING
Exeter, England

Contact: Ms. S. Williams
Conference Secretary
University of Exeter
St. Lukes
Exeter EX1 2LU, England


-- July 22-26, 1985
SUMMER COMPUTER SIMULATION CONFERENCE
Chicago, Illinois, USA

Topics: Simulation Methods, Computer Systems, Simulation Credibility and Validation, Physical and Engineering Sciences, Simulation of Systems, Chemical Sciences, Energy and Resource Management, Biomedical Simulation, Environmental Sciences, Management and the Social Sciences, Training and Research Simulators, Government Simulation/ Computer Facilities, Simulation and CAD/CAM, Artificial Intelligence, Communication Systems, Transportation Systems, and Mathematical Modelling.
Contact: Charles A. Pratt
SCS, P.O. Box 2228
La Jolla, CA 92038, USA
Phone (619) 459-3888


July 29-31, 1985

FIFTH INTERNATIONAL CONFERENCE ON
MATHEMATICAL MODELLING
Berkeley, California, USA

Topics: Engineering Systems, Resources, Biomedical Systems, Socio-Economic Problems, Environmental Sciences, Methodology, Model Validations.
Contact: Pr. Xavier J.R. Avula
Institute for Applied Sciences
Branch Office
P.O. Box 1488
Rolla, Missouri 65401, USA
Phone (314) 341-4585


July 29-August 2, 1985
1985 WORLD CONFERENCE ON COMPUTERS IN
EDUCATION
Norfolk, Virginia, USA

Contact: Mr. John McGregor
Department of Computer Studies
Murray State University
Murray, Kentucky 42071, USA


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AUGUST
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** August 4-8, 1985
1985 ASME INTERNATIONAL COMPUTERS IN
ENGINEERING CONFERENCE
Boston, USA

Contact: Dr. Steve M.Rhode
Power Systems Research Department
General Motors Research Labs
Warren, Michigan 48090-9055, USA
Phone (313) 575-3004 & (313) 492-6635


August 5-9, 1985
ELEVENTH IMACS WORLD CONGRESS/ SYSTEM
SIMULATION AND SCIENTIFIC COMPUTATION
Oslo, Norway

Topics: Systems modelling and simulation, model identification and validation, numerical methods for differential and integral equations, simulation of large scale systems, simulation of discrete systems, control and optimization theory and applications, simulation tools, parallel computation, special computers and software for simulation and scientific computation.
Registration Deadline: June 15, 1985


Contact: Eleventh IMACS World Congress
NFA, Kronprinsengt. 17
N-Oslo 2, Norway
Phone (02) 41 87 35
Telex 18213 XFIN


** August 20-23, 1985
1985 INTERNATIONAL CONFERENCE ON PARALLEL
PROCESSING
Pennsylvania State University, USA

Topics: Parallel/ Distributed Processing, Distributed Data Bases, Reliability and Diagnostics, Modelling and Simulation Techniques, Performance Measurements.
Deadline: February 1, 1985
Contact: Dr. Doug DeGroot
M/S 21-133
T.J. Watson Research Center
P.O. Box 218
IBM Corp.
Yorktown Heights, NY 10598, USA
Phone (914) 945-3497


August 26-31, 1985
SECOND INTERNATIONAL SYMPOSIUM ON SYSTEMS
ANALYSIS AND SIMULATION
Berlin, German Democratic Republic

Topics: Methods and Fundamentals, Simulation Techniques, Applications.
Deadline: February 1, 1985
Contact: Central Institute of Cybernetics and Information Processes of the Academy of Sciences of the GDR
DDR-1086 Berlin
Kurstrasse 33
P.O.B. 1298
German Democratic Republic
Phone 2072365
Telex 114536 zki dd


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SEPTEMBER
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-- September 2-6, 1985
TWELFTH IFIP CONFERENCE ON SYSTEM
MODELLING AND OPTIMIZATION
Budapest, Hungary

Topics: Optimal Control, Modelling and Optimization of Stochastic Systems, Linear and Nonlinear Programming, Integer Programming, Optimization Software, Applications.
Abstract Deadline: January 31, 1985

Contact: Dr. J. Szelezsan
John von Neumann Society for Computer Sciences
Budapest 5, P.O. Box 240
H-1368 Hungary
Phone 361 1138 50

** September 10-12, 1985
SECOND IFAC/IFIP/IFORS/IEA CONFERENCE: ANALYSIS, DESIGN, AND EVALUATION OF MAN-MACHINE SYSTEMS
Varese, Italy

Contact: Prof. Dr. Ing. Gunnar Johannsen
Laboratory for Man-Machine Systems
University of Kassel
P.O. Box 10 13 80
D-3 500 Kassel, FRG

** September 17-20, 1985
SEVENTH IFAC/IFIP/IMACS SYMPOSIUM: DIGITAL COMPUTER APPLICATION TO PROCESS CONTROL
Vienna, Austria

Contact: Dr. P. Kopacek
O P W Z
Postfach 131
1014 Vienna, Austria

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OCTOBER
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** October 1-3, 1985
IFAC WORKSHOP: SAFETY OF COMPUTER CONTROL SYSTEMS
Como, Italy

Contact: Dr. E. DeAgostino
Senior Researcher Engineer
ENEA Dip. Reattori Termici
CRE Casaccia
Via Anguillarese 301
I-00060 Rome, Italy

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NOVEMBER
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** November 6-8, 1985

IFAC SYMPOSIUM: ROBOT CONTROL
Barcelona, Spain

Contact: Secretariat of SYROCO 85
Institut de Cibernetica
Diagonal 647
E-080828 Barcelona, Spain

** November 18-20, 1985
IFAC WORKSHOP: AUTOMATIC CONTROL IN PETROLEUM, PETROCHEMICAL AND DESALINATION INDUSTRIES
Kuwait

Contact: Dr. Jaafar Assiri
c/o Dr. Samir Kotob
TED/ ASD
Kuwait Institute for Scientific Research
P.O. Box 2488 5
Safat, Kuwait

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DECEMBER
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** December 1985
1985 WINTER SIMULATION CONFERENCE

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JUNE
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June 1986
MATHEMATICAL MODELLING IN IMMUNOLOGY
Working Conference
Organized by IFIP (WG 7.1)
Vienna, Austria

Contact: IFIP Secretariat
3, rue du Marche
1204 Geneva, Switzerland

June 16-19, 1986
NATIONAL COMPUTER CONFERENCE

Las Vegas, Nevada, USA

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JULY
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July 1986
SUMMER COMPUTER SIMULATION CONFERENCE

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DECEMBER
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** December 1986
1986 WINTER SIMULATION CONFERENCE

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JUNE
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June 15-18, 1987
NATIONAL COMPUTER CONFERENCE
Chicago, Illinois, USA

## IFIP    CALENDAR OF EVENTS

| Event | Date | Location | Organized by |
|---|---|---|---|
| Work. Conf. on *Stochastic Modelling and Filtering* | 10-15 Dec 84 | Rome, Italy | WG 7.1 |
| 10th Anniversary Symposium: *Performance 84* | 19-21 Dec 84 | Paris, France | WG 7.3 |
| Workshop on *Can Information Technology Result in Benevolent Bureaucracies?* | 3-6 Jan 85 | Namur, Belgium | WG 9.2 |
| Work. Conf. on *Database Semantics (DS-1)* | 7-11 Jan 85 | Hasselt, Belgium | WG 2.6 |
| Work. Conf. on *Ship Office Automation* | early 85 | Gothenburg, Sweden | WG 5.6 |
| 1st Intl. Conf. on *Data Communications in the ISDN Era* | 4-5 Mar 85 | Tel Aviv, Israel | TC6/IPA |
| Workshop on *Artificial Intelligence in Economics and Management* | 12-14 Mar 85 | Zurich, Switzerland | IFAC/IFORS IFIP |
| *IFIP 25th Anniversary Symposium* | 27 Mar 85 | Munich, FRG | IFIP |
| Work. Conf. on *Decentralized Production Management Systems* | 28-29 Mar 85 | Munich, FRG | WG 5.7 |
| Work. Conf. on *Theoretical amd Formal Aspects of Information Systems* | 16-18 Apr 85 | Barcelona, Spain | WG 8.1 |
| 10th World Congress on *New Measurement Technology to Serve Mankind - IMEKO '85* | 22-26 Apr 85 | Prague, CSSR | IMEKO |
| Workshop on *Geometric Modelling* | Apr 85 | UK | WG 5.2 |
| Workshop on *Technology Independent Design (Rules)* | Apr 85 | France | WG 10.5 |
| Intl. Symposium and Work. Conf. on *Nursing Use of Information Science and Computers* | 1-8 May 85 | Calgary & Banff, Canada | IMIA |
| Conference: *Telematica 85* | 27-30 May 85 | Rio de Janeiro, Brazil | TC6/SUCESU |
| Work. Conf. on *Computerized ECG Analysis - Towards Standardization* | 2-5 Jun 85 | Brussels, Belgium | IMIA |
| Work. Conf. on *Human-Computer Communications in Health Care* | 10-14 Jun 85 | Stockholm, Sweden | IMIA |
| 1st Intl. Conf.: *Image Science-85* | 11-14 Jun 85 | Otaniemi, Finland | Helsinki U. of Tech. |
| 6th Intl. Conf. on *Software for Discrete Manufacturing - PROLAMAT 1985* | 11-13 Jun 85 | Paris, France | WG 5.3/IFAC |
| Work. Conf. on *Problem Solving Environments for Scientific Computing* | 17-21 Jun 85 | Sophia-Antipolis, France | WG 2.5 |
| 4th Scandinavian Conference on *IMAGE Analysis* | 18-20 Jun 85 | Trondheim, Norway | IAPR |
| Work. Conf. on *Pattern Recognition in Practice, II* | 19-21 Jun 85 | Amsterdam, NL | IMIA |
| Symposium on *Automation for Safety in Shipping and Offshore Petroleum Operations - ASSOPO '85* | 25-27 Jun 85 | Trondheim, Norway | WG 5.6/IFAC |
| Seminar on *CAD/CAM/CAE for Industrial Progress* | Jun 85 | Bangalore, India | WG 5.2 & 5.3 |
| 15th Intl. Conf. on *Fault Tolerant Computing* | Jun 85 | Ann Arbor, MI, USA | TC10/IEEE |
| 4th World Conf. on *Computers in Education - WCCE'85* | 29 Jul-2 Aug 85 | Norfolk, VA, USA | TC3 |
| 3rd Symposium on *CAD in Control and Engineering Systems* | 31 Jul-2 Aug 85 | Lyngby, Denmark | IFAC/IFIP TC5 co sp. |
| Workshop on *Theoretical Computer Science & VLSI Design* | Jul 85 | Edinburgh, UK | WG 10.5 |
| 11th IMACS World Congress - *System Simulation & Scientific Computation* | 5-9 Aug 85 | Oslo, Norway | IMACS |
| 3rd Intl. Conf. - *IFIP/SEC'85* | 12-15 Aug 85 | Dublin, Ireland | TC 11 |
| 11th Intl. Conf. on *Very Large Data Bases - VLDB 85* | 21-23 Aug 85 | Stockholm, Sweden | VLDB/TC2 |
| Intl. Conf. - *VLSI 85* | 26-28 Aug 85 | Tokyo, Japan | WG 10.5 |
| Work. Conf. on *The Use of Computers in Teaching Mathematics in Developing Countries* | 26-30 Aug 85 | Yamoussoukro, Ivory Coast | TC3/ICMI |
| Joint 2nd Conf. on *Advances in Production Management Systems* and 7th Conf. of the Intl. Compcontrol Committee *Conputer Applications in Production Management and Engineering - APMS-COMPCONTROL 85* | 27-30 Aug 85 | Budapest, Hungary | WG 5.7/CAEB |
| 7th Intl. Symp. on *Computer Hardware Description Languages & their Applications - CHDL 85* | 29-31 Aug 85 | Tokyo, Japan | TC10/WG10.2 |
| 3rd Conf. on *Human Choice & Computers - HCC3* | 2-5 Sep 85 | Stockholm, Sweden | TC 9 |
| 12th General Conf. on *Systems Modelling & Optimization* | 2-6 Sep 85 | Budapest, Hungary | TC7/IFORS/ Hung.Acad.Sci. |
| 11th Symposium on Microprocessing & Microprogramming - EUROMICRO 85 | 3-6 Sep 85 | Brussels, Belgium | EUROMICRO |
| Work. Conf. on *Environments to Support Information Systems Design Methodologies* | 4-6 Sep 85 | Bretton Woods, USA | WG 8.1 |
| 2nd. Conf. on *Analysis, Design and Evaluation of Man-Machine Systems* | 10-12 Sep 85 | Varese, Italy | IFAC/IFIP/ IFORS/IEA |

# NATO MEETINGS IN 1985

## NATO ADVANCED RESEARCH WORKSHOPS

### 1 9 8 5

#### (in chronological order)

**Analyse des Oeuvres d´Art et des Objets Archeologiques Par Faisceaux d´Ions Energetiques**
Pont A Mousson (France), February, 1985 – Contact: Dr. J. Ligot Laboratoire de Recherche des Musees, Palais du Louvre, 75041 Paris Cedex 01, France

**Disordered Systems and Biological Organization**
Les Houches (France), Feb/March, 1985 – Contact: Professor G.Weisbuch Groupe de Physique des Solides, Ecole Normale Superieure, 24 rue Lhomond, 75231 Paris Cedex 5, France

**Human Apoliprotein Mutants: Impact on Atherosclerosis and Longevity**
Limone sul Garda (Italy), March, 1985 – Contact: Professor Cesare R. Sirtori Chemotherapy Dept., University of Milan, Via A. Del Sarto 21, 20129 Milano, Italy

**Scientific Basis of the Role of the Oceans as a Waste Disposal Option**
Algarve (Portugal), April, 1985 – Contact: Professor G. Kullenberg Institute of Phys. Oceanography, University of Copenhagen, Harladsgade 6, DK-2200 Copenhagen, Denmark

**Evolutionary Biology of Primitive Fishes**
Bamfield Marine Station (Canada), April, 1985 – Contact: Dr. R.E. Foreman , Bamfield Marine Station, Bamfield BC V0R 1B0, Canada

**Marine Minerals: Resource Assessment Strategies**
Aberystwyth (Wales), May, 1985 – Contact: Dr. P. Teleki, Office of Intern. Geology, U.S. Geological Survey, 917 National Center, Reston VA 22092, USA

**The Effect of Acidic Deposition on Forested and Agricultural Ecosystems**
Toronto (Canada), May, 1985 – Contact:
Professor Th.C. Hutchinson Inst. of Environmental Studies, University, Toronto Ontario, Canada MS5S 1A1

**Neural Surfaces and Development (CCS Panel)**
Cargese (France), May, 1985 – Contact: Dr. M. Schachner Institut f. Neurobiologie, University Heidelberg, Im Neuenheimer Feld, D-6900 Heidelberg, Germany

**The Role of Freshwater Outflow in Coastal Marine Ecosystems**
Bodo (Norway), May, 1985 – Contact: Dr. S. Skreslet Fisheries Division, Nordland Regional College, P.O. Box 309, 8d001 Bodo, Norway

**Enzymes as Catalysts in Organic Synthesis (SAM Panel)**
Schloss Elmau (Germany), June, 1985 – Contact: Professor M.P. Schneider FB 9 Organische Chemie, Bergische Universitaet GH-Wuppertal, D-5600 Wuppertal 1, Germany

**Earth Rotation – Solved and Unsolved Problems**
Bonas (France), June, 1985 – Contact: Dr. A. Cazenave Groupe de Recherche de, Geodesie Spatiale, 18 Av Eduard-Belin, F-31055 Toulouse Cedex, France

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Schloss Ringberg (Germany), June, 1985 – Contact: Dr. H.H. Althaus Dept. Neurochemie, MPI f. Experim. Medizin, Hermann-Rein-Str. 3, D-3400 Goettingen, Germany

**Theory of Chemical Reaction Dynamics**
Orsay (France), June, 1985 – Contact: Dr. D.C. Clary University Chemical Laboratory, Cambridge University, Lensfield Road, Cambridge CB2 1EW, U.K.

**Periodic and Chaotic Dynamical Behavior in Laser Systems**
San Miniato (Italy), June, 1985 – Contact: Professor N.B. Abraham Istituto Nazionale di Ottica, Largo E. Fermi 6, I-50125 Firenze, Italy

**Seismology of the Sun and Other Stars**
Cambridge (U.K.), June, 1985 – Contact: Dr. D.O. Gough Institute of Astronomy, Cambridge University, Madingley Road, Cambridge CB3 OHA, U.K.

**Molecular and Cellular Aspects of Calcium in Plants**
Edinburgh (Scotland), June 1985 – Contact: Dr. A. Trewavas Botany Department, University of Edinburgh, Mayfield Road, Edinburgh EH9 3JH, Scotland

**Semiconductor Device Reliability**
Helsingfors (Denmark), June, 1985 – Contact: Dr. R. E. Kerwin Component Quality and Reliability Dept., Bell Labs. Whippany NJ 07981, USA

**Aspects of Face Processing**
Aberdeen (Scotland), July, 1985 – Contact: Dr. H.D. Ellis Dept. of Psychology, University, King´s College, Old Aberdeen AB9 2UB, Scotland

**Adaptation to Stress and Task Demands: Energetical Aspects of Human Information Processing**
Les Arcs (France), August, 1985 – Contact: Dr. G.R.J. Hockey Dept. of Psychology, University Science Laboratories, South Road, Durham DH1 5YN, U.K.

**Pest Control**
Bad Windsheim (Germany), August, 1985 – Contact: Professor M. Mangel Dept. of Mathematics, University of California, Davis CA 95616, USA

**Grazing Research at Northern Latitudes**
Hvanneyri (Iceland), August, 1985 – Contact: Dr. Olafur Gudmundsson , Agricultural Research Institute, Keldnaholt, IS-110 Reykjavik, Iceland

**3D Structures of RNA**
Renesse (The Netherlands), August, 1985 – Contact: Dr. P.H. van Knippenberg Dept. of Biochemistry, University of Leiden, Wassenaarseweg 64, 2333 AL Leiden, The Netherlands

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Bristol (UK), September, 1985 – Contact: Dr. J.A. Bailey Dept. of Agriculture & Horticulture, University of Bristol, Long Ashton Research Station, Long Ashton Bristol BS18 9AF, UK

**Clifford Algebras and their Application in Mathematical Physics**
Canterbury (U.K.), September, 1985 – Contact: Dr. A.K. Common Mathematical Institute, University of Kent, Canterbury CT2 7NF, U.K.

**Quantum Chemistry: The Challenge of Transition Metals and Coordination Chemistry**
Strasbourg (France), September, 1985 – Contact: Professor A. Veillard Laboratoire de Chimie Quantique, Institut Le Bel, 4 rue Blaise Pascal, 67000 Strasbourg, France

**Biological Incidences of Co-Cr-Ni Alloys used in Orthopaedic Surgery and Stomatology**
Bischenberg (France), September, 1985 – Contact: Dr. H.F. Hildebrand Institut de Medecine du Travail, Faculte de Medecine, Place de Verdun, 59045 Lille Cedex, France

**Mesenchymal-Epithelial Interactions in Neural Development (CCS Panel)**
Goettingen (Germany), October, 1985 – Contact: Professor J.R. Wolff, Zentrum Anatomie, University Goettingen, Kreuzbergring 36, D-3400 Goettingen, Germany

**Plant Response to Stress**
Sesimbra (Portugal), October, 1985 – Contact: Professor F. Catarino Fac. de Ciencias Dept. of Biology, University, 1200 Lisbon, Portugal

**Climate Modelling (GTM Panel)**
Grenoble (France), October, 1985 – Contact: Dr. M.E. Schlesinger Dept. of Atmospheric Sciences, Oregon State University, Corvallis Oregon 97331, USA

**Heat Exchange Experiment over the Sea (HEXOS Workshop) (GTM Panel)**
De Bilt (The Netherlands), October, 1985 – Contact: Dr. W.A. Oost KNMI, Postbus 201, NL-3730 AE De Bilt, The Netherlands

**Enzymes of Lipid Metabolism**
Strasbourg (France), October, 1985 – Contact: Dr. L. Freyez Centre de Neurochimie, CNRS, 5 Rue Blaise Pascal, F-67084 Strasbourg Cedex, France

**Modelling and Analysis of Arms Control Problems**
Spitzingsee (Germany), October, 1985 – Contact: Professor R. Avenhaus Fachbereich Informatik, Hochschule der Bundeswehr, Werner-Heisenberg-Weg 39, D-8014 Neubiberg, Germany

**GH Pituitary Cell Strains as Tools in Molecular and Cellular Biology**
Gouvieux-Chantilly (France), November, 1985 – Contact: Dr. A. Tixier-Vidal Directeur de Recherche CNRS, College de France, 11 Place Marcelin Berthelot, 75231 Paris Cedex 05, France

**Molecular Mechanisms in Mammalian Olfaction**
Coventry (U.K.), 1985 - Contact: Dr. G. Dodd Chemistry Department
University of Warwick, Coventrz CV4 7AL, U.K.

**The Dynamics of Partially Solidified Systems**
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das Palmeiras, 2745 Queluz de Baixo, Portugal

**Fundamental Algorithms for Computer Graphics**
Ilkley - Yorksh. (U.K.), March, 1985 - Contact: Dr. R.A. Earnshaw
Center for Computer Studies, University of Leeds, Leeds LS2 9JT,
U.K.

**Scaling Phenomena in Disordered Systems**
Geilo (Norway), April, 1985 - Contact: Dr. R. Pynn, Institut
Laue-Langevin, 156X, 38042 Grenoble Cedex, France

**The Molecular Basis for the Central and Peripheral Regulation of
Vascular Resistance**
Altavilla Milicia (Italy), April, 1985 - Contact: Dr. A.M. Magro,
Center for Laboratories & Research, NY State Deptartment of
Health, Empire State Plaza, Albany NY 12201, U.S.A.

**Nonlinear Analysis and its Applications**
Maratea (Italy), April, 1985 - Contact: Professor S.P. Singh ,
Dept. of Mathematics, Memorial University of Newfoundland,
St.Johns Newfoundland A1C 5S7, Canada

**Psychology and The Police**
Skiathos (Greece), May, 1985 - Contact: Dr. J.C. Yuille , Dept.
of Psychology, University of British Columbia, Vancouver BC V6T
1Y7, Canada

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Erice (Italy), May, 1985 - Contact: Professor P.G. Bergmann,
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York NY 10003, U.S.A.

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Tucson - Arizona (USA), May, 1985 - Contact: Professor
L. Duckstein, Inst.fuer Hydrol & Wasserwirtschaft, Universitaet
Karlsruhe, Pf. 6380, 7500 Karlsruhe, Germany

**Carbon and Coal Gasification - Science and Technology**
Algarve (Portugal), May, 1985 - Contact: Professor J.L.C.C.
Figueiredo , Department of Chemical Engineering, University of
Porto, 4099 Porto Codex, Portugal

**Advanced Physical Oceanographic Numerical Modelling**
Banyuls (France), June, 1985 - Contact: Professor J.J. O`Brien
Meteorology Annex, Florida State University, , Tallahassee
Florida 32306, U.S.A.

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Cesme-Izmir (Turkey), June, 1985 - Contact: Professor M. Erdik,
Earthquake Eng. Research Center, Middle East Technical Univer-
sity, Ankara, Turkey

**Cognitive Processes and Spatial Orientation in Animal and Man**
La Baume Les Aix (France), June/July, 1985 - Contact: Professor
P. Ellen , Dept. of Psychology, Georgia State University, Univer-
sity Plaza, Atlanta Georgia 30303, U.S.A.

**Chemical Reactor Design and Technology**
London - Ontario (Canada), June, 1985 - Contact: Dr. H. De Lasa,
Faculty of Engineering Science, University of Western Ontario,
London Ontario, Canada N6A 5B9

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**Relational Database Machine Architecture**
Les Arcs (France), July, 1985 - Contact: Dr. A.K. Sood, Comp.
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**On Growth and Forms**
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Physique / Mat. Condensee /190, Universite de Nice, Parc Valrose,
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**Targeting of Drugs with Synthetic Systems**
Cape Sounion Beach (Greece), June, 1985 - Contact: Dr. G.
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of Medicine, Pond Street, Hampstead London NW3, U.K.

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Bad Windsheim (Germany), July, 1985 - Contact: Professor J.W.
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**Architecture of Fundamental Interactions at Short Distances**
Les Houches (France), July, 1985 - Contact: Dr. R. Stora , Divi-
sion Theorique, CERN, CH-1211 Geneve 23, Switzerland

**Fuzzy Subsets Theory**
Louvain la Neuve (Belgium), July, 1985 - Contact: Professor A.
Jones, Centre Imago, Univ.Cath.de Louvain, Rue du Compas, B-1348
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**Fundamentals of Transport Phenomena in Porous Media**
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**Ion Exchange Science and Technology**
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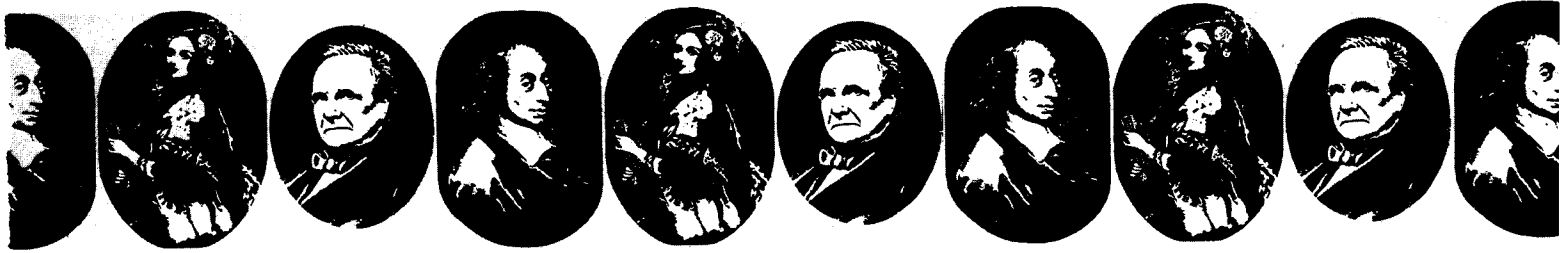
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