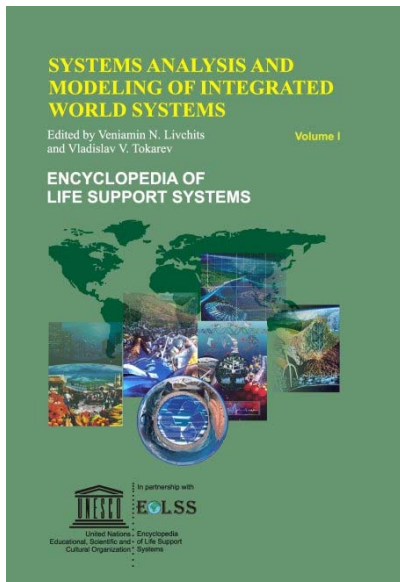


CONTENTS

SYSTEMS ANALYSIS AND MODELING OF INTEGRATED WORLD SYSTEMS



Systems Analysis and Modeling of Integrated World Systems - Volume 1

No. of Pages: 364

ISBN: 978-1-84826-088-7 (eBook)

ISBN: 978-1-84826-538-7 (Print Volume)

Systems Analysis and Modeling of Integrated World Systems - Volume 2

No. of Pages: 316

ISBN: 978-1-84826-089-4 (eBook)

ISBN: 978-1-84826-539-4 (Print Volume)

For more information of e-book and Print Volume(s) order, please [click here](#)

Or [contact : eolssunesco@gmail.com](mailto:eolssunesco@gmail.com)

CONTENTS

VOLUME I

Systems Analysis and Modeling of Integrated World Systems	1
Veniamin N. Livchits, <i>Department of Economics, Institute for Systems Analysis, Russian Academy of Sciences, Moscow, Russia</i>	
Vadim N. Sadovsky, <i>Department of Philosophy, Institute for Systems Analysis, Russian Academy of Sciences, Moscow, Russia</i>	
Vladislav V. Tokarev, <i>Department of Mathematics, State University – Higher School of Economics, Moscow, Russia</i>	

1. Introduction
2. Philosophical and General Theoretical Foundation of Systems Analysis
3. Methodological Fundamentals of Applied Systems Analysis
 - 3.1. General Scheme of Applied Systems Analysis
 - 3.2. Systems Analysis of Investment Efficiency Evaluation Decisions
4. Fundamentals of Mathematical Modeling and Simulation
 - 4.1. Some Historical Remarks on Modeling
 - 4.2. The “Model” Concept
 - 4.2.1. The Controlled Object
 - 4.2.2. The Management System
 - 4.3. Computer Simulation
 - 4.4. Stages of Modeling and Simulation Technique
 - 4.5. Prospects in Modeling Methodology
5. Application of Systems Analysis to Sustainable Development Issues
 - 5.1. Macro-Economic Growth
 - 5.2. Models of Socio-Economic Structure
 - 5.3. Regional Socio-Ecological-Economic Dynamics
 - 5.4. Global Sustainable Development
 - 5.5. Biosphere Processes

Systems Analysis of Knowledge	34
Vladimir N. Kostiuk, <i>Institute for Systems Analysis, Russian Academy of Sciences, Russia</i>	

1. Introduction
2. Hypothetico-deductive method
3. Hypothetico-inductive method (h.i.m.)
4. Computer formalization of knowledge
5. Non-cumulative evolution of knowledge
6. Decision-making under uncertainty
7. Tacit practical knowledge
8. Conclusion

Systems Analysis and Global Sustainable Development	47
Sergey V. Dubovsky, <i>Head of Laboratory, Institute of the System Analysis of RAS, Moscow, Russia</i>	

1. Introduction
 - 1.1. Elements of a Global System
 - 1.2. Global Problems
2. Basic tasks and directions of global system researches
3. Global crisis in models of system dynamics
4. Evolution of global problems in multimodel descriptions
5. Macromodels of individual fragments of world development

- 5.1. Stabilization of Population of the Earth
- 5.2. Cycle of Kondratiev
- 5.3. Replacement of Technologies and Resources
- 6. Biosphere and anthropogeneous activity: two scenarios
- 7. Conclusion

Natural Resources as an Element of the Society-Nature System 62

Alexander A. Arbatov, *RAN Council on Production Forces, Russian Academy of Sciences, Russia*
 Elena R. Orlova, *Department of Economics, Institute for System Analysis, Russian Academy of Sciences, Russia*

- 1. Introduction
- 2. Natural Resources Impact upon the Development of Human Society
- 3. Changes in Conditions of Natural Resources Resulting from Human Activities
- 4. The Present Condition of Natural Resources
- 5. Basic Lines of Nature Protection Activities
- 6. The Ways to Sustainable Development
- 7. Conclusion

Systems Analysis of Economic Policy 81

Mikhail G. Zavel'sky, *Institute for Systems Analysis, Russian Academy of Sciences, Moscow, Russia*

- 1. Introduction
- 2. Economic Policy as an Object of System Analysis
- 3. Basic Stages and Principles of the System Analysis of Economic Policy
- 4. Mechanism of Coordination of Interests as a Means of a System Approach to Economic Policy
- 5. System Modeling of Economic Policy and Its Optimization

Systems Analysis of Planning Processes 98

Emile M. Quinet, *Professor, Ecole nationale des ponts et chaussees, Paris, France*

- 1. Introduction
 - 1.1. Definitions
 - 1.2. Scope of the following developments
- 2. National planning
 - 2.1. Two Tools to Control Economy
 - 2.2. Theoretical Aspects
 - 2.2.1. The Conditions for an Efficient Market Control
 - 2.2.2. The Real World
 - 2.2.3. Market Failures and Public Intervention
 - 2.2.4. Planning as a Means to Correct Market Failures
 - 2.2.5. Centralized Planning
 - 2.2.6. Criticisms to the Principle of Planning
 - 2.3. Practical and Historical Aspects
 - 2.3.1. Departures from Theory
 - 2.3.2. Centralized Planning in the former USSR
 - 2.3.3. The former Communist Countries
 - 2.3.4. The Western European Countries: The Case of France
 - 2.3.5. Some other OECD Countries
- 3. Urban and regional planning
 - 3.1. Theoretical Reasons for Urban and Regional Planning
 - 3.2. Forms of Urban and Regional Planning
- 4. Planning inside firms
 - 4.1. Differences with Public Planning
 - 4.2. Aims of Planning inside Firms

4.3. Scope of Planning inside Firms

Systems Analysis of Regional Development Processes 113Mikhail G. Zavel'sky, *Institute for Systems Analysis, Russian Academy of Sciences, Moscow, Russia*

1. Introduction
2. Regional Systems: Components, Relationships, Attributes
3. Concept of System Analysis
4. Analysis Techniques
 - 4.1. Preferentially Normative Analysis
 - 4.2. Preferentially Descriptive Analysis
5. Mathematical Models
6. Uncertainty Consideration
7. Mechanisms of Conclusion Realization

Systems Analysis of Energy Processes 133Alexei A. Makarov, *The Energy Research Institute, Russian Academy of Sciences, Russia*

1. Introduction
2. Premises and means of the systems approach to energy development
 - 2.1. Premises of the Systems Approach
 - 2.2. Modeling of Energy Systems Development
 - 2.3. Modeling Uncertainties of Energy Systems Development
 - 2.4. Temporal Limits of Applicability of the Systems Approach to Energy
3. Long-term Energy Modeling: Today's State and Further Prospects
 - 3.1. State of the Art in Long-term Energy Modeling
 - 3.2. Modeling of Energy-Economy Interactions
 - 3.3. Energy Resources Modeling
4. Conclusion

Systems Analysis of Transport Performance and Development 149Elmar Ilja Pozamantir, *Institute for Systems Analysis of the Russian Academy of Sciences, Moscow, Russia*

1. Introduction
2. Place and Role of Transport in National Economy
3. Transport externalities
4. Forms of Property for Transport
5. National Transport System and State Management of Transport Performance and Development
6. Transport Interindustry Connections
 - 6.1. Balance of Production and Distribution of Goods and Services (Except for Transport Ones)
 - 6.2. Balance of Production and Distribution of Products According to Modes of Transport
 - 6.3. Balance of Income and Expenditures Related to Production of Material Products
 - 6.4. Balance of Income and Expenditures of Transport Enterprises
 - 6.5. Production Costs
 - 6.6. Equations of Distributing Profit of Enterprises before Taxation by Directions of its Usage
 - 6.7. Equations of Capital Assets and Capacities Reproduction
7. Planning of Transport Network Development
8. Transport in Logistic System

Systems Analysis of Investment Project Efficiency Evaluation 177Veniamin N. Livchits, *Department of Economics, Institute for Systems Analysis Russian Academy of Sciences, Moscow, Russia*

1. Introduction
2. Glossary and Main Notions
 - 2.1. General Macroeconomic Notions
 - 2.2. General Microeconomic Notions
3. Investment Projects Classification
4. Specificity of Macroeconomic Conditions
5. Main Tasks of Project Analysis
6. General Scheme of Investment Projects Evaluation
 - 6.1. Structure of Efficiency Evaluation Process
 - 6.2. Principles of Evaluating Investment Projects
7. Indicators of Evaluating Investment Projects Efficiency
 - 7.1. Indicators of Absolute Effect
 - 7.2. Indicators of Relative Effect
8. Accounting Most Important Factors
9. Conclusion

System Analysis of Financial Markets: An Overview

199

Anatoli A. Pervozvansky, *SPbSTU, St.Petersburg, Russia*

Pyotr Lvovich Vilensky, *Institute for System Analysis RAS, Moscow, Russia*

1. Introduction
2. Classification of main approaches
 - 2.1. Fundamental Analysis (FA)
 - 2.2. Technical Analysis (TA)
 - 2.3. System Analysis (SA)
3. Optimal portfolio theory (OPT) and capital asset pricing model (CAPM)
 - 3.1. Return as a Random Value
 - 3.2. Portfolio Optimization
 - 3.3. CAPM and Market Line
4. Statistical verification of classical models
 - 4.1. Statistics of Mean Values and Covariances
 - 4.2. Statistics of Market Line
 - 4.3. Random Walk Model and its Imperfections
5. Modern tendencies in FM modelling
 - 5.1. Conditional Expected Return
 - 5.2. Univariate Financial Time Series Models
 - 5.3. Multifactor Forecasting Models
 - 5.4. Linear Non-Stationary Models
6. Active portfolio management
 - 6.1. Conditionally Optimal Portfolio
 - 6.2. Principles of Active Portfolio Management
7. Value at risk
 - 7.1. VaR as a measure of risk accounting
 - 7.2. Usage of VaR
8. Conclusion

Fundamentals of Mathematical Modeling for Complex Systems

221

Yury N. Pavlovsky, *Computing Center of Russian Academy of Sciences, Russia*

1. Closed mathematical models
2. Technology of mathematical modeling
3. Example's of the mathematical models
 - 3.1. Demography Model
 - 3.2. Satellite Model
4. Deterministic and stochastic phenomena
5. The procedure of endogenous characteristics calculation

6. The forms of models exploitation
7. Simulation models and simulation systems
8. Mathematical and Humanities Methods of Prognosis
9. Mathematical modeling and problem of sustainable development

Fundamentals of Simulation for Complex Systems

235

Yury I. Brodsky, *Computer Center of Russian Academy of Sciences, Moscow, Russia*

Vladislav V. Tokarev, *Moscow State University – Higher School of Economy, Moscow, Russia*

1. Simulating Complex Systems
2. Concepts of Simulation for Complex Systems
3. Simulation of Management Systems
4. Parallel and Distributed Simulation
5. Web-based Simulation
6. Simulation Software
7. Instrumental Systems for Simulation
8. Special Purpose Simulation Systems
9. Simulation Systems' Development
10. Simulation in Social Studies
11. Artificial Life
12. Virtual Reality

Macrosystem Modeling in System Analysis

251

Yuri S. Popkov, *Institute for System Analysis, Russian Academy of Sciences, Moscow, Russia*

1. Introduction
2. Examples
 - 2.1. Economical Exchange
 - 2.2. Passenger Transport Flows
 - 2.3. Chemical Kinetics
 - 2.4. Image Reconstruction
3. Equilibrium states of macrosystems
 - 3.1. Phenomenological Scheme
 - 3.2. Stochastic Characteristics of Macrostates
 - 3.2.1. Macrosystem with Fermi-states
 - 3.2.2. Macrosystem with Einstein-states
 - 3.2.3. Macrosystems with Boltzmann-states
 - 3.3. Feasible Macrostate Set
 - 3.4. Variational Principle. Models of Stationary States
4. Dynamic processes in macrosystems
5. Applications
 - 5.1. Urban Planning
 - 5.2. Regional Development
 - 5.3. Dynamics of Biological Community
6. Conclusion

Modeling and Simulation Techniques

269

Nicholas N. Oleney, *Department of Mathematical Modeling of Economic Systems, Dorodnicyn*

Computing Center of the Russian Academy of Sciences, Moscow, Russia.

1. Introduction
2. Techniques in simulation model design
 - 2.1. Conceptual Models Design
 - 2.2. Declarative Models Design
 - 2.3. Functional Models Design
 - 2.4. Constraint Models Design

- 2.5. Multi-models Design
- 3. Techniques in execution of simulation models
 - 3.1. Serial Discrete-Event Simulation
 - 3.2. Parallel Discrete-Event Simulation
- 4. Techniques in simulation model analysis
 - 4.1. Input-Output Analysis
 - 4.2. Model Calibration
 - 4.3. "What-if" Analysis Techniques
 - 4.4. Model Validation Techniques
 - 4.5. Experiment Design
 - 4.6. Goal-seeking Problem
- 5. Perspectives
 - 5.1. Artificial Life
 - 5.2. System Dynamics
 - 5.3. Social Simulation
 - 5.4. Feasible Goals Techniques
 - 5.5. Web-based Simulation

Simulation Software 287

Yury I. Brodsky, *Computer Center of Russian Academy of Sciences, Moscow, Russia*

- 1. Simulation Software Survey
- 2. Object Oriented Simulation.
- 3. Instrumental Systems for Simulation
- 4. Special Purposes Simulation Systems
- 5. Multitasking, Parallel and Distributed Simulation
- 6. DEVS/HLA Distributed Simulation Environment
- 7. Simulation Software Development

Life Cycle Processes for Model Definition and Deployment 299

Yury N. Pavlovsky, *Computing Center of Russian Academy of Sciences, Russia*

- 1. Technology of mathematical modelling
- 2. Life cycle of mathematical model
- 3. Examples of mathematical models structure. Models of demographic processes
- 4. An example of mathematical models structure. Models of motion of the satellite
- 5. Mathematical modeling and consumption structure

Index 309

About EOLSS 317

VOLUME II

Input-Output Models 1

Iouri N. Tcheremnykh, *Faculty of Economics, Moscow State University, Russia*

- 1. History
- 2. Input-Output model
- 3. Input-Output coefficients, static input-output model, total input coefficients
- 4. Dynamic input-output models in the form of equalities and inequalities, in optimization form, open and closed dynamic input-output models
- 5. Stationary trajectories of closed dynamic input-output models in the form of inequalities
- 6. Notion about turnpike property of optimal trajectories of closed dynamic input-output models with terminal objective function

7. Development of input-output method
8. Conclusion

Differential Equation Models

33

Yury N. Ivanov, *Department of Mathematical Economics, Institute of System Analysis, Russian Academy of Sciences, Russia*

1. Introduction
2. System indicators
3. Types of dynamic systems
4. Examples from mechanics
 - 4.1. Thrown stone
 - 4.2. Rocket flight
5. Leontieff's balance
6. Criteria
7. Optimal control
 - 7.1. Maximum principle
 - 7.2. Optimal rocket trajectory
 - 7.3. Optimal economic development
8. Regulated systems
9. Probabilistic approach
10. Conclusion

Imitation of Expert Judgement

54

Oleg Ivanovich Larichev, *Institute for Systems Analysis of Russian Academy of Sciences, Russia.*

1. Introduction
2. The nature of expertise
3. The main features of expert knowledge
 - 3.1. Forward Reasoning
 - 3.2. Fast Reasoning
 - 3.3. The Performance in a Different Field
 - 3.4. Magical 10 years
 - 3.5. The Size of Expert Memory
 - 3.6. The Difference Between Novices and Experts in the Organization
 - 3.7. Unconscious Expert Knowledge
4. Computer imitation of expert knowledge
5. Main difficulties in the construction of expert knowledge base
6. The methods of expert knowledge base construction
7. The Replication of the Expert's Creative Possibilities
8. The human imitation of expert skill: tutoring the expert skill
 - 8.1. The Training on Special set of Prepared Cases
 - 8.2. The Tutoring Systems Based on ACT Theory
 - 8.3. The Tutoring System Based on Complete Expert Knowledge Base
9. Conclusion

Models of Biosphere Processes

70

Alexander M. Tarko, *Computing Center of the Russian Academy of Sciences, Moscow, Russia*

1. Introduction
2. Modeling of the Global Biosphere Cycles in the Biosphere
3. A Spatial Model of the Global Carbon Cycles in Atmosphere - Plants - Soil System
 - 3.1. Description of the model
 - 3.2. Computer Realization of the Model- Pre-industrial State of the Biosphere
 - 3.3. Le Chatelier Principle and Stability of the Biosphere- Sustainable Development of the Biosphere

- 3.4. Biosphere Dynamics under the Impact of Industrial CO₂ Emissions, Deforestation, and Soil Erosion
- 3.5. Carbon Dioxide Budget of Countries in 1995
- 3.6. Carbon Dioxide Budget of Biosphere
- 3.7. Estimation of Performance of the Kyoto Protocol to the UN Framework Convention on Climate Change
- 3.8. Application the Control Theory in the Modeling
4. Modeling the Global Carbon and Nitrogen Cycle in Atmosphere - Ocean System
 - 4.1. Description of the Spatial Carbon Cycle Model
 - 4.2. Exchange Between Ocean and Atmosphere
 - 4.3. Biotic Components
 - 4.4. Complete Model
 - 4.5. Results of Modeling
5. Modeling the Impact of Air Contamination on Forest Ecosystems
 - 5.1. Description of the Model
 - 5.2. Results of the Modeling
6. Conclusion

Macroeconomic Growth Models

92

Sergey V. Dubovsky, *Head of laboratory, Institute of system analysis, RAS, Moscow, Russia*

1. Introduction
2. Main Equations
 - 2.1. Production Functions
 - 2.1.1. Account of Capital and Labor
 - 2.1.2. Account of Scientific and Technical Progress
 - 2.1.3. Account of Natural Resources
 - 2.1.4. Account of the Human Capital
 - 2.1.5. Account of Solvent Demand
 - 2.2. Capital
 - 2.3. Technological Level
 - 2.4. Investment Demand
3. Model of Growth
 - 3.1. Closed Economy
 - 3.2. Formulation of the Optimization Problem
 - 3.3. Open Economy
4. Model of Cycles
 - 4.1. Business – Cycle
 - 4.2. Kondratiev Cycles
5. Conclusion

Models of Socioeconomic Development

109

Alexandr A. Petrov, *Department for Economic Systems Modeling at the Computing Center of RAS, Moscow, Russia*

1. Introduction
2. A general approach for the modeling of socioeconomic development
3. Model of the USSR's centrally planned economy
4. Model of the USSR's centrally planned economy with a co-operative sector
5. Model of the USSR's economy before the collapse
6. Shock Therapy model of the USSR's central planned economy
7. Russia's economic model for 1992-1995
8. Russian region's economic model for 1996-1998
9. Conclusion

Regional Socio-Ecology-Economic Models**139**

Christophe Deissenberg, *Department of Economics, University of Aix-Marseille II, France*
 Vladimir I. Gurman, *Program Systems Institute, Russian Academy of Sciences, Russia*

1. Introduction
2. Sustainable development and regional sustainable development
3. A framework for analysis
4. Formalization
 - 4.1. The Input-Output Core
 - 4.2. The Dynamics of Capital Stocks and Environmental State
 - 4.3. The Dynamics of Technological State and Innovative Capital
 - 4.4. Criteria for Sustainability
 - 4.5. Using the Model for Policy Analysis
 - 4.5.1. Simulations
 - 4.5.2. Optimization
 - 4.5.3. Sensitivity Analysis
5. A case study: The Pereslavl region
 - 5.1. Short Description of the Pereslavl Region
 - 5.2. Model specification
 - 5.2.1. Economic activities
 - 5.2.2. Environmental indicators
 - 5.2.3. Technological State
 - 5.2.4. Cone of Sustainability
 - 5.2.5. Welfare function
 - 5.3. Numerical results
 - 5.3.1. Baseline scenario
 - 5.3.2. Optimization 1
 - 5.3.3. Optimization 2
 - 5.3.4. Optimization 3
 - 5.4. Concluding remarks

Modeling of Organizations**168**

V.N. Burkov, *Institute of Control Sciences, Russian Academy of Sciences, Moscow, Russia*
 D.A. Novikov, *Institute of Control Sciences, Russian Academy of Sciences, Moscow, Russia*

1. Introduction
2. Model of the Active System and General Formulation of the Control Problem
3. Classification of the Control Mechanisms
 - 3.1. Subject of Control
 - 3.2. Extensions of Basic Model
 - 3.3. Method of Modeling
 - 3.4. Scale of System
 - 3.5. Application Field
4. Basic Mechanisms of Control of the Active Systems
 - 4.1. Mechanisms of Complex Estimation
 - 4.2. Mechanisms of Active Expertise
 - 4.3. Mechanisms of Formation of the Composition and Structure of the Active System
 - 4.3.1. Mechanisms of Control of the Active System Composition
 - 4.3.2. Mechanisms of Control of the Structure of the Active System
 - 4.3.3. Tenders
 - 4.4. Resource Allocation Mechanisms
 - 4.4.1. Nonmanipulable Mechanisms of Resource Allocation
 - 4.4.2. Competitive Mechanisms of Resource Allocation
 - 4.5. Financing Mechanisms
 - 4.6. Mechanisms of Company Control
 - 4.7. Incentive mechanisms
 - 4.8. Exchange Mechanisms

5. Areas of Application
6. Conclusion

Mathematical Models of Migration **185**

Ivan Aleshkovski, *Department of Population, Faculty of Economics, Moscow State ‘Lomonosov’ University, Russia*
 Vladimir A. Iontsev, *Department of Population, Faculty of Economics, Moscow State Lomonosov University, Russia*

1. Introduction
2. Classification of migration models
3. Macromodels of migration
 - 3.1. Interaction Models of Migration
 - 3.1.1. Gravity Models of Migration
 - 3.1.2. Intervening Opportunities Models of Migration
 - 3.1.3. Migration Models based on Alonso’s General Theory of Movement
 - 3.2. Migration Factors Models (Pull-Push Migration Models)
 - 3.3. Markov Chain Migration Models
4. Micro Models of Migration Processes
 - 4.1. Diffusion Migration Models
 - 4.2. Human Capital Models of Migration
5. Linking of Macro and Micro Approaches to Migration Modeling
6. Conclusion

Modeling of Large-Scale Systems Development **214**

Arkady Vladimirovich Dvorkovich, *Deputy Minister of Ministry of Economic Development and Trade of the Russian Federation, Russia*
 Vladimir Egorovich Krivonozhko, *Institute for Systems Analysis of the Russian Academy of Sciences, Moscow, Russia*
 Oleg Borisovich Utkin, *Global S.Consulting Co., Moscow, Russia*

1. Introduction
2. Mathematical Formulation
3. Parametric Optimization Methods
4. Calculations of Marginal Rates Using Parametric Optimization Methods
5. Modeling Results
6. Conclusion

Future Development Scenarios **242**

Paul D. Raskin, *Stockholm Environment Institute, Boston, Tellus Institute, USA*

1. Historical Transition
2. Sustainability, Long-Range Development, and Human Choice
3. The Scenario Approach
4. Visions of the Future
5. Conventional Worlds
6. Barbarization
7. Great Transitions
8. The Grandchildren’s Bequest

Index **259**

About EOLSS **265**