# **CONTENTS**

# SYSTEMS SCIENCE AND CYBERNETICS



**Systems Science and Cybernetics** - **Volume 1 No. of Pages:** 397 **ISBN:** 978-1-84826-202-7 (eBook) **ISBN:** 978-1-84826-652-0 (Print Volume)

**Systems Science and Cybernetics** - **Volume 2 No. of Pages:** 490 **ISBN:** 978-1-84826-203-4 (eBook) **ISBN:** 978-1-84826-653-7 (Print Volume)

**Systems Science and Cybernetics** - **Volume 3 No. of Pages:** 390 **ISBN:** 978-1-84826-204-1 (eBook) **ISBN:** 978-1-84826-654-4 (Print Volume)

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

Or contact : eolssunesco@gmail.com

# **CONTENTS**

# Preface

# **VOLUME I**

Systems Science and Cybernetics: The Long Road to World Sociosystemicity

Francisco Parra-Luna, Universidad Complutense de Madrid, Spain

- 1. Introduction
- 2. The Essential Features of the Systemic Method
- Types of Systems
   The Universal Scope of Systems
- 5. Current Trends
  - 5.1. The Return of the Subject
  - 5.2. Information Systems
  - 5.3. Artificial Intelligence
  - 5.4. Internet
  - 5.5. Management
  - 5.6. Critical Systems Theory
  - 5.7. The "World" System
  - 5.8. Systemic Ethics
  - 5.9. Theoretical-Methodological Integration
  - 5.10. Formal Systems
  - 5.11. Biomedical Studies
- 6. The Social System Concept: Differential Characteristics
- 7. Social Synergy as a Rational Design
- 8. Content and Structure of Contributions to this Theme
- 9. Application of Systems Science and Cybernetics: Modeling Society
- 10. Does the System Change?
- 11. Needs and Values: the Reference Pattern of Values
- 12. System Outputs: Raison D'Être of "Systems Science and Cybernetics" 12.1. The Empirical Indicators
- 13. An Axiological Model of the World Pseudosystem
- 14. A New Model for the World System?
- 15. Conclusion

#### **System Theories: Synergetics**

Hermann P.J. Haken, University of Stuttgart, Germany

53

- **Review of Subject Articles** 1.
  - 1.1. "History and Philosophy of the Systems Sciences: The Road Toward Uncertainty"
  - 1.2. "General Systems Theory"
  - 1.3. "Living Systems Theory"
  - 1.4. "Entropy Systems Theory"
  - 1.5. "Actor-System Dynamics Theory"
  - 1.6. "Ethics as Emergent Property of the Behavior of Living Systems"
  - 1.7. "Axiological Systems Theory"

  - 1.8. "Evolutionary Complex Systems"
    1.9. "Epistemological Aspects of Systems Theory Related to Biological Evolution"
  - 1.10. "Socio-Technical Systems: History and State-of-the Art"
  - 1.11. "The Geometry of Thinking"
  - 1.12. "Systemology: Systemic and Non-Systemic Entities"
- 2. Definition of Synergetics
- 3. Goals and General Approaches

- 4. Some Typical Examples
  - 4.1. The Laser
  - 4.2. The Convection Instability of Fluid Dynamics
  - 4.3. An Example from Sociology and Linguistics
- 5. Basic Concepts
- 6. Applications to Science
  - 6.1. Physics
    - 6.1.1. Mechanics
    - 6.1.2. Fluid Dynamics
    - 6.1.3. Magneto-Hydrodynamics
    - 6.1.4. Semi-Conductors
    - 6.1.5. Josephson Junctions
    - 6.1.6. Lasers
    - 6.1.7. Nonlinear Optics
  - 6.2. Chemistry
  - 6.3. Mechanical Engineering
  - 6.4. Electrical Engineering
  - 6.5. Biology
    - 6.5.1. Evolution of Living Matter
    - 6.5.2. Evolution of Species
    - 6.5.3. Morphogenesis
    - 6.5.4. Rhythms
    - 6.5.5. Movement Science
    - 6.5.6. Ecology
    - 6.5.7. Medicine
  - 6.6. Psychology
- 7. Applications to Technology
  - 7.1. Computer Science
  - 7.2. Informatics
  - 7.3. Telecommunication
- 8. Applications to Humanities
  - 8.1. Economy
  - 8.2. Sociology
  - 8.3. Linguistics
  - 8.4. Culture Including Art and Literature
  - 8.5. Philosophy
  - 8.6. Epistemology
- 9. Mathematical Tools
- 10. Relations to Other Approaches

History and Philosophy of the Systems Sciences: The Road Toward Uncertainty Charles Oscar Francois, GESI, Grupo de Estudio de Sistemas, Argentina

- 1. Introduction
- 2. Medieval Universals
- 3. The Snake of Rational Curiosity alive in Medieval Garden
- 4. The Slow Dawn of Technology in Medieval Europe
- 5. Descartes, the not very Systemic Systemist
- 6. The Expansion of the Universe of Knowledge
- 7. The Twilight of Scientific Simplicity: A Can of Conceptual Worms in 20th Century Science
- 8. In Search of a New Coherence
  - 8.1. Overview
  - 8.2. Bertalanffy, the Stitcher
  - 8.3. Energy Rules
  - 8.4. Cybernetics in its Prime
  - 8.5. New Views on Organization
  - 8.6. Cybernetics Observed

- 8.7. The Nature of Autonomy
- 8.8. New Views on Order and Disorder
- 8.9. Structure and Function in a New Light
- 8.10. Models for Autogenesis, Self Construction and Autopoiesis
- 8.11. Thermodynamics Reconsidered
- 8.12. Networks and Networkers: Natural and Artificial
- 8.13. Societies as Systems
- 8.14. New Concepts, Models and Methodologies
- 8.15. Practical Systemists
- 9. Conclusion

# **General Systems Theory**

Anatol Rapoport, University of Toronto, Canada

- 1. Contributions of General System Theory to the Philosophy of Science
  - 1.1. A Mathematical Model of Equifinality
  - 1.2. A More General Model of Equifinality
  - 1.3. The Search for a Unified Language of Science
  - 1.4. The Evolutionary Approach to the Problem of Unifying the Language of Science
  - 1.5. The Rigorously Justified Analogy the Scientific Metaphor
- 2. Reductionism versus Holism
- 3. The Second Industrial Revolution
  - 3.1. Automatization of War
  - 3.2. Enterprises perceived as Systems
- 4. The Planet as a System
  - 4.1. System Evolution as an Experimental Science
  - 4.2. The Institution as an "Organism"
  - 4.3. Causes of Wars

#### Living Systems Theory

G.A. Swanson, *Tennessee Technological University, USA* James Grier Miller, *University of California, USA* 

- 1. Introduction
- 2. Basic Concepts
  - 2.1. Concrete Systems
  - 2.2. Matter-Energy
  - 2.3. Information
  - 2.4. Meaning
  - 2.5. Conceptual Systems
  - 2.6. Information and Entropy
  - 2.7. Structure, Process and State
  - 2.8. Purpose and Goals
- 3. Characteristics of Living Systems
- 4. The Principle of Fray-Out
- 5. Levels of Life
- 6. Critical Subsystems
- 7. Observable Structures and Processes

# **Entropy Systems Theory**

Kenneth D. Bailey, University of California, USA

- 1. Introduction
- 2. History
  - 2.1. Thermodynamic Entropy

152

137

112

iii

- 2.2. Boltzmann's Entropy
- 2.3. Information Theory Entropy
- 2.4. Entropy in General Systems Theory
- 2.5. Social Entropy
- 3. Criteria for Entropy Evaluation
- 4. Assessing the Past
- 5. Future Research
- 6. Conclusion

# **Actor-System-Dynamics Theory**

Tom R. Burns, Uppsala University, Sweden Thomas Baumgartner, Swiss Technical University, Switzerland Thomas Dietz, George Mason University, USA Nora Machado, Uppsala University, Sweden

- 1. Background and Foundations
  - 1.1. Background and Overview
    - 1.1.1. Actors and Social Interaction
    - 1.1.2. Major Mechanisms of Social Stability and Transformation
    - 1.1.3. Institutional and Cultural Structures
    - 1.1.4. Material and Ecological Conditions
    - 1.1.5. Rule Governed Social Interactions Produce Concrete Outcomes and Developments
  - 1.2. Social Rule System Theory: Institutions and Cultural Formations1.2.1. The Universality of Social Rule Systems and Rule Processes
    - 1.2.2. Adherence to Social Rules and Rule Systems
    - 1.2.3. Institutions and Complex Institutional Arrangements
  - 1.3. The Theory of Consciousness and Collective Representations
  - 1.4. Socio-Cultural Evolutionary Theory
- 2. Applications and Policy Implications: The Knowledge Problematique vis-à-vis Complex Systems
  - 2.1. Introduction
  - 2.2. Information and Accounting Systems
  - 2.3. Bounded Knowledge and the Limits of Control of Complex Systems

#### **Ethics as Emergent Property of the Behavior of Living Systems** Gianfranco Minati, *Polytechnic University of Milan, Italy*

195

- 1. Introduction
- 2. Ethics
- 3. Systemic Aspect of Ethics
  - 3.1. Relations and Interactions
    - 3.2. Systems
      - 3.2.1. Example of a Methodology based on Systemics
      - 3.2.2. Closed and Open Systems
      - 3.2.3. Ethics of a Social System
      - 3.2.4. Ethics of the Global Social System
- 4. Ethics as Emergent Property of Social Systems
- 5. Interactions among Ethics
- 6. Some Metaphors
- 7. Effectiveness of an Ethics
- 8. Growth, Development, and Sustainable Development in Economic Systems: The Role of Ethics
  - 8.1. The Concepts of Growth and Development
  - 8.2. Growth Process Representation
  - 8.3. Development Process Representations
    - 8.3.1. Development as a Sequence of Linked Growth Processes
    - 8.3.2. Development as Harmonic Growth Processes
    - 8.3.3. Development as Emergent from Interacting Growth Processes

# 8.3.4. Sustainable Development

- 9. Relationship between Ethics and Quality
- 10. Systemic View of Ethics to Detect, Improve, and Design Quality of Life
- 11. Conclusions

#### Axiological Systems Theory Francisco Parra-Luna, Universidad Complutense de Madrid, Spain

225

- 1. Introduction
- 2. Fundamental Principles of Axiological Systems Theory
  - 2.1. The Values Production Principle
  - 2.2. The Synergetic Principle
  - 2.3. The Transforming Principle
  - 2.4. The Teleological Principle
  - 2.5. The Integrative Principle
- 3. John van Gigch's Contribution
  - 3.1. Chapter 7—The Morality of Systems
  - 3.2. Chapter 10—Social Indicators and the Quality of Life
- 4. The Basic Transformation Model
  - 4.1. Inputs
  - 4.2. Transformation
  - 4.3. Outputs
  - 4.4. Control
  - 4.5. Environment
- 5. The Solved Problems of Axiological Systems Theory
  - 5.1. The Universalisation of Outputs
  - 5.2. The Quantification Problem
  - 5.3. The Standardization of Indicators
- 6. Some Practical Applications of Axiological Systems Theory
  - 6.1. Organizational Efficiency
  - 6.2. Deviation Analysis
  - 6.3. Social Change
  - 6.4. Ethical Behavior
  - 6.5. Other Applications
- 7. Conclusion

# **Evolutionary Complex Systems**

Iris Belkis Bálsamo, National Academy of Sciences, Argentina

- 1. Conceptual Framework
  - 1.1. Systems
    - 1.1.1. Structure
    - 1.1.2. Organization
  - 1.2. Complexity
  - 1.3. Self-Organization
  - 1.4. Evolution
    - 1.4.1. Brief History
    - 1.4.2. Multiple Concepts
- 2. Self-contained Conceptualization
- 3. Multiplicity of Evolutionary Complex Systems and Sustainability
- 4. Evolutionary Complex Systems and Knowledge
- 5. Conclusions

# Epistemological Aspects of Systems Theory Related to Biological Evolution

Enzo Tiezzi, University of Siena, Italy

268

# Nadia Marchettini, University of Siena, Italy

- 1. Integrating Epistemology of Thermodynamics and of Biological Evolutionary Systems
  - 1.1. Entropy and Biological Evolution
  - 1.2. Biosphere, Entropy, and Dissipative Structures
- 2. Thermodynamics of Ecosystems and of Biological Evolution
  - 2.1. The Time Paradox: Towards an Evolutionary Thermodynamics
  - 2.2. Non-equilibrium Thermodynamics
- 3. Towards an Evolutionary Physics
  - 3.1. A New Concept: Ecodynamics
- 4. Concluding Remarks

# Socio-Technical Systems: History and State-of-the Art

Edeltraud Hanappi-Egger, Vienna University of Technology, Austria

- 1. Introduction
- 2. The Role of Automation of Work Processes
- 3. The Requirement of Flexible Human Skills: Road to a Socio-Technical View
- 4. The Socio-Technical System Approach with Respect to Information- and Communication Technologies
- 5. Conclusion

# The Geometry of Thinking

Curt McNamara, Digi International, USA

- 1. Generalized Principles
- 2. Universe
- 3. System
- 4. Structure
- 5. Pattern Integrity
- 6. Tetrahedron
- 7. Tensegrity
- 8. Synergy
- 9. Precession
- 10. Design Science
- 11. Sustainability
- 12. Fundamental Laws of Systems Science
- 13. Modeling a System
  - 13.1. Defining the Connections
  - 13.2. Inputs and Outputs
  - 13.3. Flows and Storage
  - 13.4. Boundary
  - 13.5. Design

# About EOLSS

# **VOLUME II**

# **Systems Approaches: A Technology for Theory Production** J. Gutierrez, *Universidad Europea de Madrid, Spain*

Juan Miguel Aguado, St. Anthony Catholic University, Spain Rafael Beneyto, Universidad de Valencia, Spain

1. Review of Subject Articles

# 304

291

341

# 2. Epistemologies of Production

- 2.1. The Instrumental Shift of Subject/World Relation
- 2.2. Thinking Techniques
- 2.3. Science as "Technics"
- 3. Genealogy of the System
  - 3.1. The Machine Metaphor
  - 3.2. The Idea of Machine
  - 3.3. The System Approach as a Logic Machine
- 4. Systems Theory as Technology
  - 4.1. Subject and Object as (Social) Products and Producers
  - 4.2. Towards a Complex Concept of Technology
- 5. Epistemic Implications of Systems Approaches
  - 5.1. Meta-technology
  - 5.2. Epistemic Complexity in Science
  - 5.3. Society, Non-trivial Machines, and Self-observation

# The Systems Sciences in Service of Humanity

Alexander Laszlo, Syntony Quest, USA

Ervin Laszlo, Club of Budapest, Hungary

- 1. Introduction
- 2. Transformations in Society
  - 2.1. The Subject of Societal Transformation
  - 2.2. The Interpretation of Societal Transformation
- 3. The Relevance of the Systems Sciences
- 4. Systems Sciences as a Field of Inquiry
  - 4.1. Definition of System
  - 4.2. Natural Systems
  - 4.3. Reduction to Dynamics
  - 4.4. Emergent Properties and Synergy
  - 4.5. General Theory
- 5. The Breadth and Diversity of the Systems Sciences
  - 5.1. Qualitative Aspects
  - 5.2. Systems and Environments
  - 5.3. Method
- 6. The Social Dimension of Systems Thinking
  - 6.1. Contrasting Worldviews
  - 6.2. Systemic Thinkers and Systems Thinkers
- 7. Recent Trends in the Humanities and the Systems Sciences
  - 7.1. A Range of Approaches
  - 7.2. Critical Systems Thinking
  - 7.3. Total Systems Intervention
  - 7.4. General Evolution Theory
  - 7.5. Social Systems Design
  - 7.6. Evolutionary Systems Design
  - 7.7. In Service of Humanity
- 8. A Bridge between Two Cultures and the Future

#### **General Systems Weltanschauung**

Jimenez-Lopez Elohim, Vienna University of Technology, Austria

59

- 1. Simplistic Generalizations have Engendered Civilizations
- 2. Humans Survive Simplistically
- 3. An Organismic Biology Emerged from GSW
- 4. Behavioral and Social Sciences Urgently Need GSW
- 5. Holistic Medicine and Education Generated by Implicit GSW

# 6. GSW Prospects

# Metamodeling

Alan E. Singer, University of Canterbury, New Zealand

- 1. Introduction
- 2. Models
  - 2.1. Conceptual Models
  - 2.2. Relationships
- 3. Metamodels
- 4. Taxonomies
  - 4.1. Guides
  - 4.2. Metaforecasting
  - 4.3. Metamodel of OR/MS
- 5. Models of Outputs
  - 5.1. Simulation-metamodels
    - 5.1.1. Environmental Change
    - 5.1.2. Service Response Time
    - 5.1.3. Capital Projects
  - 5.2. Neural Networks
  - 5.3. Bootstrapping
  - 5.4. Mind-tools
- 6. Models as Objects of Choice
  - 6.1. Static Choice
  - 6.2. Feature-comparison
  - 6.3. Metarationality
  - 6.4. Metaoptimality
- 7. Other Conceptual Metamodels
  - 7.1. Design
  - 7.2. Transition
  - 7.3. Renewal
  - 7.4. Influence
  - 7.5. Replication
- 8. Hypermodeling
  - 8.1. Chaos
  - 8.2. Epistemology
  - 8.3. Synergy and Spirit
- 9. Conclusion

# **Designing Social Systems** Bela H. Banathy, *Saybrook Graduate School and Research Center, USA*

- 1. The Design Imperative
- 2. What is Social Systems Design?
  - 2.1. What Design Is
  - 2.2. What Design is Not
  - 2.3. Design Problems are Ill-defined
- 3. Why do we Need Design Today?
  - 3.1. The New Realities
- 4. When Should We Design?
  - 4.1. Changes within the System
  - 4.2. Changing the Whole System
- 5. What is the Product of Design?
  - 5.1. Models: Definitions and Characterizations
  - 5.2. Models: Language and Utility
  - 5.3. Designers as Model Makers

# 6. What is the Process of Design?

- 6.1. The Process of Transcending
- 6.2. Envisioning and Creating the Image of the Future System
- 6.3. Designing the Systems
  - 6.3.1. The Definition of the System
  - 6.3.2. Functions
  - 6.3.3. The Organization that can Carry out the Functions
  - 6.3.4. Designing the Systemic Environment
- 6.4. Presenting the Outcome of the Design
  - 6.4.1. The Systems/Environment Model
  - 6.4.2. The Functions/Structure Model
  - 6.4.3. The Process/Behavioral Model
- 7. Who Should be the Designers?
  - 7.1. The First Generation Approach
  - 7.2. The Second Generation
  - 7.3. The Third Generation
- 8. Building a Design Culture
- 9. What Values Can Design Add to our Society?
- 10. A Closing Thought

# A Systems Design of the Future

Mario Bunge, McGill University, Canada

- 1. Introduction
- 2. Macrosocial Issues and Their Inherent Values and Morals
- 3. Utopianism and Ideals without Illusions
- 4. Social Engineering: Piecemeal and Systemic
- 5. Top-down Planning
- 6. Systemic Democratic Planning
- 7. Growth and Development
- 8. Integral and Sustainable Development
- 9. The Future of Social Studies

#### Soft Systems Methodology

Ricardo A. Rodriguez-Ulloa, Andean Institute of Systems, Peru

- 1. Introduction
- 2. Problemology
  - 2.1. Problemology as a Systemic Attitude
  - 2.2. The Problem Solving System and The Problem Content System
  - 2.3. Tipology of Problems
    - 2.3.1. Hard Problems
    - 2.3.2. Soft Problems
  - 2.4. Techniques for Defining and Solving Problems
- 3. Soft Systems Methodology SSM: A General View
  - 3.1. Stage 1: Ill Structured Situation
  - 3.2. Stage 2: Structured Situation (Rich Picture)
  - 3.3. Stage 3: Root Definitions
  - 3.4. Stage 4: Conceptual Models
  - 3.5. Stage 5: Comparison 4 vs 2
  - 3.6. Stage 6: Culturally Feasible and Systemically Desirable Changes
  - 3.7. Stage 7: Implementation
- 4. Conclusions, Recommendations and Learning Points
  - 4.1. Conclusions
  - 4.2. Recommendations
  - 4.3. Learning Points

122

# Social Problem Diagnosis: A Sociopathology Identification Model

Paris J. Arnopoulos, Concordia University, Canada

- 1. Introduction
- 2. CONTEXT: Anatomy of Sociophysics
  - 2.1. Basic Syntax
    - 1.1.1. SET Frames
    - 1.1.2. MEF Aspects
    - 1.1.3. ESE Spheres
    - 2.2. Systems
      - 2.2.1. Sociomass
      - 2.2.2. Sociomorals
      - 2.2.3. Sociosectors
    - 2.3. Symptoms
      - 2.3.1. Criteria
      - 2.3.2. Indices
      - 2.3.3. Taxonomy
- 3. CONTENT: Pathology of Socioproblematics
  - 3.1. Cognitive Inputs
    - 3.1.1. Epistemology
    - 3.1.2. Deontology
    - 3.1.3. Physiology
  - 3.2. Contemplative Conversion
    - 3.2.1. Objective Functions
    - 3.2.2. Subjective Opinions
    - 3.2.3. Collective Traditions
  - 3.3. Conceptual Output
    - 3.3.1. Problemology
    - 3.3.2. Pathology
    - 3.3.3. Methodology
  - CONCEPT: Methodology of Sociodiagnostics
  - 4.1. The Nature of Things
    - 4.1.1. Data Bank
    - 4.1.2. Physiological Paradigm
    - 4.1.3. Semiosis
  - 4.2. Human Values
    - 4.2.1. Dominant Dogma
    - 4.2.2. Ideology
    - 4.2.3. Axiosis
  - 4.3. Global Pathology
    - 4.3.1. Salient Symptoms
    - 4.3.2. Pathology
    - 4.3.3. Decisive Judgement
- 5. Conclusion

4.

# **Critical Systems Thinking**

Karl-Heinz Simon, University of Kassel, Germany

- 1. Introduction: The Role of Critical Systems Thinking within the Systems Movement
- 2. Origins: Opposition to the Hard Systems Approach, Improvement of Soft Approach
- 3. Confrontation: Different Approaches Compared
- 4. The Five Commitments of Critical Systems Thinking
- 5. A System of System Methodologies
- 6. Outlook

xi

# Total Systems Intervention

Lorraine Warren, University of Lincoln, UK

- Introduction
   Total System
  - Total Systems Intervention (TSI 1)
  - 2.1. Principles
  - 2.2. Process
    - 2.2.1. Creativity
    - 2.2.2. Choice
    - 2.2.3. Implementation
- 3. Local Systemic Intervention (LSI/TSI 2)
  - 3.1. A comparison of TSI 1 and LSI
  - 3.2. Principles
  - 3.3. Process
    - 3.3.1. Critical Review Mode
    - 3.3.2. Problem-solving Mode 3.3.3. Critical Reflection Mode
- 4. Application
- 5. Future Challenges

# Integrative Systems Methodology

Markus Schwaninger, University of St. Gallen, Switzerland

- 1. Introduction
- 2. The State of Systemic Problem-solving
  - 2.1. Two Methodological Roots
  - 2.2. The Quest for Synthesis
  - 2.3. The Challenge of Implementation
  - 2.4. The Challenge of Creation
  - 2.5. The Challenge of Validation
- 3. Outline of Integrative Systems Methodology
  - 3.1. Purpose and Scope
  - 3.2. An Outline of ISM
- 4. A Case Study
  - 4.1. Content Loop
  - 4.2. Context Loop
  - 4.3. Follow-up
- 5. Reflection

# WSR Decisions for a Sustainable Future

Z. Zhu, University of Hull, UK

- 1. Introduction
- 2. Philosophy
- 3. Methodology
- 4. Application
- 5. Conclusion

# **Psychological and Cultural Dynamics of Sustainable Human Systems** Paul Maiteny, *South Bank University, UK*

- 1. Introduction
- 2. Dimensions of Human Life-support Systems and Sustainability
  - 2.1. Outer Dimensions: Physical Sustainability
  - 2.2. Inner Dimensions: Psycho-emotional Sustainability and Development

246

271

223

- 2.3. Dynamics of Culture: Physical Law, Experience, and the Construction of Meaning
- 2.4. The Systemic Organization of Meaning and its Effects
  - 2.4.1. Low-order Meaning
  - 2.4.2. Middle-order Meaning
  - 2.4.3. High-order Meaning
- 3. Consequences of Maladaptive Meaning
  - 3.1. Maladaptive Meaning and its Ecological Consequences
  - 3.2. Psycho-emotional Consequences of Maladaptive Meaning
- 4. Can Ecological and Emotional Well-being go together?
  - 4.1. Numinous Experience, Sacred Meaning, and Sustainability
  - 4.2. Oscillation Theory: Dynamics for Transforming Meaning into Sustainable Living
    - 4.2.1. Intra-dependence, or Realization (Experience of action)
    - 4.2.2. Regression to Extra-dependence (Experience of fragmentation)
    - 4.2.3. Extra-dependence, or Identification (Experience of Meaningfulness)
    - 4.2.4. Transformation to Intra-dependence (Experience of Transforming Convictions into Action)
- 5. Conclusion: Reducing Impacts while Increasing Well-being

# The Dynamics of Social and Cultural Change

R. Vanderstraeten, Utrecht University, Netherlands

- 1. Introduction
- 2. Systems Theory
  - 2.1. 'Paradigm Change' in Systems Theory
  - 2.2. Social Systems Theory
  - 2.3. Second Order Cybernetics
- 3. Sociological Theory
  - 3.1. Instrumental Activism
  - 3.2. Functional Differentiation
  - 3.3. Ecological Communication
- 4. Conclusion

# Formal Approaches to Systems

Antonio Caselles, Universidad de Valencia, Spain

- 1. Introduction
- 2. A Template to Analyze General Systems Approaches
  - 2.1. Targets of a General Systems Approach
  - 2.2. Towards a Unified General Systems Theory
- 3. Current General Systems Approaches
  - 3.1. Klirs Approach
  - 3.2. Mesarovic and Takahara's Approach
  - 3.3. Wymore's Approach
  - 3.4. Lin and Ma's Approach
  - 3.5. Zeigler's Approach
  - 3.6. Caselle's Approach
- 4. The Basic General Systems Concepts
- 5. Other Comparisons and Open Questions
- 6. An Eventual Unified Approach to General Systems
- 7. Conclusion

# The Quantification of System Domains

John P. van Gigch, California State University, USA

1. Introduction

295

- 2 Quantification, Mathematization and Measurement
- The Scientific Imperative and the Quantification Problem 3.
- 3.1. How Does A Scientific Discipline become more Rigorous?
- 4. Quantification Means Representation and Evaluation
- 5. Quantification. Formal Definition
- 6. Adequacy in the form of Quantification
- 7. Quantification of Attributes in Soft System Domains
  - 7.1. An Unfinished Business
  - 7.2. Examples of Inadequate/Unsuitable Quantification of a Soft-System Domain
  - 7.3. Three Cases Illustrating Adequate/Suitable Quantification Through Mathematization
- 8. The Formalization and Quantification of Complexity
- 9. The Failure in Modeling Large-Scale Systems
  - 9.1. A Case of Attempted Quantification which may Fail
  - 9.2. The Metalevel Arbiter
  - 9.3. Quantification vs. Influencing Behavior
  - 9.4. Postscript
- 10. Traditional Approaches to the Evaluation Problem. The Theory of Measurement
- 11. The Application of Qualitative and Quantitative Reasoning
- 12. Quantification Theory and Quantifiers in Logic
- 13. Implicit Quantification and Implicit Quantifiers
- 14. A [Not Quite] "New" Quantification Approach. Implicit Quantification
- 15. Implicit Quantifiers in a Hierarchy of Imperatives
- 16. A Simple Calculus of Quantifiers
  - 16.1. Aesthetic Imperative
  - 16.2. Ethical Imperative
  - 16.3. Epistemological Imperative
  - 16.4. Political Imperative
  - 16.5. Legal Imperative
  - 16.6. Scientific Imperative
  - 16.7. Economic Imperative
  - 16.8. Management Imperative
- 17. Conclusions

# Chaos: Back to "Paradise Lost": Predictability. The Century of the Emergence of Systemic **Thought and Chaos Theory**

Lorenzo Ferrer Figueras, Universidad de Valencia, Spain

363

387

- 1. Introduction
- 2. The 20th century: the difficult co-existence of Mechanicist Thought and Systemic Thought: emergence of chaos
- 3. Structure
- 4. A multi-stage modeling process to research on the detection and control of chaos dynamics in the evolution of biological and social systems
- An Outstanding Example of a Chaotic Dynamic System: the Logistic Map 5.
- Other important chaotic systems 6.
- 7. Conclusions

# **Transdisciplinary Unifying Theory: Its Formal Aspects**

Marilena Lunca, World Organization of Systems and Cybernetics (WOSC), The Netherlands

- 1. Introduction
- Rationales to Unifying Transdisciplinarily 2.
- External and Internal Constraints 3
  - 3.1. Related Constraints
  - 3.2. The Independent Constraint
- 4. Systemhood Unifying Theories

- 4.1. Primitive and First-derivative Terms
- 4.2. The Domain of the Unifying Theory
- 4.3. Restrictions on Interpretation
- 4.4. Cybernetic and Anticipative Systems
- 5. Unifying the Unifying Theories
  - 5.1. From the Physical to Non-physical and Back
  - 5.2. The Model of the Unifying Theory
- 6. Foreseeable Developments

# **General Systems Problem Solver**

George J. Klir, State University of New York at Binghamton, USA

- 1. Introduction
- 2. Classification of Systems in GSPS
  - 2.1. Epistemological Categories of Systems
  - 2.2. Methodological Classification of Systems
- 3. Systems Problem Solving
  - 3.1. Problem Requirements
  - 3.2. Systems Problems
- 4. Methodological Outcome of the GSPS
- 5. Conclusions

## About EOLSS

# **VOLUME III**

- **Cybernetics: Cybernetics and the Theory of Knowledge** Ernst von Glasersfeld, *University of Massachusetts, Amherst, USA*
- 1. Review of Subject Articles
  - 1.1. History of Cybernetics
  - 1.2. Existing Cybernetics Foundations
  - 1.3. Second-Order Cybernetics
  - 1.4. Knowledge and Self-Production Processes in Social Systems
  - 1.5. Cybernetics and the Integration of Knowledge
  - 1.6. Cybernetics and Communication
  - 1.7. Bipolar Feedback
- 2. First-Order Cybernetics
  - 2.1. Historical Roots
  - 2.2. The Notion of Feedback
  - 2.3. The Function of Difference
  - 2.4. Self-Regulation and Equilibrium
  - 2.5. The Domestication of Teleology
  - 2.6. Purpose and Goal-Directed Behavior
  - 2.7. Communication

3.

- Second-Order Cybernetics
  - 3.1. The Epistemological Problem
  - 3.2. A New Theory of Cognition
  - 3.3. The Construction of Knowledge
  - 3.4. Rational Models and the Role of the Observer
  - 3.5. Operational Definitions
  - 3.6. Several Parallel Developments
    - 3.6.1. Radical Constructivism
    - 3.6.2. The Theory of Autopoiesis
    - 3.6.3. The Italian Operational School

410

463

- 4. Applications of Cybernetic Principles
  - 4.1. Anthropology and Sociology
  - 4.2. Psychotherapy
  - 4.3. Education
- 5. Conclusion

#### **History of Cybernetics**

Robert Vallee, Universite Paris-Nord, France

- 1. Origins of Cybernetics
  - 1.1. Contemporary Initiators
  - 1.2. Past Contributors
- 2. Basic Concepts
  - 2.1. Foundations
    - 2.1.1. Retroaction
    - 2.1.2. Information
    - 2.2. Other Important Concepts
      - 2.2.1. Variety
      - 2.2.2. Observers
      - 2.2.3. Epistemology and Praxiology
      - 2.2.4. Isomorphism and Multidisciplinarity
- 3. Links with Other Theories
- 4. Future of Cybernetics

# **Existing Cybernetics Foundations**

Boris M. Vladimirski, Rostov State University, Russia

- 1. Introduction
- 2. Organization
  - 2.1. Systems and Complexity
  - 2.2. Organizability
  - 2.3. Black Box
- 3. Modeling
- 4. Information
  - 4.1. Notion of Information
  - 4.2. Generalized Communication System
  - 4.3. Information Theory
  - 4.4. Principle of Necessary Variety
- 5. Control
  - 5.1. Essence of Control
  - 5.2. Structure and Functions of a Control System
  - 5.3. Feedback and Homeostasis
- 6. Conclusions

#### Second Order Cybernetics

Ranulph Glanville, CybernEthics Research, UK

- 1. Introduction: What Second Order Cybernetics is, and What it Offers
- 2. Background—the Logical Basis for Second Order Cybernetics 2.1. A Reflection on First Order Cybernetics
  - 2.2. Circularity
- 3. Second Order Cybernetics-Historical Overview
  - 3.1. The Beginnings of Second Order Cybernetics
  - 3.2. Precursors
- 4. Theory of Second Order Cybernetics

59

22

34

XV

- 4.1. The Development of an Approach, Theories, and an Epistemology
- 4.2. Central Concepts of Second Order Cybernetics
- 5. Praxis of Second Order Cybernetics
  - 5.1. Second Order Cybernetics Extended into Practice
  - 5.2. Subject Areas
    - 5.2.1. Communication and Society
    - 5.2.2. Learning and Cognition
    - 5.2.3. Math and Computation
    - 5.2.4. Management
    - 5.2.5. Design
- 6. A Note on Second Order Cybernetics and Constructivism
- 7. Cybernetics, Second Order Cybernetics, and the Future
  - 7.1. A Third Order Cybernetics?
  - 7.2. Second Order Cybernetics: a Vanishing Conscience?
  - 7.3. Cyber this and Cyber that

# Knowledge and Self-Production Processes in Social Systems Milan Zeleny, Fordham University, USA

1. Introduction

- 2. Social Systems
  - 2.1. Free-market "Invisibility"
  - 2.2. Social Kinship Networks
  - 2.3. Boundaries of Social Systems
- 3. Autopoiesis (Self-Production) of Networks
  - 3.1. Organization and Structure
  - 3.1.1. Concepts and Definitions
  - 3.2. Organizational Embedding
  - 3.3. The Role of Feedback
  - 3.4. Summary of Autopoiesis
- 4. Knowledge as Coordination of Action
- 5. Model of Autopoiesis
- 6. Autopoietic Social Systems
  - 6.1. Self-sustainability
  - 6.2. Regional Enterprise Networks
  - 6.3. Amoeba Systems
    - 6.3.1. Biotic Amoeba Analogy
  - 6.4. TCG Triangulation Networks
  - 6.5. Bat'a System of Management
- 7. Individuals in Networks

# Cybernetics and the Integration of Knowledge

Bernard Scott, University for the Highlands, UK

- 1. Introduction
- 2. Cybernetic Explanation and the Concept of Mechanism
- 3. Cybernetic Epistemology
  - 3.1. Radical Constructivism
    - 3.2. What is Learning, What is Knowledge?
    - 3.3. A Model of "Coming to Know"
    - 3.4. A Model of "Knowledge Sharing"
- 4. The First Order Study of Natural Systems
- 5. Approaches to the Study of Social Systems
- 6. Cybernetics and the Arts, Humanities and Vocational Disciplines
- 7. Cybernetics and Philosophy
- 8. Concluding Comments

# **Cybernetics and Communication**

Vladimir U. Degtiar, Moscow State University, Russia

- 1. Methodology
- 2. Communication between Man and Machine
- 3. Cybernetics and Communication on a Biological Level (cybernetics b)
- 4. Cybernetics and Communication on a Social Level (cybernetics s)
  - 4.1. Communicational Interactions and Consciousness
    - 4.2. Cognitive Communication
    - 4.3. Stability of Communication, Architecture of the Nervous System, and Organization
    - 4.4. Complex Problems of the Process of Communication

# **Bipolar Feedback** Hector Sabelli, *Chicago Center for Creative Development, USA*

- 1. Introduction
- 2. Bipolar Feedback in Natural Processes
- 3. Models of Bipolar Feedback
- 4. Biotic Patterns Generated by Bipolar Feedback in Natural and Human Processes
- 5. Creative Development Generated by Bipolar Feedback
- 6. Feedback Models in Biology, Economics, and Psychotherapy
- 7. Conclusions

# **Computational Intelligence**

Klaus Mainzer, University of Augsburg, Germany

- 1. Review of Subject Articles
  - 1.1. General Principles and Purposes of Computational Intelligence
  - 1.2. Neural Networks
  - 1.3. Simulated Annealing
  - 1.4. Adaptive Systems
  - 1.5. Biological Intelligence and Computational Intelligence
- 2. Introduction
- 3. Computability, Decidability, and Complexity
- 4. Computational Intelligence and Knowledge-based Systems
  - 4.1. Beginning of Artificial Intelligence (AI)
  - 4.2. Knowledge-based Systems and Problem Solving
- 5. Computational Intelligence and Neural Networks
  - 5.1. Beginning of Computational Networks
  - 5.2. Neural Networks and Learning Algorithms
- 6. Computational Life and Genetic Programming
  - 6.1. Computational Growth and Cellular Automata
  - 6.2. Computational Evolution and Genetic Programming
- 7. Computational Intelligence and Life in the World Wide Web

# General Principles and Purposes of Computational Intelligence

Leonid Reznik, Victoria University, Australia

- 1. Introduction
- 2. Definition and Understanding of Computational Intelligence
- 3. Goals of Computational Intelligence and their Accomplishment to date
- 4. Goals for Future Research
- 5. Other Views of Computational Intelligence
- 6. Soft Computing
- 7. Computational Intelligence and Soft Computing: Combinations of different Components

129

148

- 7.1. General Principles
- 7.2. Neural Networks Fuzzy Systems7.2.1. Similarities and Differences7.2.2. Neuro-fuzzy Architecture7.2.3. ANFIS Systems
- 7.3. Neural Networks Evolutionary Programming
- 7.4. Example of the Combined Structure
- 8. Research Outcome Statistics

#### **Neural Networks**

Igor Vajda, Academy of Sciences of the Czech Republic, Czech Republic Jiri Grim, Academy of Sciences of the Czech Republic, Czech Republic

- 1. Introduction: Nervous Systems and Neurons
- 2. Perceptrons and More General Models of Neurons
- 3. Multilayered Perceptrons and General Neural Networks
- 4. Radial Basis Function Networks
- 5. Probabilistic Neural Networks
- 6. Self-Organizing Maps

# Simulated Annealing: From Statistical Thermodynamics to Combinatory Problems Solving 249 Daniel Thiel, *ENITIAA, Nantes, France*

- 1. Complexities of Problems and Algorithms
- 2. Introduction to Global Search Methods
- 3. Contribution of Statistical Physics and Thermodynamics
- 4. The Simulated Annealing Algorithm
  - 4.1. The Simulated Annealing Algorithm
  - 4.2. Model Calibration and Algorithm Convergence
- 5. Examples of Problems Solved Thanks to Simulated Annealing
  - 5.1. The Quadratic Assignment Problem
  - 5.2. The Travelling Salesman Problem
- 6. Comparisons with Other Heuristics and SA Performance Improvements
  - 6.1. SA Comparisons and Complementarity with Other Heuristic Methods
  - 6.2. Future Prospects

# Adaptive Systems

Rafael Pla-Lopez, University of Valencia, Spain

- 1. Introduction
- 2. Controllability
- 3. Fulfillment of Goals
- 4. Strategies of Decision
- 5. General Theory of Learning
- 6. Models of Probabilistic Learning
  - 6.1. General Linear Model of Probabilistic Learning
  - 6.2. Reciprocal Linear Model of Probabilistic Learning
  - 6.3. Adaptive Linear Model of Probabilistic Learning
- 7. Dilemma of the Prisoner
  - 7.1. Single Dilemma of the Prisoner
  - 7.2. Iterative Dilemma of the Prisoner
- 8. Anticipatory Adaptation
- 9. A General Model of Social Evolution

270

# **Biological Intelligence and Computational Intelligence**

Gilbert A. Chauvet, Universite Paris V, France

- 1. Introduction
- 2. Historical Concepts of Intelligence
- 3. The Neurobiological Bases of Intelligence
  - 3.1. What is a Neural Network? Hierarchy and Functional Units
  - 3.2. Biological Intelligence is Based on Memorization and Learning
  - 3.3. An Approach to Biological Intelligence
  - 3.4. The "Intelligence" of Movement as a Cognitive Function
- 4. The Relationship between Intelligence as a Physiological Function and the Organization of the Nervous System
  - 4.1. A Theory of Functional Biological Organization
    - 4.1.1. The Conceptual Framework
    - 4.1.2. Functional Interactions are Identified by Structural Discontinuities
    - 4.1.3. A Three-dimensional Representation of a Biological System
    - 4.1.4. The S-Propagator Formalism Describes the Dynamics in the Structural Organization
      - 4.1.4.1. Fields and Functional Interactions
      - 4.1.4.2. S-Propagator Dynamics
  - 4.2. Neural Field Equations Based on S-Propagators
  - 4.3. The Cerebellum and the "Intelligence" of Movement
    - 4.3.1. The Cerebellar Cortex is a Network of Networks
    - 4.3.2. The Purkinje Unit Associated with the Deep Cerebellar Nuclei is the Functional Unit of the Cerebellar Cortex
    - 4.3.3. The Network of Purkinje Units
- 5. Biological Intelligence and Computational Intelligence
  - 5.1. The Brain and the Computer
  - 5.2. Cognition and Functionalism
- 6. Conclusion

# About EOLSS