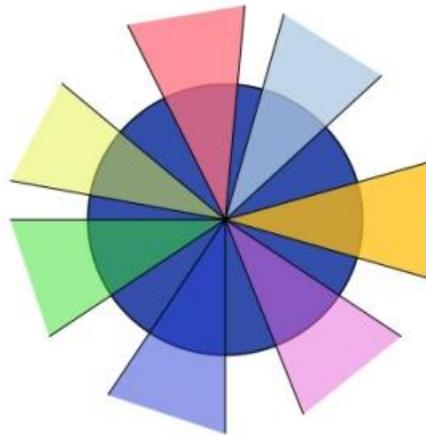


Book of Abstracts of the 26<sup>th</sup> European Conference on  
Operational Research  
Rome 2013

Euro Working Group  
Methodology of Societal Complexity (MSC)

Volume 26

Dorien DeTombe (Ed.)



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Euro Working Group Methodology of Societal Complexity (MSC)  
Volume 26

Dorien DeTombe (Editor)

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### [The subject of Methodology of Societal Complexity \(MSC\)](#)

Methodology of Societal Complexity focuses on methodologies, methods and tools for analyzing, structuring, guiding and evaluating complex societal problems. Complex societal problems are often policy problems that can occur in many fields, like in the Agro-industry (Mad-Cow disease, BSE; Foot and Mouth disease; Fowl Plague), in the transportation sector, in healthcare (Malaria, HIV/Aids, Flu), in Water affairs and in economy (credit crisis). It focuses also on handling local safety problems like large city issues and natural disasters as flood and hurricanes and global safety problems like war and terrorism. Although many of these issues have different causes, they have so much in common that they can be approached in the same way.

Complex societal problems, as such, are unstructured, dynamical, constantly changing and have a large impact on society on macro, meso and micro level. Handling complex societal problems needs a special multi-disciplinary approach. The content knowledge comes from content experts. The process knowledge comes from facilitators. The power is in the hand of actors. The attention of the research of Methodology of Societal Complexity is on the methods and tools facilitators need for guiding these kinds of problems. The facilitators use methodologies specially created for the field of societal problems combined with methods and insights derived from fields like medicine, law, economics, societal sciences, methodology, mathematics, computer sciences, technology, engineering sciences, socio-cybernetic, chaos theory and operational research combined with content knowledge. Often a combination of methods is needed.

The set of lectures presented on the Euro XXVI conference in Rome 2013 uin the track of Methodology of Societal Complexity focuses on methodology of handling real life complexity with an emphasis on global safety, sustainable development, healthcare, credit crisis and simulation.

Keywords: Methodology, Complex Societal Issues, Decisions, Sustainable Development, Healthcare, Economy, Simulation



**The 26<sup>th</sup> European Conference on Operational Research EURO XXVI Rome July 2013  
Euro Working Group Methodology for Complex Problems  
Chair Dorien DeTombe**

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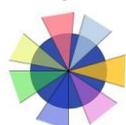
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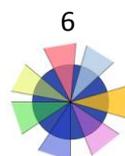
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## I METHODOLOGY OF SOCIETAL COMPLEXITY AND HEALTHCARE

**Chair Prof. Dr. Dorien DeTombe**

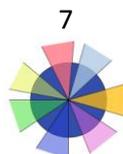
### I-1 The Roman Catholic Church as a Complex Societal Problem

**Prof. Dr. Dorien DeTombe**

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In the world there are several large religious institutes. Each with their own traditions and rules, prohibitions and promises for the future for their religious followers. The Roman Catholic Church is a large international religious institute. This institute prescribes certain moral standards and traditions for human interaction. Some of these standards are not stealing, not lying and no sexual abuse. These are highly esteemed values in the world. However, do the employees of the Roman Catholic Church follow these rules themselves? Media news of the last decennia indicates differently. It is for many people hard to understand how the preaching of the Church can differ so much from reality. This behavior has negative effect for the members of this religion and even for others. When considering the Roman Catholic Church as a firm, it becomes easier to see what is happening behind the facade of holiness. The actions and the influence of the Roman Catholic Church can be considered as a complex societal problem. If one wants to analyze the actions of this firm, one has to use a scientific methodology for handling complex societal problems. This is the methodology Compram (complex problem handling method) of DeTombe (1994; 2013) developed in the field of Methodology of Societal Complexity. This can hopefully lead to a more realistic view on the acts of this firm.

Keywords: Roman Catholic Church, Complex Societal Problems, Compram, Ethics, Healthcare



## I-2 Inter-Religious Conflict Resolution

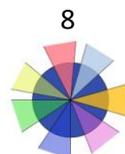
### Prof. Dr. Cathal Brugha

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This paper contextualizes religious-political interaction as a mutual adapting process starting with Hegel's proposals about the separation of church and state to prevent Conflict, then moving to Confrontation firstly in terms of the freedom to act productively as in Rawls, and then to promote the common interests of society without being abused as proposed by Habermas.

The paper uses a conflict-resolution meta-framework to propose where the discussion should go in the future, which is into Cooperation, where people with different views openly discuss what they have in common, such as belief in God, the good of society, peaceful coexistence, etc. and work together to foster what they have in common, to develop trust, and to build relationships. It also uses the same framework to map the difficulties with this process, and to show why the final phase of Collaboration is so far from our grasp.

Keywords: Philosophy, Politics, Religion



### I-3 Dialogical Paradoxes for Self-regulation in Complex Societal Systems

**Prof. Dr. Marcos Estellita Lins, Lísia Maria Cabral, Angela Estellita Lins, Angela Cristina Moreira, Marcelo Poirot Land**

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Traditional behavioral assumptions that support the regulatory model for complex systems comprise two main actors. On the one hand, private agents moved by limbic emotions: the fear of not having their needs met, and the desire to satisfy their unbounded ambitions. On the other hand, the regulatory agents are assumed as strictly rational, with enough power and exemption information, able to regulate social systems and prevent the excesses of private agents.

Even if the actors play their roles to perfection, various approaches regarding scientific knowledge in management and education demonstrate the importance of considering other forms of interpersonal relationship. Feldman and McPhee (2007) synthesize the four alternatives to teaching-learning developed over the last century: behaviorism, cognitivism, constructivism and humanism, which span every possibility of human relationship whatsoever.

Three paradoxical dimensions of complex systems regulation are proposed in the present work:

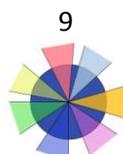
- i) If the regulation aims at the preservation or the evolution of the system.
- ii) If the regulator is located externally or internally to the system under regulation.
- iii) If the perception and action on the system are localized or distributed.

These dimensions are the result of two paradoxes identified in this study as inherent to complex systems: conservative x evolutionary, external x internal (to the membrane that defines an organizational whole) and localized x distributed.

While the conservative regulation requires the mere observance of previously agreed rules to maintain the cohesion of the system, the evolutionary regulation requires mechanisms for inhibiting obstructions to evolution.

The present dominant regulatory design doesn't assign social responsibility to agents running public services. It rather assumes that external regulation can be performed through models and indicators, monitored by a bureaucratic apparatus and implemented through awards and punishment measures (stick and carrot policy). We propose here that knowledge, thinking or cognitive maps can be powerful tools to manage the dynamics of paradoxes in real world contexts and facilitate regulation of complex systems.

**Keywords:** Methodology, Decision, Simulation, Societal Complexity, Healthcare, Economy, Sustainable Development



## **I-4 Governance and Dissent in the Complex Society**

### **Prof. Dr. Stephen Taylor**

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Among the challenges facing democratic societies today is the difficulty of managing dissent while providing good and fair governance. As established western democracies become more complex societies through immigration and shifting demography, there is increasing variety in the underlying philosophy, values, and ethics of their residents and citizens. In addition, electronic communications such as social media have made it easier for individuals and groups to broadcast their opinions and mobilize support for positions that run contrary to the policies of duly elected representative governments. Our patterns of governance are rooted in relatively slow to change agricultural, pastoral, and industrial societies of past generations. Increasingly, our people are connected electronically to fast paced change, and expect instant response from their governments. Simultaneously, population increase and diversity foster the need for more government intervention and regulation. This presentation should provoke a discussion of where we are headed.

Keywords: Governance, Dissent, Complex Society, politics



## I-5 Research Methodology Strategies in Strategic Management

**Prof. Dr. José G. Vargas-Hernández**

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This paper review and examine how strategic management researchers apply research methods, and what strategies use as part of the research process, to locate, organize, manage, transform, create, communicate and evaluate research tools, data and information resources. It also analyzes recent developments on research methodology to create scientific knowledge in theory building and practice in strategic management offering an overview of methodologies used in strategic management research. The assessment of strategic management's research methodology is based on a review and analysis of strategies for the incorporation of knowledge of managerial research methods. Finally, the paper identifies and discusses some methodological research issues and reviews future directions on research methodologies in strategic management.

Keywords: Research Methodology, Research Strategy, Strategic Management.



## II METHODOLOGY OF SOCIETAL COMPLEXITY AND SUSTAINABLE DEVELOPMENT

**Chair Prof. Dr. Eizo Kinoshita**

### **II-1 Contemporary Natural and Artificial Biodiversity set of problems and COMPRAM method**

**Prof. Dr. Nicolae Bulz**

Prof. Dr. Nicolae Bulz

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The prospect to elicit a step by step research: The interdisciplinary links between the construction and praxis related to the construct sustainable survival and the profound possibilities of the Compram methodology. The construct sustainable survival belongs to the Contemporary Natural and Artificial Biodiversity set of problems – the Compram method belongs to the Professor Dr. Dorien DeTombe /

<http://www.complexitycourse.org/doriendetombe.html>.

It is possible to detail the following steps of this research: The necessary and transferable university teaching experience regarding the Compram methodology. The affirmation on an equivalence between: the concepts ‘problem’ and solve / solution across the Roman philosopher and mathematician Boetius' (ca. 480–524 or 525 A.D.) text of Consolation of Philosophy, and Methodology for Societal Complexity (COMPRAM). The interdisciplinary (open contributions) related to the understanding/explanation of the constructs: sustainable survival, Natural and Artificial Biodiversity, necessity and transferable university teaching and research experience.

Keywords: Sustainable, Boetius, Compram methodology,



## II-2 Sustainable Development and Sustainable Future of Humankind

**Hon. Ricaardoe Di Done, Prof. Dr. Timi Ecimovic, Slovenia, Sir Prof. Dr. Roger Haw, Malaysia, Prof. Dr. Igor Kondrashin, Russia and Greece, Prof. Emeritus DDr. Matjaz Mulej, Slovenia Prof. Dr. Hakikur Rahman, Bangladesh and Portugal, Prof. Dr. Marjan Vezjak, Malija, Slovenia, Prof. Emeritus Dr. Raoul Weiler, Belgium, et al<sup>1</sup>**

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Sustainable development and advanced method, societal technology or possible evolvement of the Global Community of Humankind – Sustainable Future of Humankind are of great importance for long lasting survival of Homo sapiens at the Biosphere of the planet Earth. Education, education and education is answer to any action towards evolutionary achievements of the humanity. Education as the truth about nature knowledge is opening new frontiers for future of humankind on the Earth. However we are at Globalization era, but we have internet and far better communication techniques commencing from information era and they are key for better education.

Keywords: Agenda 21, Age of Globalization, Global Community of Humankind, Distant Learning, Education, Harmonious and Complementary Coexistence, Homo sapiens, Homo Urbanus, Homo Slumus, Land, Water and Air Basic Environments, Nature, Space and Environment Protection, Pollution, Sustainable Development, Sustainable Future of Humankind, Systems and System Thinking, Requisite Holism, The Planet Earth System.

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<sup>1</sup> Prof. dr. Dana M. Barry, USA, Prof. Dr. Garfield Brown, South Africa, Prof. Dr. Truly Busch, Germany, Dr. Santhi Nath Chattipadhyay, India, Prof. Dr. Alexander Chumakov, Russia, Prof. Dr. Elias Demirtzoglou, Greece, Prof. Dr. Jan Dobrowolski, Poland, Prof. Dr. Robert G. Dyck, USA, Prof. Dr. Mark Esposito, France and USA, Prof. Dr. Jagdish Gandhi, India, Prof. Dr. Jorn Hamann, Germany, Prof. Dr. James Hanson, USA, Prof. Dr. Marion Hersh, UK – Scotland, Anita Hrast, Slovenia, Prof. Dr. Zinaida Ivanovna, Russia, Prof. Dr. Sait Kacapor, Serbia, Prof. Dr. Slavko Kulic, Croatia, Prof. Dr. David Lingiah, UL – Scotland, Prof. Dr. Alexander Makarenko, Ukraine, Prof. Dr. Glen T. Martin, USA, Prof. Dr. Jalil Mehrzad, Iran, Dr. Moamenm Nassr, Palestine, Prof. Dr. Philippos Nicolopoulos, Greece, Prof. Dr. Negoslav P Ostojic, Serbia, Prof. Dr. H A Shankaranarayana, India, Prof. Dr. Yonghui Song, China, Prof. Dr. T N Sreedhara, India, Prof. Dr. Shahid Sidiki, Canada, Prof. Dr. Shishir Srivastava, India, Prof. Dr. Stuart Unplebay, USA, Prof. Dr. Daniella Tilbury, UK, Prof. Dr. Rajarama Tolpady, India, Prof. Dr. Seminur Topal, Turkey, Prof. Dr. Fidel Gutierrez Vivanco, Peru, Ingrid Mula De Wall, UK.



### **II-3 An Interpretive Systems Methodology for Structuring the Strategic Problems**

**Prof. Dr. Slavica P. Petrovic**

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Interactive Planning (IP), as a theoretical, methodological and applicative approach to addressing the complex and ambiguous management problems in organizations has been developed within the interpretive systems paradigm. This approach is focused on designed a desirable future and finding ways for its achieving. Through the five main phases - formulating the problem situation, ends planning, means planning, resource planning, design of implementation and control, IP endeavours to creatively support a process of managing the strategic problems in organizations.

Keywords: Systems Methodology, Strategic Problems



### III SOCIETAL COMPLEXITY AND ECONOMY

**Chair Prof. Dr. Stephen Taylor**

#### **III-1 Energy consumption and related- CO<sub>2</sub> emissions in Tunisia over 1990-2008: A decomposition analysis using Logarithmic; Mean Divisia Index technique**

**Sana Essaber-Jouini**

Dr. Sana Essaber-Jouini

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The International Network for Research into Organization and Sustainable Development (RIODD)

Energy use in various forms plays a critical role in affecting local environment and global climate change (Tietenberg, 1998). Reducing energy use alone should not be the best solution to ensure a certain desired level of environmental quality along with a desired level of economic growth and social welfare. The qualitative dimension of energy use is becoming increasingly important for sustainable development. One important question in this context is how it could be possible to achieve the separation of greenhouse gases (GHG) emissions from economic growth and energy consumption.

Several gases, collectively labeled, GHG, contribute to the global warming process. The Intergovernmental Panel on Climate Change IPCC (2007) report highlights the fact that the most important environmental problem of our ages is global warming. Carbon dioxide (CO<sub>2</sub>) is the most important of the greenhouse gases that are causing this global warming and energy use is considered the principal source of pollutant emissions in the local, national and global level. Then and since the emissions mainly result from consumption of fossil fuels, reducing energy consumption seems to be the direct way of handling the emissions problem, related economic growth and social welfare.

Several methodologies have been developed to surround temporal variations in energy and environmental factors for a single country or a panel of countries. Decomposition Analysis (DA) methodologies, i.e. Index Decomposition Analysis (IDA) and Structural Decomposition Analysis (SDA), was developed to identify the specified factors which contribute to energy demand and related CO<sub>2</sub> emissions (Ang, 2004b, 1999). Reviews of IDA can be found in Ang (2004b, 1995) and Ang and Zhang (2000). Two main methods are used, those based on the Laspeyres index and those based on the Divisia index. In current research, the production sectors are generally divided into three or four sectors, and the factors that influence carbon emissions are usually economic activity, economic structure, energy intensity, and the energy mix of production sectors (Liu et al, 2010; Zhang et al, 2009; Oh et al, 2010; Zhao et al, 2010).

From the beginning of the Eighties, Tunisia set up a long term policy of energy management which was based on four instruments: institutional, lawful, financial and tax.

But not much attention has been devoted to investigate the decomposition analysis of the energy use in general and of the energy-use-related CO<sub>2</sub> emissions in particular. By applying the logarithmic mean Divisia index (LMDI) to a dataset of 4 economic-energy-using sectors (manufacturing, agriculture, transport and tertiary) and the residential sector in Tunisia, we



identify the factors that have influenced the changes in the level of energy consumption and energy-related CO<sub>2</sub> emissions. The observed changes in total energy consumption are analyzed in terms of three factors: energy intensity, structural changes and economic activity. But the changes in carbon emissions are analyzed in terms of 6 causal factors including economic activity and population size which reflect the effect of activity change; energy intensity and energy consumption per capita which reflect the effect of intensity change; economic structure, and energy mix of production and household sectors which reflect the effect of structural change. The study refers to the major economic sectors of Tunisia for the period 1990–2008. Our results can reflect the reason of energy consumption and carbon emissions changes and provide a solid basis for policy makers to propose emission reduction measures and energy efficiency approaches.

Keywords: Energy Consumption, CO<sub>2</sub>



### **III-2 Corporate foresight and strategic decision making: Dealing with societal complexity**

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Companies deal with societal complexity along their international value added chains. Their strategies consider different political, societal and economic systems, media and opinion leaders, wealth and education levels and thus diverse opportunities and risk factors. Society expects them to provide solutions to overcome current challenges such as scarcity of energy, water and food supply, climate change, health and infectious diseases, poverty and insufficient infrastructures, digital divide and safety issues. Media and analysts call for strategic leadership and employees, sectors and regions within the companies call for an attractive vision and mission.

If almost every strategic decision has worldwide implications, corporate foresight and issues management become crucial arts. They help identifying megatrends and anticipating future developments in order to shape the future rather than being forced to react to external changes. This article explains how strategic decision making works within a company, how it is influenced by tools like scenario techniques, by corporate communications and government affairs networking, by internal and external expertise and consultancy, by corporate values, goals and psychology (behavioral economics). The author, a scientist and long-term insider within one of the world's huge industrial global players, shows how trend projects influence the planning procedures within regional and sectoral entities of a company. She reveals how trends often become a self-fulfilling prophecy through learning and communicating with various stakeholders inside and outside the company.

**Keywords:** Corporate Foresight, Strategic Decision Making



### III-3 A Modified Gravity Model for Mexico- U.S. Migration Data

**Duygu Cinar, Deniz Duman, Prof. Linet Ozdamar**

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One of the major concerns of recent decades is the continuously growing number of international migrants. In the global, regional and national development perspectives, effects of massive migration flows are socially, economically and environmentally significant. In line with this, mathematical models of migration gained importance to project future numbers of migrants.

In this paper, we theoretically and empirically investigate the determinants of net migration flows into United States from Mexico, by using the modified gravity model based on factors that are relevant for both countries. These factors include food and clean water availability per capita, the Gross Domestic Product per capita, employment rates, poverty headcount ratio, and percentage of migration prone population in source and destination countries. A multivariate regression model where net migration flow depends on these factors is constructed. Analysis of prediction errors indicates that the model works with tolerable error.

Keywords: Migration, Mathematical Models, GDP



### III-4 A Proposition of Thetical and Antithetical Business Management

**Prof. Dr. Eizo Kinoshita**

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In this paper, the author discusses the theme of "Thetical and Antithetical Business Management." The thetical business management signifies "a management style which enables such formulation as to make consumers' minimum amount of service goods expenditure an objective function, while making a minimum guaranteed level of expenditure concerning service goods a constraint condition at the same time." On the other hand, the antithetical business management is "a management style which enables such formulation as to make consumers' maximum satisfaction concerning service goods an objective function, while making the maximum limits of their service goods expenditure a constraint condition at the same time". In other words, the thetical business management can be formulated as Primal Problem of Linear Programming, whereas the antithetical business management as Dual Problem of Linear Programming. A typical example of the thetical business management is "McDonald's" ,and that of the antithetical business management in Japan is "Gi-on (Ichiriki-tei)." The author demonstrates how different the management philosophies of the two entities are, which are diametrically opposed to each other (demonstrating duality), in this paper by citing concrete examples.

Keywords: Business Management, Dual Problem



### III-5 Complex impact of atypical employment on European demography

**Prof. Dr. Dr. Andranik Tangian**

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The negative consequences of atypical employment, which is often precarious, are analyzed in the previous studies by the author (Tangian 2011a-b), particularly with regard to the crisis. Section “Predictions for the future” of Chapter 11 in Tangian (2011a) discusses negative consequences of atypical employment for the European demography at a qualitative level. The given paper provides empirical evidence for the trends discussed there. The socio-economical message is that the actually observed increasing share of atypical employment is damaging for the European demography. It is illustrated by four figures with actual trends based on statistical data 2001, 2005, and 2010; and four figures with the trends extrapolated to 2020 and 2030. All the graphs have the same independent variable

Keywords: Atypical Employment, European Demography



## IV SOCIETAL COMPLEXITY AND SIMULATION

**Chair Prof. Dr. Cathal Brugha**

### IV-1 Sustainable Development and Simulation Game Modeling

**Prof. Dr. Zhana Tolordava**

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The study of the existing concepts of sustainable development and corresponding simulation game models is necessary for making conclusions on the problem of simultaneous sustainable economic and environmental development. Sustainable development means not only non-existence of the human impact on the environment but also adequate economic development ensuring satisfaction of the people's material wants determined by the concrete social and cultural conditions of the public life. A simulation modeling of the sustainable development both the economic and environmental criteria should be considered equally. Although most of the models do not allow for the perfect forecast of the dynamics of environmental and economic entities and forming of recommendations for the people dealing with these issues, the models play immensely important role in solving environmental problems, ecological education and environmental awareness. At the same time it is necessary to remember that sustainable development cannot be accomplished all by itself and requires special targeted management actions. It is necessary to provide for management of activities directed at achieving conditions ensuring the sustainable development. This is the field where simulation game models render invaluable facilities at determining the most efficient actions for reaching the said objectives. Sustainable development business games within our training practices use models solving the issues of the justified strategy of the acceptable options of economic activities consistent with environmental protection. It is common knowledge that in real life withdrawal from economic development due to the following principles of the environmental awareness in its extreme leads to the "zero growth" of the countries' economy. For this reason it is important to follow economic principles, or as the Russian scientist Nikita Moiseev puts it, "economic imperatives" that ensure certain level of satisfaction of material needs through economic activities (industry, services and infrastructure development), as well as satisfaction of other life values: life expectancy, education level and etc. The Noble Prize winner Amartya Sen has set forth the concept of the "Human Development", according to which the life condition requirements should include not only income levels but satisfaction of the other life values, such as the adequate lifespan and proper education. Business games used within our training practices are presented in their, so to say, "manual edition" as well as



in combination of the computer generated simulation and the traditional game techniques. That is to say, this is not a computer dialogue mode but decision making during the direct dialogue between the players, who use computer for calculations and evaluation of accessory models, necessary for verification and selection of the most feasible solutions. At the same time computer is used for implementation of the computer simulation scenarios; finding optimization management solutions and receiving expert recommendations.

Keywords: Sustainability, Economic, Environmental Simulation Games



## IV-2 Is topological invariance a reasonable assumption for studying social systems too? Methodological remarks on the application of NK simulation modeling

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NK simulation modeling is a methodology based on Boolean network dynamics mostly developed by Kaufman (1984, 1993) for studying biological systems and their complexity. Boolean networks theory has its roots in the 60s in the theory of dynamic systems (Bertuglia, 2003, Brian, 1984; Klir, 1991; Weisbuch, 1991, Wuensche, 1998), cellular automata (Gill, 1962; Hanson, 2009; Ilachinski, 2001, Shannon and McCarthy, 1953; Sutner, 2009; Trakhtenbrot and Barzin, 1973, Waldrop, 1992, Wolfram, 2002) and cybernetics (Ashby, 1956; Ashby and Walker, 1966; Glushkov, 1966; Kauffman, 1984, 1993; Trappl, 1983, von Foerster, 1982, 2003). During the last decade NK simulation modeling has been used for studying social systems too, but without a clear awareness of the methodological implications deriving from the ontological differences between biological and social systems, and in particular of their different degree of complexity. In fact, the idea is that the dynamics of a *topologically invariant* system – a system that does not mutate neither its size nor the distribution of the specific connections between its nodes - it is defined deterministically (or stochastically) by the interaction of its components according to certain interaction rules. Therefore, given a certain topology and certain activation rules it is possible to define all the states in which the network can be found through all the possible trajectories. Attractors characteristics, network stability, role of nodes' interdependence and complexity, and many other issues concerning system dynamics can be effectively studied. However, this methodology requires the methodological assumption of topological invariance, at least according to the kind of application that has been made until now. Indeed, in principle it is possible to violate that assumption, but at a double price: i) the risk of never reaching any attractor in non-small networks; ii) a tremendous computational charge. In this paper it is argued that, given these prices and the high complexity of social systems, it is better to hold the assumption and to apply NK simulation modelling only to very small and simple social networks. Moreover, this methodology should be used only for getting general indications, like in the so-called scenario analyses. A remarkable implication of this view is that most social sciences applications of NK simulation modelling made to date have a rather doubtful value. The current fascination for this methodology seems to be more a fact of scientific fashion than a true analytic usefulness.

Keywords: NK Modelling, Simulation, Scenario



### IV-3 A Sinusoidal Six Steps Systemic Method (SSSSM)

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Many complex problems can be solved by the Sinusoidal Six Steps Systemic Method (SSSSM) described here:

Step 1- Problem. Diagnostic of a complex problem, for example: environmental pollution, poverty, insecurity, etc.

Step 2. Context. Put the problem in its real context. Research all possible sources of the problem, and imagine some probable solutions. State of the art of the problem and its feasible solutions.

Step 3- Propose. Generate, through an “ideas storm” or other means, some theoretical ideas to solve the problem.

Step 4- Theoretical evaluation. Analyze theoretically the proposals to detect their potentials and limitations, to choose the more viable.

Step 5- Experimental evaluation. Analyze experimentally, in a small scale or in controlled situation, to see which alternatives are more feasible.

Step 6- Real Evaluation. Analyze in a normal scale or in real situation, to see if the chosen alternatives really work.

Graphically, this SSSSM can be presented as a sinusoidal curve which starts at real situation level, rises through an intermediate real-theoretical step, arrives to some theoretical solutions, descends through an intermediate real-theoretical evaluation, and finally arrives to a real situation evaluation, and the cycle of research ends and may start again, forming a systemic loop.

This Sinusoidal Six Step Systemic Method (SSSSM) has been developed and evaluated in different situations and works well, but we still continue to improve it.

Keywords: Sinusoidal Six Steps Systemic Method



#### **IV-4 Cellular Automata Methodology for Societal Complexity. Methods and Applications**

**Prof. Dr. A. Makarenko, D. Krushinskiy, A. Musienko, A. Popova, G. Poveshenko, E. Samorodov, E. Terpil, A. Trofimenko, V. Zavertanniy**

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It is described the new possibilities of well known cellular automata approach to complex societal problems. Some new possibilities of improving cellular automata models and it are adjusting to the complex societal systems are described. The accounting of mental properties of society members had been proposed. Also the binding ideas of cellular automata and moving agents are considered.

The ways of using real data base and geography of real social systems are described. The examples of applications are election problem, pedestrian crowd's movement, public opinion formation, sportive games, evolution of social systems, epidemics spreading, city development etc.

Keywords: Cellular Automata, Societal Systems, Modeling, Applications



## IV-5 Development of network planning technology using computer

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The article aims to explore the development of network graph parameters calculation methodology. Computer programs are investigated to serve the identification process of the above mentioned parameters. There is examined a particular example aiming to show additional preferences of implemented methodology.

Major additional preferences of proposed methodology are the following: calculation of time instants to start and finish concrete events, activities and the whole project, determination of time resources associated with particular event and activity, identification of critical activities, visibility of reserves' distribution prospect, which enable the optimization of arranged plan by redistributing available time and material reserves and invoking, if necessary, external sources of these reserves.

It is very important that any changes in network plan schedule, after entering them into the investigated computer program, are reflected without additional logic changes calculated in the parameters' table. This is particularly valuable during the project implementation process because deviations from the plan allow updating parameters' settings and thus enabling manager to manage the project implementation process specifically and purposefully.

**Keywords:** Network Planning, Parameters, Reserves, Computer Program.



## IV-6 Random Stub Matching Models of Multigraphs

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Network data involve relational structure representing interactions between actors and are commonly represented by graphs where the actors are referred to as vertices and the relations are referred to as edges connecting pairs of vertices. A multigraph is defined as a graph where loops and multiple edges are permitted and appear natural in many contexts, for instance social interactions between people during a period of time, or business contacts between companies in a region or industry.

A random multigraph is a family of multigraphs with a probability distribution, and appropriately chosen it can be a model for a considered application. Two main multigraph models are here considered. The first model is random stub matching (RSM) which is also referred to as the configuration model or the pairing model. Stubs or semi-edges are vertices that are paired to an edge. Under RSM, the edges are formed by randomly coupling pairs of stubs according to a fixed stub multiplicity or degree sequence. Thus, edge assignments to vertex pair sites are dependent. The second multigraph model is obtained by independent edge assignments (IEA) according to a common probability distribution over the sites.

The local and global structure of multigraphs under RSM are analyzed and compared to IEA models using moments, entropies and information divergences. The local structure of the number of loops at a fixed vertex and the number of edges between two distinct vertices are analyzed. Their moments are determined as functions of the number of edges and the degrees of the vertices. Information divergence and entropies are used to compare the marginal edge multiplicity distributions under RSM and IEA. Approximations to the entropies are given and numerically investigated. The main results concerning the distributions of edge multiplicities at local sites can be summarized as follows. The variance of the number of loops under RSM is shown to be less than the variance under IEA, except for some degenerate cases. The variance of the number of edges between two distinct vertices under RSM is generally less than the variance under IEA, except for some illustrated special cases. A new formula for the probability of an arbitrary number of loops at a vertex and the more intricate expression for the probability of an arbitrary number of edges at any site is found.

The global structure of multigraphs is analyzed by the multivariate distribution of edge multiplicities. Simplicity and complexity of multigraphs under RSM are investigated. Two well known asymptotic results for the probability that an RSM multigraph is simple are numerically investigated and an alternative way of approximating this probability is presented. Some other variables that identify simplicity and complexity are proposed and investigated. The main results concerning the global structure of multigraphs can be summarized as follows. The distributions of multigraphs under RSM are shown to depend on a single complexity statistic. Entropies of the RSM and IEA distributions of multigraphs are



given and approximate entropies are found using covariance matrices. The two asymptotic formulae for the probability that an RSM multigraph is simple do not perform well for multigraphs with small numbers of vertices and edges and the new proposed approximation is shown to perform better.

Keywords: Multigraph, Edge Multiplicity, Entropy, Information Divergence, Simplicity And Complexity



## IV-7 Modeling and simulating complex societal problems: a methodological challenge

**Prof. Dr. Cor van Dijkum**

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Many phenomena in the social world can be viewed as complex social systems. Through systems theory one recognizes that events are related and make up systems. With dynamic systems theory one understands that the events are related in a dynamic way, feedback between events let the system evolve in time.

With the idea of ‘complex social systems’ one comprehends that feedback can be non linear, building systems that are difficult to follow and predict, just as many phenomena in the social world are. Computer simulation seems to be an adequate tool to generate knowledge about complex systems because they can simulate non linear feedback by sophisticated mathematical models. By doing research, supported by computers, pioneering social scientists make models of phenomena in the social world that could not be modeled adequately before. Those models make it possible to understand and handle complex societal problems such as the spread of a disease, ecological disasters, financial crisis, big city problems, problems with migration, collapsing societies.

There is a range of methodologies and methods to facilitate the understanding and handling of complex systems. In this paper three approaches are compared: system dynamics, system dynamics embedded in gaming and agent based simulation.

Keywords: Simulation, Methodology



## **IV-8 Compram Method for Handling Societal Problems - Case Study in a Brazilian Research and Development (R&D) Program for the electric sector**

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The Brazilian Electricity Regulatory Agency – ANEEL establishes guidelines and instructions that regulate investments made by companies in R&D Program for the Brazilian Electric Energy Sector. Nowadays, about two hundred utilities must apply in R&D projects. Based on the utilities' net operational incomes, the annual obligatory investment reaches about US\$ 200.000.000,00 (two hundred million dollars). Despite of Brazilian electrical sector context is, in a certain way, stable, considering that there are no major changes in the market and technological demands, resulting in a relatively low interest in research by the utilities, the government policy points to technological improvement, more efficiency and energy quality. In this context, ANEEL needs to balance different and sometimes opposite interests. A new set of rules and guidelines was published by ANEEL in 2008, R&D Manual, in order to improve the Program results. Established the big picture, the main problem in ANEEL's point of view is to reduce the utilities' R&D financial risk as they develop research projects and at the same time reduce bureaucratic procedures, especially to the expenditures control. For instance, amplify the use of developed technologies, stimulate new research centers and so on. The described social problem has many variables and actors and therefore is difficult to analyze and handle. In order to improve the regulation the R&D Manual has many revisions but none of them has applied a methodology to deal with the complexity. In the scope of present work it's proposed to use the Compram method. The Compram Method suggests that two kinds of knowledge are needed for handling complex social problems: context knowledge, by experts and actors involved, and process knowledge, which comes from facilitators. The method also states that complex social problems must be handled cooperatively by two different kinds of teams: The neutral context experts team and the actors team. One of the actors is the problem owner, the ANEEL's Research and Development and



Efficiency Superintendence. Other actors are the utilities and academy. It's proposed to invite the stakeholders located at Brasilia, Federal District where ANEEL is situated, to handle the problem in two discussion meetings in 2010's first semester. The first one should involve the experts: National Confederation of Industry, a R&D policy expert and Brazilian Association of Technological Institutions. The second meeting involves the actors: ANEEL, Brasilia's utilities and University. Both meetings should develop the steps 1 and 2 of Compram Method: describe and analyze the problem and unfold the interventions. Steps 3 and 4, select interventions and anticipate societal reactions, will be developed in a third meeting with experts and actors together. Steps 5, implementation of the interventions, and step 6, evaluation of the changes, depend on the Problem Owner. These two last steps are out of the scope in the present work.

Keywords: Group Decision Making and Negotiation, OR/MS and the Public Sector, Research and Development



