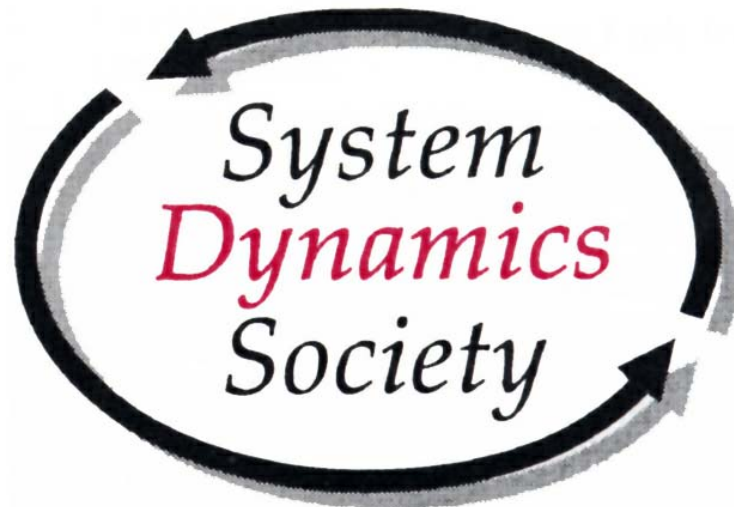# Proceedings of the
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Cambridge Massachusetts 02142
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http://web.mit.edu/sdg/www/

Ventana Systems, Inc.
60 Jacob Gates Road
Harvard Massachusetts 01451
United States of America
Phone: + 1 508 651 0544
Fax: +1 508 650 5422
www.vensim.com

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United States of America
Phone: + 1 617 364 3890
Fax: +1 617 364 3893
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100 Institute Road Fuller Labs
Worcester Massachusetts 01609-2280
United States of America
Phone: + 1 508 831 5220
Fax: +1 508 831 5881
www.wpi.edu/Academics/ADLN/

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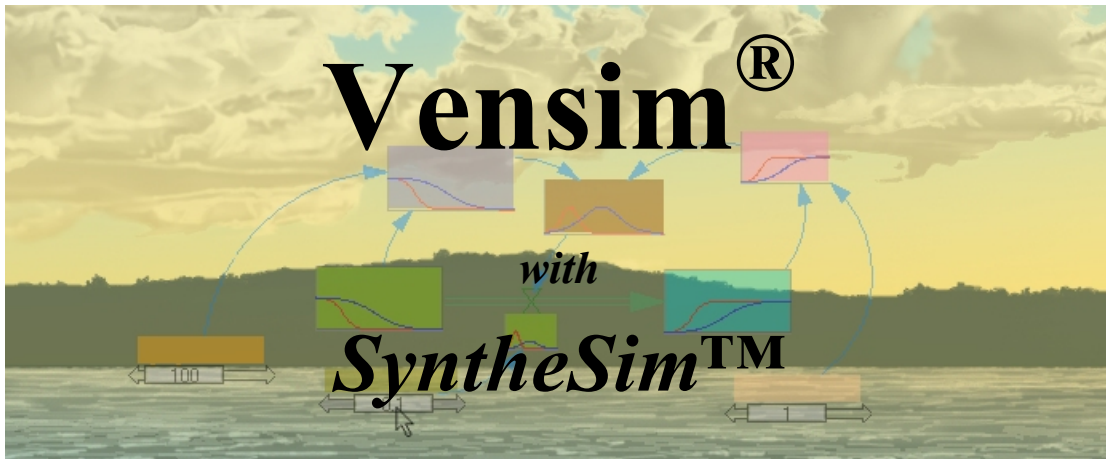
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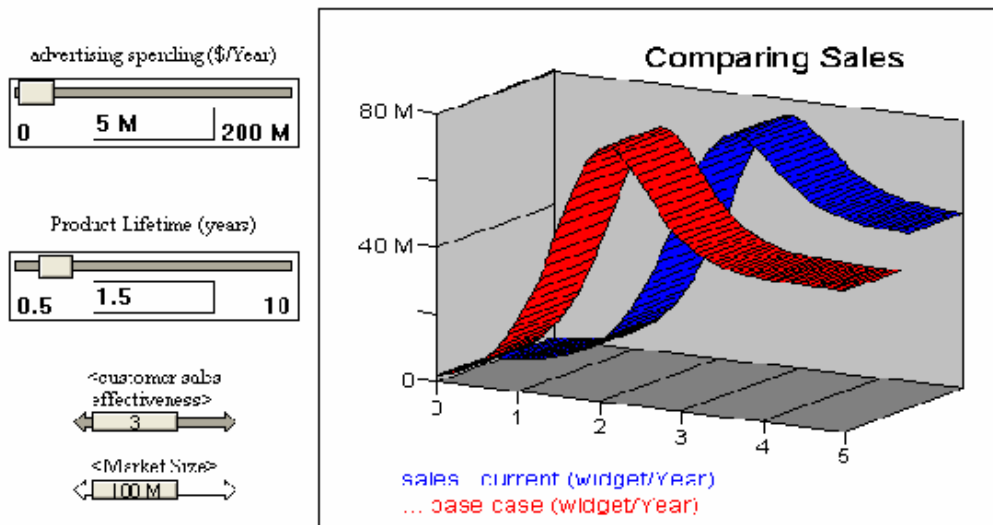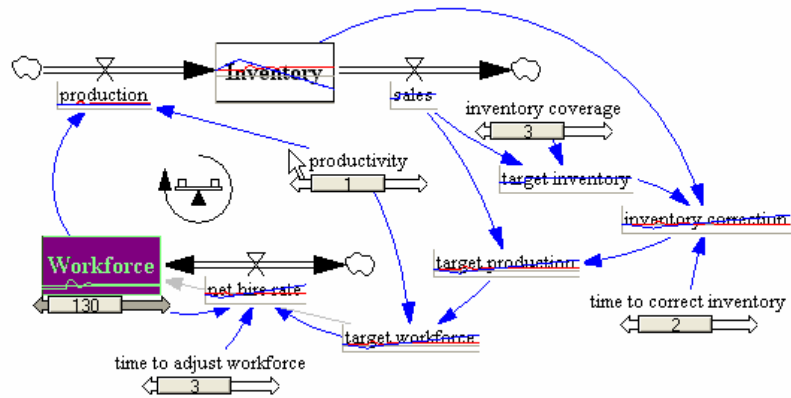
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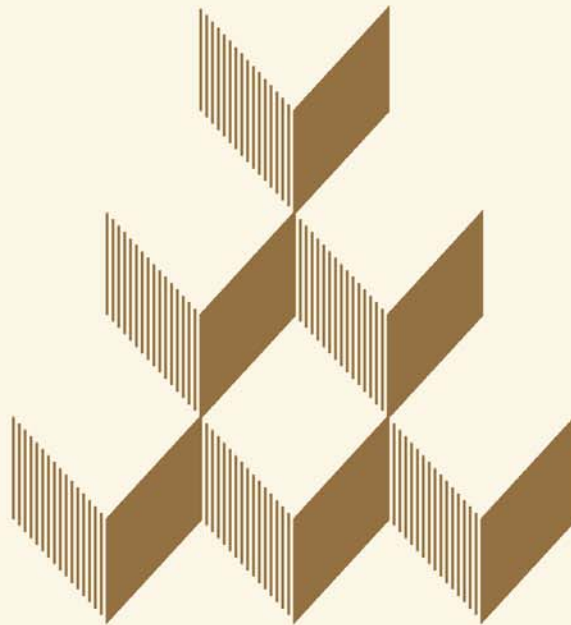
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———————————

Allen L. Boorstein, President

IT HAS BEEN OUR PLEASURE to help fund the Dana Meadows Student Paper Prize, given annually for the best student paper presented at the International System Dynamics Conference. Thanks to all who helped establish the fund to permanently endow this valuable award.

Best wishes to all the students, who are the future of system dynamics.

HVR has been providing System Dynamics consultancy services to a wide range of clients in government and industry since 1994.

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HVR has supported the System Dynamics Society over many years and was a key player in establishment of the UK Chapter. We were proud to have been official host of last year's conference in Oxford.

How We Work

As one of the UK's leading providers of System Dynamics consultancy, our reputation for professionalism is second to none.

We work with our clients to deliver solutions precisely tailored to their needs. HVR believes very strongly in the need to transfer its technology to clients, many of whom now have the capability to undertake entire projects on their own.

HVR's team of consultants is also proficient in a wide variety of other methodologies so we know when, and when not to apply System Dynamics.

Contacts

David Exelby
david.exelby@hvr-csl.co.uk

HVR Consulting Services Ltd.
Selborne House
Mill Lane
Alton
Hampshire GU34 2QJ
United Kingdom

Tel: +44 (0)1420 87977
Fax: +44 (0)1420 89819

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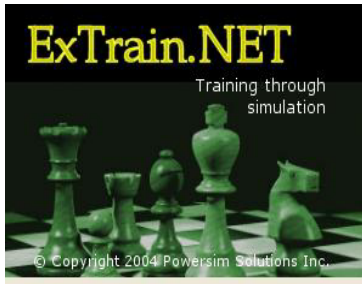
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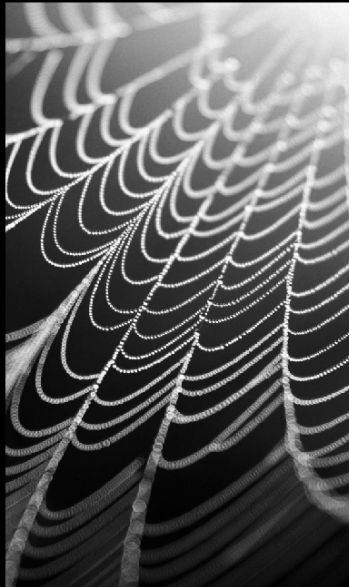
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THE *SYSTEM DYNAMICS CAREER LINK*

What is it? The *SD Career Link*, in its sixth year of operation, is hosted by the System Dynamics Society at the University at Albany. It includes on-line information and links to organizations who employ candidates with system dynamics and systems thinking backgrounds. We hope that the *SD Career Link* will provide a valuable exchange of information about organizations, positions and people in the field of system dynamics. Please visit the *SD Career Link* bulletin board at the conference.

Career Link Allows Companies and Universities to Describe General Career Information as Well as Specific Job Opportunities. The Career Link section of the Society web site has two subsections: (1) career information; and (2) specific job postings. In the career information section, employers and universities provide general descriptive information about how system dynamics fits into their organization, typical jobs, career paths, and other aspects of employment with the company. This subsection allows employers to provide information about system dynamics opportunities within their firms to supplement the more general information contained on their corporate or academic websites. Such career information is valuable to those interested in studying system dynamics, and we urge companies and universities to describe system dynamics in their organization even if they do not have specific open jobs at the present time. The subsection on specific job postings allows employers to advertise active openings.

How to participate? Please refer to the System Dynamics Society website at www.systemdynamics.org/ or send an email message to the Society office at <system.dynamics@albany.edu>. All information about access to and use of the site will remain confidential. We look forward to your participation.

Dana Meadows Student Award Endowment Fund Drive

In the fall of 2004 the System Dynamics Society announced a fundraising drive to permanently endow the Dana Meadows Student Award, given for the best work by students presented at the annual conference of the Society. For the first three years (2001, 2003, 2004) Jane and Allen Boorstein generously funded the award.

Our goal is $60,000. To help reach it, a group of Dana's colleagues, former students, and supporter of the Society pledged to match donations, until the overall goal of $60,000 was met. We quickly came within $2,000 of reaching the goal with 64 individual contributions and two organizations, the UK-based Operational Research Society and the Sustainability Institute.

We hope to successfully conclude this fundraising drive at the Boston conference. Please join the list of donors! Contributions in any amount are welcome and can be made at the Registration Desk during the conference. All contributions are tax deductible (in the US). More information about the Award can be found on the System Dynamics Society website.

Sincere thanks to all the donors.

List of Donors
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The 24th International Conference of the System Dynamics Society
NIJMEGEN   July 23 - 27, 2006

The 2006 conference of the System Dynamics Society will be held at the campus of Radboud University in Nijmegen, the Netherlands. A range of accommodations, from a luxury spa hotel to bed & breakfasts and economical hostels, is available within walking distance or up to a 15-minute bus (or bike!) ride depending on the location. Nijmegen is a small, friendly city and very easy to navigate. Nijmegen can be easily reached from Amsterdam Schiphol Airport by a 1.5 hour scenic train ride.

Nijmegen is the Netherlands' oldest city and celebrates its 2000th anniversary in 2005. The city offers historic sites and museums and borders beautiful forest countryside and polder landscapes, our unique low-lying terrains that have been reclaimed from water and are protected by dikes.

Radboud University is a leading research center in diverse fields such as human cognition, materials and magnetism, wetland ecology, and business law. The University enrolls 14,500 students in eight faculties and is renowned for its green campus, modern buildings, and state-of-the-art equipment. For more information, please visit the website of the Institute for Management Research at www.ru.nl/fm/imr.

Conference meetings will be held in auditoria and parallel rooms. For coffee breaks and lunches the university restaurant and open-air bar are available. The conference program will consist of plenary, parallel, and poster sessions demonstrating the state of the art in theory and application of system dynamics. In coaching sessions and workshops, experienced system dynamicists will assist in working on modeling questions. The program will also include the PhD colloquium, panel discussions, special interest group sessions, vendor displays, exhibits, demonstrations, and Society business meetings.

The conference schedule provides ample opportunities for meeting with colleagues and friends, including an opening reception in the city centre and a conference banquet. Discussions in a relaxed atmosphere will contribute to the exchange of innovative ideas. We look forward to welcoming you in Nijmegen and combining academic and practical interests in a pleasant setting!

CONTACTS

Organizing Chair Etiënne Rouwette Methodology Department Nijmegen School of Management Radboud University Nijmegen The Netherlands e.rouwette@fm.ru.nl	**Conference Chair** Jac Vennix Methodology Department Nijmegen School of Management Radboud University Nijmegen The Netherlands j.vennix@fm.ru.nl	**Program Chair** Andreas Größler Mannheim Business School Mannheim University Germany agroe@is.bwl.uni-mannheim.de

Conference Manager   Roberta L. Spencer, System Dynamics Society, system.dynamics@albany.edu

For updated details, please visit the Society website at www.systemdynamics.org

Reading Supporting Material

Supporting Material files can be found by clicking on the appropriate link in the *Paper Index*, found on the conference website and on the CD proceedings. Papers are listed alphabetically by the last name of the primary author.

➢ **Viewing/Opening/Reading the Supporting Material:**

Some of these files are regular texts or presentations which are in widely accessible formats such as .doc, .ppt, .pdf, etc., but others are model files, which need to be viewed using the appropriate system dynamics modeling software. Below, find information on how to access freeware/demo/trial versions from several system dynamics software manufacturers. Follow the links within the descriptions below to the software needed to view the files.

In following chart, find the three-letter extension of the file name, then the software you need to view the file.

File Name Extension	Software Needed
.itm, .stm	ithink, STELLA*
.sip	Powersim Studio
.sim	Powersim
.vmf, .mdl	Vensim

*ithink and STELLA can each be used to open both .itm and .stm files.

STELLA/ithink by isee systems (formerly High Performance Systems):
http://www.iseesystems.com/softwares/player/iseeplayer.aspx

This link will navigate you to the FREE isee Player. The isee Player lets you view, run, print and share both STELLA and iThink models. Available in both Windows and Macintosh versions, the isee Player allows exploration of all model layers - map, model, equation, and interface, and never "times out."

Powersim Studio by Powersim Solutions:
http://www.powersimsolutions.com/SDConference2005/sdconference.asp

Powersim Studio Express is a 60-day trial version of Powersim Studio 2005. Note that this installation will automatically replace any previous version of Studio 2000, 2001 or 2003 that is installed on the computer. Studio 2005 can open files from earlier versions of Studio, but earlier versions cannot open a file that has been updated or created in Studio 2005. Studio 2005 contains an array of new and exciting features, including tools for optimization and risk analysis, number formatting, new user assistance features, the ability to customize the user interface, and more.

Vensim by Ventana Systems:
http://www.vensim.com/reader.html

The Vensim Model Reader can be used to open Vensim models which are files with extension .vmf. This is free software which will allow you to view and simulate models changing the assumptions but not model structure. Many models (both .vmf and .mdl) can also be opened using Vensim PLE which is free for educational use. Both are available from:
http://www.vensim.com/freedownload.html

Papers: Parallel, Poster, Research

Ahmed AbdelTawad AbdelGawad

ahgawad@hotmail.com
Information and Decision Support Centr
1 Magless ElShaab Str
Downtown
Cairo Egypt

Bahaa Eldin Aly Abdel-Aleem

baleem@idsc.net.eg
Egyptian Cabinet
Information and Decision Support Ctr
1 Magles El-shaab Street
Cairo Egypt

Mohamed Mostafa Saleh

msaleh@idsc.net.eg
Egyptian Cabinet
Information and Decision Support Ctr
1 Magless Al-Shaab Street
Cairo Egypt

Pål I. Davidsen

davidsen@ifi.uib.no
University of Bergen
Department of Geography 7th Floor
Hermann Fossgt 6
5020 Bergen Norway

Automated Eigenvalue Analysis of System Dynamics Models

The method presented in this paper allows for an investigation of how the eigenvalues characterizing the model behavior is created from the underlying model structure and how this behavior feeds back to change instantaneously the relative significance of the model structure. The method also allows us to identify the relative significance of the various parameters that governs the gains of the links and loops of the model. The method has been implemented using Matlab software for the purpose of facilitating an eigenvalue analysis of system dynamic models. This work is based on control theory as well as the previous work on eigenvalue analysis in system dynamics. It summarizes the thesis work by Ahmed AbdelTawab AbdelGawad (2004) and Bahaa E. Aly Abdel-Aleem (2004), under the supervision of Mohamed Saleh and Pål I. Davidsen. The method outlined and Matlab code developed in preparation for this paper may be implemented as part of any simulation package.

Tarek Abou Ali

t.aboualy@computer.org
IEC
3 Baghdad Street
Heliopolis 11341 Egypt

Khaled Wahba

khaled.wahba@riti.org
Cairo University
Faculty of Engineering
11A Hassan Sabry Street Zamalek
Cairo 11211 Egypt

Assessment of Egyptian Software Export Capabilities Using a System Dynamics Approach

The purpose of this research was to assess the Egyptian software industry using a Systems Dynamics approach based on the Software Export Success Factors Model developed by Heeks and Nicholson, 2002. A CLD was prepared as a step towards building a model to simulate the expected effect of key software-related infrastructure variables on the Egyptian software export revenue. Simulations of software export industry over a period of 10 years point to the following: (1) Injecting an additional 30% financial resources resulted in an increase of 8.4% in software export revenue and 2.1% in job opportunities with respect to the reference mode, (2) Improving IT staff productivity by 42%, and delivered software quality by 10%, with a decrease in resistance to change of 20% led to an increase of 68.7% in software export revenue and of 12.9% in job opportunities with respect to the reference mode, (3) Enhancing R&D by 50% and

IT staff innovation contribution by 10% resulted in an increase of 14.4% in software export revenue and 3% in job opportunities with respect to the reference mode, and (4) Improving the software export promotion efficiency by 14% and quality of delivered software by 10% led to an increase of 38.7% in software export revenue and 8% in job opportunities with respect to the reference mode.

Emmanuel D. Adamides

adamides@mech.upatras.gr
University of Patras
PO Box 5064
26004 Patras Greece

Yeoryios A. Stamboulis

ystambou@uth.gr
Plastira 26
38221 Volos Greece

Nikolaos Pomonis

npomo@yahoo.gr
University of Patras
Dpt Mechanical & Aeronautical Eng
IMIS Lab
26500 Patras Greece

Modularity and Strategic Flexibility: A Cogntive and Dynamic Perspective

The paper addresses the question whether a modular organizational structure breeds mechanisms that promote proactive strategic flexibility. We examine this question from the perspective of the cognitive school of strategic management and with the aid of system dynamics modeling and simulation to explore long-term dynamic effects. Both our analysis and our experiments with the model suggest that modular organizations do not necessarily encourage the construction of managers' mental models with a capability to generate more strategic options and, thus, do not promote strategic flexibility at a higher degree compared to more traditional organizational structures.

Ashish Agarwal

ashish_ka@yahoo.com
Indira Gandhi National Open University
School of Engineering & Technology
Department of Management Studies
New Delhi 110016 India

Ravi Shankar

ravi1@dms.iitd.ernet.in
Indian Institute of Technology Delhi
Department of Management Studies
Hauz Khas New Delhi 110 016
New Delhi 110 016 India

Modeling Supply Chain Performance in Different Market Scenarios

Performance of a supply chain depends on the integration of its trading partners and its ability to quickly respond to market changes. A system dynamics approach has been attempted in this paper to model the effect of integration and agility on performance of a case supply chain involved in FMCG business. The dynamic interactions between the different variables related to cause and effect of integration and agility of a case supply chain have been modeled and analyzed under different market scenarios. Simulation result of the dynamic interactions of case supply chain performance variables indicates that the influence of increase in integration level on the performance of the case supply chain is relatively more significant as compared to the influence of a similar increase in the agility level.

Fadl M. Ahmed

fadlmaster1@yahoo.com
Cairo University
Systems and Biomedical
Engineering Dept
Cairo
Egypt

Khaled Wahba

khaled.wahba@riti.org
Cairo University
Faculty of Engineering
11A Hassan Sabry Street Zamalek
Cairo 11211
Egypt

The Dynamics of Glucose Regulatory System: An Educational Tool for the Students of First Medical Year

The glucose regulatory system in man is a complex system. It is a nonlinear, multiloop, self-regulatory feedback system which exhibits behavior which is often counter-intuitive and which is insensitive to many external interference. The challenge in this work is to employ a model that is "simple, but not too simple" for the students of first medical year with the purpose to help them understand the glucose regulatory system in the human being body by quasi-practical approach based on simulation tool and not my theoretical understanding. This model describes the carbohydrate metabolism,

Abdallah S. Ahmed
Cairo University

digestion, absorption and fate of intake carbohydrates. The model attempts to reflect the underlying (patho) physiology of insulin action and carbohydrate absorption in quantitative terms such as insulin sensitivity, volume of glucose and insulin distribution and maximal rate of gastric emptying. The model represents the integration of two existing models proposed earlier by Foster et al. (1970) and Lehmann et al. (1992).

Bahadir Akcam
bahadirakcam@gmail.com
University at Albany
135 Western Avenue
Draper 113
Albany NY 12222 USA

Victor Asal
vasal@email.albany.edu
University at Albany
135 Western Avenue
Albany NY 12222 USA

The Dynamics of Ethnic Terrorism

Despite the fact that much of recent terror is ethnically based, little attention has been paid to systematically explaining ethnic violence. We build on the work done by the Minorities at Risk Project (MAR) to the issue of ethnic terror using systems dynamics. While there has been important work done using MAR to explore ethnic violence as a base using statistics and qualitative analysis (Gurr 2000) there has been little work exploring ethnic terrorism specifically and none that has exploited systems dynamics as an analytical tool. The application of a systems dynamics approach will help us go beyond some of the limitations of statistical analysis to explore how government policy and ethnonationalist terrorism feed of each other in a cycle of violence, discrimination and repression. This work has three broad goals. First, it is targeted at understanding the causes of ethnic terror and second examining the way the relation between the ethnic policies of governments and the behavior of ethnic groups - particularly their choice to use or not use terrorism relate systematically. Third, this work sees to apply for the first time the tools of systems dynamics to political violence.

Jens Alkemper
alkemper@research.ge.com
GE Global Research
1 Research Circle
Niskayuna NY 12308
USA

Don Mango
don.mango@ge.com
GE Insurance Solutions
6 Hunt Lane
Gladstone NJ 07934
USA

Simulation of the Reinsurance Market using Agent-Based Modeling

Prices in the Property and Casualty Reinsurance market are known to undergo significant fluctuations. In order to understand the reasons for these fluctuations a simulation model was built that replicates relevant features of the reinsurance market: a limited number of market participants are competing, low product differentiation, volume constraints for each market participant and discrete volume decisions based on estimated rather than actual market prices. Despite a number of simplifications the model captures the current market dynamics. In a further development the model was made interactive allowing actual "players" to take the role of the reinsurance companies and make the individual volume decisions based on current financials and the market history. The model was built using agent based instead of system dynamics modeling techniques particularly to simplify implementation of critical discrete events and to create a simple to understand structure. We will discuss the model, the trade-offs between the Agent-based and System-dynamics approach as they applied to this model and share some experience in communicating the model structure with the business owners.

Raed Al-Qirem
raed.qirem@sunderland.ac.uk
University of Sunderland
Room DM-401 Media Centre
St Peter's Campus
Sunderland SR6 0DD UK

Alfredo O. Moscardini
alfredo.moscardini@sunderland.ac.uk
University of Sunderland
School of Computing and
Technology
St Peter's Campus
Sunderland SR6 0DD UK

Mohamed Loutfi
mohamed.loutfi@sunderland.ac.uk
University of Sunderland
School of Computing & Technology
St Peters Campus
Sunderland SR6 0DD UK

The Use Of System Dynamics Models To Evaluate The Credit-Worthiness Of Firms

Evaluating new bank loans has been considered as one of the main dilemmas that banks managers have to deal with in order to reduce the probability of default. The lending process is a series of activities involving two main parties whose association ranges from the loan application to the successful or unsuccessful repayment of the loan. This paper describes the construction of a flight simulator which uses the ideas of System Dynamics and the Viable Systems Methodology. The Decision Support Tool thus formed uses systemic approaches to measure a firm's performance and can provide a risk assessment in the sense of evaluating performance under different (what-if) scenarios. The credit worthiness from this model can then be evaluated against the usual estimate based only on financial ratios.

Carlos Alvarez Sierra
ALSI SAC
Jr Huanuco No 978
Av Jacinto Ibarra No 998
Huancayo Peru

Abel F. Alvarez Sierra
abelsierra72@hotmail.com
Jr Huanuco No 978
Huancayo Peru

Application of the Dynamics of Systems as an Alternative Solution to the Garbage in the Valley of the Mantaro

The valley of the Mantaro embraces great part of three counties of the department of Junín (Huancayo, Concepción, Jauja), with a problem in common, of the different municipalities that are in the whole journey of the river Mantaro, as treating the solid waste. Throw organic waste, inorganic to the river Mantaro; it is not a good solution for the Municipal administrations, because it is contaminated seriously to river, for the great quantity of waste that hurtles daily, besides already to be contaminated by the pollutants that are thrown by the center metallurgist of the Oroya. The sanitary filler was not a good alternative to solve this problem; Which is the best solution?, is it a question that they cannot respond, the Municipalities that are located in the valley of the Mantaro; the constant disagreements among their administrators what they achieve is to continue prolonging the contamination of the rivers and of the environment.

Carlos Alvarez Sierra
ALSI SAC
Jr Huanuco No 978
Av Jacinto Ibarra No 998
Huancayo Peru

Abel F. Alvarez Sierra
abelsierra72@hotmail.com
Jr Huanuco No 978
Huancayo Peru

Model Dynamic of Evaluation of the Environmental Impact of the Reforestations

The integral handling of the basins in semi-arid areas implies to face many problems. Among them: decrease of the vegetable covering, inadequate use of the earth on the part of the farmers, with the rising erosion processes and transport of silts. On the other hand, in many places of the Andean area, the population's increase and their growing necessities have caused a process of alarming environmental degradation. The handling of trees and bushes in the properties of the peasants are one of the key components of the handling of basins, mainly in semi-arid areas, where the few but intense precipitation events can cause severe damages in the areas of influence of the valleys. The program of reforestation of the PRONAMACHS this at the moment being executed but up to where it will contribute to solve these problems. To be able to get a sustained growth of the community of the Mariac Tingo, we need to know like it will be the long term environmental impact and which will be the economic benefits that it achieved the planned reforestation and systemic.

Lianjun An
alianjun@us.ibm.com
IBM
TJ Watson Research Center
1101 Kitchawan Rd Rte 134
Yorktown Heights NY 10598 USA

Bala Ramachandran
rbala@us.ibm.com
IBM
TJ Watson Research Center
1101 Kitchawan Rd Rte 134 Box 218
Yorktown Heights NY 10598 USA

System Dynamics Model to Understand Demand-Conditioning Dynamics in Supply Chains

Demand Conditioning is one of the methods used to address imbalances between supply and demand in supply chains. This requires the manufacturer to adjust the demand plan to respond to supply issues. The supply chain has several sources of delays and uncertainties such as lead times at different stages, forecast error, supply yield variability etc. that could potentially trigger or influence the conditioning process. In this paper, we examine dynamical effects in the conditioning process to study potential instabilities. We developed a Systems Dynamics model of a PC manufacturing supply chain to examine instabilities in the supply chain. This model provides insight on supply chain risks and error propagation due to unsynchronized execution. We also use the model to study the effect of different countermeasures to stabilize the supply chain.

Edward G. Anderson
egandersonjr@hotmail.com
University of Texas
McCombs School of Business
1 University Station B6300
Austin TX 78712 USA

An Initial Dynamic Model of Transactive Memory Systems

A key determinant of any group's performance in such contexts as varied as product development, consulting, and craft manufacturing is its transactive memory system (TMS): that is, its shared, tacit memory

Kyle Lewis

kyle.lewis@mccombs.utexas.edu
University of Texas
McCombs School of Business
1 University Station B6300
Austin TX 78712 USA

system for managing and communicating information relevant to the group. Using the methodology of system dynamics, we model the relationship between TMS and productivity by leveraging the theory of learning-by-doing at both the group and individual levels. We also incorporate into the model the concepts of "group forgetting," in which employee turnover reduces group knowledge. We also include the effects of specialization, overspecialization, and knowledge obsolescence. We then simulate the impact of each of these refinements and perform sensitivity analyses on them. Finally, we discuss several implications of this model for future research. One implication is that representing group learning processes by a single, traditional, power-law learning curve may be in many cases inadequate. Another is that the very development of a TMS may create excessive individual specialization that is detrimental to future productivity levels.

Santiago Arango

santiago.arango@ifi.uib.no
University of Bergen
Information Science
PO 7800
N-5020 Bergen Norway

Oscillatory Behavior as a Function of Market Complexity: Experiments on Commodity Cycles

This paper examines results on a series of Cournot markets with groups of five seller subjects. Step by step, we add complexity (and realism) to the simplest market and test the effects on behavior in an accompanying laboratory experiment. Consistent with previous experiments and the rational expectations hypothesis, price behavior was explained with Cournot Nash equilibrium with biases towards competitive prices. When complexity is increased, there rationality is degraded and lead to a salient cyclical tendency. Indications of cyclical behavior were induced by the application of spectral analysis and autocorrelation. We found that the more problematic effect of complexity in market behavior is the extra delay rather than accumulations. We proposed a heuristic based on the bounded rationality theory, but the tests were not satisfactory.

Fernando Arenas

farenas@puj.edu.co
Pontificia Universidad Javeriana
Calle 18 118-250 Av Canas Gordas
Pance
Cali Valle 017
Colombia

An Adaptive Expectations Approach to the Mechanisms of Transmission Model of the Central Bank of Colombia

An Adaptive Expectations Approach to the Mechanisms of Transmission Model of the Central Bank of Colombia Fernando Arenas – Pontificia Universidad Javeriana Franz Hamann – Banco de la República ABSTRACT Looking for the potential applications of system dynamics in macroeconomic modeling at the Central Bank of Colombia, the Mechanisms of Transmission Model (MTM) was recast in a system dynamics model. The forward-looking function of the model that, in the case of the MTM is a rational expectations based function, was approached by means of the TREND function. This document describes the system dynamics model and shows comparative impulse-response results between the models, when PULSE and STEP shocks are applied to inflation target, monetary policy, food supply, nominal depreciation rate, and risk premium.

Steven Arquitt

sarquitt@uq.edu.au
University of Queensland
7 Mirreh Pl
Chapel Hill Queensland 4069
Australia

An Application of Saeed's Environmental Mitigation Banking Model: Restoring Mangroves for a Sustainable Shrimp Industry

Saeed's environmental mitigation banking system dynamics model is applied to a case study in Thailand in which shrimp producers buy mitigation credits to compensate for damage done to mangrove ecosystems. Simulating the model suggests that a mitigation banking system can promote sustainable development of both mangroves and the shrimp farming industry if a direct one-off subsidy is given to the mitigation bank. The model is a work in progress embracing many uncertain assumptions and is considered, at this stage, as a tool for learning and focusing further research.

Daniel J. W. Arthur

d.arthur@surrey.ac.uk
University of Surrey
CCSR
Guildford GU2 7XH
UK

Upscaling Diffusion Models to Represent General Purpose Technologies for Industry Modelling

Modelling of technology adoption has tended to be based on individual product diffusion, although traditional models have been extended to incorporate replacement, competition, generations of substitution and other managerial variables such as pricing. A question is: how can these models be broadened to represent service industry applications and generalised or upscaled to model the phenomenon of General Purpose Technologies? GPTs have the properties of pervasiveness and complementary technologies. GPTs suffer from long development delays or start-up problems involving the co-ordination problems of complementary bandwagon behaviour. System dynamics modelling is proposed as an effective industry-level modelling approach to link standard expert judgement market forecasting used in industry and theoretical analysis used by economists in order to provide robust technology management policies. This paper represents an overview of the work-in-progress research themes and a modelling agenda.

Mohamed Askar

maskar@aucegypt.edu
American University in Cairo
11 Youssef El Gindi Street
Bab El Louk 12511 Cairo Egypt

Karim Assabghy
karim_assabghy@yahoo.com
American University in Cairo
4A Ibn Zinky St
Zamalek Cairo Egypt

Syed Imam
simam@aucegypt.edu
American University in Cairo
11 Youssef El Gindi Street
Bab El Louk Cairo Egypt

Business Dynamics Exploratory Model for Reviewing Industry in Developing Countries: The Case of Egyptian Automotive Industry

The automotive industry is considered as one of the main drivers of today's global economy. The industry spans across the globe, with nearly each country trying to develop the industry and its supply chain within its boundaries. This paper presents a Business Dynamics model that maps the Egyptian Automotive industry, which started as a public industry and then transformed to a market driven private industry. The Egyptian automotive industry focuses on the local Egyptian market, with no current plan for exporting to the global market. Such focus provides the Egyptian automotive industries with challenges that impede its growth. The Business Dynamics model presented in the

paper presents an explanation of the current status of the Egyptian Automotive industry. The model is then used to provide insights for the current status of the industry, as well as testing several policy options for stimulating the industry's growth.

Bent Erik Bakken

beerikba@online.no

Norwegian Defence Research Est
PO Box 25
NO-2027 Kjeller
Norway

Pål R. Østby

pos@ffi.no

Norwegian Defence Research Est

Arne Røksund

aroksund@fsts.mil.no

Norwegian Defence Staff Academy

Transforming a Military Personnel Policy – Learning from a Model Supported Intervention

The Norwegian Armed Forces used to have a unitary personnel policy. All officers were recruited with prospects of life-long employment. The long time constants in such a system meant that a transformation into a younger corps was almost impossible to achieve. The model-supported intervention significantly reduced the probable risk of failure in policy design and implementation. A number of achievements must be attributed to the model intervention per se. First, the model's base case projected a 100% surplus of senior officers. This was an eye-opener. Moreover, the lack of suitable options within the current policy regime became obvious. Finally, the suitability of the new policy was convincingly presented and its implementation success virtually secured. The success of the model intervention is discussed. Though the most aggregated model sufficed analytically, the existence of a more detailed model that reflected the production system, crucially enhanced the analysis' face validity, especially as a cost analysis was called for. However, more critical than the model's transparency was that the results fell within the comfort zone of most key stakeholders. The results challenged intuitions enough so that the model was considered invaluable, but not so much so as to question the approach.

Giorgio Ballardin

giorgio.ballardin@enicorporateuniversity.eni.it

Eni Corporate University
Scuola Mattei
Via Salvo 1 San Donato Milanese
20097 Milan Italy

Environmental Benefits and Economic Rationale of Expanding the Italian Natural Gas Private Car Fleet

Natural gas for automotive purposes is an appealing alternative: curbing local and global pollution and dependence on foreign oil are among the most remarkable advantages. The other side of the coin implies building and maintaining an on purpose network entailing financial requirements. The final aim of this work is to compare its advantages with economic rationale. A system dynamics model is built and taken as reference for all quantitative assertions. It contains data referring to two scenarios: business as usual versus expansion. The model treats separately global and local emissions and infrastructure needs. Quantitative results are the basis for the final assessment, that is grounded on the externalities' theory. By analyzing the scenarios' gap numerous remarks follow. Regarding global emissions, beneficial effects seem modest. Local emissions would either decrease or not vary depending on the pollutant. Avoided externalities estimates exceed infrastructure financial requirements. Natural gas is a suitable answer in tackling some issues related to the road transport industry.

Yaman Barlas

ybarlas@boun.edu.tr
Bogaziçi University
Dept of Industrial Engineering
34342 Bebek Istanbul
Turkey

Suat Bog

sbog@ku.edu.tr
Koc University

Automated Dynamic Pattern Testing, Parameter Calibration and Policy Improvement

System Dynamics (SD) is a special type of simulation modeling where output validity refers to validating the patterns of dynamic behaviors, such as oscillations, growth or decline. The developers and users of these models (the decision makers and people affected by decisions based on such models) are all rightly concerned with whether a model and its results are "valid." Structural model validity and validation have long been recognized as one of the main issues in system dynamics. This concern is addressed through pattern recognition and testing in this paper. Another issue in dynamic simulation methodology is parameter calibration; assuming that the structure of simulation model constructed by the user is valid. Parameter calibration is the minimization of an error function which is a measure of the correspondence between numerically calculated output patterns and the respective real behavior patterns. We offer a software that does automated parameter calibration with respect to a given (desired) dynamic pattern. This particular feature can also be used in policy improvement design.

Pawel Bartoszczuk

b_pawel@hotmail.com
System Research Institute
Newelska 6
01447 Warsaw
Poland

Optimisation of Consumption with Emission

Our objective is to conduct simulations with economic – environmental model. We list the important and causal relationships among the levels and trace the feedback loop structures. In describing an economic and environmental model we focus on the relations among income, consumption, emission, and damage. This paper yields insight into maximization of welfare. Next, we present the simulation runs of the model, conducted with the help of existing system dynamics modeling tools.

Pankaj Barua

p_barua@tezu.ernet.in
Tezpur University
Business Administration Department
Assam 784028
India

Purnendu Mandal

mandal@marshall.edu
Marshall University
Lewis College of Business
400 Hal Greer Boulevard
Corby 412
Huntington WV 25705
USA

Rajib Goswami

rgos@tezu.ernet.in
Tezpur University

BARISS (BAsin and River Information and Simulation System): A Web Based DSS for Water Resources using System Dynamics Model

Abstract : A web based DSS framework for water resources management on basin scale named as BARISS has been presented. The dynamics of water consumption and availability has been addressed in BARISS by using system dynamics as model base. The model component has been integrated with a RDBMS based information system to enhance its applicability. Applicability of BARISS has been tested on Brahmaputra River Basin, India and named as BRISS (Brahmaputra River Information and Simulation System). BRISS has been presented as a web based DSS using thick client and thin server approach and some examples of policy analysis has been done . The emphasis of this study has been on designing the

framework rather than detailed policy analysis. The framework has been designed as generic and platform independent with user-friendly interface and can be used for any river system.

Andrea Marcello Bassi

4141@stud.liuc.it
University of Bergen
via Jean de Fernex 5
Olgiate Olona VA 21057
Italy

Tobias Lorenz

space56@freenet.de
University of Bergen
Villaveien 3
5007 Bergen
Norway

Management Flight Simulators: Development of a Multiplayer, Asymmetric, Network, ILE

The importance of management flight simulators for learning has been already tested and documented. Single player simulation games are usually utilised, but a multiplayer simulation game adds direct competition to the existing problems (delays, nonlinearities and feedbacks). An asymmetric game also introduces bounded rationality and the dynamics of the information flow within the team. A network team game finally allows for the analysis of cooperation dynamics (by letting the users play against each other: against an unpredictable competitor, with no pre-defined strategy). This paper presents an asymmetric multiplayer network game that is considered to be easy to play and understand. The main advantage of the ILE here introduced is the facilitation of the analysis of: learning and decision making processes, cooperation and competition dynamics.

Steffen Bayer

s.bayer@imperial.ac.uk
Imperial College London
Tanaka Business School
South Kensington Campus
London SW7 2AZ UK

David Gann

d.gann@imperial.ac.uk
Imperial College London
Tanaka Business School
South Kensington Campus
London SW7 2AZ UK

Ammon Salter

a.salter@imperial.ac.uk
Imperial College London
Tanaka Business School
South Kensington Campus
London SW7 2AZ UK

Balancing Work – Bidding Strategies and Workload Dynamics in a Project-Based Professional Service Organisation

Project-based professional service organisations supply their services as tailored or one-off projects for specific clients. The particular form of their organisation, the character of their relationships with their clients necessary to deliver highly customised projects and the non-routine, creative nature of the work come together in a way which makes the management of these service firms particularly demanding. A common challenge is fluctuation in the workload. While this is partly influenced by changes in demand, the external environment does not provide a comprehensive explanation and the interaction between business processes and project processes needs to be examined. In providing a generic explanation of the causes of workload fluctuation as well as an assessment of different bidding strategies based on a system dynamics model, this paper aims to help to advance the theoretical understanding of the project-based professional service organisation and ultimately to help to provide tools for its managers.

Todd BenDor

bendor@uiuc.edu
University of Illinois
111 Temple Buell Hall
611 Taft Drive
Champaign IL 61820
USA

Conceptual Modeling and Dynamic Simulation of Brownfield Redevelopment

The negligent upkeep of many abandoned industrial sites ("brownfields") throughout the twentieth century has had grave impacts on the urban landscape of American and European cities. In recent years, brownfield redevelopment has come to be viewed as a strategy for sustainable land use and urban revitalization. This study assesses the feasibility of the construction of a dynamic simulation

Sara Metcalf
ssm@uiuc.edu
Univ of Illinois Urbana-Champaign
Dept of Geography Rm 220
Davenport
607 South Mathews Avenue
Urbana IL 61801-3671
USA

model of urban brownfield redevelopment. Literature surrounding brownfield redevelopment is reviewed and used to construct a dynamic hypothesis of brownfield redevelopment as it relates to site liability, economic viability, and availability of redevelopment funding. Finally, an initial system dynamics model of the brownfield redevelopment process is constructed. This quantitative analysis is performed using the 2003 US Conference of Mayors brownfield survey, which serves as a dataset on brownfield distribution and average site size. We conclude with suggestions for the extension of the model to capture spatial feedback in order to assess redevelopment effects on the surrounding matrix of urban land-uses.

Céline Bérard
berard.celine@courrier.uqam.ca
University of Quebec at Montreal
School of Management

Martin Cloutier
cloutier.martin@uqam.ca
University of Quebec at Montreal
Dept Management and Technology
315 Ste-Catherine East
Montreal QC H2X 3X2
Canada

Luc Cassivi
cassivi.luc@uqam.ca
University of Quebec at Montreal
Dept of Management and
Technology
315 Ste Catherine East
Montreal Quebec H2X 3X2
Canada

Performance Evaluation of Management Information Systems in Clinical Trials: A System Dynamics Approach

The complexity and characteristics of the pharmaceutical firm present an intriguing context for underlying information management issues during clinical trials for new drug development. This paper reports on the evaluation and performance of MIS for information management in clinical trials in new drug development. The main objective of the study is to examine the economic and business impacts of automating that process, to enhance our understanding of informational stakes involved, using a system dynamics (SD) model. The SD method is enriched in this paper with other conceptual frameworks such as Alter's (2001) Work Centered Analysis (WCA) and the Balanced Scorecard (BSC) (Kaplan and Norton, 2001). Results of the simulations for alternative sensitivity analyses on errors rates in data transmissions, that is, on alternative error-rate specifications, do not necessarily influence project delay, but rather work intensity. A discussion details the usefulness of enriching the SD modeling process with alternative conceptual frameworks in the problem definition in such complex settings.

Carmine Bianchi
bianchi@unipa.it
University of Palermo
c/o Business Dynamics SRL
Via Mazzini 59
90100 Palermo Italy

Graham W. Winch
graham.winch@plymouth.ac.uk
University of Plymouth
Plymouth Business School
Drake Circus
Plymouth PL4 8AA UK

'Stunted Growth' in Small Firms: How to Turn Them Round and Unleash Their Potential

The phenomenon of 'dwarf' or 'stunted' small and micro firms (in Italian nanismo aziendale) is recognised in the small business literature. These are firms that have survived through many years, maybe many generations, providing their owners with acceptable returns and lifestyles, but have remained very small. They might therefore represent potential lost opportunities for owners and, given the importance of the SME sector, local employment and economies. A system dynamics model replicating the basic no-growth, cyclical behaviour attributed to "stunted" SMEs is firstly analysed. Alternative policies arising from different entrepreneurial views and aimed at changing behaviour to one of stability or steady growth, are then tested and analysed. In this relatively simple form, the model does link behaviours to system structure and could support individual entrepreneurs in understanding the reasons for dwarfism in their firm

and the potential for unleashing growth. It could also form the basis for a more detailed model to support the identification and evaluation of strategic alternatives in individual firms.

Carmine Bianchi

bianchi@unipa.it
University of Palermo
c/o Business Dynamics SRL
Via Mazzini 59
90100 Palermo Italy

Enzo Bivona

enzobivona@sciepol.unipa.it
University of Palermo
Faculty of Political Sciences
Via Maqueda 324
90100 Palermo Italy

Using System Dynamics ILEs in Service Business Interventions

Modelling knowledge in SD organisational interventions may become a puzzling task because of difficulties in achieving a common shared view among business key-actors about the impact of Intellectual Capital (IC) investments on future company performance. Such difficulties are not only related to the intangible nature of IC, but also to the indirect role of knowledge in affecting performance drivers and outcomes. This phenomenon is particularly relevant in service businesses, where intangibles account for a high percentage of total assets. In order to overcome such problems, a conceptual framework has been developed by the authors to build a generic SD model aimed to support business decision makers in IC planning, with particular regard to service firms. Such model has provided the basis for developing two ILEs focused on a telecom mobile service provider and an insurance company. The first application was related to an education project, while the second one was linked to a consulting assignment. The use of a conceptual framework as a basis to build an ILE has proved to be a successful strategy in order to better communicate business key-actors the potential of SD in modelling and assessing IC policies. Main key-issues underlying model development and the ILEs' application are discussed in the paper, and most significant outcomes from simulations are commented.

Enzo Bivona

enzobivona@sciepol.unipa.it
University of Palermo
Faculty of Political Sciences
Via Maqueda 324
90100 Palermo Italy

Francesco Ceresia

fceresia@libero.it
University of Palermo
Faculty of Psychology

Designing Long Term Oriented Policies to Build Strong Manufacturer-Dealer Relationships: A System Dynamics Approach

In today's economy all manufacturers need to pay attention on how to build strong and long-term relationships with their dealers' chain. In fact, it has been demonstrated that short term policies aimed to provide dealers immediate benefits (e.g., price discounts) may prevent the development of long term and fruitful relationships. Also supporting dealers in promoting manufacturers' products has been proved as a sustainable strategy in long run. Another implication of manufacturers bounded policies refers to their inclination to reinvest significant amounts of their sales revenues in advertising and product portfolio improvement, without taking into account the need to invest in dealers' human resources, to make their strategies sustainable. Based of the above remarks, this paper aims to demonstrate the usefulness of a system dynamics approach in involving both manufacturers and dealers in strategic reasoning. Empirical evidence arising from a research project conducted by the authors with a manufacture operating in a high-tech industry, shows that using system dynamics as a methodology to support communication and learning may act as a significant lever to design successful long term

oriented policies. Such policies ought to increase dealers' skills and motivation, and improve potential customers' awareness of product benefits, at the same time.

Enzo Bivona

enzobivona@sciepol.unipa.it
University of Palermo
Faculty of Political Sciences
Via Maqueda 324
90100 Palermo Italy

Giovan Battista Montemaggiore

giannimonte@hotmail.com
University of Palermo
Via del Segugio 8
90125 Palermo Italy

Evaluating Fleet Maintenance and Management Strategies through a System Dynamics Model in a City Bus Company

The evolution of fleet maintenance and management policies highlights the growing importance of maintenance issues in both private and public companies. The need to improve maintenance performance requires an accurate evaluation of the trade-off between costs and benefits related to alternative fleet maintenance and management policies. However, the complexity of maintenance system makes this evaluation a very difficult task. More often a fleet manager deals with the following key issues: • is it more profitable to repair or to renew the company fleet? • Is it more convenient to reduce the average age of the different assets (e.g., by increasing investments in new bus) or to expand the maintenance activities (e.g., by rising repairing costs)? In fact, fleet managers cannot ignore the impact of their decisions on both company service and financial performance over time. Aim of this paper is to show how the System Dynamics approach can effectively support fleet managers in designing and evaluating their strategies. The simulation model here presented is based on the result of a project with two Italian city bus companies. Through such tool decision makers can test different fleet strategies and assess their effects on company performance.

Jason W. Black

jwblack@mit.edu
MIT
134 Third Street #2
Cambridge MA 02141
USA

Diffusion Of Demand Response Technology In Electricity Systems

Electric power systems are traditionally designed and developed with the assumption that demand is exogenous to the system. Connecting the feedbacks from the system to consumers will provide incentives for consumers to reduce demand during periods of high system prices. A system dynamics model is used to analyze the dynamics and long term implications of adoption of technology to enable demand response. The model includes the decision by consumers to adopt demand response technology along with decisions by investors to build generation capacity. The adoption process reduces overall system prices for peak demand periods, creating feedbacks with generation investment. The effects of technology improvement via learning, long term demand elasticity, and policies to promote adoption are considered. The results of the simulations show that diminishing returns to adopters and significant externalities in terms of free rider effects limit the attraction of individual adoption. A subsidy to alleviate the costs to individuals can be justified by the significant system level savings from widespread adoption. Several pernicious effects can emerge from large scale demand response, however, including increased price volatility due to a reduction in generation capacity reserve margin, an increase in long term demand, and increased emissions from the substitution of coal plants for natural gas and renewable generation capacity.

Mercedes Bleda
mercedes.bleda@mbs.ac.uk
University of Manchester
Insitute of Innovation Research
Booth Street West Harold Hankins
Bldg
Manchester M13 9PL UK

Simon Shackley
simon.shackley@manchester.ac.uk
Manchester Business School
Pariser Building H8
PO Box 88
M60 1QD Manchester UK

The Formation of Belief in Climate Change in Business Organisations: A Simulation Model

This paper aims to develop a simulation model of the formation of the belief in climate change of business organisations using a systems dynamics approach. A good understanding of how decision-makers in business organisations change their perceptions and beliefs regarding climatic issues, and modify the form, function and strategy of their organisations accordingly, constitutes the base for an analysis of business adaptive behaviour in relation to climate change. The main assumption of the model is that the dynamics of the belief in climate change that businesses hold is driven essentially by the perceived actual and potential changes in competitiveness associated with the occurrence of climate related events. That is, the way belief in climate change is formed in business organisations is driven more by economic interests rather than by the growth of an ecological 'business conscience'. The model has been built based upon theoretical hypotheses drawn from behavioural studies of organisations, organisational learning theories, and evolutionary theories of adaptation and change.

Mary Bourne
bourneml@jmu.edu
James Madison University
ISAT 153 MSC 4107
Harrisonburg VA 22807
USA

Michael L. Deaton
deatonml@jmu.edu
James Madison University
Integrated Science and Tech MSC
4102
Harrisonburg VA 22807
USA

The Dynamics of Identity Theft: A Comparison of Symptomatic and Systemic Solutions

This paper presents a dynamic hypothesis explaining the system dynamics underlying the identity theft epidemic. The causal loop structure synthesizes current understanding of the problem and suggests that any strategy to address the identity theft epidemic by primarily focusing on prosecuting thieves without effectively mitigating the underlying forces is doomed to failure. The causal loop diagram elucidates the dominant feedback structure ...a collection of rapid-feedback, self-reinforcing dynamics that generate ample opportunities for would-be thieves. Preliminary results from the analysis provide a foundation for exploring policy options through a full working model, yet to be developed.

Jeffrey Boyer
jeff_boyer@plugpower.com
Plug Power Inc
968 Albany Shaker Road
Latham NY 12110
USA

John Elter
john_elter@plugpower.com
Plug Power Inc
968 Albany Shaker Road
Latham NY 12110
USA

The Dynamic Behavior of a Zero-to-Landfill Strategy for Consumer Products

Environmental strategies such as Zero-to-Landfill are gaining increasing attention throughout the world. Product take back is a significant means of ensuring that products that have reached the end of their useful lives are reclaimed for reuse, remanufacturing, or recycling. Such a strategy is expected to minimize environmental impacts, reduce overall resource consumption, and provide economic value to manufacturers and consumers. The reverse logistics, however, can be quite complicated as product collection, product disassembly, processing, component returns, and component reclamation must be considered. Further, the costs and magnitude of

the requisite system must be projected to support appropriate planning and execution. In this paper, we present a model of a reverse logistics system for a consumer product. The impacts of closed-loop logistics on product adoption rate, product costs, and component reliabilities are balanced against the cost of new infrastructure, shipping and tracking, and processing and inventorying of expended components. We illustrate how a reverse logistics approach may develop as a function of product adoption, the total value of returned components, product reliability, and product lifetime. A Zero-to-Landfill strategy has a significant potential to improve the triple bottom line – people, planet, and profit – of companies that adopt it.

Bill Braun

bbraun@ursuline.edu
Ursuline College
3833 Kirkwood Road
Cleveland Heights OH 44121-1803
USA

The Dynamics of Economic Value Depletion: A Proposal for Accelerated Feedback Loops in Production and Purchasing Decisions

Organizations may fail to adopt sustainable solutions as a result of incomplete and/or inaccurate feedback into the decision making process. Events that cause harm - environmental, health, or social - are commonly the delayed effect of a prior course of action, itself the result of decisions that emerge from endogenous policy. By accelerating the cost of future harm into current period decisions, producers and purchasers have greater access to the quantity and quality of information that influence decisions to produce and consume. The creation of a financial policy structure that makes future, long-term costs of production, promotion, and consumption explicit in the decision process will correct a current deficiency in the analysis of costs and benefits made by producers and purchasers. Such a feedback loop would correct a structural market failure and could reduce the need for governmental regulation.

Berndt Brehmer

berndt.brehmer@fhs.mil.se
Swedish National Defence College
PO Box 27805
SE-115 93 Stockholm
Sweden

Fredrik Elg

freel@gmx.net
Vanguard Strategy
68 Long Acre
London WC2E 9JG
UK

Heuristics in Dynamic Decision Making: Coping with the Time Constants of a Dynamic Task by Doing Something Else

Laboratory studies have shown that people cannot handle the time con-stants in dynamic tasks. Yet they obviously cope with such tasks with some success outside the laboratory. This study is one in a series of studies that examine the hypothesis that people cope by relying on heuristics that allow them to simplify the task. The heuristic studied here was that of relying on frequency differences, i.e., what Reason (1990) calls frequency gambling. It examines the effects of varying the relative frequency of scenarios that require different responding, and where relying on frequency rather than learning the actual time con-stants will lead to some success. The results show that the participants did not learn the time constants, that frequency had a strong effect on their decisions, but that their responding also seemed to be influenced by another heuristic identified in earlier studies, viz., that of rapid and massive responding. Implications of these findings for system dynamics modellers are discussed.

Uroš Breskvar
dafko@email.si
University of Maribor
Faculty of Organizational Sciences
Kidriceva 55a
4000 Kranj Slovenia

Warehouse Stock Optimization with Visual Continuous and Discrete Simulation

This paper describes warehouse stock optimization with continuous and discrete simulation. Warehouse optimization is a part on integrated business information system with a task of providing help to operative management level at important decisions referring to production activities. The first goal was to validate the model of the actual system using some defined ordering strategy with a consideration of actual consumption. Ordering strategy consists of order frequency and order quantity. The second goal was to find optimal ordering strategy, by using two simulation methods, minding minimal holding and ordering costs. Several optimization algorithms were used with both simulation methods.

Douglas Brown
drb33@cornell.edu
Cornell University
313 Warren Hall
Ithaca NY 14853
USA

A Spatiotemporal Model of Shifting Cultivation and Forest Cover Dynamics

Shifting cultivation is the primary means of livelihood for subsistence farmers throughout the humid forests of the tropics. They rely on the forest landscape as a source of fertile land to sustain their livelihood. Sustainable use of the resource base requires long periods of fallow and the ability to move the zone of active cultivation from one location to another over time. At the individual patch or field level, shifting cultivation is essentially a resource extraction problem somewhat akin to a pulse fishery – intensive use of the stock of soil fertility for a short period followed by a long idle period to allow regeneration of the stock. This paper describes a spatiotemporal model of resource extraction adapted to the use of forest resources by shifting cultivators. In contrast to other models of spatial resource exploitation, decision criteria depend on a nonseparable agricultural household model extended to accommodate both the temporal and spatial dimensions. The paper focuses on the theoretical issues related to modeling shifting cultivation. It concludes with a demonstration of the concept in a dynamic simulation model of subsistence agricultural production in southern Cameroon implemented using Simile, a software tool for computer simulation of complex dynamic systems especially suited to modeling human-environment interactions.

Fernando Buendia
fernando.buendia@udlap.mx
University of the Americas Puebla
Santa Catarina Mártir
Cholula Puebla
Mexico

Increasing Returns to Economic Activity Agglomeration

This paper introduces the notion of increasing returns to economic activity agglomeration and develops a formal system-dynamic model where this notion is used to explain the self-organizing nature of the spatial structure of industrial clusters. In this model, both pecuniary and external economies based on knowledge spillovers are considered.

Newton Paulo Bueno

npbueno@ufv.br

Federal University of Viçosa
Dept de Economia Campus
Universitário
36571-000 Viçosa Minas Gerais
Brazil

Stabilization Policy Debate, Control Theory and System Dynamics Methololology

The objective of the paper is to show that the one of the main source of macroeconomic investment instability is similar to that which makes difficult managing supply line in famous Beer Game developed by the system dynamics group of MIT Sloan School of Management. It will be pointed out that ignoring production time delays causes instability not because economic agents simply ignore supply line delays, but because they adjust their expectations more rapidly than the delays involved in supply lines, whatever those delays could be. The paper is structured in three sections. In the first we present the classic Phillips' argument about unintentional destabilizing effects of stabilization policy in modern dynamic system language, in order to show how to build a simplified macroeconomic supply line model for investment dynamics; in the second section, the macroeconomic model is developed and simulated. Third section concludes the paper suggesting that the inclusion of production time delays in macroeconomic models reopens the space to the control theory in stabilization policy debate.

Ali Afsin Bulbul

afsinbulbul@yahoo.com

Portland State University
Harder House
1604 SW 10th Avenue
Portland OR 97201 USA

Capturing Project Dynamics with a New Project Management Tool: Project Management Simulation Model (PMSM)

Capturing Project Dynamics with a New Project Management Tool: Project Management Simulation Model (PMSM) Ali Afsin Bulbul Portland State University Systems Science Ph.D. Program Harder House 1604 SW 10th Ave. Portland, OR 97201 Phone: (503) 221-4576 Fax: (503) 725-8489 afsin@pdx.edu In this research, traditional project management concepts, methods, and their deficiencies relative to increasing complexity of projects is discussed. System Dynamics (SD) modeling is proposed as a complementary project management tool to be used at the higher level to augment operational level project management methods. The potential usage of SD models to promote the learning from projects, both in individual and organizational dimensions, is discussed. Working as a project management laboratory, SD project models can be successfully used to improve understanding of the project process. They can be used to design the project in the project-planning phase, to monitor and control the project in the project-execution phase, and to learn from the project in the post-mortem phase working as a learning infrastructure. A generic SD project management simulation model (PMSM) is built to serve for this purpose. The model structure and the graphical user interface are explained briefly. Tests performed to validate the model revealed that the model is appropriately designed, works properly, and it is robust relative to the purpose of the model.

James Burke

jay@anl.gov
Argonne National Laboratory
9700 S Cass Ave Building 900
Argonne IL 60439
USA

John R. Hummel

jhummel@anl.gov
Argonne National Laboratory
Decision and Information Sciences
Div
9700 South Cass Avenue
Argonne IL 60439-4832 USA

System Dynamics Characterizations of the Defense Industrial Base Critical Infrastructure

The Department of Homeland Security (DHS) is funding the development of a Critical Infrastructure Protection Decision Support System (CIP DSS) that is intended to be used by DHS decision makers to assess the impacts of deliberate attacks or disruptions on the United States' infrastructures and how they might be mitigated by investments in protective or recovery technologies. One of the 17 critical infrastructures is the "Defense Industrial Base." The basic mechanisms of such a model are the flows, especially surge response flows, of war materiel from private sector defense industries to the Department of Defense (DoD). In order to capture surge flows, additional models of military logistics, especially deployment, and military missions are needed to drive the behavior of interest. Basic system dynamics models are being considered to provide this feedback to the basic mechanisms. With this consideration of military mission effectiveness, the models main output decision metric is an estimation of casualties, which presents its own system dynamics modeling challenges.

James R. Burns

jburns@ba.ttu.edu
Texas Tech University
Rawls College of Business Admin
15th and Flint
Lubbock TX 79409-2101 USA

Balaji Janamanchi

bjanamanchi@ba.ttu.edu
Texas Tech University
Rawls College of Business ISQS
Box 42101
Lubbock TX 79409-2101 USA

Offshoring Knowledge Worker Jobs – Boom or Burst for the US Economy

This paper takes a system dynamics perspective of the contemporary trend of "Offshoring Knowledge Worker jobs from USA" to gain a better and deeper understanding of the results and implications of the trend, its impact on the jobs and workforce dynamics. The results not only support the viewpoint of economists that offshoring is beneficial to the economy, but also highlight another impending phenomena just round the corner, namely the slow rate of growth of workforce. Net U.S. workforce growth is slowing because seventy-one million baby boomers are beginning to retire. In this context, model outputs suggest that offshoring is postponing the undesirable state of U.S. jobs outstripping the U.S. workforce by nearly five years. Thereby, policy-makers have longer to find effective solutions to tackle the impending shortage of workforce in decades to follow. The model suggests that offshoring could not have come at a better time for the US economy.

James R. Burns

jburns@ba.ttu.edu
Texas Tech University
Rawls College of Business Admin
15th and Flint
Lubbock TX 79409-2101 USA

Balaji Janamanchi

bjanamanchi@ba.ttu.edu
Texas Tech University
Rawls College of Business ISQS
Box 42101
Lubbock TX 79409-2101 USA

Project Dynamics with Applications to Change Management and Earned Value Tracking

In this paper, we present a novel project management model that incorporates several features yet to be actively addressed in the literature and focuses on earned value management. The model utilizes the basic structures employed in building project dynamics models. The effects of time-varying project team size, of training and communication overload, and of change management are incorporated into our model. With the help of our model and a hypothetical software technology project, we demonstrate how our system dynamics model can contribute beyond basic project tools like MS

Project, in generating the earned value management indicators required by project managers under different scenarios and starting assumptions. Results are consistent with well-known behavior of projects in that the later the changes arrive, the longer is the delay in completing the projects. These phenomena are propagated through the earned value measures to see the actual effects upon schedule and cost performance indices. The study also focuses on the use of earned value measures as well as critical chain concepts to understand how these separately impact project duration and cost.

Lester P. J. Burton

lester.burton@basell.com
Basell USA
912 Appleton Road
Elkton MD 21921 USA

Seetha Coleman-Kammula

seetha.coleman-kammula@basell.com
Basell USA Inc
912 Appleton Road
Elkton MD 21921USA

John Sterman

jsterman@mit.edu
MIT
Sloan School of Management
30 Wadsworth Street E53-351
Cambridge MA 02142 USA

David F. Andersen

david.andersen@albany.edu
University at Albany
315A Milne Hall
135 Western Avenue
Albany NY 12222 USA

George P. Richardson

gpr@albany.edu
University at Albany
Dept of Public Administration &
Policy
Milne 101 Rockefeller College
Albany NY 12222 USA

A System Dynamics Study of a Commodity Plastics Industry

Faced with new challenges in managing the cyclical and volatile business environment, management at a Commodity Plastic (COM-P) Company agreed to apply System Dynamics (SD) to support strategy development. A SD model of COM-P industry was built by adapting the Pulp and Paper Model. The structure of COM-P Index Price creation was mapped and added to the generic model. The following were investigated: a) The effect of current delays in adjusting prices on phantom demand, on capacity utilization and shipment rates; b) The phenomenon of Phantom demand or pre-buying when customers perceive that prices may be about to go up was modeled; c) By applying the model, the amount of margin lost or gained by the industry due to the price protection terms in the contracts was estimated; d) The risk in the top ten long term contracts under different supply and demand conditions and oil prices in order to support the sales organization with their negotiations; e) The model was applied to get guidance on capital investment timing and to assess the effect of different oil prices and supply & demand scenarios on the profitability of new investments. In many cases the results were counter-intuitive.

Carlos Capelo

carlos.capelo@galpenergia.com
ISCTE
Aldeamento Vale Sao Giao
Alameda das Acacias 50
2665-381 Milharado Portugal

João Ferreira Dias

fdias@iscte.pt
ISCTE
CACIFO 238-B
Av Forcas Armadas
1600-083 Lisboa Portugal

Double Learning and Performance Improvement with the Balanced Scorecard – A Simulation-Based Experiment

Kaplan and Norton propose a double-loop process that integrates the concepts of Balanced Scorecard and Strategy Map to support managers to define and implement the firm strategy more effectively. The BSC is a performance management system based on a set of few and critical indicators. These key performance indicators are linked together in a causal diagram that represents the hypotheses about the strategy. This approach supports what Argyris calls double-loop learning which facilitates the strategic learning of managers and leads to better performance. This type of learning produces changes in

manager assumptions about cause-and-effect relationships and leads to a better understanding of the context, what means a process by which managers can explicit and improve their mental models about the business system. This article describes a simulation-based research for testing a system of hypotheses about the influence of the BSC approach on strategic learning and performance, which uses a System Dynamics-based micro world.

Edoardo Cavalieri-D'Oro

edo@ed0.it
LIUC
Via Molino 14
21047 Saronna VA Italy

Michael Golay

golay@mit.edu
MIT
Nuclear Department

Preparing for the Near-Term Deployment of New Nuclear Fission Technologies: A SD Analysis of the Nuclear Market's Behaviours

A method of overall analysis for a compared evaluation of various nuclear fission and fourth generation units is here described. In this paper a series of questions related to the near-term deployment of new nuclear technologies in the US and Worldwide are answered and validated by reproducing the mechanisms that drove the nuclear market to the actual configuration. It is then presented a simplified model of the form often used to project market competition ad hoc configured for the case of the energy production by nuclear power. The reproduced mechanisms of interest as well as the out coming model had been designed following the SD approach since it was considered a most suitable and necessary tool for the research and evaluation of the typical feedback effects, which are characteristic of the destination market. The most outstanding mechanism in terms of importance, uniqueness and significance was undoubtedly the "lock-in effect," also referred to as long-term market domination. According to the lock-in phenomenon, even though a nuclear power plant is less attractive from a technical point of view it can take control of the market by being the first to be installed or by moving faster along its learning curve.

Robert Y. Cavana

bob.cavana@vuw.ac.nz
Victoria University of Wellington
PO Box 600
Wellington
New Zealand

Revisiting Medium Term Macro-economic Scenarios (1985 – 1995) Generated by a System Dynamics Model of the New Zealand Economy

This paper revisits the macro-economic modelling and medium term scenarios undertaken at the New Zealand Planning Council (now disbanded) in the mid 1980's. The following major reports were published: "A Macro-Economic Model and Scenarios to 1995" (by Eric Haywood & Bob Cavana) and "Towards 1995: Patterns of National and Sectoral Development" (by Dennis Rose, Adolf Stroombergen, et al). These reports discussed the development and use of a macro-economic system dynamics model (SDMACRO), used to generate trends for the main macro-economic variables, and a general equilibrium price sensitive sectoral model (JULIANNE), which generated compatible sectoral and national forecasts of a range of variables for each of 22 sectors for nominated years. The (JULIANNE) model used outputs from (SDMACRO) as constraints and inputs. A brief overview of the SDMACRO model and its use at the NZ Planning Council will be presented. Also, the reforms of the New Zealand economy that have taken place since the mid 1980's

will be summarised and a comparison of the SDMACRO scenarios will be provided against what actually happened over the period between 1985 to 1995. Finally, the paper indicates the development that has taken place with the macro-economic model and how it is currently being used.

Liang-Cheng Chang

d9142809@student.nsysu.edu.tw
National Sun Yat-Sen University
70 Lien-hai Rd
Kaohsiung 804
Taiwan ROC

Yi-Ming Tu

ymtu@mis.nsysu.edu.tw
National Sun Yat-Sen University
Dept of Information Management Systems
70 Lian Hai Rd She-Tze Wan
Kaohsiung 804 Taiwan

Attempt to Integrate System Dynamics and UML in Business Process Modeling

The integration of information systems and business process will affect competitive advantages of firms. In order to develop information system, modeling of business process is a fundamental work of system analysis and design. System dynamics is useful to solve non-linear, complex, time delay and feedback problems of business processes. However it still belongs to a special field of modeling language because it can't be integrated well with information systems in organizations. The purpose of this paper is to integrate system dynamics with UML and thus they can be developed synchronously during information systems implementation in enterprise. For this reason, integrated development process and system architecture with system dynamics and UML have also been proposed in this paper.

Jie Chen

chjie_2@hotmail.com
University of Bergen
System Dynamics Group
Fantoft PB 945
5075 Bergen Norway

Modeling Shanghai Real Estate Market

In this paper, I try to grasp the inner significance of abnormally sustaining house price growth, or so-called house market bubble in Shanghai real estate industry by the tool of system dynamics which especially focuses on the systems with highly dynamic characteristics, and complicated feedback relationships involved, which is consistent with the real estate market system. The most fundamental purpose of this project is to see whether it is the speculators' intervention that causes the problem of unsuitable high price in Shanghai house market or not and to see what kind of impacts both on the aspects of society and economic fields will be after the trend of speculation is quenched. This paper mainly divides the system into 6 parts, population and economy sector, family house demand sector, speculators' demand sector, speculators' profitability sector, house price sector, and house construction and sale sector to analyze how these subsystem can directly or indirectly work on the whole real estate industry in Shanghai.

Yibai Chen

chyb@nje.cn
Nanjing AV Educational Center
No 5 Cibeishe
Nanjing 210029 China

Hongbing Zhu
Jinling High School
No 169 Zhongshan Road
Nanjing 210005 China

Pleasantly Surprised in Applying Systems Thinking to Teaching High School Students

The system thinking is a kind of new thinking mode that fostering the creative ability. It already has some successful applied experience abroad, particularly in education. In the chemistry teaching —— especially the calculation of chemical equation of high schools，students are always puzzled by the numerous and complicated superficies of chemical equation and hardly grasp its mathematics essence，which result in bad teaching effect.

Min Jiang

jljiangmin@hotmail.com
Nanjing Jinling High School
No 169 Zhongshan Road
Nanjing Jiangsu 210005 China

Yonggen Yuan
Nanjing Normal University
High School
37 Chahaer Road
Nanjing China

Yu Chen

yierro87@163.com
Nanjing Normal University
High School
37 Chahaer Road
Nanjing China

Yuqin Yao
Nanjing Normal University
High School
37 Chahaer Road
Nanjing China

This dissertation makes some beneficial quests. Aiming at the relevant problem of the calculation of chemical equation, we put up some teaching practice in 5 classes by using the system thinking method and its related software STELLA, such as the teacher's brief introduction to the software, the basic calculation model establishment way and student's activity etc. In this process, students can hold the calculation regulation more effectively. At the same time, the study moving ability between teachers and students also improves dramatically, which leads to the exciting development in other realms.

Research on the Change Process of the Curved Roof of Chinese Ancient Architecture by System Dynamics

As a high school student who really enjoy the world of architecture, I use the Stella software to have a try on explaining the former of the curved roof of Chinese ancient architecture by system dynamics view: the factors we call "structure", "practical", "aesthetic judgment", "economy" affect each other. The trend of the using of the curved roof was increased a lot at first, and then reached a balance eventually; the explanation itself has caused and satisfied my interest of a kind of research. But something more important is that I have cemented an opinion here: in our world, physical and mental (we call it a system), so many social phenomena exist under the control of different basic factors. It's more complicated than we expect most of the time. Luckily the system dynamics view makes us face the complicating world in a deeper, wider sight, and retrace the procedure of its former and change. Then we can make sense of world better. So this kind of try has encouraged me a lot.

Martin Cloutier

cloutier.martin@uqam.ca
University of Quebec at Montreal
Dept Management and Technology
315 Ste-Catherine East
Montreal QC H2X 3X2
Canada

Céline Bérard

berard.celine@courrier.uqam.ca
University of Quebec at Montreal
School of Management

Luc Cassivi

cassivi.luc@uqam.ca
University of Quebec at Montreal
Dept of Management and
Technology
315 Ste Catherine East
Montreal Quebec H2X 3X2
Canada

Diffusion of an Innovative Biotechnology: The Case of Plant-Derived Vaccines using System Dynamics

The possible diffusion of plant-derived vaccine (PDV) biotechnology in developing countries offers an interesting potential substitute to existing more expensive vaccine technology currently available on the market. This paper is concerned with the potential impact that the introduction of such a technology could have on the cost of immunization, and also, more broadly on the incidence of hepatitis B cases on India's population overtime. The objective of the paper is to look at the hypothetical issues of a PDV diffusion using a system dynamics (SD) model. Some illustrative results are presented to show the interaction between infection rates, mortality rates, and immunization costs. In spite of promising features, such as much lower production costs, institutional hurdles to a widespread diffusion of the technology still need to be overcome.

David L. Cooke

dlcooke@ucalgary.ca
University of Calgary
1008 Beverley Blvd SW
Calgary AB T2V 2C5
Canada

Thomas R. Rohleder

tom.rohleder@haskayne.ucalgary.ca
University of Calgary
Haskayne School of Business
2500 University Drive NW
Calgary AB T2N 1N4
Canada

A Conceptual Model of Operational Risk

This paper addresses the question of whether there is a conceptual model that can explain operational risk in a wide range of organizations. It utilizes case studies and other research literature to build on the foundation laid by previous modeling research into system failures. The validity of the model is tested by how well it fits the parameters of operational risk failures and successes in case studies representing a diverse range of situations in manufacturing, mining, financial services and government.

Adolfo Crespo Márquez

adolfo.crespo@esi.us.es
University of Seville
School of Engineering
Camino de los Descubrimientos s/n
41092 Seville
Spain

Front-end, Back-end and Integration Issues in Virtual Supply Chain Dynamics Modeling

In this paper we discuss the way in which dynamic modeling can be used to deal with front-end, back-end and integration issues in current high-tech virtual supply chains (SC). In a first part of the paper we review and propose dynamic modeling options to connect customer value to business targets. This is done by explaining how to characterize target market by formalizing what are often informal but deeply held beliefs about what drives their customers' purchase decisions. We explain how dynamic models may help to connect planned investments to expected improvements in the customer's perception of the product critical attributes and thus increase sales, revenue, and market share. In a second part of the paper we review and discuss the operational and financial effectiveness of existing virtual tools used in supply chain integration. We discuss how dynamic modeling may help to obtain a comprehensive model of supply chain integration. A modeling effort that can be used for the analysis of the effectiveness of various levels of integration. In a third part of the paper we discuss and explain experiences in modeling different types of supplier contracts to accomplish varying degrees of security and flexibility.

Matthew A. Cronin

mcronin@gmu.edu
George Mason University
School of Management
Mail Stop 5F5
Fairfax VA 22030-4444 USA

Cleotilde Gonzalez

conzalez@andrew.cmu.edu
Carnegie Mellon University
Social and Decision Sciences
5000 Forbes Ave Porter Hall 223C
Pittsburgh PA 15213 USA

Understanding the Building Blocks of Dynamic Systems: What Is the Problem, Really?

Previous research has shown that individuals fail to understand the basic building blocks of complex systems such as stocks and flows, feedbacks, and time delays. This paper presents three empirical studies intended to understand why individuals misperceive the relationships between stocks and flows. We used problems that were quite familiar to the participants, interventions to motivate participants to think harder in the problem, simplifications of graphs and direction of attention to specific aspects of the graphs. The results seem to disclose some of the mechanisms that individuals use to make their inferences about the graphs. That is, individuals attend to the most salient features of the graphical representation to make their inferences about the stock in the task. Does this really imply a

misunderstanding of stocks and flows? We believe the further research needs to address this problem in realistic presentations rather than graphical representations.

Didier Cumenal

dcumenal@groupeisc.com
ISC Paris
22 Boulevard du Fort de Vaux
Cedex 17
75848 Paris
France

Simulating Organizational Change: Moving and Shaking

We still know very little about the long-term learning patterns of organizations. Analysis tends to favor the more immediate factors over more distant ones. We focus on synchronic portrayals of the organization while ignoring diachronic representations. The model presented here analyzes changes in the state of the organization over time. It describes and investigates the totality of forces and actions that generate the organization's dynamic. It offers a speeded-up aging of the organization intended to bring out, over time, the counter-intuitive effects of decisions. Moreover, it endeavors to identify the "cost drivers" that contribute to increasing or shrinking the firm's profits. We have used the meta-model that we developed to derive an application model whose purpose is to reproduce the long-term life of an organization. Our simulation speeds up the aging of the organization, enabling us 1) to show the counter-intuitive effects of decisions over the long term versus the short term, and 2) to highlight the cost drivers that generate hidden costs. Through its decisions, the firm gives rise to its own factors of development and decline: its own actions eventually change both the organization's health and its properties.

Parviz Daneshgari

perry@mca.net
3040 Airpark Drive South
Flint MI 48507
USA

Frank Murdock

fmurdock@mca.net
MCA Inc
3040 Airpark Drive South Suite C
Flint MI 48507
USA

Operational Model for Improving System Productivity of Distributors: Internal Cost Drivers

Distribution must make a decision regarding its role in the specialty contracting supply chain. It can continue its historical role as wholesale/retail combination and hope for profitability, or it can choose to manage the channel by providing low cost products and services. Profitability can only come through system productivity. System productivity depends on recognition and elimination of waste in the current operations and can be further improved by operational process innovation. The cost drivers (CDs) of distributors can be impacted by identifying and addressing internal inefficiencies, effects of customer interactions, and the impact of suppliers on price and delivery. By managing the following elements, distributors can improve their bottom line by better than 30%: 1. First-time pass yield of order taking and delivery 2. Identification and reduction of waste 3. Customer point of entry This paper suggests a methodology for improving the system productivity through management of these elements.

Brian C. Dangerfield

b.c.dangerfield@salford.ac.uk
University of Salford
Centre for OR & Applied Statistics
Maxwell Building The Crescent
Salford M5 4WT UK

Towards a Transition to a Knowledge Economy: How System Dynamics is Helping Sarawak Plan its Economic and Social Evolution

Accounts of the real-world use of system dynamics as a policy evaluation tool in macro-economic management are relatively rare. This paper offers an overview of current research being undertaken for the government of the State of Sarawak in E. Malaysia where an SD model is being formulated to inform the State's future economic and social planning to 2020. Although still a work-in-progress, enough has been achieved to enable an interim account of the research to be written. Positive engagement with State government officials at the highest level has put system dynamics on the map in this corner of SE Asia.

Lori Dauelsberg

lorid@lanl.gov
Los Alamos National Laboratory
PO Box 1663 MS K557
Los Alamos NM 87545
USA

Alexander Outkin

outkin@lanl.gov
Los Alamos National Laboratory
MS K575
Los Alamos NM 87544
USA

Modeling Economic Impacts to Critical Infrastructures in a System Dynamics Framework

Our paper presents a model of economic impacts arising from disruptions to critical infrastructures. This model is a component of the Critical Infrastructure Protection Decision Support System (CIP/DSS) which simulates the dynamics of a set of interconnected individual infrastructures. We use factors of production (such as energy, telecommunications, and labor) from the CIP/DSS model to estimate the effects of interruptions to these infrastructures. The system dynamics approach we use is compared to equilibrium-based approaches such as input-output modeling. This method allows an understanding of the economic benefits of various protective measures. We incorporate non-equilibrium dynamics that arise from these disruptions to provide values for various economic impacts such as lost revenues and lost sales. The results from a disruption due to an infectious disease outbreak are presented. We show that the effects of quarantine dominate the overall economic impacts in a number of cases.

Michael A. Deegan

md7875@albany.edu
University at Albany
56F Weis Road
Albany NY 12208
USA

Extreme Event Policy Design: A Conceptual Model to Analyze Policies and the Policy Process for Natural Hazards

Extreme Events are low probability, high consequence events, often resulting in billions of dollars of damage each year in the United States. Natural hazard issues connect experts in the natural science and social science, which complicates the problem for policymakers who may have balance multiple objectives as well as short term and long term goals. The recent devolution revolution trend in government has made its way to natural hazard policy domains. There is more pressure on local communities to create and implement mitigation

plans that will promote long term sustainable development at the local level. The conceptual model for this research project explores the primary mitigation policy alternatives and depicts the "false sense of security" trap, with endogenous explanations, in a stock and flow feedback structure.

Sonja Derrick

sonja.derrick@plymouth.ac.uk
University of Plymouth
Postgraduate Medical Centre
Derriford Hospital
Plymouth PL6 8DH UK

Graham W. Winch

graham.winch@plymouth.ac.uk
University of Plymouth
Plymouth Business School
Drake Circus
Plymouth PL4 8AA UK

Beryl Badger

bbadger@plymouth.ac.uk
University of Plymouth
Plymouth Business School
Drake Circus
Plymouth PL4 8AA UK

Joan Chandler

jchandler@plymouth.ac.uk
University of Plymouth
Faculty of Social Science and
Business
Drake Circus
Plymouth PL4 8AA UK

Evaluating the Impacts of Time-Reduction Legislation on Junior Doctor Training and Service

If junior doctors are to work significantly fewer hours in the future, how can they still receive full training and continue to provide necessary levels of medical service to patients? Historically, excessive hours have been a way of the life for junior doctors worldwide, but New Deal regulations, a revised junior doctor contract, and the EU Working Time Directive are changing this. A project at Derriford Hospital in Plymouth is researching the nature of 'quality and effective training', and constructing SD models to yield insights and eventually support operational decision-making. This has already yielded significant insights for those at Derriford wrestling with this seemingly impossible task, including, the circularity between junior doctor training, consultants' service and their training-supervision role, and the quality of training provided, and the likely importance of recruiting outside the progression process in addressing service imbalances. It also highlights some of the special challenges in projects where there are many stakeholders, political agendas, and a continuously changing environment.

Jenny Lovett

jenny.lovett@phnt.swest.nhs.uk
Plymouth Hospitals NHS Trust
Derriford Hospital
Plymouth PL6 8DH Devon UK

Tim Nokes

tim.nokes@phnt.swest.nhs.uk
Plymouth Hospitals NHS Trust
Derriford Hospital
Plymouth PL6 8DH Devon UK

Rajat Dhawan

r.dhawan@econ.usyd.edu.au
University of Sydney
2/68 Duke Street
Campsie NSW 2194
Australia

Usefulness of Probabilistic System Dynamics in Dynamic Decision Making

Most dynamic decision making tasks include assumptions which have a huge uncertainty attached to them. Organizations are inherently complex. The combination of uncertainty and complexity results often in a sub-optimal decision. This paper emphasises on the usage of probabilistic system dynamics (SD). The focus of probabilistic SD is to represent the behaviour of uncertain variables in a realistic manner. The information generated by probabilistic SD could produce "complete" information thereby improving the mental models of decision makers. Many SD models use deterministic values of variables. However, "determinism" is untrue for real business settings. In order to test the effectiveness of probabilistic SD on managerial decision making, this study aims at conducting a series of rigorous and controlled experiments. Specifically it tests the usefulness of (1) system dynamics itself, (2) model validation techniques and (3)

probabilistic system dynamics on decision-making. Furthermore, these experiments are conducted in two settings – (1) using a simple model and (2) using a complex model. It is hoped that probabilistic SD would be instrumental in producing relevant information that would help in improving managers' mental models, especially in complex scenarios. This in turn will result in better decisions under uncertainty in complex business environments.

Vedat G. Diker

diker@glue.umd.edu
University of Maryland
College of Information Studies
4105 Hornbake Building
College Park MD 20742
USA

Robert B. Allen

bob.allen@cis.drexel.edu
Drexel University
College of Information Sci & Tech
3141 Chestnut Street
Philadelphia PA 19104-2875
USA

It's About Time: The Why and How of Using XML for Developing an Interchange Standard for System Dynamics Models

This paper discusses the benefits of having an interchange standard for system dynamics models, why XML is a good candidate on which to build such as standard, and how the development process may take place through community-wide participation. The paper also presents XMILE, a prototype model interchange standard, as a proof of the concept.

Gökhan Dogan

gdogan@mit.edu
MIT
30 Wadsworth Street
Building E53 Room 364
Cambridge MA 02139
USA

John Sterman

jsterman@mit.edu
MIT
Sloan School of Management
30 Wadsworth Street E53-351
Cambridge MA 02142
USA

When Less Leads to More: Phantom Ordering in the Beer Game?

We analyze experimental data from the Beer Game in which the customer orders are constant (4 cases/week) and all the subjects are informed about this fact before the game starts. Even though the experimental settings disfavor oscillation and amplification, we still observe them. To analyze the decisions made by the subjects, we first estimate the decision rule used by Sterman (1989). This analysis suggests that typically subjects do not understand the time delays and the stock and flow structure of the Beer Game. Next, we relax some assumptions of this decision rule and use more sophisticated alternatives. These alternative decision rules do not yield overall improvement in terms of fit to the real data. However, for some subjects, these decision rules lead to significant improvement. Our analysis reveals strong evidence that these subjects were caught up in a reinforcing phantom ordering loop even though the experimental conditions strongly disfavor such behavior.

Richard G. Dudley

rgd6@cornell.edu
c/o PMB 239
14845 SW Murray Scholls Dr Ste 110
Beaverton OR 97007-9237
USA

A Generic Look at Payments for Environmental Services: Plan or Scam?

Sustainable use of a natural resource ensures that the ecosystem associated with that use will also provide long term environmental services to society. Such services might include the provision of clean water, removal of excess CO_2 from the atmosphere, flood protection, pleasant vistas, or enhanced biodiversity. These benefits are becoming less abundant as inappropriate resource uses hasten environmental degradation. In theory, if beneficiaries pay for the environmental services received, and these payments are given to the resource

users/owners to reward, or encourage, sustainable resource use, then such sustainable use will be assured. Schemes to implement such arrangements might be able to support conservation programs, and also supplement income of poor farmers and forest dwellers. Such payments are also seen as a means of encouraging better management of carbon dioxide in our atmosphere, by paying for forest practices which can store CO_2. How do such systems actually work? Can payments for environmental services encourage better resource management? Might they also create disincentives for management based on ethics, altruism, and stewardship? A generic system dynamics model was used to examine these questions.

Jim Duggan

jim.duggan@nuigalway.ie
National University of Ireland
Galway
Department of Information
Technology
University Road
Galway Ireland

Using Multiple Objective Optimisation to Generate Policy Insights for System Dynamics Models

Multiple objective optimisation (MOO) is an optimisation approach that has been widely used to solve optimisation problems with more than one objective function. The benefit of this approach is that it generates a set of non-dominated solutions which a policy maker can explore and evaluate before making a final optimal selection. This paper demonstrates that MOO can be used to assist policy makers explore a richer set of alternatives when deciding on a range of values for key parameters in their system dynamics model. In order to demonstrate the approach, a well-known case study – The Domestic Manufacturing Company – is used, and a stock and flow model and a multiple objective optimiser are designed and coded. The results show that valid solutions are generated, and that each of these solutions can be examined independently – and hence give greater insight into the problem at hand - before a decision is made as to the most appropriate solution.

Josko Dvornik

josko@pfst.hr
University of Split
Gospinica 10
21000 Split Croatia

Ante M. Munitic

amunitic@pfst.hr
University of Split
Maritime Faculty
Zrinjsko-Frankopanska 38
21000 Split Croatia

Frane Mitrovic

SD Simulation Modelling of Organisational Business System of Management of Material & Informational Flows in Productive Company

System Dynamics simulation models of organizational business system of management of material (raw-materials, orders, money, labor, personnel, population, capital equipment: tools, units and factories e.t.c.) and informational flows in productive company will be presented in this paper. Organizational business-production system is simulated by effective scientific discipline System Dynamic and realized by Dynamo (PD4) and PowerSim program packages, also. Due to complexity and extensiveness of business management of organizational business process or production-distribution system global simulation models of companies are presented on the modular way, i.e. with seven relevant sub systems: 1. Production-inventory sub system; 2. Credits sub system; 3. Debits sub system; 4. Sub system of productive capacities; 5. Sub system of Cash-Flow; 6. Gross income-net income sub system; 7. Sub system of demand for organization products, which are common structural characteristic in every productive business organization. These sub system are modelled

according to its specific quality. The paper is conceived as follows: sub systems of business production organization, entire model of productive organization system and its simulation, conclusion and used references.

Isaac Dyner

idyner@unalmed.edu.co
Universidad Nacional de Colombia
Institute of Systems and
Decision Sci
Carrera 80 #65-223 Bloque M8
AA 1027 Medellin Colombia

Energy Contribution to Sustainable Rural Livelihoods in Developing Countries: A System Dynamics Approach

Access to energy, particularly through clean and modern technology, can make substantial contributions to promote rural development in the poor areas of developing countries. However, the relationship between energy, poverty alleviation and sustainable development is still unclear. Additionally, while improving access to energy is required for development, the way that this has been supplied has not always warranted a sustained livelihood in rural areas. With the purpose of gaining a better understanding of the relation between energy and development, the current research "Renewable Energy for Sustainable Livelihoods-RESURL", aims to assess and measure the factors that contribute or hinder the development of efficient, viable and appropriate access to energy provision in remote rural areas by using a multidisciplinary and participative perspective. A System Dynamics model is constructed to evaluate the contribution of energy to rural livelihoods. SD modeling facilitates understanding feedback and control processes, as well as delays in decision making. Simulations show how isolated communities in conditions of poverty could attain a satisfactory level of human, social, physical and financial development by making sustainable use of their natural resources through energy technologies. The study draws on the sustainable livelihoods approach as a framework for assessing community assets and capacities.

William Edgar

edgar_william@bah.com
Booz Allen Hamilton
8283 Greensboro Drive
Allen 881
McLean VA 22102
USA

C. Lance Durham

durham_lance@bah.com
Booz Allen Hamilton
8283 Greensboro Dr
Allen #887
McLean VA 22102
USA

Aparna Higgins

higgins_aparna@bah.com
Booz Allen Hamilton
6010 Executive Blvd
Rockville MD 20850
USA

The AIDS Epidemic: Integrating System Dynamics and Gaming for Strategic Simulation

The rapid spread of HIV/AIDS is a global crisis – one that is particularly devastating to the economies of nations where the disease is most prevalent. Booz Allen Hamilton, in conjunction with the Global Business Coalition on HIV/AIDS (GBC) and the Confederation of Indian Industry (CII), developed an innovative approach for The AIDS Epidemic in India: A Strategic Simulation. Their approach captures the complex interdependencies that drive the HIV/AIDS epidemic and its economic consequences. At the core of this strategic simulation is an analytic framework that leverages epidemiological and economic System Dynamics modeling, partnerships with leading academic centers, and simulation-driven gaming.

Marie Elf

marie.elf@ltdalarna.se
Center for Clinical Research Dalarna
Nissersväg 3
791 82 Falun
Sweden

Maria Poutilova
IT University

The Care Planning Process – A Case for System Dynamics

Health care is a complex dynamic setting suitable for system dynamics analyses. The method has the potential to be an important quality improvement tool in the near future. However, it will be necessary to develop the models beyond the pure production model focus on the clinical care process from a patent perspective and in doing so it is inevitable that variables such as health, communication and care planning are involved. Consequently, useful and valid models for modern health care must involve variables that are unfairly designated as intangible. The present paper describes an exploratory system dynamics model of the care planning process. It draws on a range of studies and theories about the process. The paper discusses how it could be possible to incorporate and validate variables alongside the more traditional way.

R. Evan Ellis

ellis_evan@bah.com
Booz Allen Hamilton Inc
742 Allen Building
8283 Greensboro Drive
McLean VA 22102 USA

Paramilitary Demobilization in Colombia – Insights from a System-Dynamics Based Seminar Game

This paper presents insights from an interactive seminar game using system dynamics to help the U.S. Latin American policy community explore issues associated with the process of paramilitary demobilization in Colombia. The game used system dynamics to represent the strategic interactions of the key actors in the Colombian paramilitary peace process, including their pursuit of both competing and complimentary goals. The process leveraged the gaming mode and rapid causal tracing capabilities of the Vensim™ system dynamics software to generate an interactive event in which players generated a rich set of strategic interactions in a hands-on learning environment. The success of the event suggests a promising new approach for leveraging the power of systems thinking and system dynamics software in policymaking and learning environments.

Philip C. Emmi

emmi@arch.utah.edu
University of Utah
College of Architecture and Planning
375 South 1530 East
Room 235 AAC
Salt Lake City UT 84112-0370
USA

Craig Forster
forster@arch.utah.edu
University of Utah
College of Architecture and Planning
135 South 1460
East Rm 719
Salt Lake City UT 84112-0111
USA

Insights into the Dynamics of a Carbon-Based Metropolis

This paper offers insights into the dynamics of carbon emissions in metropolitan regions. These emerge from a system dynamics model of urban land-atmospheric interactions. The paper provides contextual background, outlines modeling methodology, inventories insights and documents policy implications. Section One considers climate change, worldwide urbanization, urban CO_2 emissions and urban land-use/transportation dynamics. Section Two identifies the study area, the modeling tool, its dynamic organizing principle, its structure and the scenarios used to explore system behavior. Section Three considers urban CO_2 emissions and the mitigating effects of land-use and transportation policies. It compares these to practicable improvements in fossil fuel combustion efficiencies and finds that

James I. Mills

jimills@onewest.net
University of Utah
311 N Placer
Idaho Falls ID 83402 USA

modifying urban form compare favorably to improving combustion efficiencies. Section Four asserts that, given today's global-scale inter-metropolitan economic competition, today's urban challenge will be largely met by cooperation at the metro-regional scale to tame the dynamics of carbon-based metropoli.

Mary Ewers

mewers@unm.edu
University of New Mexico
MSC 05 3060
1 University of New Mexico
Albuquerque NM 87131
USA

Combining Hydrology and Economics in a Systems Dynamics Approach: Modeling Water Resources for the San Juan Basin

Water supply is a hydrologic phenomenon, whereas water demand is largely driven by human wants and needs. The combination of these two systems, hydrology and economics, is necessary for accurate modeling of our water resources. Moreover, in times of drought or water scarcity it is the human behavioral component that will determine whether a region's water supply can be sustained. The stakeholders of the San Juan Basin are many and varied, from Indian tribes, agriculture interests, and municipalities, to recreational fisherman, power generators and conservationists. Stakeholders must make policy decisions regarding shortage sharing in times of drought to ensure their water supplies are sustainable. We develop a system dynamics simulation model for the San Juan Basin watershed (located in the states of New Mexico and Colorado). The model can be used to quantify shortage-sharing amounts needed for sustainability of water supplies. Hydrology drives the water supply while economics drives the water demand.

David R. Exelby

dave.exelby@hvr-csl.co.uk
HVR Consulting Services Ltd
Selborne House Mill Lane
Alton Hampshire GU34 2QJ
UK

John Holt

john.holt@hvr-csl.co.uk
HVR Consulting Services Ltd
Selborne House Mill Lane
Alton Hampshire GU34 2QJ
UK

Sion Cave

sion.cave@hvr-csl.co.uk
HVR Consulting Services Ltd
Selborne House Mill Lane
Alton Hampshire GU34 2QJ
UK

Systems Modeling of Lancashire Drug Intervention Programme (DIP)

In the UK, drug misuse gives rise to between £10 billion and £18 billion a year in social and economic costs, 99% of which are accounted for by problematic drug users. There are strong links between problematic drug use and crime. The Drug Interventions Programme (DIP) is a critical part of the Government's strategy for tackling drugs. The implementation of the UK Drug Intervention Programme poses a number of challenges. This includes providing a through-life approach to drug user treatment management. This must take place within a multi-agency system some of which have been newly formed. This paper discusses a study working with one such coordinating body – Lancashire Drug Action Team (DAT) in its Drug Intervention Programme (DIP) strategy. Initial work has focused on Aftercare Services in the Burnley area. A systems modelling approach using System Dynamics has been adopted.

Laércio Ferracioli

laercio@npd.ufes.br
Federal University of Espírito Santo
ModeLab/Departamento de Física
Campus de Goiabeiras
29060-900 Vitória ES Brazil

System Dynamics and Science Education: A Curricular Innovation Experience

Current technological advance has raised a wide debate over its integration to the educational context. Under this perspective it becomes necessary to delineate an investigation about its effective

Mara Mulinari
hombremulinari@yahoo.com.br
Federal University of Espírito Santo
Departamento de Física
Av. Fernando Ferrari s/n
29.060-900 Vitória ES
Brazil

Mariana Rampinelli
mariana@modelab.ufes.br
Federal University of Espírito Santo
Departamento de Física
Campus de Goiabeiras
29.060-900 Vitória ES
Brazil

usage in the classroom. This work reports on the experience of using system dynamics as framework for infusing new technologies in the Information, Science and Technology in Science Education subject, taught to students of the Physics and Biological Sciences graduation classes. The results disclosed differences in the two students groups, both in the development of models and in the educational modules structuring, proposing new directives to attend each group specifically.

Michael Fletcher
mefletcher@gmail.com
9007 Meadow Heights Road
Randallstown MD 21133
USA

The Dynamics of Analytic Collaboration

Abstract: This paper examines the nature and effects of collaboration using a System Dynamics Model. The goal of the model was to place collaboration into a System Dynamics operational construct using stocks and flows in order to examine its workings. Using simple representations of two analysts attempting to learn from a dynamic document set, questions regarding collaboration, skill, learning and the effects of rapidity of change within the document set are examined. Findings indicate a knowledge-based rationale for collaboration during periods of increased operational tempo. However, there also appear to be knowledge-based reasons not to collaborate under certain conditions. The knowledge-based rationale is mirrored by the behavior of real social systems.

Christian Flury
christian.flury@flury-giuliani.ethz.ch
Flury & Giuliani GmbH
Sonneggstrasse 33
CH-8092 Zurich Switzerland

Gabriele Mack
gabriele.mack@fat.admin.ch
Swiss Federal Research Station
Agricultural Economics &
Engineering
8356 Ettenhausen
Switzerland

Birgit Kopainsky
birgit.kopainsky@iaw.agrl.ethz.ch
Swiss Federal Institute of
Technology
Agricultural Economics SOL F10
Sonneggstrasse 33
CH-8092 Zürich
Switzerland

A Composite Optimisation-Simulation Model for the Analysis of the Dynamic Interactions in the Swiss Milk and Meat Market

By 2011 Switzerland aims to liberalise the milk market which will result in market changes in the basic conditions for agriculture. The impacts of the liberalisation are investigated with a composite model obtained by combining an optimisation model for the agricultural sector and a dynamic simulation model for the milk and meat market. The calculations with the composite model indicate that milk price depends strongly on the phasing out of market support, while the abolition of milk quotas in 2009 is less decisive. An introduction of a dairy cow premium leads to a higher milk production, especially with abolished milk quotas. In this case the European milk price level represents the lower limit for the milk price in Switzerland. Compared to the milk market, with falling quantities meat prices are likely to exhibit a stable development.

Hilary Flynn

hhflynn@wsu.edu
Washington State University
ESRP
PO Box 644430
Pullman WA 99164-4430 USA

Andrew Ford

forda@mail.wsu.edu
Washington State University
Environmental Science
PO Box 644430
Pullman WA 99164-4430 USA

A System Dynamics Study of Carbon Cycling and Electricity Generation from Energy Crops

The Climate Stewardship Act, a global warming mitigation policy calling for a cap-and-trade program, was reintroduced in the United States Senate this year. The Energy Information Administration analyzed the implications of the bill and found that under such a policy renewable energy will increase, with the strongest response coming from biomass energy. Dedicated energy crops are one source of biomass that is expected to contribute significantly to the future biomass energy supply. This paper describes a system dynamics model of the carbon impacts from a dedicated energy crop. The work relies on another carbon accounting model, GORCAM, which uses spreadsheet modeling to investigate various land management regimes. We were able to reproduce the GORCAM results for a 20-year harvest rotation; we then simulated several different harvesting intervals to gain insight into the carbon impacts of these rotations. Our results show that a shorter harvest rotation will remove more carbon from the atmosphere if the biomass is used to replace a fossil-fuel burning power plant compared with no-harvest or longer harvest scenarios. These results agree with previous work that found long-term benefits were greater for scenarios where trees were planted for energy generation rather than specifically for carbon sequestration.

Jonah Fogel

jfogel@utk.edu
University of Tennessee
274 Ellington Hall
Knoxville TN 37996
USA

Learning to See a Brighter Future for Morgan County, TN

There is a critical need to develop land planning processes that can build the capacities of local communities to address stewardship and sustainability at both the individual and collective/landscape scales. Social learning has been advocated as a process by which to build the capacity of local communities to address these issues. This paper outlines a social learning process currently being conducted to collectively develop a common mental model (or schema) of local landscape change among private forest landowners of Morgan County, Tennessee. By seeking a shared schema of landscape change landowners will elucidate and engage hidden assumptions that guide their land use decisions. This learning process is expected to increase community capacity by giving landowners a common understanding from which to make and/or support more sustainable land use decisions. The effectiveness of the social learning process is evaluated using individual cognitive mapping in a pre/post test quasi-experimental research design.

David N. Ford

davidford@tamu.edu
Texas A&M University
Department of Civil Engineering
College Station TX 77843-3136
USA

Tim Taylor

xftu@tamu.edu
Texas A&M University
Department of Civil Engineering
College Station TX 77743-3136
USA

Scott T. Johnson

johnsost@bp.com
BP
501 WestLake Park Blvd
MC 21.128
Houston TX 77253
USA

Why Good Projects Go Bad: Managing Development Projects Near Tipping Points

Previous system dynamics work models the tipping of a series of product development projects into fire-fighting mode in which rework overwhelms progress. Similar dynamics also threaten the performance of individual development projects. The current work extends previous tipping point dynamics research to single projects and demonstrates how a simple, common feed back structure can cause complex tipping point dynamics, trap projects in deteriorating modes of behavior, and cause projects to fail. Basic tipping point dynamics in single projects are described, analyzed, and demonstrated with the model. Researchers recommend dynamic resource allocation policies to improve project performance threatened by tipping point dynamics. This existing work and the potential robustness of adaptive policies suggest that dynamic resource allocation policies can protect projects tipping point-based failure. But this hypothesis has not been tested for specific policies. We test several strategies for managing projects near tipping points, including dynamic resource allocation. The effectiveness of dynamic resource allocation as protection against project failure are modeled and described. Implications for project management practice and future research opportunities are discussed.

Travis Read Franck

travler@mit.edu
MIT
130 B Oxford St
Cambridge MA 02140
USA

Quantifying the Cost Uncertainty of Climate Stabilization Policies

Climate change researchers are often asked to evaluate potential economic effects of climate stabilization policies. This paper examines what impact modelers' assumptions have on a model's results. Specifically, MIT's Emissions Prediction and Policy Analysis (EPPA) model is examined to understand how uncertainty in input parameters affect economic predictions of long-term climate stabilization policies. Eleven difference categories of parameters were varied in a Monte Carlo simulation to understand their effect on two different climate stabilization policies. The Monte Carlo simulation results show that the structure of stabilization policy regulations has regional welfare effects. Carbon permits allocated by a tax-based emissions path favored energy importers with developed economies (e.g., the US and the EU). Countries with energy-intensive economies (e.g., China) will likely have negative welfare changes because of strict carbon policy constraints. Oil exporters (e.g., the Middle East) will also be negatively impacted because of terms of trade fluxes. These insights have implications for stabilization policy design. The uncertainty surrounding economic projections exposes some countries to larger economic risks. Policies could be designed to share risks by implementing different permit allocation methods. Direct payments are another means to compensate countries disproportionately disadvantaged by a stabilization policy.

Douglas Franco

dfranco@cantv.net
CANTV
Res Pza Real Ap D32 Ave Autocine
La Boyera Caracas 1083
Venezuela

Insurance Dynamics: Managing Information Flows

Insurance Companies sell information to clients, written in contracts called policies. Clients buy those contracts by paying a premium. Those contracts are promises to pay for possible future casualties. Thus, it is essential to manage information flows to improve profits and stability. Loss Ratio LR, claims cost to premiums ratio, is a key profitability factor, used for management and underwriting decisions with the help of different actuarial models. However, the fragmented visions provided by those actuarial models, mislead decisions and deteriorate performance. This paper integrates basic insurance statistics into a comprehensive SD model, to price insurance coverage. The emphasis is stressed on modeling rather than on policy design, so experience can be used elsewhere; however, tampering and major deteriorating loops are analyzed. Policy design complement policy underwriting.

Meg Fryling

mfryling@uamail.albany.edu
University at Albany
MSC 100
1400 Washington Ave
Albany NY 12222 USA

ERP Implementation Dynamics

ERP projects are often undertaken by project managers in an effort to solve a problem, increase efficiency, and/or provide a higher level of customer service. Although ERP systems can provide all of these benefits and more, they can also cause havoc in an organization if not managed correctly. There are far too many horror stories about organizations failed ERP initiatives. In fact, the success rate of ERP implementations is only around 33% and approximately 90% of ERP implementations are late or over budget. ERP implementation articles consistently report that implementation failure or success is people-related. It's often easier to blame the technology then to explore these deeper issues but in the end they are the controlling factors. It is important for managers to understand the complexities of the people-related issues, relationships and office politics before embarking on a new ERP project. This research is intended to provide insight regarding ERP implementation dynamics through modeling; to build and explore theories regarding what causes ERP success/failure and ultimately aid project managers in avoiding common pitfalls.

Rosanna Garcia

r.garcia@neu.edu
Northeastern University
202 Hayden Hall
Boston MA 02115
USA

Anand Nair

nairana@auburn.edu
Auburn University
418 Lowder Business Building
Auburn AL 36849-5247
USA

Allocation of Resources in Exploration and Exploitation of Technologies: Re-evaluation Using an Adaptive Agent Application

Technologically oriented firms must allocate resources between exploration (research) and exploitation (development) activities. March (1991) proposes that the ecology of competition will directly influence the degree of emphasis on exploration and exploitation activities by organizations; the greater the competition, the greater the need to emphasize exploration activities. Exploratory case studies and real market data indicate that this is seldom true. This study examines this issue by adopting a two-pronged approach. First, a game-theoretic model is used to gain insights regarding the optimal strategies for

firms. Second, the intuition from game theoretic analysis is enhanced and validated using complex adaptive systems approach. An agent based model is used to simulate the complex market place where competitors R&D strategies directly affect the focal firm's R&D strategy outcomes. The authors find that organizational adaptation to dynamic environments significantly impacts the firm's performance over time.

Zhou Ge
sudagezhou@sina.com
Nanjing Foreign Language School
30 East Beijing Road
Nanjing
China

Yonggen Yuan
Nanjing Normal University
High School
37 Chahaer Road
Nanjing
China

Systematic Dynamics Thinking in Innovative Teaching

There are two parts.The first,Systematic dynamics and students innovational activities.The second ,Systems dynamics selective breeding physics theory study. Student's achievement indicated that, with the system pondered instructs student's innovation, may sharpen student's innovation ability, causes the student to experience the innovation pleasure, raises students' innovation spirit.

Nicholas C. Georgantzas
georgantzas@fordham.edu
Fordham University Business Schools
113 W 60th Street Suite LL 617-D
New York NY 10023-7484
USA

Disruptive Innovation Diffusion

An exploratory system dynamics (SD) model presents disruptive innovation diffusion as a replicable process that can spawn business growth for d, Inc., a company that offers an over the air digital subscription TV service. Building on diffusion processes in epidemiology, marketing and sociology, the eight-sector SD model shows customer switching in the high-and low-end and non-consumption markets that disruptive innovators exploit. As extreme-condition scenarios test its robustness, the model shows performance results for the multiple market penetration and defense tactics that disrupter and incumbent firms execute through time. In a relentless hunt for superior performance and a sea of external-change triggers and internal-change levers, d, Inc. takes on cable operators who overlook low-end markets and devote their attention to and invest in higher-end tiers, their service tailored to more demanding customers. But low-end markets cannot absorb sustaining innovations that exceed what non-consumers need or know how to exploit. The results show that despite the high environmental turbulence, market risk and uncertainty facing d, Inc., being in a market that blends its commercial and technological competence with discontinuity and instability transients suggests ample opportunity for sustainable disruptive growth, even if markets contract.

Mila Getmansky
msherman@som.umass.edu
University of Massachusetts Amherst
121 Presidents Drive 308C
Amherst MA 01003
USA

Limits of Arbitrage: Understanding How Hedge Funds Fail

Even if arbitrage opportunities are found in a statistical sense, they might not be exploitable due to unexpected widening of spreads. This paper models such a case in the framework of a hedge fund. Specifically, Long Term Capital Management is presented as a case

study. In particular, we calculate the likelihood of hedge fund failure and survival given different statistical arbitrage opportunities and hedge fund risk management decisions. Dynamic relationships between a hedge fund, dealer, and market (investor) are modeled.

Elias Goncalves

eliasgoncalves@gmail.com
Federal University of Espírito Santo
Rua Presidente Lima 685
Centro Vila Velha ES 29100-330
Brazil

Laércio Ferracioli

laercio@npd.ufes.br
Federal University of Espírito Santo
ModeLab/Departamento de Física
Campus de Goiabeiras
29060-900 Vitória ES
Brazil

An Exploratory Study of the Use of System Dynamics with High School Students

This paper presents results of the investigation on the use of Quantitative Computer Modelling environment into the exploratory learning of specific contents of Science. The results presented refer to the study of the interaction and performance of high school students, during the use of the quantitative computer modelling environment based on the Iconic Metaphor STELLA for developing basic causal framework activities, that is, causal framework without feedback loop, causal framework with either positive and negative feedback loop, and a fourth activity about cooling water. The data analysed with the use of Systemic Network, suggested the students were able to develop the proposed models, identifying all types of causal framework of the problem-situations proposed, and of the cooling water phenomenon.

Paulo Gonçalves

paulog@miami.edu
University of Miami
KE 404
Coral Gables FL 33124
USA

John Sterman

jsterman@mit.edu
MIT
Sloan School of Management
30 Wadsworth Street E53-351
Cambridge MA 02142
USA

Overordering Games in Supply Chains

When demand exceeds supply, customers often hedge against shortages by placing multiple orders with multiple suppliers. The resulting demand bubbles creates instability leading to excess capacity, excess inventory, low capacity utilization, and financial and reputation losses for suppliers and customers. This research contributes to the understanding of phantom demand caused by shortages by developing a formal model of the relationship between a single supplier and multiple retailers. The research combines simulation and game theory to explore equilibrium strategies that arise as a result of a dynamic game. When retailers must commit to a single strategy in a static retailer game, our analyses suggest that a prisoner's dilemma arises if appropriate incentives are not in place, allowing retailers to reach equilibrium with an aggressive ordering strategy (inflating their orders and later canceling them) even though a conservative ordering strategy (ordering just what they need) is mutually more profitable. The conservative strategy dominates the aggressive one when sufficient incentives are in place. In addition, we investigate a number of strategies (e.g. tit-for-tat, severe punishment, etc.) for retailers in an infinitely repeated game and we explore the static and dynamic games for the supplier-retailer interactions.

Alan K. Graham

alan.graham@paconsulting.com
PA Consulting Group Inc
One Memorial Drive
Cambridge MA 02142
USA

Achieving Win-Win in a Regulatory Dispute: Managing 3G Competition

Hutchison Telecom Hong Kong had a problem. The telecoms Regulator, OFTA, wanted to take away some of its spectrum and use it to add yet another competitor into this already highly-competed market. Hutchison perceived that the proposed action would not only

Jeremy Godfrey

jeremy.godfrey@paconsulting.com
PA Consulting Group
20F St George's Bldg
No 2 Ice House St
Hong Kong

be unfavourable for Hutchison, but also for the consumer. But this view hadn't been accepted by the Regulator, when expressed in the form of traditional regulatory arguments. This case study describes how Hutchison commissioned and used a System Dynamics simulator of the Hong Kong wireless markets (2G and 3G, voice and data) to rigorously and transparently quantify the situation. The simulator used 1) interviews with many experts and stakeholders, including the regulator, 2) confidential company data, appropriately protected, 3) judicious calibration against 2G history and 3G plans, 4) optimization of 3G competitor's pricing and investment strategies to "game out" future market evolution, under different regulatory decisions. Sensitivity testing showed that the remaining uncertainties did not alter the fundamental results: The regulator's proposed action would not benefit the public. After due consideration, OFTA dropped its plans and will not bring in more 3G carriers. Both Hutchison and OFTA have done well for their respective stakeholders.

Stefan Grösser

stefan.groesser@web.de
University of Bergen
Fantoftvegen 14 PO Box 506
5075 Bergen
Norway

Does Experience or an Education in System Dynamics Help People to Solve Simple, Dynamic Problems? – A Laboratory Experiment

The Methodology of System Dynamics claims to promote understanding of complex systems. Accepting this claim, the question 'Does experience or an education in System Dynamics help people to solve simple, dynamic problems?' arises. It guides the conduction of our experiment. The first hypothesis about no influence of additional information for problem solving has to be accepted. The performances of two different information treatment groups are not significantly different. Our second hypothesis, that people with and without experience in System Dynamics will have the same performance, has to be rejected. A significant difference between the performances of experienced people and people with no or little experience exists. A possible reason for this circumstance is that an education in System Dynamics doesn't immediately, but over a longer time horizon, enables people to comprehend dynamic systems. At last, the experimental design will be discussed and several weaknesses will be pointed out. Keywords: Experiment, Applicability of System Dynamics, Hypothesis Testing, Dynamic Problem, Education, Comprehension.

Stefan Grösser

stefan.groesser@web.de
University of Bergen
Fantoftvegen 14 PO Box 506
5075 Bergen
Norway

Modeling the Health Insurance System of Germany: A System Dynamics Approach

The German Health Insurance System is balanced on the edge. Decision makers seem not successful in developing and implementing sustainable health policies, which ensure at least a balanced health insurance fund. Highly dynamic factors influence the health insurance fund situation and complicate the decision making. The System Dynamics Methodology is used to examine first possible causes of the enduring problem. In the formal simulation model, we include among other variables the population dynamics, personal income,

contribution fraction and health expenses per capita as well as behavioral states of the agents. Second, the model is used to conduct simulation-based policy testing to find improved decision rules. The policy 'expenses reduction pressure' forces the government to reduce health insurance ex-penses per request. It can improve the health insurance system situation best. The result will be a reduction of the health insurance fund shortfall. Other policies worsen the problem significantly due to increased oscillatory tendency in the health insurance system. As result of the study, the different policies are discussed separately. Keywords: Soft System Dynamics, German Health Insurance, Sustainable Policy, Co-Payment Policy.

Andreas Größler

agroe@is.bwl.uni-mannheim.de
Mannheim University
Industrieseminar Schloss
D-68131 Mannheim
Germany

An Exploratory System Dynamics Model of Strategic Manufacturing Capabilities

This paper investigates the dynamics of accumulation processes of strategic capabilities in manufacturing, i.e. cost, quality, time orientation and flexibility. The analysis is conducted with the help of an exploratory system dynamics model that represents a hierarchy of these accumulative capabilities. By applying a dynamic view, concepts from the operations management literature are tested and shortcomings are identified. In a further step, the exploratory model is parameterized with empirical data from a large international survey of manufacturing plants. Implications concern the distribution of managerial attention on the different capabilities and its dynamic consequences. The value of this paper lies in the insights gained by the transformation of a verbal model in a quantified simulation model and the learning resulting from simulation experiments

Burak Güneralp

guneralp@uiuc.edu
Univ of Illinois at Urbana-Champaign
1102 S Goodwin Avenue
W-515 Turner Hall
Urbana IL 61801 USA

Towards Coherent Loop Dominance Analysis: Progress in Eigenvalue Elasticity Analysis

Formal model analysis tools are essential elements in understanding how structure drives behavior. Conventional model analysis relies heavily on a time-consuming experimental iterative process. Current formal tools are not mature enough for application to most models. This paper presents a loop dominance analysis approach based on eigenvalue elasticity analysis (EEA). EEA, although a potentially strong formal model analysis tool, has drawn criticisms over the years for a number of reasons. The approach proposed in this study attempts to bring proper solutions to the issues raised by those criticisms. To this end, a ten-step procedure is proposed. Among the most prominent features of the proposed procedure is the ability to track the influences of feedback loops on a specific variable of interest. Others include the ability to track the loop dominance dynamics over time and an attempt to the codification of the proposed features of the EEA. The application of the proposed approach is demonstrated using a simple economic long wave model and two other models, all chosen from earlier methodological studies on formal loop dominance analysis. The results of these applications also facilitate the comparison of the proposed approach to other formal model analysis tools.

Hördur V. Haraldsson

hordur.haraldsson@chemeng.lth.se
Lund University
Department of Chemical Engineering
PO Box 124
22100 Lund Sweden

Rannveig Ólafsdóttir
Lund University
Department of Physical Geography
Solvegatan13
SE 223 52 Lund Sweden

A Modelling Approach for Evaluating the Pre-Industrial Natural Carrying Capacity of the Human Population in Iceland

A simple approach was used to evaluate the potential human population that the pre-industrial Icelandic environment could sustain. A model was constructed that simulated the population size according to potential biological production available for livestock. Biological production was determined by the extent of the total poten-tial vegetation cover based on the Degree-day concept. Fluctuations in the mean an-nual temperature cause changes in the potential vegetation cover and as a conse-quence change the biological production sustaining livestock and ultimately human population. The simulation's results indicate that the potential population that the environment could sustain during the pre-industrial period fluctuated around 40-80 thousand. The results further indicate that the severe land degradation experienced after the settlement period had a marginal impact on the population size. The pre-historical population did however overshoot the natural sustainability on few occa-sions.

Hördur V. Haraldsson

hordur.haraldsson@chemeng.lth.se
Lund University
Department of Chemical Engineering
PO Box 124
22100 Lund Sweden

Harald Sverdrup
harald.sverdrup@chemeng.lth.se
Lund University
Dept of Chemical Engineering Box 124
221 00 Lund Sweden

Making Art into a Science: Adaptive Learning Behaviour and Managing Group Modelling Innovation Processes

The use of System Dynamic software tools are becoming a popular way of investigating complex problems. However, along with the use of these tools exists the risk of relying too heavily on the numerical part of the analysis and neglecting the preparation phase for analysis. Any modelling procedure in System Dynamic modelling goes through a conceptual phase that uses the 'Learning Loop' approach. This phase is most often done unintentionally. Using the Learning Loop approach consciously facilitates the 'group modelling' process to acquire four successive phases, i.e. Definition, Clarification, Confirmation and Implementation. This enables a clear structure in the process, from acquiring the task to documenting the results. Only by intentionally using the Learning Loop approach in a managed manner, can the full potential of the process be exploited. Qualitative analysis does not replace simulations with a computer model but simulations should serve as a continuation to reconfirm or refute qualitative hypothesis and a simulation should only occur when the mental model has been tested. Systems Analysis, including its thinking, analysis and dynamics, is not a method, but rather an adaptive learning behaviour. It is a behaviour that finds the optimally adapted method, applying at some times SD computer tools.

Hördur V. Haraldsson

hordur.haraldsson@chemeng.lth.se
Lund University
Department of Chemical Engineering
PO Box 124
22100 Lund Sweden

Harald Sverdrup

harald.sverdrup@chemeng.lth.se
Lund University
Dept of Chemical Engineering Box 124
221 00 Lund Sweden

On Aspects of System Analysis and Dynamics Workflow

The workflow in System Dynamics may be seem to follow certain general flow patterns within the adaptive-iterative approach required. We constructed some diagrams to gain transparency and understanding of different tasks in the model-ling process. The modelling workflow involve systems analysis, group modelling and system dynamics. The systems analysis as executed during group modelling consists of three model building stages and one implementation task. The stages involves Definition, Clarification, Confirmation and Implementation. After defin-ing the issues and questions, the process evolves the Causal Loop Diagram (CLD) iteratively with the Stock and Flow Diagram (SFD), which form the construction drawings for the programming of the model incorporated as a System Dynamic Tool Diagram (SDTD). The third stage is the testing of the computerized model version created by the System Dynamic tool (SD-tool) and the fourth task is the implementation of the outputs into results and policies. This may be considered an iterative process in all the stages. Innovation is the emergent output from a proc-ess operating according to the learning loop: Finally the roadmap given to our students for going from question to model diagram is shown.

Hördur V. Haraldsson

hordur.haraldsson@chemeng.lth.se
Lund University
Department of Chemical Engineering
PO Box 124
22100 Lund Sweden

Harald Sverdrup

harald.sverdrup@chemeng.lth.se
Lund University
Dept of Chemical Engineering Box 124
221 00 Lund Sweden

Salim Belyazid

salim.belyazid@chemeng.lth.se
Lund University
Dept of Chemical Engineering
Chemical Technology Box 124
221 00 Lund Sweden

The Tyranny of Small Steps I: Discovery of an Archetypical Behaviour

A new archetype, The Tyranny of Small Steps (TYST) has been observed. Explained through a system dynamics perspective, the archetypical behaviour TYST is an unwanted change to a system through a series of small activities that may be independent from one another. These activities are small enough not to be detected by the 'surveillance' within the system, but significant enough to encroach upon the "tolerance" zone of the system and compromise the integrity of the system. TYST is an unintentional process that is experienced within the system and made possible by the lack of transparency between an overarching level and a local level where the encroachment is taking place. The Örby case study illustrates a real life manifestation of the TYST archetype in planning. The TYST illustrates the necessity for total transparency in any systems in order to avoid unintended consequence of the archetype. The TYST process may be regarded as a part of wide range of complex systems but depending on the conditions, it can remain dormant, and only become active when the conditions for lack of transparency are fulfilled.

Chi-Zho He

zz@chang.cv.nctu.edu.tw
National Chiao Tung University
Hsinchu
Taiwan ROC

The Application of System Dynamics Modeling to Study Impact of Water Resources Planning and Management in Taiwan

The demand for water in Southern Taiwan has increased significantly in recent years because of industrial growth and increasing living standards. However, due to the financial reasons, only a limited scale of existing surface water facilities can be expanded in a river basin. Therefore, it often requires a suitable strategy to consider the fixed costs and operating costs for expansion. On the other hands, the conjunctive use of surface water and groundwater can enhance the reliability of water supplies by providing independent sources so that research on conjunctive use is important, especially with reference to fixed and operating costs. In light of above reason, resolving the tension between water deficit and economic profit, while ensuring the sustainable development of water resources is very urgent for government authorities. Accordingly, this investigation proposes a process of integrating the system dynamics and impact analysis for evaluating water strategy systematically and quantitatively, with reference to water shortage and economic profit as they pertain to the planning and management of regional water resources.

John F. Heinbokel

jheinbokel@ciesd.org
CIESD LLP
75 Green Mountain Drive
South Burlington VT 05403
USA

P. Jeffrey Potash

jpotash@ciesd.org
CIESD LLP
75 Green Mountain Drive
South Burlington VT 05403
USA

Endogenous Human Behaviors in a Pneumonic Plague Simulation: Psychological and Behavioral Theories as Small "Generic" Models

This report builds on a previous epidemiological model of a pneumonic plague outbreak that incorporated three behavioral responses as exogenous drivers and evaluated their importance in allowing us to replicate the actual outbreak (Heinbokel& Potash, ISDC-2003). The current paper describes our subsequent efforts to incorporate those critical and controlling behavioral dimensions into this model as critical feedback loops. We conceptually deconstructed the event into four segments: becoming aware of the outbreak, deciding to act in response, choosing a specific response, and returning to normal behavior. We utilized current psychological theories, such as the "Psychometric Paradigm" and "Brunswik's Lens Model," to build small, conceptually clear, transferable, and combinable behavioral submodels to simulate the first three segments involving information and social networks, social trust, and risk perceptions. We believe these modeling efforts comprise first steps in a critical process of translating current, frequently static, risk theories to dynamically responsive vehicles that can be flexibly and quantitatively applied to reliably aid in understanding and influencing responses to such public health threats, other extreme events, and other dynamic risk scenarios in general.

Gary B. Hirsch

gbhirsch@comcast.net
Creator of Learning Environments
7 Highgate Road
Wayland MA 01778 USA

Jack B. Homer

jhomer@comcast.net
Homer Consulting
3618 Avalon Court
Voorhees NJ 08043 USA

Geoff McDonnell

gmcdonne@bigpond.net.au
University of New South Wales
382 Bronte Road
Bronte NSW 2024 Australia

Bobby Milstein

bmilstein@cdc.gov
Centers for Disease Control
360 Brooks Avenue NE
Atlanta GA 30307 USA

Achieving Health Care Reform in the United States: Toward a Whole-System Understanding

The U.S. health care system faces serious problems of high cost, limited access, unequal treatment, and inadequate health protection. Though these problems have persisted for decades and various reforms have been attempted, the overall impact of reform efforts has been only modest. This paper examines potential types of reform and the history of reform efforts. Causal-loop diagrams are presented which together comprise a theory to explain what created the set of problems that exist and why efforts at reform have largely failed. Different philosophical bases for reform and the need for an eclectic approach are discussed, and a sequential "bootstrapping" approach to comprehensive reform is outlined. The diagrams and discussion of this paper are intended as a starting point for further collaborative work on health care reform among system dynamics practitioners and health policy experts, leading to simulation modeling and further insights.

Yufeng Ho

hyfarch@ms32.hinet.net
PO Box 30-117
Taichung
Taiwan

ShuSone Wang

edge0711@seed.net.tw
Chungkuo Institute of Technology
PO Box 25-128
Taichung
Taiwan

System Dynamics Model for the Sustainable Development of Science City

Hsinchu Science Park is an example of hi-technology industry development in Taiwan. Its rapid growth has brought tremendous economic benefits, though not without social and environmental impacts, resulting in conflict between economic growth and sustainable development of the science city. This study establishes a system dynamic model using STELLA programming language to simulate different development scenarios of Hsinchu Science City. Our analysis reveals that the development of the science city should comply with the objectives of (1) maximizing the profits from industries in the science park, (2) minimizing the damages incurred by the science park on its mother city, (3) decrease in consumption of natural resources, (4) reduction in environmental pollution, and (5) attention to relevant social problems.

Siang Hong

slh343@psu.edu
Pennsylvania State University
266 Recreation Building
Dept of Kinesiology
University Park PA 16802 USA

Karl M. Newell

kmn1@psu.edu
Pennsylvania State University
Coll of Health and Human Development
201 Henderson
University Park PA 16802 USA

Reorganizing Motor Behavior through Practice

Skilled human movement is apparently easily produced and highly coordinated despite the high number of degrees of freedom controlled during its execution. Here, we examine the learning of a whole body movement over practice from three levels of analysis: 1) elemental, 2) subsystem, and 3) macroscopic order parameter, with respect to the role of constraints in motor skill acquisition. With practice, the body segments were re-organized to achieve the 3 sub-tasks, namely: 1) a medio-lateral forcing torque, 2) a vertical downward force and 3) an anterior-posterior equilibrating torque. The output complexities of the two subsystems, the forcing (medio-lateral) and equilibrating

(anterior-posterior) motions of the center of mass changed in a compensatory manner, increasing or maintaining the stability of the overt behavior. This pattern of findings supports the ideas of dynamical approaches to motor learning and holds interesting parallels to tenets of the Theory of Constraints (Goldratt, 1990) for system (re)organization.

Peter S. Hovmand

phovmand@wustl.edu
Washington University in St Louis
GWB School of Social Work
One Brookings Drive Campus Box 1196
Saint Louis MO 63130
USA

Ron Pitner

rpitner@wustl.edu
Washington University in St Louis
GWB School of Social Work
One Brookings Drive Campus Box 1196
St Louis MO 63130
USA

Combining System Dynamics, Social Networks, and Geographic Information Systems

System dynamics has always held the potential to synthesize and advance theories in social science. Increasingly, social scientists and policy makers are recognizing the importance of complexity and turning to methods like system dynamics, geographic information systems, social network analysis, and agent based modeling. All of these approaches draw on some underlying modeling mathematical framework. This research reports on a method for integrating system dynamics with social network analysis and geographic information systems. The method is then applied to the specific problem of improving city residents' perceptions of crime and safety in a model based on existing social theory.

Peter S. Hovmand

phovmand@wustl.edu
Washington University in St Louis
GWB School of Social Work
One Brookings Drive Campus Box 1196
Saint Louis MO 63130 USA

Melissa Jonson-Reid

jonsonrd@wustl.edu
Washington University in St Louis
GWB School of Social Work
One Brookings Drive Campus Box 1196
St Louis MO 63130 USA

Brett Drake

brettd@wustl.edu
Washington University in St Louis
GWB School of Social Work
One Brookings Drive Campus Box 1196
St Louis MO 63130 USA

Flows in the Child Welfare Systems: A Computation Theory Approach to Developing Numerical Reference Modes

Mental health service systems are inherently complex, both in their detail and dynamics. System dynamics offers great potential to help policy makers, administrators, and researchers make better decisions about service system changes. However, efforts have been constrained by not being able to construct numerical reference modes without making strong assumptions about the structure of the case flows. This paper presents a novel approach to generating numerical reference modes from administrative databases that is based on computation theory. The method is validated with simulated datasets, and its feasibility and substantive significance demonstrated in an analysis of a merged child welfare database containing 10,250 children and adolescents.

Chao-Li Hsu

chaoli@mail.ntctc.edu.tw
National Taichung Teachers College
140 Ming-Shen Rd
Taichung 403
Taiwan

Evaluating Effects of a Systems Thinking Model on Curriculum and Instruction Planning in Taiwan

Given that systems thinking is a useful methodology in organization learning, the main purpose of this study was to identify and evaluate how and in what ways we could use systems thinking on

Yuan-Zu Chen
yjchen@mitux.tcavs.tc.edu.tw
283 Taichung Rd
Taichung
Taiwan

Hsiao-Shen Wang
hswang@isst.edu.tw
140 Ming-Shen Rd
Taichung
Taiwan

curriculum/instruction planning in schools. In this study, we used ethnographic methods of observation and in-depth interviewing to gather information. The study took place in six public elementary schools. The evaluation was focused on the following questions: (a) What happened when the model were used?, (b) What did participants think about using the model in planning and instruction? and (d) In what ways did the use of the model influenced professional development? Evaluation data was collected from three primary sources: (a) principals' and administrators' interview (b) teachers' curriculum, lesson plans, interview, and responses to an attitude survey; and (c) researchers' observational notes. Conclusions made based on the results of this study. First, systems thinking can increase the quality of administrator-teacher and teacher-teacher interaction, teachers' curriculum/instruction planning, continuous assessment of curriculum/instruction, and immediate and formative feedback. Secondly, it can also decrease overall time required on task of curriculum/instruction designing in the long run. Consequently, it promises curriculum/instruction design with more accountable quality.

Margarita Hurtado Hernández
mhurtado@mx.up.mx
Universidad Panamericana
Augusto Rodin 498
03920 México DF
México

Héctor Debernardo
hdebernardo@alumni.unav.es
Universidad Panamericana
Augusto Rodin 498
03920 México DF
México

A Paradigm Shift in Solid Waste Collection Systems Design and Operation

A new solid waste collection model, called MST, has been developed. It is a result of combining System Thinking and Aggregation Theory and it takes into account real world constraints such as collection frequency, labor shifts and both preventive and corrective maintenance. MST is a paradigm shift in solid waste collection systems design and operation. It makes possible a more efficient utilization of resources (vehicles and labor) and it is robust against variability sources. MST is the result of having challenged and invalidated a deeply rooted assumption in all models developed up to date. Simulation and Design Of Experiments were used to compare MST against existing models. Experimental results show significant reduction in the number of trips (Up to 33%), crews (Up to 49%) and vehicles (Up to 40%), which means dramatic operation cost and investment improvements.

Lihlian Hwang
lihlian@mcu.edu.tw
Ming Chuan University
12F No 82 Chang Kang Yi
Hu Hsin Tsun
Gweishan Taoyuan 333 Taiwan

Exploring the Strategies of Hospitals Facing a Global Budget and Evaluating its Effects in Taiwan

The National Health Insurance (NHI) program has implemented in Taiwan since March 1995. The initial balance of revenues and expenditures was stable, but there has been a deficit since 1998. As the deficit problem was mostly caused by the payment system of fee-for-service, the Bureau of NHI (BNHI) implemented global budget (GB) payment system. Under GB, the benefit payments were under control as planned. Since the benefit payments from BNHI are the most part of revenues of hospitals, some hospitals have financial imbalance. This study uses system dynamics to explore the strategies of hospitals facing GB and evaluate its effects on hospitals and patients. This research is still ongoing and will reach two

achievements. First, submitting the stock-flow diagrams can provide the managers of hospitals to have a further understanding on their strategies. Second, building the model can simulate and evaluate the effects of multiple strategies on hospitals and patients.

Lihlian Hwang

lihlian@mcu.edu.tw
Ming Chuan University
12F No 82 Chang Kang Yi
Hu Hsin Tsun
Gweishan Taoyuan 333 Taiwan

Using Simulation to Evaluate Policies for the Financial Imbalance of the National Health Insurance in Taiwan

This study applies system dynamics to explore the long-term influences of multiple policies on handling the financial imbalance of the National Health Insurance (NHI). In order to improve the financial imbalance of the NHI, three policies and three scenarios are proposed. Each policy is evaluated for each scenario. According to the simulation results, the policy of a 20% increase in premium rate, plus a 2% decrease each year in annual rate of change of benefit payments per beneficiary can improve the financial imbalance. However, the benefit payments will be greater than premium revenues from 2008. So, the financial imbalance of the NHI will present again.

Jacob J. Jacobson

jacob.jacobson@inl.gov
Idaho National Laboratory
2525 N Fremont Avenue
Idaho Falls ID 83415-3710 USA

Steven J. Piet

pietsj@inel.gov
Idaho National Eng and Env
Laboratory
PO Box 1625
Idaho Falls ID 83415-3605 USA

A. M. Yacout

yacout@anl.gov
Argonne National Laboratory
9700 S. Case Avenue
Argonne IL 60439 USA

G. E. Matthern

gretchen.matthern@inl.gov
Idaho National Laboratory
2525 N Fremont Ave
Idaho Falls ID 83415 USA

Anton Moisseytsev
Texas A&M University

Modeling the Nuclear Fuel Cycle

The Advanced Fuel Cycle Initiative is developing a system dynamics model as part of their broad systems analysis of future nuclear energy in the United States. The model will be used to analyze and compare various proposed technology deployment scenarios. The model will also give a better understanding of the linkages between the various components of the nuclear fuel cycle that includes uranium resources, reactor number and mix, nuclear fuel type and waste management. Each of these components is tightly connected to the nuclear fuel cycle but usually analyzed in isolation of the other parts. This model will attempt to bridge these components into a single model for analysis. This work is part of a multi-national laboratory effort between Argonne National Laboratory, Idaho National Laboratory and United States Department of Energy. This paper summarizes the basics of the system dynamics model and looks at some results from the model.

Jacob J. Jacobson

jacob.jacobson@inl.gov
Idaho National Laboratory
2525 N Fremont Avenue
Idaho Falls ID 83415-3710
USA

Vision: A Business Planning Simulator

"Past performance may not be a not true indicator of future performance." Everyone has seen this disclaimer at one time or another. Although this may certainly be true, past performance should certainly be considered when planning for the future. Executives are always seeking ways to make decisions that will help their company to perform better. This paper examines a model that was developed to

Martin E. Maren

maren@alum.mit.edu
1861 N Claudia Ave
Simi Valley CA 93065
USA

take a company's financial records and transform them into easy to understand trends and long-term predictors. In addition, it allows the user to adjust system parameters to see the long-term effects to performance.

Anil B. Jambekar

abjambek@mtu.edu
Michigan Technological University
School of Business and Economics
1400 Townsend Drive
Houghton MI 49931 USA

A Season of Resolutions, Continuous Improvement and Systems Thinking

As New Year rolls in, many of us take on challenge of personal change. Many set goals to lose weight; do more exercises; watch less television; do more studying; do less partying; or to shed a habit such as smoking. For several years in our Quality Management course students were asked to work on a term-long personal continuous improvement projects. The students were briefly introduced to basic concepts of causal loop diagrams and were encouraged to use them to clarify their theories regarding their own progress or lack of it. The basic premise is that the result students obtain and the dynamics they experience are built into the structure of their worldview and they learn if they can communicate and influence their worldview. This paper uses systems thinking lens to discuss the improvement framework and the experience reported by students. Majority of students did not make the progress toward their goals as much as they would have preferred. The student generated diagrams to explain their theories were either too simple or overly complicated, awkward and partially flawed. However, it can be claimed that the process of using the tool to clarify their thinking itself was worthwhile. After reviewing their narratives and the diagrams, several archetypes were consistently noted.

Karen Jarzynka

karenjarz@yahoo.com
University at Albany
201 Park Ave Apt 40
Albany NY 12202
USA

U.S. Low Income Housing Policy – A Dynamic System Evaluation

Housing for the poor remains a major policy problem in U.S. cities. Jay Forrester's 1969 Urban Model predicted that increasing the availability of low income housing exacerbates the city deterioration. Poverty and homelessness are on the rise in this country. Families, often single parents with children, and the elderly are two of the largest groups affected. Subsidized housing is one way to fight homelessness. This year's budget proposal has President Bush slashing funding to the department of Housing and Urban Development, including many programs that help supply housing to the poor. I plan to investigate various low income housing policies to determine how and why they would or would not work.

Eva Jensen

eva.jensen@fhs.mil.se
Swedish National Defence College
Dept of War Science
PO Box 27805
SE-115 93 Stockholm
Sweden

Balancing Bathtubs in Math Class

What aspects of basic system dynamics are covered by the traditional school math curriculum? The Booth Sweeney and Sterman (2000) bathtub tasks and the Jensen and Brehmer (2003) rabbits-and-foxes task were dissected into aspects. Questionnaires with tasks tapping into the identified aspects were administered to first-semester

university students with a math-intensive high school background. Performance were as expected and conformed to the results of previous studies with these tasks. These results encourage further effort to devise additional tasks covering more basic aspects identified, and refining the existing tasks. Equipped with a well-design battery of tasks, it would in all likelihood be informative to test it with different participant groups, such as undergraduate, as well as graduate, students in math, engineering, and system dynamics.

Min Jiang

jljiangmin@hotmail.com
Nanjing Jinling High School
No 169 Zhongshan Road
Nanjing Jiangsu 210005
China

Yibai Chen

chyb@nje.cn
Nanjing AV Educational Center
No 5 Cibeishe
Nanjing 210029
China

ENJOY LEARNING – Deepened Application of Systems Thinking in High School Chemistry Teaching Practice

This paper, through two separate teaching fragments in the delivery of chemistry education, is to demonstrate the use of system dynamics and the subsequent research process by using software "STELLA", which clearly reflects the system thinking. As to the decomposing reaction of H_2O_2, students encountered some unexpected reaction phenomenon. With the help of the "STELLA", they conducted in-depth research on the causes that lead to such phenomenon mentioned above. The final modeling process clarifies the reaction for the students. What's more important, it also helps them form the initial concept of system thinking. When studying molar volume of gas, the teacher took as the starting point the four famous Chinese ancient inventions and then moved further to the study of rocket propeller. From the viewpoint of a student at secondary school, they gradually uncover the underpinning theories of rocket propeller. This process brought to them a great sense of achievement and joy. Such a process is beyond any imagination in our traditional teaching conduct. It is not only a harmonious combination of system thinking and the studying of chemistry theories, but in addition, it brings the fundamental reforms in the chemistry education at secondary schools.

Neng Jiang

nj138@mdx.ac.uk
Middlesex University
34A Finchley Lane
Hendon
London NW4 1DL UK

Study on Applicability of System Dynamics for Stock Price Realization

Inspired by the transdisciplinary nature of system dynamics (SD) and previous research on the efficient market hypothesis, I applied SD to help understand the long-term price realization in stock market. After innovatively identifying the components for SD modeling in line with the features of stock price movement, the conceptual causality model and simulation equations for experiment, mainly driven by intrinsic values, are set up and tested for two distinctive examples: WM Morrison Supermarket plc and Tadpole Technology plc. The experimental outcomes show that with appropriate estimates of attributes the SD model is well capable of reflecting the trend of long-term price realization and the applicability of SD for it also has been empirically justified, however the short-term price waves are out of my model's competence due to the exclusion of short-term adaptive attributes and the difficulty to specify the exact influence of noise factors at present.

Nitin R. Joglekar

joglekar@bu.edu
Boston University
School of Management
595 Commonwealth Avenue
Boston MA 02215 USA

A Behavioral View of Core-Periphery Dynamics in Social Networks

We model the dynamics associated with evolution of the core and the periphery of a social-network. The model is based on an existing behavioral theory of the inter-firm (Baum and Ingram 2002). The formalization allows us to refine this existing theory through the introduction of a target setting process. Allied analysis documents the efficacy of exploration and exploitation policies within the core and across the periphery of a social network. Our results show that the competitive advantage accrued through exploration and exploitation is crucially affected by the behavioral biases, imitation and the target setting associated with the evolution of key constructs.

Charles A. Jones

skuk_jones@yahoo.com
University of Massachusetts Boston
26 Walk Hill Street #2
Jamaica Plain MA 02130
USA

Behavioral Theory In Simulation: Ambiguous Results From Simple Relationships

A system dynamics model of individual performance is developed and simulated. Performance, a behavioral factor, depends upon and influences emotional and cognitive factors: stress, mood, and motivation. Activation, found in both stress and motivation literatures, is treated separately. Each causal relationship is assumed to be simple and unambiguous. Analysis of the model output under a range of work conditions shows that ambiguous or complex relationships would be supported by traditional research. Complex relationships between stress, motivation, and individual performance emerge from model structure and interactions, rather than from assumed causality. This work demonstrates the benefit of simulation in theorizing when multiple factors operate in tandem.

Andreas Patric Jost

andreas.jost@dcx.com
DaimlerChrysler Research &
Technology
Wilhelm-Runge-Str 11
89013 Ulm
Germany

Tobias Lorenz

space56@freenet.de
University of Bergen
Villaveien 3
5007 Bergen
Norway

Gerald Mischke

gerald.mischke@daimlerchrysler.com
DaimlerChrysler Corp
HPC G252
Mercedesstr 137
D-70327 Stuttgart
Germany

Modeling the Innovation-Pipeline

Regularly generating innovative products is a key success factor in established industries. Major companies frequently outpace each other with innovations and product offensives. But what are the effects of such initiatives? And how can companies organize their innovation pipelines in order to successfully manage such ventures? The process in which innovations are developed and integrated into marketable products is highly complex and can be organized in various ways. An important distinction introduced by this paper is to separate between product development processes and processes for innovation generation. In established industries the first ones regularly initiate product development projects and strive to meet certain launch periods. The latter are problem-solution oriented and driven by the search for new, innovative concepts. They are characterized by risk and a high degree of uncertainty regarding success und completion time.This paper introduces a work-in-progress-model of such innovation pipelines oriented at the typical structures in the automotive industry.

Andreas Patric Jost

andreas.jost@dcx.com
DaimlerChrysler Research &
Technology
Wilhelm-Runge-Str 11
89013 Ulm
Germany

Alexander Franke

franke_alex@web.de
DaimlerChrysler

Residual Value Analysis

Residual values are considered of major importance for an automotive product/brand in various aspects. They are believed to have a major influence on attributes such as: new car sales, pricing options, buyback risk, and image perception. The presented paper refers to a work in progress model developed for the analysis of residual values in the automotive industry. It is designed to analyze how an automotive company can support and take advantage of residual values. Among others, the following questions are addressed: -What are leverages/policies that effect residual values? -Which leverages/policies are particularly effective/sensitive? -What effects/consequences regarding the new car business are to expect by changes in residual values? Although the model is designed and developed for practical use in the automotive industry and can not be revealed in detail, it provides important aspects that are worthy of discussion with experts in the field of System Dynamics. It represents a new approach to the subject of residual values and connects to previous work such as Sterman (2002). The developed model realistically reproduces the course of residual values in relation to specified market cycles and given exogenous factors. It has proven valuable for questions regarding effective leverages and policies to residual values.

Phil Joyce

philj@it.swin.edu.au
Swinburne University
Johns Street
Hawthorne Melbourne
Australia

Graham W. Winch

graham.winch@plymouth.ac.uk
University of Plymouth
Plymouth Business School
Drake Circus
Plymouth PL4 8AA
UK

An Integrating Framework for Internet-Based E-Business Ventures in Service-Based and Product Supply Chains

For many organisation going on line in an eBusiness venture is often fraught with difficulties in discerning the strategy and value in such a venture and the possible outcomes. Organisations are revisiting their services and/or products and developing eBusiness systems that are capable of exploiting the organisations business supply chains. Central to any development of this nature is the manager's understanding of the implications of an Internet eBusiness venture to the organisation and industry they wish to compete in. This paper outlines an insight into a framework for mapping business process models onto service and product based business models.

Jan Juerging

juerging@is.bwl.uni-mannheim.de
Mannheim University
Industrieseminar
Schloss Suedfluegel
Mannheim 68131
Germany

Peter M. Milling

pmilling@is.bwl.uni-mannheim.de
Mannheim University
Schloss S 203 Industrieseminar
D-68131 Mannheim
Germany

Interdependencies of Product Development Decisions and the Production Ramp-up

Many companies, especially in high tech industries, are facing shrinking product lifecycles and increasingly complex production and product technologies. Selling many products in semiconductors, disk-drives or products in telecommunications has shrunk has shrunk to a time span less than a year. These market dynamics pressure production facilities to begin full scale production at a point when the underlying process technology is still ill understood. Consequently companies suffer from substantial yield losses, which can dramatically affect the economics of the product, production facility,

and business. The production ramp-up will be defined as the time span equal to the difference between 'time to market' and' time to volume'. A major goal of innovators is to reduce the 'time to market', but they cannot evaluate the effects on the 'time to volume'. This paper will give insights in these interdependencies and compare two policies for the management of changes during production ramp-up.

Christian Erik Kampmann

cek.lpf@cbs.dk
Copenhagen Business School
Kolshoejen 8
DK-8800 Viborg
Denmark

Rogelio Oliva

roliva@tamu.edu
Texas A&M University
Mays Business School
325M Wehner - 4217
College Station TX 77843-4217
USA

Loop Eigenvalue Elasticity Analysis: Three Case Studies

The paper explores the application of loop eigenvalue elasticity analysis (LEEA) to three models in order to reveal the potential of the method for generating insights about model behavior and to uncover issues in developing the method further. The results indicate that the utility of the method depends upon the character of the model and dynamics involved. In models where the transient behavior is of interest, the method yields insights on par with the pathway participation method, though better tools to link the method to time paths of particular variables is needed. In models involving near-equilibrium oscillation, LEEA is clearly the most powerful, though more efficient computer programs are needed to handle large-scale models. In highly non-linear models exhibiting deterministic chaos, LEEA, being based upon linear concepts, does not appear to yield any insight because the eigenvalues may change substantially even when the mode of behavior appears constant. The paper also describes the set of tools and processes that we have developed and the design for a web-based toolbox to make the methods readily available to a wider audience in the hope that others will join the efforts to develop analytical methods for interpreting model behavior.

Kyungmin Kang

psalm23@ihanyang.ac.kr
Hanyang University
17 Heangdang-dong
Seongdong-gu
Seoul 133-791 Korea

Moosung Jae

jae@hanyang.ac.kr
Hanyang University
Dept of Nuclear Eng
17 Haengdang Sungdong
Seoul 133-791
South Korea

Development of An Ingestion Pathways Model Using System Dynamics

In this study, a dynamic model for ingestion pathway has been developed and applied for considering several agricultural practices, and food consumption behavior, etc. It is shown that the dynamic radiological model can be used as a tool for comprehensive ingestion dose assessment during accidental release of radionuclides.

Shivraj Kanungo

kanungo@gwu.edu
George Washington University
Monroe Hall 302H
2115 G Street NW
Washington DC 20052
USA

Maturity Dynamics in Software Process Improvement: Analyzing the High Maturity Equilibrium

In this paper we focus on understanding what it means to operate at high maturity levels in a software organization and also address a specific facet of the improvement paradox caused by changing business policy. Using system dynamics modeling and basing our

Vikas Jain

vikas_j@gwu.edu
George Washington University
2115 G St NW
MON 403
Washington DC 20052 USA

Asha Goyal

gasha@in.ibm.com
IBM Global Services India
DLF Silokhera Sector 30
NH-8 Opp 32 Milestone
Gurgaon Pin 122002 Haryana India

hypotheses on empirical data as well as past research, we simulate various scenarios. Given that our domain of research includes relatively few high maturity software organizations (implying, thereby, the sparseness of research data and our consequent dependence for insights on the world of work) we based our work on published empirical data that was complemented by other sources of data from the industry. Results from this study will help improve our understanding of the improvement paradox. Our findings are directly beneficial to software organizations seeking to protect and leverage their investment in process improvement – especially in an industry where second chances are rare.

Florian Kapmeier

florian.kapmeier@bwi.uni-stuttgart.de
Universität Stuttgart
Betriebswirtschaftliches Inst Abt IV
Keplerstr 17
70174 Stuttgart Germany

Common and Private Goals in Learning Alliances

This paper proposes a model that gives deeper insights into the dynamics of interorganizational learning at the example of an alliance of two partnering firms. Current alliance research often tends to neglect a feedback-perspective which might be the reason why certain behavioral effects cannot be explained. However, we identify some major feedback-loops that influence interorganizational learning dynamics based on literature-based alliance research. Here, we focus on the concept of common and private benefits. According to literature findings the dilemma between the two kinds of benefits determines how many resources the parent companies invest in the alliance. We show how gatekeepers might lead a learning alliance to common success. We also show how short-term views of potential private benefits might not only lead to failed common goal attainment but also ruin a firm's collaborative reputation in the industry.

Andjelka Kelic

sly@mit.edu
MIT
38 Glenwood Ave
Cambridge MA 02139
USA

Government Policy vs. the Fiber-to-the-Home Supply Chain

A policy for rapid deployment of fiber-to-the-home may be in direct conflict with the health of the transceiver component supplier industry. The interests of consumers, regulators, and even service providers are in conflict with the industry that provides a critical component necessary for the service. The industry needs to recognize this conflict and explore strategies to keep itself viable in light of these conflicts. A system dynamics model is used to explore the effects of government policy on the deployment of fiber-to-the-home as a broadband technology. Specifically this article investigates the effects of a policy for rapid broadband deployment on the component supplier that is farthest from the consumer in the value chain.

Michael S. Kennedy

mike.kennedy@lsbu.ac.uk
London South Bank University
School of Computing IS and Maths
103 Borough Road
London SE1 0AA UK

An Extended Taxonomy of System Dynamics Models of Information Systems Investment Appraisal

A number of papers have been published describing various System

Dynamics (SD) models of the Information Systems Investment Appraisal Process from several academic and professional viewpoints. This paper builds on previous papers that provided a catalogue and classification of this work in order to highlight potential areas of research in this field of study and to identify system archetypes at different hierarchical levels and discover new ones. This paper therefore presents an updated taxonomy of System Dynamics Models of Information Systems Investment Appraisal. This paper builds on the earlier taxonomy by widening the scope of the survey of completed SD investigations in the field. The findings from these investigations are briefly described. The taxonomy classifies the completed investigations into five specific areas of concern and six viewpoints.

Michael S. Kennedy

mike.kennedy@lsbu.ac.uk
London South Bank University
School of Computing IS and Maths
103 Borough Road
London SE1 0AA UK

An Updated Taxonomy of System Dynamics Models of Higher Education

A number of papers have been published describing various System Dynamics (SD) models of Higher Education institutions and issues, on topics including the role of SD in Corporate Governance, Planning, Resourcing & Budgeting, Teaching Quality, Teaching Practice, Microworlds and Enrolment Demand. This paper builds on previous papers that provided a catalogue and classification of this work in order to highlight potential areas of research in this field of study and to identify system archetypes at different hierarchical levels and discover new ones. This paper therefore presents an updated taxonomy of System Dynamics Models in Higher Education. This paper builds on the earlier taxonomy by widening the scope of the survey of completed SD investigations in higher education management. The findings from these investigations are briefly described. The taxonomy classifies the completed investigations into six specific areas of concern and five hierarchical levels.

Dong-Hwan Kim

sddhkim@cau.ac.kr
Chung Ang University
Dept of Public Administration
456-756 Ansung-Si
Kyunggi-Do South Korea

Psychological Gaps between Constructors and Interpreters of Causal Maps

This paper investigates psychological differences between constructors and interpreters of causal maps. This paper argues that dissipation effects and dilution effects applies to those who are to interprete causal maps not to those who construct them. Dissipation effects are psychological tendency that people perceive causal effect as weak as the number of causal links increases. Dilution effects occur when people undervalue the strength of causal relation as the number of causal variables increases. Experimental results show that concentration effects opposite to the dissipation effects and dilution effects explain more correctly the perception of constructors of causal maps. This paper points out that this asymmetric psychological tendencies between constructors and interpreters of causal maps is the psychological source of the communication problems between systems thinkers and their clients.

Hyunjung Kim

hk8459@albany.edu
University at Albany
11 South Lake Avenue Apt 110
Albany NY 12203
USA

James A. Goggi

jg0691@albany.edu
Commerce Bank
214 Colonial Road
West Babylon NY 11704
USA

System Dynamics Modeling for Long Term Care Policy

Rising long-term care cost due to increase in senior population is a serious issue that concerns many public policy makers in the U.S. States come up with different policies to tackle the problem, and one of the policies that recently gained much support is a single point of entry system. The single point of entry is a place where people visit, have their needs assessed, and obtain information about different long term care service options. The supporters argue that by implementing the single point of entry, it is possible to reduce long term care cost by directing many potential institutional care recipients to better fitted home and community based care. This paper is about a system dynamics model built for a government agency that is about to propose the policy to key decision makers. The modeling process and insights gained from the model will be discussed in this paper.

Gerald King

gerardk@deakin.edu.au
Deakin University
Geelong Victoria 3217
Australia

Gus Geursen

gus.geursen@unisa.edu.au
University of South Australia
School of Marketing
GPO Box 2471
Adelaide SA 5001
Australia

The Use of System Dynamics to Examine the Relationship amongst Quality, Value, Price and Profitability

This paper argues that the positivist approach adopted by many studies into the relationship between customer satisfaction and revenue is limited; the ontology associated with positivism permits surface relationships only to be determined. What is required is a method grounded in a more realistic ontology that allows for a deeper investigation. The paper proposes that system dynamics is one such method. The differences between the positivist approach and a systems approach are expounded, and, though the positivist approach is not completely rejected (on the contrary, it is defended), its limitations, particularly when applied to a social environment, are apparent. In particular, the paper expands on the differences between studies in the natural sciences and those in the social sciences. It is these contrasts that make extremely suspect an effective translation of the methodology applied so successfully to the natural sciences, across to the social environment, and which demands an alternative methodology. This paper presents one such methodology and posits system dynamics clearly within that methodology.

Andrey I. Koblov

akoblov@suct.ru
South-Urals State University
Applied Mathematics Dept
Lenina avenue 76
Chelyabinsk 454080 Russia

Alexander B. Blinov

blinov@suct.uu.ru
South Urals Cellular Telephone
Kirova Street 104/122
Chelyabinsk 454000 Russia

Mobile Service Market Model of the Region

Paper presents a system dynamics approach to modeling mobile service competitive market of the region. The model includes dynamic competition between operators. The pricing policy, service quality, subscriber base, potential subscribers, marketing, etc influence their number of subscribers. The task of defining the market share carrying capacity to forecast the sales process is described. The method for the saturation level identification is considered and the problem of the optimal pricing is formulated. Real data from several regions of Russia and Europe are used in this paper.

Vladimir I. Shiryaev

vis@prima.susu.ac.ru
South-Urals State University
Dept of Applied Mathematics
pr Lenina 76
454080 Chelyabinsk Russia

Davorin Kofjac

davorin.kofjac@fov.uni-mb.si
University of Maribor
Faculty of Organizational Science
Kidriceva 55a
4000 Kranj Slovenia

Miroljub Kljajic

miroljub.kljajic@fov.uni-mb.si
University of Maribor
Faculty of Organizational Sciences
Kidriceva cesta 55a
SI-4000 Kranj Slovenia

Andrej Skraba

andrej.skraba@fov.uni-mb.si
University of Maribor
Faculty of Organizational Sciences
Kidriceva cesta 55a
SI-4000 Kranj Slovenia

Valter Rejec

valter.rejec@iskra-ae.com
Iskra Avtoelektrika dd
Polje 15
5290 Šempeter pri Gorici
Slovenia

The Virtual Reality Concept for the Warehouse Simulation Model Implementation

This paper presents the method of warehouse simulation model implementation using concepts of virtual reality. The basic idea is to compare the "Real process" controlled by operator with his/her heuristics with the "Virtual process" represented by simulation model, controlled by the optimization algorithm. Optimization algorithm is based on SD model of the warehouse and decision support module. The SD warehouse model represents the abstraction of "Virtual process" and is considered as a model of a model. The state of the "Virtual process" is controlled with help of decision support module and is compared with the state of Real process on the basis of actual information regarding the state of warehouse. This concept is useful for predictive model validation where the parallel observation of the actual system and virtual one takes place at the same time, and for the optimization algorithm migration into practice.

David Širok

david.sirok@iskra-ae.com
Iskra Avtoelektrika dd
Polje 15
SI-5290 Sempeter pri Gorici
Slovenia

Birgit Kopainsky

birgit.kopainsky@iaw.agrl.ethz.ch
Swiss Federal Institute of
Technology
Agricultural Economics SOL F10
Sonneggstrasse 33
CH-8092 Zürich
Switzerland

Luis F. Luna-Reyes

luisf.luna@udlap.mx
Universidad de las Americas Puebla
School of Business NE-221J
Santa Catarina Martir
Cholula Puebla 72820
Mexico

Reflections on Theory Building and Theory Integration Following a System Dynamics Approach

Conceptualization is a critical task in the development of system dynamics models, which starts early in the modeling process, and extends to later stages in the development of any system dynamics project. The procedures and characteristics of model conceptualization have striking parallels with the process of theory building as described in many different strands of literature. Considering also that the modeling process as a whole is an iterative process of comparing and contrasting data and current theories by means of a rigorous yet intuitive process, it seems appropriate to reflect on the modeling process as a theory building effort, which is the main purpose of this paper. In order to illustrate the differences between theory building approaches, the paper presents two examples of system-dynamics-based theory building efforts. Thinking of the model development work as a theory building process has the potential of bringing new insights to the conceptualization of system dynamics models, and to the criteria used to assess the suitability of our models. The paper

concludes with the introduction of a set of criteria to assess good theories and with reflections on the further development of these criteria for model validation purposes.

Victor V. Korobitsin

korobits@univer.omsk.su
Omsk State University
55A Mira pr
Omsk 644077Russia

Julia V. Frolova
Omsk State University
55A Mira pr
Omsk 644077Russia

Landscape Delimitation between Ethnoses by Modelling

The aim of presented research is the construction of mathematical model of ethnic field. The model is described by the system of parabolic equations. It is the tools for research the evolution of interactive ethnic systems under landscape influence. The ethnic system includes a few ethnoses and provides their interactions. The interactions transmit by ethnic fields. This model describes the behavior of society on ethnic solidarity level. The software TERRI is used for the forecast of arising the ethnic conflicts. We carry out analysis of simulation results of ethnic fields: ethnic map coloring; delimitation three borders between super-ethnoses on the ethnic map of investigation region; comparison the experimental data with the facts; relationship of ethnic fields model with real ethnic processes. Based on simulation result the researcher can compute the direction of ethnic field distribution and the most probable points of skirmish between ethnoses.

Nina Kostina

kni40@yahoo.com
State Tax Administration of Ukraine
8 Feodory Pushinoy Str Apt 222
Kiev 03 115
Ukraine

Victor Bazylevich
bazil@econom.univ.kiev.ua
Kiev Taras Shevchenko National Univ
90a Vasilkovskaya St
Kyiv 03022
Ukraine

Multipurpose Simulation Systems for Regional Development Forecasting

We examine the development of automaton-modeling multipurpose simulation systems as an efficient form of simulation software. Such systems constitute a singe problem–oriented package of applications based on general simulation model, which is equipped with task source language, interaction, and file management tools, and an output editor. The simulation models are described by the method of probabilistic-automaton modeling, which ensures standard representation of the modeling algorithm. An example of such systems includes the Demographic Forecasting System (DEPROG) main description of which is represented in the article.

Lubomir Kostron

kos@fss.muni.cz
Masaryk University
School of Social Studies
Gorkeho 7
602 00 Brno
Czech Republic

Marek Susta
m.susta@proverbs.cz
Proverbs Corporation
Zitna 52
120 00 Prague 2
Czech Republic

Communicating the Vision of an Urban City Development: A Model

A small group at the School of Social studies in Brno and Proverbs Inc. Prague, Czech republic, worked on a composition of a model, which is to test communication policies. The City hall faces problems in communication and explaining some of its long-range goals. The model is derived from the J.W. Forrester's model of urban growth and includes also some „soft" variables, which seriously effect the perceived leadership role of the City hall and its ability to proceed further and to gain public support. The paper discloses the structure of the model as well as the process of its construction and obstacles, which the group encountered while attempting to offer its expert service.

Ladislav Lakomy

lakomy@mybox.cz
Masaryk University
Dept of Psychology
School of Social Studies
Brno Czech Republic

Michael Krail

krail@iww.uni-karlsruhe.de
University of Karlsruhe
Inst for Economic Policy Research
Kollegium am Schloss Bau IV
76128 Karlsruhe Germany

Quantification of Climate Policy Scenarios for Long-Term Trends in Sustainability in ASTRA

One aim of this paper is to show the mode of action of the integrated transport-economic-environment model ASTRA that is based on the System Dynamics Modelling method. Furthermore two policy scenarios - one in which a tax per ton of CO2 emitted by transport will be introduced and another with a significant increase of crude oil price until 2020 - will be compared to a reference case. The reference scenario results will be analysed to identify long-term trends in transport, economy and environment. The scenarios results show the impact on a sustainable development by an introduction of transport emission pricing by policy makers on the one hand and of a stronger increase of crude oil prices based on the fact of growing scarcity of oil resources on the other hand.

Veasna Kum

veasna_kum@yahoo.com
Royal University of Phnom Penh
Dept of Environmental Science
Main Bld
Russian Confederation Blvd
Phnom Penh Cambodia

A System Dynamics Study of Solid Waste Recovery Policies in Phnom Penh City

There is an economic reason to extend the useful life of the landfill because once the old landfill is filled, the new one can be found only at greater distance, and this increases remarkably the transportation cost. Therefore, waste has to be recovered as much as possible. To do this, in developing countries context, small scale composting promotion is widely accepted and the contribution of informal recycling is also widely recognized. The question remains to what extent composting and informal recycling contribute to the waste diversion. To create a platform for discussion and learning, a model is established. The model in this paper is based on the system dynamics (SD) approach. The simulation results with the data collected in Phnom Penh city, Cambodia, show that waste recovery through small-scale composting and informal recycling cannot contribute significantly to the waste diversion without other supporting policies.

Martin H. Kunc

mkunc@london.edu
London Business School
Regent's Park
London NW1 4SA UK

John D. W. Morecroft

jmorecroft@london.edu
London Business School
Regent's Park
London NW1 4SA UK

Competitive Advantage, Strategy and Problem Structuring: Revealing the Role of Managerial Cognitive Asymmetries

The resource-based view of strategy (RBV) seeks to explain why some firms consistently outperform rivals in the same industry by acquiring a unique set of strategic assets (or resources). We suggest firms achieve competitive advantage through 'cognitive asymmetries' (differences between dominant managerial mental models) that lead rival management teams to implement distinct resource building

strategies. This managerial and cognitive view of competition and rivalry lends itself to investigation through problem structuring methods. We suggest that resource maps, as a problem structuring method, can be used to interpret managerial mental models for strategic decision-making in terms of resource building processes. Through resource maps, we represent the system of asset stocks believed to be most important for driving business performance. We illustrate the framework by comparing and contrasting maps of the system of resources (asset stocks) that best characterise the four leading firms in the UK Commercial Radio Broadcasting Industry.

Martin H. Kunc

mkunc@london.edu
London Business School
Regent's Park
London NW1 4SA
UK

Illustrating the Competitive Dynamics of an Industry: The Fast-Moving Consumer Goods Industry Case Study

There are some industries whose strategic innovations are easier and faster to replicate because the products are mostly commodities, one of such industries is the fast-moving consumer goods industry (FMCG). In the fast-moving consumer goods industry, companies face a very difficult, if not almost impossible, task developing a competitive advantage based on differentiation or low cost strategies. The main reason is that competitors match or, even overtake innovations and costs reductions in a very short period. A case study illustrates the competitive dynamics of a market segment of this industry using a behavioral model (Morecroft, Lane, and Viita, 1991). The model captures the management team understanding of the competitive dynamics of the industry.

Chet Labedz

labedz@bc.edu
Boston College
PO Box 114057
North Providence RI 02911
USA

George Stalker

georgestalker@dataleaf.net
Dataleaf Technologies Inc
486 Concord Street
Carlisle MA 01741
USA

Addressing Methodological Issues in Simulating a Human Resources Problem across Multiple Levels of Observation

Problems of strategic human resource management, such as proposed reductions in prospective retirement benefits under an American pension plan, present complex challenges. Typically, a firm pursues strategic objectives such as Cost control through changes in focal policies and programs affecting its workforce. At such times a firm should be wary of long-term consequences among individual employees, since the firm, its programs, and its employees, comprise a three-level feedback system. Unintended consequences at the micro-organizational level may lead in turn to additional unpleasant surprises at the program or firm levels. This paper discusses the development of a simulation model combining the approaches of agent based and system dynamics disciplines in addressing a client's multi-level concerns. It articulates differences between the agent based and system dynamics modeling disciplines in the service of this task, and discusses issues of implementation and praxis which have governed our design at points of tangency between these approaches in such a hybrid model.

Peter Lacey

peter.lacey@ndirect.co.uk
Whole Systems Partnership
The Old Crown
Farnham North Yorks HG5 9JD
UK

Futures through the Eyes of a Health System Simulator

A demonstration and discussion of the process and benefits of building a 'high level' strategic simulation tool for a UK Health Authority seeking to build an evidence base to support strategic investment decisions across the primary and secondary health care system. The presentation will discuss the key drivers for change and performance expectations in the UK health system. It will describe the rationale behind the Health Authority's request and the means of delivering on this. Particular emphasis will be placed on the learning process that took place during model construction, the key links to strategic decision making, evidence of the benefits to the Authority during and since the simulator development and the way in which the simulator tool has been placed locally to inform and influence performance monitoring. The workshop will demonstrate the model itself as well as outputs generated by at least one 'future scenarios' workshop held locally.

Rene LeClaire

rjl@lanl.gov
Los Alamos National Laboratory
275 Kimberly Lane
Los Alamos NM 87544
USA

B. Bush

bwb@lanl.gov
Los Alamos National Laboratory
PO Box 1663
Los Alamos NM 87545
USA

Lori Dauelsberg

lorid@lanl.gov
Los Alamos National Laboratory
PO Box 1663 MS K557
Los Alamos NM 87545
USA

Critical Infrastructure Protection Decision Support System

The Critical Infrastructure Protection Decision Support System (CIP/DSS) simulates the dynamics of individual infrastructures and couples separate infrastructures to each other according to their interdependencies. For example, repairing damage to the electric power grid in a city requires transportation to failure sites and delivery of parts, fuel for repair vehicles, telecommunications for problem diagnosis and coordination of repairs, and the availability of labor. The repair itself involves diagnosis, ordering parts, dispatching crews, and performing work. The electric power grid responds to the initial damage and to the completion of repairs with changes in its operating characteristics. Dynamic processes like these are represented in the CIP/DSS infrastructure sector simulations by differential equations, discrete events, and codified rules of operation. Many of these variables are output metrics estimating the human health, economic, or environmental effects of disturbances to the infrastructures.

Dennis Powell

drpowell@lanl.gov
Los Alamos National Laboratory
PO Box 1663
Los Alamos NM 87545
USA

S. DeLand

smdelan@sandia.gov
Sandia National Laboratories
PO Box 5800
Albuquerque NM 87185
USA

M. Samsa

msamsa@anl.gov
Argonne National Laboratory 9700 S
Cass Avenue
Argonne IL 60439
USA

Rene LeClaire

rjl@lanl.gov
Los Alamos National Laboratory
275 Kimberly Lane
Los Alamos NM 87544
USA

Leveraging a High Fidelity Switched Network Model to Inform a System Dynamics Model of the Telecommunications Infrastructure

A generic representation of the telecommunications infrastructure in a metropolitan area designed to be integrated into a much larger

Gerald O'Reilly

goreilly@lucent.com
Bell Laboratories/Lucent
Technologies
Lucent Technologies
101 Crawfords Corner Rd
Holmdel NJ 07733
USA

simulation of the seventeen key infrastructures[1] has been implemented in Vensim[2]. This Critical Infrastructure Protection Decision Support System (CIP/DSS) is designed to provide insights for the Department of Homeland Security (DHS) in making decisions about investments related to critical infrastructure protection[3]. Although a system dynamics representation was well suited to representing the dynamics and interdependencies in this complex system of systems, it was recognized early on that collaborations with key infrastructure domain experts and organizations would be important to the success of the project. This paper summarizes the results of a collaborative effort with Bell Laboratories, Lucent Technologies to leverage a detailed switched network simulation to inform the telecommunications system dynamics model in CIP/DSS.

Rene LeClaire

rjl@lanl.gov
Los Alamos National Laboratory
275 Kimberly Lane
Los Alamos NM 87544 USA

Dennis Powell

drpowell@lanl.gov
Los Alamos National Laboratory
PO Box 1663
Los Alamos NM 87545 USA

Jeanne Fair

jmfair@lanl.gov
Los Alamos National Laboratory
PO Box 1663
Los Alamos NM 87545 USA

Leslie Moore

lmoore@lanl.gov
Los Alamos National Laboratory
PO Box 1663
Los Alamos NM 87545 USA

David Thompson

dt.home@comcast.net
Crescent Solutions
1102 Russell Drive
Highland Beach FL 33487 USA

Sensitivity Analysis of an Infectious Disease Model

A model of infectious diseases has been developed for integration within a larger simulation structure to assess the interdependencies of critical infrastructures. The model has been parameterized to model a disease outbreak a large metropolitan area. The model subsequently calculates the spread of the infection and the influence of vaccination policies, quarantine and isolation procedures. Consequences are deaths, illnesses, and a variety of economic costs. Sensitivity analysis is a statistical technique to investigate how uncertainty in the input variables affects the model outputs and which input variables tend to drive variation in the outputs. Such analysis can provide critical information for decision makers and public health officials who may have to deal with the realities of a virulent infectious disease. This paper presents the results of preliminary analyses of the effects of inputs to the infectious disease model on the calculated consequences.

Man-Hyung Lee

manlee@cbnu.ac.kr
Chungbuk National University
Dept of Urban Planning and Eng
12 Kaeshin-Dong Heungduck-Ku
Cheongju 361-763
 South Korea

Resource Cyclical Dynamics of Electric and Electronic Equipment Waste

As a practical means to upgrade urban sustainability, this paper focuses on resource cyclical systems concerned with electric and electronic equipment waste (EEEW) in Korea. Borrowing System Dynamics concepts and approaches, it examines behavioral changes of EEEW dynamics to see whether the existing management methods can be readjusted. The measurement is based upon both reuse and material and thermal recycle simulation works in the individual stage of EEEW discharge, collection, and treatment, going beyond the traditional recycle-only customs. This research estimates that the newly introduced Extended Producer Responsibility (EPR) system

would definitely exert a significant impact on the final stage of EEEW treatment, decreasing the final treatment volume in the first half of the research period. The trend, nonetheless, would be reversed in the second half, mainly owing to the additional waste volume originated from the local government and recycling center. Sensitivity analysis poses, among others, that the local government-supported reuse center should take charge of a pivotal role in the EEEW management and treatment in the long run. The research also shows that sufficient and necessary conditions for the EEEW management and treatment should be given to the combined efforts, both from the private sectors and the public domains. Based on these research findings, the paper recommends that key stakeholders including the producer and the public organizations should devise how to carry out specific agenda centered around partnership or network buildings.

Tsuey-Ping Lee

tping@mail.thu.edu.tw
Tunghai University
Department of Public Administration
181 Taichung-kang Rd Sec 3
Taichung Taiwan ROC

Implementing Local Social Welfare Policy: A Systems Dynamics Perspective

This article intends to conceptualize the problem of low interagency collaboration in implementing local social welfare policies into a system dynamics model. This conceptualized model is introduced to explore the possible factors facilitating and hindering interagency collaboration between Department of Social Welfare (DSW) of city government and Social Affairs Section (SAS) of district office in both Taipei City and Kaohsiung City of Taiwan. The model combines insights from policy implementation theory, qualitative data from interviews with DSW and SAS staffs, and system dynamics literatures. Although this model is not yet formulated, several insights have been obtained. This study finds that the institutional design has made cooperation between two agencies difficult. Such an interagency relationship is reluctant compliance rather than partnership. This article argues that a homogeneous realization of the cooperation pattern among implementation participants is necessary for building effective interagency relationships in policy implementation.

Geng Li

gli005@student.uib.no
University of Bergen
Postbox 366 Fantoft Studentboliger
5075 Bergen
Norway

Modeling the Effect of Information Feedback on the SARS Epidemic in Beijing

Compared with many preventable epidemics, how did a relatively insignificant disease like SARS develop into an international scare? This article describes the application of system dynamics to understand the SARS epidemic in Beijing. The powersim model simulates the structure of transmission dynamics and factors that impact the epidemic. Here, the probable impacts of changes in the system delays, including delays to quarantine, delays of disease diagnose, and the authorities' epidemic information transmitting delays, are discussed. The model aims to present detailed understanding of delayed feedback mechanisms inherent to eliminate the misperceptions of basic dynamics, and then to design high leverage policies for preventing SARS. The article concludes that an open and transparent public information system is the most powerful

weapon to curb SARS panics. The government's prompt epidemic information feedback system and relatively instant strong quarantine policies have substantial impacts on containing SARS epidemic.

Jun Lin

linjun@nus.edu.sg
National University of Singapore
QRE Lab ISE Dept Blk E1 #07-17
10 Kent Ridge Crescent
11920 Singapore

Kah Hin Chai

iseckh@nus.edu.sg
National University of Singapore
Dept Industrial & Systems
Engineering Singapore

Yoke San Wong

mpewys@nus.edu.sg
National University of Singapore
Department of Mechanical
Engineering Singapore

Aarnout C. Brombacher

a.c.brombacher@tm.tue.nl
Eindhoven University of Technology
Faculty of Technology Management
Eindhoven The Netherlands

Dynamic Modeling of Distributed Product Development Processes

Market and technology changes have brought about new characteristics of product development. One of the most significant changes from the traditional to the new paradigm is the change from sequential and collocated development processes to concurrent and distributed processes. Although some researchers have built models of development processes and product development performance, most of these studies are about collocated development projects where the coordination between tasks is not explicitly studied. Consequently, there is a need to model the relationships between development processes and project cycle time in the distributed context, with special attention to the coordination between tasks. With the support of a design company, we developed and validated the model with data from mobile phone projects.

Chao-Yueh Liu

chaoyueh.liu@gmail.com
University at Albany
14 Niblock Ct Fl 2
Albany NY 12206
USA

Wei-Tsong Wang

ww8256@albany.edu
University at Albany
School of Information Science &
Policy
840 Washington Avenue
Albany NY 12203
USA

A System Dynamics Approach to Simulation of Tax Policy for Traditional and Internet Phone Services

Voice Over Internet Protocol (VOIP) is the fastest-growing market in the United States. VOIP technology provides telephone-like service without the restrictions of telecommunication regulations. State governments fear that more calls traveling over Internet protocol (IP) enabled phone services will impact on the heavily-taxed fixed line phone service, which means less tax revenue to support crucial public services. However, states are struggling with how to tax VOIP services and reduce the impact of VOIP development. In this paper, we build a system dynamics model to gain insight into interactions between the VOIP market, traditional phone market, and tax policy. Two tax policy tests reviewed in this paper show tax policy does not significantly affect market competition. In addition, we show government is able to collect sufficient funds when applying new tax policy. We believe the model can help policy makers find a better way to collect maximum tax revenue with less impact on the market.

Elaine Lizeo

elaine.lizeo@sloan.mit.edu
MIT
Sloan School of Management
305 Memorial Dr 211A
Cambridge MA 01239 USA

A Dynamic Model of Group Learning and Effectiveness

The objective of this study is to explore the factors that influence the quality of group learning and group effectiveness in organizations. Learning enables groups to acquire new skills, improve processes,

find new ways of working, and enhance their decision-making process. However, group learning is affected by a set of structural, cognitive and interpersonal factors, which may foster or hinder the engagement of group members in learning-oriented activities. This study regards work groups as complex social systems and suggests that the explanation of the quality of learning and the effectiveness of a group lies in the interrelations of these factors. Existing research on group learning tends to follow an input-process-output approach; in contrast, this study offers a system dynamics model to explore the intricate relationships that arise from the factors such as group dynamics and leader behavior and that influence the outcomes of a work group. Although the model is highly aggregated, the simulation results can improve our understanding of the interrelations of key factors that influence group learning and effectiveness and farther the path for future research using system dynamics to study work groups as complex systems.

Yu-Tang Lo

m9141616@student.nsysu.edu.tw
National Sun Yat-Sen University
PO Box 59-35
Kaohsiung 804
Taiwan ROC

Shyh-Jane Li

d9041813@student.nsysu.edu.tw
National Sun Yat-Sen University
PO Box 59-35
Kaohsiung 804
Taiwan ROC

Yu-Lung Hsueh

yulung.hsueh@gmail.com
National Sun Yat-sen University
PO Box 59-35
Kaohsiung
Taiwan ROC

Showing H. Young

young@cm.nsysu.edu.tw
National Sun Yat-Sen University
Department of Business
Management
PO Box 59-35
Kaohsiung Taiwan

China Dynamics: Limits to Growth?

1989, Berlin Wall collapsed; 1991, Soviet Union collapsed; communists systems around the world collapsed one after the other. Communist China not only survived, but started to grow even stronger. Why? Our research tries to use systems approach to better understand these issues. We first use systems thinking to analyze China's economic growth, which showed limits to growth archetypes with the limit of implicit control goal of Chinese Communist Party (CCP): maintain unilateral control. Further studies in this research showed that this implicit control goal relates to the nature of CCP. Our efforts then focused on the degree of change of this nature. We found that the nature of CCP, deceit, violence, and control, are still the same, which are just hidden from the outside world. Our causal loop analysis also showed that China's opening reform will lead to unintended consequences of various socio-economic problems. We then build a system dynamics model to simulate electricity supply as just one example to examine its limit to economic growth in China; the simulation showed a boom and bust result. This research shows that China will encounter very serious social and economic upheavals in the near future seems inevitable.

Corey Lofdahl

clofdahl@bos.saic.com
SAIC
Simulation and Info Technology Div
20 Burlington Mall Road Ste 130
Burlington MA 01803 USA

Designing Information Systems with System Dynamics: A C2 Example

It has long been thought that simulation could be used to design Command and Control (C2) systems, but simulation's benefits have not matched their promise. Instead Enterprise Architecture Planning (EAP) tools have become ascendant in the design of C2 systems, though problems remain. EAP tools break down proposed systems into their low-level, constituent parts and place them into sophisticated relational databases. The resulting architectures however do not yield an intuitive sense of whether the proposed system

actually solves the motivating problem. Consequently, fundamental conceptual issues continue to emerge deep into the design process. This study proposes using simulation early in the design process to envision the total system and avoid problems by generating requirements and metrics early in the design process. Issues regarding an Air Force Air Operations Center (AOC) are explored, most notably flow of control and the coordination of sensor, decision, and operator assets.

Luis López

luis.lopez@incae.edu
INCAE Graduate School of Business
PO Box 960-4050
Alajuela 4050
Costa Rica

Porfirio Guevara

Roy G. Zúñiga-Saenz
roy.zuniga@incae.edu
INCAE
Apdo Postal 1347-1011 y Griega
San Jose
Costa Rica

Forecasting Primary Education Efficiency

Education is considered one of the main drivers of welfare in society. However, countries in the world follow different paths when creating basic human capabilities, many of them not in the right direction. Linear extrapolation is still widely utilized to predict future behavior based on statistics like the Primary Completion Rate. This paper presents a dynamic model of primary education as a first step to understand the structure and behavior of educational systems and as an alternative way to extrapolate outcomes of this and other relevant key indicators, like the Gross Enrollment Rate. The model is calibrated for the case of Nicaragua.

Luis López

luis.lopez@incae.edu
INCAE Graduate School of Business
PO Box 960-4050
Alajuela 4050
Costa Rica

Forgetting Curves: A Case Study

We explore organizational forgetting, the notion that firms' knowledge can be lost through human capital decay. An in-depth case study research, which is guided by the conceptualization of a system dynamics model, is conducted. The evidence appears to support the presence of forgetting. This gives rise to the possibility of productivity falling in spite of continued output accumulation, due to changes in the characteristics of the resource where experience resides. Most prior research on learning curves, however, assumes that productivity will always increase with cumulative firm output.

Tobias Lorenz

space56@freenet.de
University of Bergen
Villaveien 3
5007 Bergen
Norway

Andrea Marcello Bassi
4141@stud.liuc.it
University of Bergen
via Jean de Fernex 5
Olgiate Olona VA 21057
Italy

Comprehensibility as a Discrimination Criterion for Agent-Based Modelling and System Dynamics: An Empirical Approach

Agent-based modelling seems to be an alternative way of modelling to System Dynamics. Criteria for discriminating the methodologies, and criteria for the choice of which one to use, still remain vague. This study compares both approaches on an empirical basis, utilizing an exploratory experiment aimed at investigating the respective comprehensibility of each methodology. The gained results, considering all the observations, show no significant differences between the two treatments. Nevertheless if the subjects are grouped into SD students and non-SD students, differences are observed. Interestingly it shows an advantage of the AB approach for the SD student group, whereas the non-SD students seem to have an advantage with the SD methodology.

Qiang Lu

q.lu@auckland.ac.nz
University of Auckland
MSIS Department
2/1759 Great North Road
Auckland New Zealand

Kambiz E. Maani

k.maani@auckland.ac.nz
University of Auckland
Business School Tamaki Division
Private Bag 92019
Glen Innes
Auckland AK1005 New Zealand

Analyzing the Conflict between Production and Manufacturing Engineering: A System Dynamics Model

Based on an in-depth field study in an electronics plant in Singapore, this paper examines the dynamic interaction between two of the key functions, Production (P) and Manufacturing Engineering (ME). P and ME are responsible for process execution and process development respectively, and for process smoothness jointly; their relationship is asymmetrical if judged from organizational and structural aspects. The paper reveals the causes and effects of three types of short-sighted functional behavior – burden-shifting, resource-fighting, and corner-cutting. The resulting P-ME conflict due to short-sighted behaviors is analyzed in a qualitative system dynamics model. Although this research is based on a single firm, the findings have implications for many contemporary plants where the proliferation of new processes puts stress on the P-ME interface. Future researchers can use more samples to test and theorize the findings of this research.

Alexander Lubyansky

al8295@albany.edu
University at Albany
6 South Lake Avenue Apartment
S1R
Albany NY 12203
USA

A System Dynamics Model of Health Care Surge Capacity

The author has created a system dynamics model to investigate how health care providers can and should respond to increases in patient demand for treatment above usual levels. This response by the health care system is called surge capacity and is an important issue in emergency and disaster planning and response. The model describes how hospital and home care treatment providers can alter their internal staffing and patient treatment policies as well as movements of staff and patients between each other. These providers can fail to respond adequately to surge events by exhausting their staff or by moving too much burden from the hospital sector to the home care sector.

Luis F. Luna-Reyes

luisf.luna@udlap.mx
Universidad de las Americas Puebla
School of Business NE-221J
Santa Catarina Martir
Cholula Puebla 72820
Mexico

Ignacio J. Martínez-Moyano

im7797@albany.edu
University at Albany
Milne 318
Rockefeller College
Albany NY 12222
USA

Group Modeling of IT-Based Innovations in the Public Sector

The system dynamics group at the Rockefeller College of the University at Albany has been developing techniques to create system dynamic models with groups of managers during the last 25 years. Building upon their tradition in decision conferencing, the group has developed a particular style that involves a facilitation team in which people plays different roles. Throughout these years of experience, the group has also developed several "scripts" to elicit knowledge from experts based on small-groups research, and well-established practices in the development of system dynamics models. This paper constitutes a detailed documentation of a relatively small-scale modeling effort

Theresa Pardo
tpardo@ctg.albany.edu
University at Albany
Center for Technology in
Government
187 Wolf Road
Albany NY 12205 USA

that took place in early 2001, offering a "soup to nuts" description of Group Model Building at Albany. The paper describes in detail 8 of the scripts that the group has developed, offering some reflections about their advantages and limitations.

Anthony M. Cresswell
tcresswell@ctg.albany.edu
University at Albany
Center for Technology in
Government
187 Wolf Road
Albany NY 12205 USA

David F. Andersen
david.andersen@albany.edu
University at Albany
315A Milne Hall
135 Western Avenue
Albany NY 12222 USA

George P. Richardson
gpr@albany.edu
University at Albany
Dept of Public Administration &
Policy
Milne 101 Rockefeller College
Albany NY 12222 USA

Luis F. Luna-Reyes
luisf.luna@udlap.mx
Universidad de las Americas Puebla
School of Business NE-221J
Santa Catarina Martir
Cholula Puebla 72820 Mexico

Vedat G. Diker
diker@glue.umd.edu
University of Maryland
College of Information Studies
4105 Hornbake Building
College Park MD 20742 USA

Deborah Lines Andersen
dla@albany.edu
University at Albany
113 Draper Hall
135 Western Avenue
Albany NY 12222 USA

Interviewing as a Strategy for the Assessment of System Dynamics Models

System dynamics requires the intense use of qualitative data and human judgment in all stages of model development. Most approaches to the formal inclusion of qualitative data have been developed with the purposes of knowledge elicitation during the conceptualization or formulation stages of model development. Although the importance of using expert judgment to assess the validity of system dynamics models is well recognized, the development of approaches to use this kind of judgment is not well developed. In recent years, efforts to develop tools to assess the validity of system dynamics models by interviewing experts have been explored in some doctoral work. This paper reviews the basic concepts of model validation, and explores the use of interviews as a research and knowledge-acquisition technique. Finally, it documents and compares four applications of interviewing as a tool to assess system dynamics models, ending with recommendations for both the practitioner and researcher.

Yufeng Luo
yufengluo@163.com
Wuhan University
School of Water Resources &
Hydropower
8 Donghunan Road
Wuhan Hubei 430072 China

Shahbaz Khan
shahbaz.khan@csiro.au
Charles Sturt University
School of Science and Technology
Wagga Wagga NSW 2650
Australia

Yuanlai Cui
Wuhan University
School of Water Resources &
Hydropower
8 Donghunan Road
Wuhan 430072 China

A System Dynamics Model for Sustainable Irrigation Water Management in the Lower Yellow River Basin

This paper describes a system dynamics study to investigate sustainable irrigation water management of irrigation systems where water resources scarcity and irrigation-induced soil salinization threaten the sustainability of irrigated agriculture. The study focuses on the Liuyuankou Irrigation System (LIS) in the lower Yellow River Basin, China. In LIS, crops in the upland are usually irrigated with surface water from the river and crops in the lowland are mainly irrigated with pumped groundwater. Seepage from irrigated field in upland is an important source of recharge to lowland groundwater and if there is not enough recharge to lowland groundwater, deep watertables increase cost of groundwater abstraction, even result in overdraft conditions. On the other hand, too much seepage results in shallow groundwater tables that cause secondary soil salinization. A conceptual model of the LIS hydrologic system is developed and it is implemented using the system dynamic tool, Vensim. The validated

model is used to simulate the responses of groundwater table under different management scenarios. Analysis of the simulation results reveal under what conditions the groundwater tables reach alarming levels and with what strategies it can be controlled and strategies for sustainable water resources development are investigated.

Kambiz E. Maani

k.maani@auckland.ac.nz
University of Auckland
Business School Tamaki Division
Private Bag 92019
Glen Innes Auckland AK1005
New Zealand

Managerial Intervention and Firm's Performance

Decision-makers and managers have often an irresistible tendency to "over intervene" in the systems (companies, organizations, communities, etc) for which they are responsible hence generating unnecessary fluctuations and instability in their organizations. Sterman, et al (1989; 2000) and Maani & Li (2004) have studied these phenomena in simulated and experimental settings. This paper examines the impact of change and managerial intervention on firm's performance. Frequency and magnitude of change actions are used as proxy for managerial intervention. Based on prevailing assumptions and common practice two hypotheses are postulated as follows: H01 : The more frequent the change (interventions), the better the results. H02 : Dramatic change leads to dramatic (positive) results. The above hypotheses and our own observations collectively inform the key research question posed in this paper: "How do the style (extent) and frequency of change and the interpretation of feedback affect the outcomes of interventions in organizations?" In this research, Microworlds are employed as proxy for complex systems. Research subjects comprise MBA and graduate business students and practicing managers. With some exceptions, the results refute the above hypotheses and suggest that over intervention could often lead to counter productive outcomes.

Raymond Madachy

madachy@usc.edu
University of Southern California
7734 Via Sorrento
Burbank CA 91504
USA

Software Business Case Modeling

Business value attainment should be a key consideration when designing software processes. Ideally they are structured to meet organizational business goals, but it is usually difficult to integrate the process and business perspectives quantitatively. This research uses modeling and simulation to as-sess process tradeoffs for business case analysis. An improved model for com-mercial software enterprises relates the dynamics between product development investments, software quality practices, market size, license retention, pricing and revenue generation. The system dynamics model allows one to experiment with different product strategies, software processes, marketing practices and pricing schemes while tracking financial measures over time. It can be used to determine the appropriate balance of process activities to meet goals. Examples are shown for varying scope, reliability, delivery of multiple releases, and de-termining the quality sweet spot for different time horizons. Results show that optimal policies depend on various stakeholder value functions, opposing mar-ket factors and business constraints.

Stuart Madnick

smadnick@mit.edu
MIT
30 Wadsworth Street Room E53-321
Cambridge MA 02142
USA

Nazli Choucri

nchoucri@mit.edu
MIT
E53-493
Cambridge MA 01239
USA

Michael Siegel

msiegel@mit.edu
MIT
Sloan School E53-323
Cambridge MA 02142
USA

Research Initiative to Understand and Model State Stability: Exploiting System Dynamics

In its Preface, The 9/11 Commission Report states: "We learned that the institutions charted with protecting …national security did not understand how grave this threat can be, and did not adjust their policies, plans, and practices to deter or defeat it" (2004: xvi). Given current realities and uncertainties "better preparedness" can be achieved by identifying, controlling and managing the elusive linkages and situational factors that impact state stability and fuel state decay and destruction – and hence create new threats to the nation's security. We propose to focus on the use of system dynamics modeling techniques to help understand, measure and model the complex dynamics shaping state stability, initially for two regions. We will specifically consider the impacts of unanticipated disruptions, such as a tsunami and its aftermath, on the dynamics of the two regions. For each region, we will develop a country model, along with an analysis of conditions and casual links between predicted futures plus corresponding mitigated options. The presentation will include an update on the status of this project.

Mohammad Majdalawi

abhjmhm@yahoo.com
Arab Organization for Agricultural Dev
PO Box 1206 Tela,a Al-Ali
11953 Amman

Modeling Re-Used Water in Agriculture and Its Future Environmental Impact – A Case in Jordan

The availability of water as a natural resource in the agricultural sector is directly related to the development of farming and rural systems. Water quality is closely linked to water use and to the state of economical development. The re-use of water could be another source for increasing water availability. The use of high quality water for irrigation might be reallocated to other sectors. The re-use of water may, however, potentially engender environmental problems in water resources. This paper aims to simulate and measure the impact of future strategies of water availability and quality on the pattern of crops, and to assess the possibilities of avoiding negative impacts on the environment. It aims to find out a model could be used and modified by other countries suffer from water quantity. The dynamic system approach has been used to analyse the environmental impact of using treated wastewater on planting different crops. The main results show that the quantity of treated wastewater increases and the quality becomes worse over time. The quality of water until 2020 is suitable for use in irrigating fruit trees in area far from treatment plant and feed crops in area near treatment plant unless the efficiency of the treatment plant decreased.

Abhijit Mandal

abhijit.mandal@wbs.ac.uk
Warwick Business School
ORS Group
Gibbet Hill Road
Coventry CV4 7AL UK

Mental Models, Resource Constraints and Differential Performance

This paper integrates the resource-based view (RBV) with concepts from the literature on managerial cognition and organizational slack to

show how shifts in resource constraints can lead to shifts in firm performance and even industry structure over time. Using a process-based method, we show that a shift in constraints of resources, under the moderating impact of heterogeneous mental models and resource structure, shift resource allocations. In turn, this creates and sustains resource heterogeneity, leading to differential performance. Previously developed propositions are tested using simulation in two strategic business units from a leading player in the UK insurance industry. The conclusion highlights implications for research methods, strategy theory and managerial practice.

Massimo Maoret

maoretm@cs.unibo.it
University of Bologna
Mura Anteo Zamboni 7
40127 Bologna Italy

Gianluca Colombo

gianluca.colombo@lu.unisi.ch
University of Lugano
Via Giuseppe Buffi 13
CH-6904 Lugano Switzerland

Edoardo Mollona

emollona@cs.unibo.it
Università degli Studi di Bologna
Department of Computer Science
Mura Anteo Zamboni 7
40127 Bologna Italy

Why So Many Start-Ups Fail: A Resource-Based Approach Through System Dynamics

In the article we address recurring causes of failures in starting up a new company. In particular, we explore flaws in entrepreneurs' mental model when dealing with feedback and delays in building up stocks of assets. The work that we are presenting is in progress but scored the following targets. First, under a theoretical point of view, we laid down borders to define a theoretical territory where the strong connections can be observed that entwine literatures on start-up, on the resource-based view of the firm and system dynamics. Second, we created an experimental laboratory to test individuals' recurring mistakes when dealing with a start-up. Further developments of this work are in the direction of setting an experimental protocol to conduct empirical research on a sample of players.

Maria Angélica Martínez Medina

angelica.martinez@itesm.mx
Tecnologico de Monterrey
Eugenio Garza Sada 2501
Edificio Cedes Oficina S1020
Monterrey Nuevo Leon 64849
Mexico

Carlos Scheel

cscheel@itesm.mx
Tecnologico de Monterrey
Ave Eugenia Garza Sada 2501 Sur
Colonia Tecnologico CP 64849
Monterrey Nuevo Leon Mexico

Gloria Pérez Salazar

gloria.perez@itesm.mx
Tecnologico de Monterrey
Dept of Industrial and Systems Eng
Av E Garza Sada 2501 Sur
64849 Monterrey NL Mexico

Roberto Rodríguez

rjrdz@itesm.mx
Tecnologico de Monterrey

Regional Industrial Development Based on the Dynamics of the Technological Innovation Cycle

This paper describes a systems dynamics model that reflects the possibility of having three levels of complexity together and articulated on a synchronous synergy of all relevant participants of value added systems: the activities at the firm level, networks of industries, and supporting organizations at the regional level. Following a systemic approach, we have identified eight parameters to measure the attractiveness effect of a region: Clustering and associativeness, Value added, Differentiation value, EVA, Attractiveness leverage, Global market coverage, Innovation and Social Capital. Based on these indicators, we have developed dynamic models for emergent industries which have uncertain trends and no previous regional developments. At this moment we are working on models for the Software, Biotechnology, Aerospace and Autoparts Industries that are currently in the process of clustering in the State of Nuevo Leon (Mexico).

Ignacio J. Martínez-Moyano

im7797@albany.edu
University at Albany
Milne 318 Rockefeller College
Albany NY 12222 USA

David McCaffrey

d.mccaffrey@albany.edu
University at Albany
135 Western Avenue
Albany NY 12222 USA

Rogelio Oliva

roliva@tamu.edu
Texas A&M University
Mays Business School
325M Wehner - 4217
College Station TX 77843-4217
USA

A Dynamic Theory of Rule Compliance: Evidence from the United States Securities Industry

This paper uses a system dynamics model to analyze rule compliance in organizations. The analysis takes securities regulation as an illustrative case but applies to other private, nonprofit, and public activities complying with rules overseen by external bodies in the course of producing goods and services. We consider how three levels of behavior—producers, internal organizational controllers, and external regulators—interact in shaping compliance with rules.

Ignacio J. Martínez-Moyano

im7797@albany.edu
University at Albany
Milne 318 Rockefeller College
Albany NY 12222 USA

R. Joel Rahn

jrahn@sympatico.ca
4636 Sugar Maple Drive
Ottawa ON K1V 1Y6 Canada

Roberta L. Spencer

system.dynamics@albany.edu
System Dynamics Society
Milne 300 Rockefeller College
University at Albany
Albany NY 12222 USA

The Beer Game: Its History and Rule Changes

This paper explores the history of the Beer Game, its rules, and lessons. By triangulating information from the literature, archival analysis, and interviews with experts in the field, we have identified the main changes in the game over its almost 50-year history. Additionally, an exploration of possible changes to the game and new games in the field of system dynamics are examined.

Ali N. Mashayekhi

mashayekhi@alum.mit.edu
Sharif University of Technology
Grad School of Management and Econ
PO Box 11365-8639 Azadi Avenue
11365 Tehran Iran

Navid Ghaffarzadegan

navid3000@yahoo.com
Sharif University of Technology
No 14 Sadi Alley
Vali-Asr Ave Tajrish Sq
Tehran Iran

Stock Market Fluctuations: A System Dynamics Approach

Developing strategic policies which could protect the stock market from wild fluctuations and bubbles is a challenging area in financial management. When the price index rises fast, the chances of its collapsing increase. The collapsing of bubbles leads to large negative returns. Researchers have argued the stock price behavior does not always follow the economics fundamentals. There are nonlinear and complex factors affecting changes in the stock prices. System dynamics as a way of analyzing complexity and nonlinearity could give us a new perspective to analyze the dynamic behavior of stock price index. This paper develops a model to examine main causes of growth and shrink of stock market index.

Dian Masyita

dianmasyita@fe.unpad.ac.id
Padjadjaran University
Faculty of Economics
Unpad Dipati Ukur no 35
Bandung Indonesia

Muhammad Tasrif

ppeitb@bdg.centrin.net.id
Bandung Institute of Technology
Energy Research and Development
Group
Jl Ganesha 10
Bandung 40132 Indonesia

Abdi Suryadinata Telaga

abdi.suryadinata@astra-honda.com
Astra Manufacturing Polytechnic
Information System Department
Jakarta
Indonesia

A Dynamic Model for Cash Waqf Management as One of the Alternative Instruments for Poverty Alleviation in Indonesia

This research tries to offer a design of the cash waqf management system in a system dynamics model. The Cash Waqf Management is expected to become one of the alternative instruments for the poverty alleviation programs in Indonesia. These programs require huge amount of fund that cannot be provided thoroughly by the government. Therefore, initiation of new sources of fund for such a program is inevitable. In the Islamic sosio-economic concept, there is a source of social fund that is economically and politically free of charge, namely cash waqf. In this concept, Nadzir (cash waqf fund manager) collects the fund from Waqif (cash waqf payer) and invest the money in the real sector and in any syariah-based investment opportunities. Nadzir could allocate profits and returns gained from the investments to poverty alleviation programs. Nadzir is obliged to maintain the amount of fund in such a way that it does not go below the initial amount. Therefore, Nadzir not only should be highly capable, but also needs an experienced financial institution in helping SMEs development efforts. Using the system dynamics methodology, we tries to know the structure of cash waqf system and simulate the behaviour of cash waqf model.

Geoff McDonnell

gmcdonne@bigpond.net.au
University of New South Wales
382 Bronte Road
Bronte NSW 2024
Australia

Mark Heffernan

mheffernan@evanspeck.com.au
International System Dynamics Pty
Ltd
20B/390 Eastern Valley Way
East Roseville NSW 2069
Australia

The Dynamics of Hospital Medication Errors: A Systems Simulator Testbed for Patient Safety Interventions

Medication errors in hospitals are a large and increasing problem, which has traditionally been considered a result of human error. Recent attempts to reduce errors have emphasised systems approaches and improvements in information and communications technologies (ICT). As part of a multi-method evaluation project for hospital point of care clinical systems, we assembled a team of professionals from a variety of clinical, information management, health management, sociology, linguistics and engineering backgrounds. We built a systems simulation for explicitly representing the interactions among the key determinants of medication errors. These included the complex interactions of patients and staff, information, medications, work practices and the infrastructure and policies within a hospital environment. Our team simulated hospital inpatient and staff flow, generation and interception of medication errors, and the potential impacts of ICT-enabled work practice changes. This paper describes the System Dynamics Model of long-term context that produces errors in the medication management process. Future extensions include the use of a combined agent based and SD simulation to produce a multi-method, multi-level systems simulation testbed as an integrating framework for evaluating combinations of improvement interventions.

Nicholas McKenna

nickmck@mit.edu
MIT
199 Massachusetts Ave Apt # 1012
Boston MA 02115
USA

Executing Major Projects through Contractors

Project based organizational structures are utilized in many industries. The firms engaged in these endeavors, project sponsor and contractor alike, risk both capital and reputation in the market-place with each new project. The relationship between project sponsor and contractor influences the outcome of the project to a significant extent. Complex and challenging projects are made more so by the adversarial relationships that frequently exist between the sponsor and contractor(s). This paper presents a model for examining the influence of the contractor/sponsor relationship on the execution of a project. The focus is on the effects of the relationship, as determined by the financial performance of the engaged firms and key project performance indicators (schedule, budget etc), on the degree to which the firms engage and the impact this has on project performance. Analysis of the model indicates the importance of appreciating the project's need for effective team integration in determining the financial arrangements.

Alan Charles McLucas

a.mclucas@adfa.edu.au
Australian Defence Force Academy
UNSW School of Aerospace Civ &
Mec Eng
Northcott Drive
Campbell ACT 2600 Australia

Michael J. Ryan

mj.ryan@adfa.edu.au
University of New South Wales
Australian Defence Force Academy
Northcott Drive
Campbell ACT 2600 Australia

Meeting Critical Real-World Challenges in Modelling Complexity: What System Dynamics Modelling Might Learn From Systems Enginee

System dynamics is still evolving. This paper argues additional rigour is needed if system dynamics is to achieve its full potential in helping us understand complex behaviour of human activity systems. It argues that a detailed appreciation of how systems engineers define, analyse, specify, manufacture, operate and support complex systems could inform the evolution of system dynamics even though there are significant differences between the two disciplines. The proffered approach integrates systems thinking, system dynamics modelling and systems engineering. This integrated approach enables group model building and building of exceedingly complex models through top-down design and careful management of the complexity introduced at each stage of the model-building process. The approach promises to engender greater confidence that models developed using it work and are both necessary and sufficient representations of the real world. The greatest potential gain accruing from application of this methodology is enhanced acceptance of system dynamics.

Alexandra Medina-Borja

nmedina@vt.edu
American Red Cross
2507 Fowler Street
Falls Church VA 22046
USA

Uncovering Relationships in System Dynamics Modeling Using CART/CHAID/SEM

One of the premises of system dynamics is that the modeler would make relationship assumptions with enough precision to make the model useful. A common validation method is to consult with field

Kalyan Pasupathy

kalyan@vt.edu
Virginia Tech
1741 N Troy Street #426
Arlington VA 22201
USA

experts. But with the advent of the internet and automated data collection methods, knowledge is diluted, as companies store abundant information without time to process it. Customers' dislikes, perceptions, intentions, opinions, and service characteristics reside in data warehouses (e.g. survey data is stored as categorical, nominal, ordinal or qualitative without further analysis). Without experts, companies are data rich but not necessarily knowledge rich. We present an application of known nonparametric predictive methodologies to uncover/confirm significant variable relationships and build the equations to feed the model: Classification and Regression Trees (CART), Chi-Square Automated Interactive Deduction (CHAID) and Structural Equation Modeling (SEM). A developing application of CHAID/SEM to explore restructuring decisions in a large service organization will be briefly discussed.

Arif Mehmood

mehmood@delsys.ca
Delsys Research Group Inc
45 Rideau Street Suite 400
Ottawa ON K1N 5W8
Canada

A Prototype Model to Understand the Implications of Interventions to Reduce Deceptive Advertising in a Marketplace

Deceptive Advertising (misrepresentation of price or quality) of products has been rampant over the last decades. The increase in such activities is a growing concern for consumer protection agencies as they are subject to limited resources to monitor and prosecute the retailers who adopt deceptive advertising as a marketing strategy. This paper describes a prototype model that addresses the problem of deceptive advertising in the consumer marketplace. The simulation model integrates consumer purchasing behaviour, the behaviour of retailers who adopt and who do not adopt the deceptive advertising, and the behaviour of consumer protection agencies for law enforcement and compliance- promotion strategies. The preliminary results of a few simulation scenarios are discussed.

Arif Mehmood

mehmood@delsys.ca
Delsys Research Group Inc
45 Rideau Street Suite 400
Ottawa ON K1N 5W8
Canada

Modeling Framework for Understanding the Dynamics of Learning Performance in Education Systems

Both developing and developed countries allocate a substantial amount of their budgets to their education sectors in an attempt to improve the learning performance of the students at each stage in the education system. The stages in the education system are typically conceived as being: Early Childhood (EC), Elementary to Secondary School (K-12), and Post Secondary Education (PSE). Each of these stages requires attention to address its unique problems, particularly when each stage is viewed as a separate, isolated component. This paper presents a modeling framework that integrates the stages of the education system into a one complete system to evaluate the implications of success in one stage to other stages. This paper illustrates that in designing effective and robust strategies to improve learning performance, it is necessary to fully understand how the problems of one stage evolve over time and if not fixed, could

generate or intensify the problems in other stages. This research helps in understanding "where and why" to focus education system reform efforts in order to improve the performance of the students throughout all stages of the education system.

Esther Menezes
esther@cpqd.com.br
Fundaçao CPqD
Rod Campinas Mogi-Mirim km 118
5 s/n
CEP 13083-970
Campinas SP Brasil

Cristiane Ogushi
ogushi@cpqd.com.br
Fundaçao CPqD
Rod Campinas Mogi-Mirim km 118
5 s/n
CEP 13083-970
Campinas SP Brasil

Graziella C. Bonadia
bonadia@cpqd.com.br
Fundação CPqD
Rod. Campinas-Mogi Mirim
Km 118 5
CEP 13083-970 Campinas SP
Brasil

Juliano Dall'Antonia
juliano@cpqd.com.br
Fundação CPqD
Rodovia SP 340 km 118
Campinas SP CEP 13086-902
Brazil

Giovanni M. de Holanda
giovanni@cpqd.com.br
Fundaçao CPqD
SP 340 Km 118.5
CEP 13086-902 Campinas SP
Brasil

Socioeconomic Factors Influencing Digital TV Diffusion in Brazil

The aim of this paper is to present an analysis of the socioeconomic factors which may affect the terrestrial Digital TV diffusion in Brazil. Such an ex ante analysis is supported by system dynamics models that represent non-linear relations influencing users' interest for this new media. The model inputs are derived from market surveys which reflect users' demand and expectations for Digital TV services. The basic model evaluates penetration of terrestrial digital TV according to the number of households with Digital TV receiver. Although the proposed simulation model is based on Bass diffusion model, other factors influencing diffusion of digital TV were implemented, due to deployment alternatives and Brazilian socioeconomic conditions, specifically the disposable income per socioeconomic class. Furthermore, it is shown how this and other conditional variables, such as attractiveness of new services, might affect digital receiver adoption in the Brazilian society.

Sara Metcalf
ssm@uiuc.edu
Univ of Illinois Urbana-Champaign
Dept of Geography Rm 220
Davenport
607 South Mathews Avenue
Urbana IL 61801-3671
USA

Mark Paich
m.paich@att.net
Decisio Consulting Inc
201 Linden Street 3202
Fort Collins CO 80524
USA

Spatial Dynamics of Social Network Evolution

Even in the absence of population growth, many communities continue to experience urban sprawl, or low-density fringe development. Motivated by the example of post-industrial dynamics in a small Illinois town, this paper explores the problem of fragmenting social networks enabled by spatial distancing between distinct socioeconomic classes. Increased fragmentation becomes a concern for community efficacy in establishing new economic opportunities and for potential sources of conflict between sub-communities. This paper develops a framework for considering the spatial dynamics of social network evolution in the face of neighborhood and community migration. The social network is initialized using a small world formulation (Watts 1999) that then evolves as migration patterns affect the probability of "rewiring" social connections. Spatially, some connections are established for neighborhood proximity. Socially, connections are added based upon similarity of economic class. In effect, the probability of rewiring becomes endogenous as the social network evolves over time. A variety of analyses are conducted with migration probabilities under this endogenous rewiring to explore the relative cohesiveness of the emergent community networks. The development of this abstract

model is discussed in relation to further application and calibration to a real-world case community. Watts, Duncan J. 1999. Small Worlds: The Dynamics of Networks Between Order and Randomness. Princeton, NJ: Princeton University Press.

Grischa Meyer

grischa.meyer@gmx.de
Volkswagen AG
Letterbox 1882
38436 Wolfsburg
Germany

Marcus Schroeter

marcus.schroeter@tu-bs.de
Technical University of
Braunschweig
Dept of Production Management
Katharinenstr 3
D-38106 Braunschweig
Germany

Thomas Spengler

t.spengler@tu-bs.de
Technical University of
Braunschweig
Inst for Economics and Business
Admin
Dept of Production Management
38106 Braunschweig
Germany

Modelling and Evaluation of Car-Related Taxes in Japan

In Japan, fuel consumption and CO_2 emissions in transport sector increased significantly and assuming past increase rates in the future, emission level in transportation sector is expected to rapidly increase. A variety of environmental policies are under debate in Japan, especially tax reduction schemes. As a consequence of 'green' tax incentives, changes in the composition of vehicle fleet can be observed and anticipated. For European Automotive Manufacturers in particular, these transportation and environmental conditions are hard to understand and even harder to influence. However, there are different alternatives to cope with these challenges, e.g. reactive or proactive strategies. As a proactive strategy, a concept for modeling, evaluation and forecasting of environmental regulations is developed in this contribution.

Stanislava Mildeova

mildeova@vse.cz
University of Economics in Prague
nam W Churchilla 4
Praha 3 130 67
Czech Republic

Viktor Vojtko

v.vojtko@proverbs.cz
Proverbs
Zitna 52
120 00 Prague 2
Czech Republic

Results of First Steps in Applications of System Dynamics Principles at the University of Economics in Prague, Czech Republic

The authors will attempt to overview domestic experience of using the system dynamics models in various fields, mainly with respect to practical use of simulations for management decision-making support. This paper will present management flight simulators created at University of Economics in Prague. Theoretic background of these simulators comes from the methodology of system dynamics and systems thinking. These simulators are considered to be tools that would help to understand dynamic relations in an organization as a whole. The authors will show two ways for their simulator development. One is situated in enabling the students as future managers to build their own dynamic problem-solving oriented models. The authors call the simulators prepared in this way "transparent boxes". In this case advanced users can change virtually everything in the simulator and test the consequences. The other way is to aim to learn some crucial principles of systems thinking and system dynamics using the simulators in a very short time. These simulators called "black boxes" have user interface, which contains the vital information, but the end users cannot change the model structure. This paper is supported by Czech Science Foundation within grant project "System Dynamics Theory And Market Structures", number GACR 402/05/0502.

Pratap K. J. Mohapatra

pratap@hijli.iitkgp.ernet.in
Indian Institute of Technology
Industrial Engineering and Mgt
Kharagpur 721302
India

Control Strategies for an Activated Sludge Treatment System

The activated sludge treatment system for treating municipal wastewater presents an interesting application of system dynamics modeling. This paper presents such a modeling approach to the strategy formulation of the treatment system in order to economically control effluent quality. First, factorial designs are carried out on the simulation results to identify factors that significantly affect effluent quality. Thereafter, open-loop control (both constant and time-varying), output feedback control, and output-integrated feedback control strategies have been applied. Statistical tests of significance indicate that the strategy of output feedback control has the maximum potential, in both summer and winter, to achieve the dual objectives of maintaining effluent quality within acceptable limits and minimizing aerator energy.

René Molkenthin

rene.molkenthin@uni-mainz.de
Johannes-Gutenberg-University of Mainz
Jakob Welder-Weg 9
55128 Mainz
Germany

Real Time Diagnostics of Problem-Solving Behavior for System Dynamics-Based Business Simulations

Business simulations are composed of a (SD-)model which represents the complexity and dynamics of business structures and concepts. Within a simulation the participants can make decisions to control the modeled enterprise. A business simulation can make the interdependencies between the different activities within an enterprise transparent to the participants. From an economical perspective the success within a business simulation can be measured by a set of specific core variables. From an educational perspective the structure of the cognitive system which is responsible for the economical success is relevant. A subsequent aspect refers to the possibilities to support the elaboration of the mental model during the activities within a business simulation. Furthermore in the context of web-based learning environments there is the issue how to foster self-regulated learning processes. A prerequisite for an effective feedback which supports learning is a continuous diagnosis of the problem solving process, in particular the diagnosis of the information-retrieval and decision-making processes. This paper describes the basic concept of the diagnostics within a prototype of a web-based business simulation called solarSYDUS. Besides the SD-model this simulation contains a component for recording information-retrieval and decision-making processes during the simulation for analyzing problem solving behavior.

Edoardo Mollona

emollona@cs.unibo.it
Università degli Studi di Bologna
Department of Computer Science
Mura Anteo Zamboni 7
40127 Bologna Italy

Revisiting the Theory of Intra-Organizational Ecology and Organizational Change: A System Dynamics Approach

I develop a System Dynamics simulation model to examine the conditions under which large firms adapt to sharp changes in the

competitive landscape. This paper capitalizes on, and aims to extend the intra-organizational ecological theory of organizational adaptation, which reconciles the workings of selection and adaptation forces in the process of organizational change. The paper interprets the narrative theory from the feedback perspective, translates it into a system dynamics model, and simulates the model under different assumptions of firm characteristics. More specifically, I experimentally reproduce in vitro a firm's adaptation process to closely scrutinize how the morphology of firm's resource allocation mechanisms interacts with stocks of available resources to mould an unfolding adaptation path. The simulation experiments unveil the role of timing, path-dependence and self-reinforcing mechanisms in decision-making.

John D. W. Morecroft

jmorecroft@london.edu
London Business School
Regent's Park
London NW1 4SA
UK

Stewart Robinson

stewart.robinson@warwick.ac.uk
University of Warwick
Warwick Business School
Coventry CV4 7AL
UK

Explaining Puzzling Dynamics: Comparing the Use of System Dynamics and Discrete-Event Simulation

Both system dynamics (SD) and discrete-event simulation (DES) are used to help understand and explain puzzling real world dynamics. But what are the similarities and differences between these two approaches and which should be used in a specific circumstance? These are questions few have ventured to answer. In this research the two approaches are compared by developing an SD and DES model of the same problem situation, a fishery. An SD expert and a DES expert separately develop a model of the fishery through a number of evolutionary steps. At each step differences in the representation and interpretation of the models are identified. Overall it is apparent that while SD illuminates 'deterministic complexity', DES illuminates 'constrained randomness'. Either or both may be important in understanding and explaining puzzling dynamics. SD and DES should therefore be seen not as opposing modelling approaches, but as complementary.

Don R. Morris

donr.morris@worldnet.att.net
Miami-Dade County Public Schools
5838 SW 74th Terrace #303
South Miami FL 33143
USA

Causal Inference in the Social Sciences: Variance Theory, Process Theory, and System Dynamics

The social sciences are in need of an alternative to the variance approach to causal inference, which—because it requires a counterfactual—restricts the claim of valid inference to conclusions drawn from experimental and quasi-experimental methods. Process theory proposes an alternative by way of demonstrating the presence of observable characteristics of the causal mechanism, a method that, while accepted in principle, has proven elusive in practice. It is suggested that system dynamics can improve the process approach, and in so doing open a path for itself to wider application in the social sciences. Educational research is suggested as a place to start, and results from two models drawn on topics from that field are offered as examples.

J. Bradley Morrison

bmorriso@brandeis.edu
Brandeis University
19 Fox Run Road
Bedford MA 01730
USA

Implementation as Learning: An Extension of Learning Curve Theory

Firms often attempt to imitate successful practices of other firms. When implementing new practices, individuals in organizations learn new ways of doing things, develop new skills, and adopt new organizational routines. In the paper, we view implementation as a learning process and apply learning curve theory to the understanding of implementation dynamics. We extend classic learning curve to include a required output level for an individual who must choose between an old and a new way to achieve the output. Doing work the new way builds experience, increasing productivity and thus favoring continued use of the new skill, but this reinforcing process works to favor the new skill only at relatively high levels of productivity. Otherwise, the same process is a vicious cycle, driving out the new skill. We use a system dynamics model to demonstrate a mode of behavior in which learning begins and then stalls and another mode in which the new skill becomes the preferred one. We identify the tipping point between these two modes and characterize the transition problem: Learning by doing is a dynamic process, a transition from use of an old way to a new way that requires accumulating experience beyond a threshold.

Erling Moxnes

erling.moxnes@ifi.uib.no
University of Bergen
System Dynamics Gp Dept of
Geography
Postbox 7800
N-5020 Bergen Norway

Arne Kråkenes

arne.kraakenes@powersim.no
Powersim
Sandbrugaten 5-7 Postboks 3961
Dreggen N-5835 Bergen
Norway

SOPS – A Tool to Find Optimal Policies in Stochastic Dynamic Systems

The task of finding optimal policies in stochastic dynamic systems is challenging. The theory of stochastic dynamic programming (SDP) is quite complex and the available software packages are not intended for non-specialists. Furthermore, SDP is traditionally limited to quite small and well defined problems. Stochastic optimization in policy space (SOPS) seems to be an attractive alternative, particularly for people with a background in simulation of dynamic systems. However, to date no user friendly software has been available for this method. In this paper we present and demonstrate a new program package for this task. The resulting software allows the user to formulate the model in a well-known simulation program, Powersim Studio 2005. The model is automatically transferred to a standalone program. The SOPS program allows the user to reset model parameters, to specify search criteria, and to study the results of repeated searches for optimal policies. To maximise speed, Monte Carlo simulations utilise C+ code.

Rodney S. Myers

rodney.myers@navy.mil
US Navy Personnel Command
Personnel Research Dept
5720 Integrity Drive
Millington TN 38055 USA

Navy Personnel Enterpise Model – A System Dynamics Approach

An enterprise model is a computational representation of the structure, activities, processes, information, resources, people, behavior, goals, and constraints of an organization. It can be both descriptive and definitional—spanning the "as-is" and/or the "to-be." The role of an

enterprise model is to achieve model-driven enterprise design, analysis, and operation. Of particular concern is an analyst's ability to determine the impact of changes, and/or proposed changes, on each functional component of the enterprise. For example, how would relaxing recruiting standards affect the quality of Sailors throughout the enterprise? What is the attrition impact to the fleet if we shorten or expand time in the delayed entry program? Upon successful completion, analysts and/or decision-makers will receive an interactive analysis system to facilitate strategic planning. The system will allow component managers to explore the impact that functional policy and resource decisions have across the entire personnel enterprise. The goal is to create a more effective personnel environment through strategic evaluations of potential futures.

Xiaowen Ni

nxwmjznwq@yahoo.com.cn
Nanjing Normal University
High School
37 Chahaer Road
Nanjing
China

Yuqin Yao

Nanjing Normal University
High School
37 Chahaer Road
Nanjing
China

System Dynamics in Development and Management of Traveling Resources

Abstract: By means of system thinking, the issues of traveling resources, traveling condition and finance in tourism business as well as the interrelations among them were analyzed to search the effective approach to the prosperity of tourism business. The software STELLA is used to build the operation model of tourism business, including the modules of ticket price, the payment of loans and the development and demolishment of resources in order to find out an efficient way to prosper the tourism industry while protecting the environment. There's no real data for it's just a student's exercise. It mainly analyzes the genegal idea, and every related aspects. Also, its purpose is to show the importance of system thinking in high school students' studies.

Xiaoqian Ning

dr_lizhigang@hotmail.com
Tonji Development Institute

Qifan Wang

qfwang@fudan.edu.cn
Fudan University
School of Management
220 Han Dan Road
200433 Shanghai
China

Bing Wu

info@suntek.info
Tongji University
LongGaolu 88 JiuTing Songjiang
Shanghai 201615
China

The Influence of Schedule Targets on Project Performance

Many organizations set ambitious schedules for their product development projects to gain competitive advantages. However, ambitious schedules might be the main factor to deteriorate project performance. The features of system dynamics application in project management is discussed and a generic simulation model is built for studying the effects of schedule pressure and providing a helpful tool for project management to understand feedbacks, delays and nonlinear relationships among projects and how project behaviors are driven by project structures. Finally, the future works about this study are discussed.

Patricia Ochoa

patricia.ochoa@unil.ch
HEC - Université de Lausanne
BFSH1
CH1015 Lausanne
Switzerland

Policy Changes in the Swiss Electricity Market: A System Dynamics Analysis of Likely Market Responses

The Swiss electricity market - as well as the European electricity markets, is now facing a period of fundamental structural changes.

Emergent liberalisation is taking place, and nuclear dismantling is being debated. Given this scenario, it is important to evaluate market response to those changes in terms of security of supply and the viability of international exchanges - imports and exports of electricity from and to neighbouring countries. The approach we adopt to analyse various aspects of security of supply in Switzerland differs from the traditional economic methodology which focuses on equilibrium of outcomes as opposed to on how the new situation is reached. We use system dynamics simulation models, which incorporate information feedback and behavioural policies, to study scenarios of the transient period currently faced by the Swiss electricity market.

Camilo Olaya

colaya@uniandes.edu.co
University of St Gallen
Institute of Management
Dufourstrasse 40a
9000 St Gallen Switzerland

The Significance of Addressing System Dynamics Explanations

In a previous work the philosophical concept of Mechanism was proposed in order to characterize the kind of scientific explanations provided by the system dynamics approach. That earlier paper positioned such idea epistemologically contrasting it with the traditional view used by mainstream management research and developed a different ontological ground based on the structuralist approach of Bertrand Russell. However, it seems to be needed an emphasis on the epistemological nature of the Mechanism thesis because of its common association with reductionism and the view of mechanistic thinking as supposedly opposed to holism and emergentism. This paper constitutes a second part; it underlines the epistemic status of Mechanism which explains why it is in no way opposed to ideas like holism or emergentism, on the contrary it is consistent with such worldviews. Based on this condition the paper explores the repercussions of such characterization for philosophy of science and for system dynamics by developing a research agenda for both fields around this topic.

Rogelio Oliva

roliva@tamu.edu
Texas A&M University
Mays Business School
325M Wehner - 4217
College Station TX 77843-4217
USA

Paulo Gonçalves

paulog@miami.edu
University of Miami
KE 404
Coral Gables FL 33124
USA

Behavioral Causes of Demand Amplification in Sypply Chains: 'Satisficing' Policies with Limited Information Cues

Overreaction to supply shortages can create havoc in supply chains, costing millions of dollars in excess inventory and manufacturing capacity. In an experiment with the Beer Distribution Game, we explore overreaction to shortages as a complementary behavioral cause of supply chain instability. As in previous studies, we find that players ignore the supply line. We find, however, that instead of overreacting to shortages, players limit the size of their order adjustment while aiming for higher than necessary inventory level; a policy that is more stable than the linear response suggested in previous studies. Since an ordering rule that fails to account for the supply line leads to higher than necessary costs and order amplification, our results suggest that players are not fully rational. However, evaluating the performance of the estimated policy we find

that, given the information cues available, players show bounded rationality and develop a "satisficing" replenishment decision rule that minimizes local cost at the expense of higher upstream cost. We explore the implications of these findings for the design of information and incentive systems for supply chain management.

Nathaniel Osgood

nosgood@mit.edu
MIT
77 Massachusetts Ave Rm 1-376
Cambridge MA 02139
USA

Combining System Dynamics and Decision Analysis for Rapid Strategy Selection

An important class of decision problems involve the selection of a policy in the presence of both uncertainty regarding future eventualities and a system exhibiting complex policy response. Within this paper, we examine the performance benefits of performing strategy selection for such problems using a hybrid modeling approach that combines decision analysis and system dynamics. Within this approach, a modeler uses a decision tree to encapsulate choices, uncertainties, and consequences (the last computed by a system dynamics model). While this hybrid technique offers many additional advantages in terms of expressiveness and the encouragment of systematic investigation of policy space, this paper focuses on the performance gains it provides. In particular, the use of decision trees to represent such decision problems permits the use of dynamic programming, which can dramatically decrease the costs of identifying a preferred policy beyond what is possible by evaluating possible policies in turn. The paper quantifies these performance advantages by means of recurrence relations for arbitrary trees, and derives inductively proven closed-form expressions of performance gain for complete trees. The results suggest that the hybrid method yields speedups exponential in the depth of the tree for both complete and randomly generated trees.

Peter A. Otto

ottop@dowling.edu
Dowling College
School of Business
150 Idle Hour Boulevard
Oakdale NY 11769
USA

Martin Simon

si.m@bluewin.ch
ipgroup
Ruetistrasse 4
CH-8126 Zumikon
Switzerland

Growing Ownership and Instilling Confidence for a Decision Support Approach at the Stakeholder Level

In a globally operating company, when a country management team base their opposition to the global product marketing strategy on a System Dynamics simulation tool, the model is definitely to support communication across the management layers in a bottom-up way. To reach out to stakeholders and global management at the HQ, neither of them being familiar with the System Dynamics approach, it's not sufficient to provide a technically convincing simulation tool. This paper describes a bottom-up model building initiative and its vital educational component. Building the model with the client had to both grow ownership at the country level, overcome "black-box" attitudes and establish a shared understanding for the approach at the stakeholder level in order to structure the discussion about critical issues beyond trailing market dynamics or covering up by fanciful statistics. Keywords: Black box, Stakeholder, Ownership.

Martsin P. Papadatos

mpp26@cam.ac.uk
University of Cambridge
Wolfson College
Barton Road
Cambridge, CB3 9BB
UK

George Dikos

gdikos@alum.mit.edu
Eugenides Group
PO Box 65582
Athens Neo Psychiko 15402
Greece

Henry S. Marcus

hsmarcus@mit.edu
Massachusetts Institute of
Technology

Vassilis Papakonstantinou

vpap@alum.mit.edu
Eugenides Group

Inverse System Dynamics in Competitive Economic Modelling: The Case of Tanker Freight Rates

A system identification approach is used in order to model and identify the structural relationship between freight rates in the tanker industry and a set of exogenous inputs. Our motivation results from the limited data availability and the prohibitive theoretical complexity of economic models for the evaluation of managerial decisions and risk management. The combination of statistical analysis and economic insight leads to an innovative multidisciplinary approach for modelling competitive economic systems. We calibrate the model with real data from 1980-2002, achieve estimation and identification of the system and fully track the directional changes in freight rates. After conducting performance evaluation an innovative hybrid model is introduced and system performance is maximized both within and out-of-sample. Finally we discuss potential uses of this model for policy analysis, managerial investment decisions and risk management.

Hun-Joon Park

hjpark@yonsei.ac.kr
Yonsei University
School of Business
134 Shinchon-dong Seodaemoon-ku
Seoul 120-749
South Korea

Sang-Joon Kim

skgkrtod@freechal.com
Yonsei University
134 Shinchon-dong Seodaemun-gu
120 749 Seoul
South Korea

Najung Kim

najung@yonsei.ac.kr
Yonsei University
134 Shinchondong Seodaemungu
Seoul
Korea

From Discount to Premium: An Integrative Transparency System for Corporate Sustainability

This paper examines a new approach to understanding corporate transparency (or, in reverse, opacity) system, which is used to recognize interconnections existing among firm-related agents – how they sanction and monitor each other's behaviors, ultimately tuning the activity of a firm in a systematic context. Firm-related agents include internal stakeholders (especially board of directors) and external stakeholders. While former approach individually can only examine corporate transparency/opacity in a one-sided way, we attempted to take on a more holistic and dynamic view using system dynamics. With our new integrative model, we propose a systematic solution to corporate transparency/opacity problems and provide a new means of studying corporate value more transparently than ever before, thus offering a better chance of corporate sustainability and also enhancing corporate value.

Sang-Hyun Park

alraview@infovil.co.kr
Electronics and Telecom Research
Inst
1-262 ETRI
161 Gajong-Dong Yusung-Gu
Daejon
Republic of Korea 305-350

The Dynamic Effects of Government Policies on Korean Telecommunication Services Market Focusing on the Regulations of Mobile Phones

The government regulation policy, in the mobile phone services market which is characterized by its 'asymmetric' stance, has been provoked debates on many issues amid pros and cons. For that, many previous studies have endeavored to point out the limitations of asymmetric regulations and suggested the improving measure tools,

Seung-Jun Yeon

naege@infovil.co.kr

Electronics and Telecom Research Inst
161 Gaejeong-dong Yuseong-Gu
Daejeon 305-350 South Korea

most of previous studies showed common shortcomings. This study aimed at evaluating the government regulation policies over mobile phone market, by analyzing in advance the efficacy of any potential regulation policies, and by estimating the timeliness of the enforcement. To achieve this objective, a simulation model based on the system dynamics methodology was developed to test the impact of governmental regulation policies being enforced under various scenarios of the mix of government policies.

Sang-Wook Kim

sierra@chungbuk.ac.kr

Chungbuk National University
Dept of Management Information
Systems
48 Gaesin-dong Heungdeok-gu
Chong-ju Chungbuk 361-763 S
Korea

Doahoon Kim

dhkim@sookmyung.ac.kr

Sookmyung Woman's University
53-12 Chungpa Dong 2 Ga
Yongsan Ku Seoul 140-742
South Korea

Won-Gyu Ha

wgha@etri.re.kr

Electronics and Telecom Research Inst
161 Gajeong-dong Yuseong-gu
Daejeon 305-350
South Korea

Jamshid Parvizian

jparvizian@gmail.com

Goethe Institut
Sonnenstrasse 25
80331 Munich
Germany

Adaptive Socio-Economic System Dynamics

In this paper, we propose an adaptive method for the proper policy-making in socio-economic dynamic systems. This method is based on the adaptive control theory that has been developed and used in many electro-mechanical systems for several decades. The control parameters are modified on-line with the dynamic changes of the system in the way that the behavior of the system would remain under control in different conditions. By using an adaptive method the system would overcome the unpredictable environment changes. An inventory control system as one of the most common models in system dynamic is used as an example. The suggested method is implemented and the results are compared with the conventional feedback system.

Jamshid Parvizian

jparvizian@gmail.com

Goethe Institut
Sonnenstrasse 25
80331 Munich
Germany

Oil Revenue and the Sustainable Development of Iran: A System Dynamics Approach

Development and growth of Iranian economy upon the oil revenue encountered two basic problems. First, the efficiency of investment of the revenue in the main economic streams has been very low so far. Second, the dependency of the economy on imports financed by oil revenue has been constantly increasing. However, the country cannot continue to export oil in near future due to the increasing domestic demand on one hand and the run out of the resources on the other hand. Therefore, oil revenue will be soon expired and the country may face severe economic and social problems. Lack of exchange revenue makes the manufacturing capacity inefficient. In this paper, a dynamic system model is developed to analyze the effects and roles of oil revenue and government investment policies on various sectors of the economy, with regards to economic indicators. In the base simulation, results show that if the economic conditions of Iran continue as they are, when the oil revenue becomes less available in near future, the economy faces a severe stagnancy in the activities of all sectors. In order to access stationary economic development, the government can

use foreign exchange reserve account, reduce the dependency on oil revenue by imposing restrictions on oil production, and support the domestic productions.

Oleg V. Pavlov

opavlov@wpi.edu
Worcester Polytechnic Institute
100 Institute Rd
Worcester MA 01609
USA

Nigel Melville
Boston College

Robert Plice
San Diego State University

Unsolicited Commercial Email: An Attention Resource Perspective

The growth of unsolicited commercial email (UCE) imposes increasing costs on organizations and causes considerable aggravation on the part of email recipients. A thriving anti-spam industry addresses some of the frustration. This paper contributes to our understanding of the UCE phenomenon by drawing on scholarly work in areas of marketing and resource ownership and use. Adapting the tragedy of the commons to the email context, we identify a causal structure that drives the direct e-marketing industry. Computer simulations indicate that although filtering may be an effective method to curb UCE arriving at individual inboxes, it is likely to increase the aggregate volume, thereby boosting overall costs. The analysis advances understanding of the digital commons, the economics of UCE, and has practical implications for the direct e-marketing industry.

Gloria Pérez Salazar

gloria.perez@itesm.mx
Tecnologico de Monterrey
Dept of Industrial and Systems Eng
Av E Garza Sada 2501 Sur
64849 Monterrey NL
Mexico

Irving Arellano
a00628497@itesm.mx

Tania Fierro
a00945404@itesm.mx

Morales Gabriela
a00785927@itesm.mx

Carlos Sánchez
a00786098@itesm.mx

Modeling the Development of a Biotechnological Cluster

Worldwide competition is evolutionary and dynamic; therefore it is necessary that countries not only think in terms of immediate cost but that they foment the necessary conditions under which their companies or new companies can develop competitive advantages based on the innovation. According to this, it is important that countries like México foment the creation and the development of new industries in the biotechnological cluster, in order to develop new areas in which we could be competitive. This paper is about the design of a model that could help us to evaluate de viability of the development of a biotechnology cluster in Mexico. Keywords: biotechnology, cluster development, Innovation.

Gloria Pérez Salazar

gloria.perez@itesm.mx
Tecnologico de Monterrey
Dept of Industrial and Systems Eng
Av E Garza Sada 2501 Sur
64849 Monterrey NL
Mexico

System Dynamics Projects Presented by Poster: Product and Process Synthesis

The purpose of this work is to share the experience using a Poster presentation of projects in System Dynamic (SD). The paper focus in how this didactic resource has been a helpful tool supporting the didactics of SD methodology (process) and at the same time a great resource to share with the students the entire project made by each of the class teams (product). Key words: Poster, systems dynamics, Project Oriented Learning.

P. Jeffrey Potash

jpotash@ciesd.org
CIESD LLP
75 Green Mountain Drive
South Burlington VT 05403
USA

John F. Heinbokel

jheinbokel@ciesd.org
CIESD LLP
75 Green Mountain Drive
South Burlington VT 05403
USA

Unleashing the Revolutionary Implications of a System Dynamics 'Education'

As self-described "educators," in our formal instruction of students and teachers and our more recent outreach to a wider array of clients, we have focused on systematically using the full range of system dynamics tools to become, and assist our clients to become, better thinkers and modelers. In a conscious effort to build that capacity through collaborative problem solving, we have devised a "ladder of engagement." It is a structure and sequence of activities supporting a powerful and integrated process by which continuously "better questions" allow us to: (1) probe progressively more deeply into describing the behavior of the system (a rung of KNOWLEDGE); (2) identify the system's features (feedback loops and delays) controlling its behaviors (UNDERSTANDING); and (3) locate and evaluate leverage points in the system where intervention can effectively and efficiently affect its behavior (INFLUENCE). In addition to the ladder's hierarchical structure, at each rung or level the process explicitly incorporates feedbacks designed to develop an iterative learning process that continually reinforces the linking of answers to better questions and the parleying of one's facility within a limited sphere of interest into broader abilities and motivations to pursue more diverse challenges and "enduring" and generic problems.

Marsha J. Price

marshaprice@earthlink.net
Upstartiae Projects
79 Myrtle Street #5
Boston MA 02114
USA

Thomas G. Kelly

tom.kelly@paconsulting.com
PA Consulting Group
One Memorial Drive 16th Floor
Cambridge MA 02142
USA

Boston Housing Dynamics, The Boom and Bust

Boston's residential real estate market has seen dramatic growth in recent years. Prices have doubled and then doubled again. No one knows how long this will last. Is it a "bubble"? If so, when will it burst? Is it still safe to invest? Is it time to move? Fine questions for owners and speculators--but the consequences of the continuing boom are disastrous for those of lesser means working in Boston. Boston's Mayor Menino has made his Affordable Housing initiative a top priority. Understanding the dynamics driving the market and the success or failure for these initiatives could be a key enabler of robust public strategies. The dynamics displayed and described in this session were developed on a pro bono basis working with Boston's Department of Neighborhood Development at the request of Mayor Menino. Extensions of this work with the Mayor's office and additional housing agencies are underway.

Hassan Qudrat-Ullah

hassanq@yorku.ca
York University
School of Administrative Studies
4700 Keele Street Atkinson 282
Toronto ONT M3J 1P3
Canada

Improving Dynamic Decision Making through Debriefing: An Empirical Study

Empirical evidence suggests that people perform poorly in dynamic tasks. The thesis of this article is that dynamic decision performance can be improved by helping people to develop more accurate mental models of the task stems through training with debriefing supported computer simulation-based interactive learning environments

(CSBILEs). I report a laboratory experiment in which subjects managed a dynamic task by playing the role of fishing fleet managers. One group of participants used a CSBILE with debriefing, whereas another group used the same CSBILE but without debriefing. A comprehensive model consisting of four evaluation criteria is developed and used: task performance, structural knowledge, heuristics, and cognitive effort. It is found that debriefing was effective on all four criteria; debriefing improves task performance, helps the user learn more about the decision domain, develop heuristics, and expend less cognitive effort in dynamic decision making.

Timothy D. Quinn

tdquinn@mit.edu
MIT
Sloan School of Management
30 Wadsworth Street E53-358A
Cambridge MA 02139 USA

Jenny W. Rudolph

jrudolph@bu.edu
Boston University Sch of Public Health
Health Services Department
715 Albany Street
Boston MA 02118 USA

David G. Fairchild

dfairchild@tufts-nemc.org
Tufts-New England Medical Center
General Medicine
750 Washington Street
Boston MA 02111 USA

Lab Turnaround Time and Delayed Discharges: A Systems-Based Action Research Investigation

This paper reports an action research study in which we applied Edgar Schein's process consultation approach to a cross-functional problem in a large academic teaching hospital. The project task force was charged with investigating a hypothesized effect of poor lab turnaround time on the risk of probable discharges being postponed until the following day, thereby increasing average length of stay and associated hospital operating costs. The tools we used at different stages of our process included group facilitation, interviews, process flowcharts, systems thinking with causal loop diagrams, and what-if analysis with a system dynamics simulation model. Through facilitation of the task force's work, we were able to reorient each constituent group's perspective from a parochial to a systemic view, greatly improving the task force's functioning and chances for successful sustainable improvement.

Michael J. Radzicki

mjradz@wpi.edu
Worcester Polytechnic Institute
Dept of Social Science and Policy
100 Institute Road
Worcester MA 01609-2280 USA

Oleg V. Pavlov

opavlov@wpi.edu
Worcester Polytechnic Institute
100 Institute Rd
Worcester MA 01609 USA

Khalid Saeed

saeed@wpi.edu
Worcester Polytechnic Institute
Social Science & Policy Studies Dept
100 Institute Road
Worcester MA 01609 USA

Stability in a Superpower-Dominated Global Economic System

This paper provides an example of a system dynamics model that incorporates soft variables. The model examines the challenges that a superpower faces while maintaining its position in the global economic system. The effects on aggregate welfare of the population at home and abroad, as well as, issues of sustaining authority in the long run are explored through experimentation with a computer model. This theory is an extension of the framework developed by Saeed(1990), which was used to understand political instability and the failure of the government to stay committed to welfare agendas in the developing countries. The present model captures the interaction between several institutional actors involved with the economic and the governance systems. They include the public, the authoritarian regime, the reformist movements that seek change within the existing framework, and the dissident movements that turn to violent methods.

Hazhir Rahmandad

hazhir@mit.edu
MIT
Sloan School of Management
30 Wadsworth Street E53-354A
Cambridge MA 02139 USA

Dynamics of Platform-Based Product Development

Product development (PD) is a crucial capability for firms in competitive markets. Building on case studies of software development constructed from fieldwork at a large firm, this paper explores the interaction among the different stages of the PD process, the underlying architecture of the product, and the products in the field. The study corroborates the dynamics of tipping into "firefighting" (Repenning 2001) that follows quality-productivity tradeoffs under pressure. Moreover, we introduce the concept of the "adaptation trap," where intendedly functional adaptation of workload can overload the PD organization and force it into firefighting because there is a delay in seeing the additional resource need from the field and underlying code-base. Finally, the study highlights the importance of architecture and underlying product-base in platform-based product development, through their impact on quality of new models under development, as well as resource requirements for bug-fixing. Put together, these dynamics elucidate some of the reasons why PD capability is hard to build and how it erodes. Consequently, we offer hypotheses on the characteristics of the PD process that increase its strategic significance and discuss some practical challenges in the face of these dynamics.

R. Joel Rahn

jrahn@sympatico.ca
4636 Sugar Maple Drive
Ottawa ON K1V 1Y6
Canada

F.E.A.R. & G.RE.E.D. – A Political Archetype

A novel archetype, abstracted from published work and supported by anecdotal analogies is proposed. Its novelty is evidenced by a comparison with the 'Relative Control' archetype from Wolstenholme's classification. The significant difference is the erasure of the system boundary from 'Relative Control'. The effect is to bring the dynamics entirely within the system thereby creating a 'political' archetype: a structure internalizing the struggle between two opposed policies.

Boris Ramos

bramos@wpi.edu
Worcester Polytechnic Institute
Social Science and Policy Studies
100 Institute Road
Worcester MA 01609 USA

Khalid Saeed

saeed@wpi.edu
Worcester Polytechnic Institute
Social Science & Policy Studies
100 Institute Road
Worcester MA 01609 USA

Oleg V. Pavlov

opavlov@wpi.edu
Worcester Polytechnic Institute
100 Institute Rd
Worcester MA 01609 USA

An Analysis of Wireless and Value-Added Services on the Regional Dispersion of Telecom Services in Developing Countries

Telecommunications in developing countries lack adequate planning and policies, so their telephone densities show the lowest values worldwide. The failure in considering the complexity of the regional telecommunication system in developing policies and technological strategies has increased the telecom gap between other regions and this particular sector of the world. We used a system dynamics modeling approach as a methodology that deals with the complexity of the system in order to evaluate existing value added services and access technologies in telecommunications that could accelerate the dispersion of regional telephone services in developing countries. The role of wireless systems, which have a low deployment delay, was found to be crucial in the growth of urban and rural telecom

infrastructure in developing countries. The value added services were found to have a positive impact by increasing the financial resources of the telecom company and the number of urban telephone lines.

C. Michael Reilly

reillycm@comcast.net
H SMOAS
126 Harding Road Apt A
Red Bank NJ 07701-2010
USA

An Exercise in Using System Dynamics to Enrich the Scenario Simulations Used in Another Research Paper

The December 4th, 2004 issue of "The Economist" had a 3-page Special Report entitled "The future of the dollar" which cites the following from the Roubini-Setser (R-S) paper ; "if the real trade-weighted value of the dollar remains close to its average in 1990-2003 (slightly above current levels) and there is no change in domestic policy, America's current-account deficit would rise to 8% of GDP in 2008 and its net debt would increase to over 50% of GDP". This projection came from one of three scenario simulations (their Baseline scenario) based on a model described in the R-S paper. The R-S paper's model, when replicated in Vensim, contains one positive feedback loop to represent how interest on debt leads to exponential debt growth but excludes much of the of the paper's rich mental models which imply much more endogenous model structure than that used in the paper's scenario simulation model. This SD conference paper recreates the R-S scenario simulation model and then presents another version which tries to include more endogenous model structure based on the R-S paper's own rich discussion and mental models.

Eliot Rich

e.rich@albany.edu
University at Albany
Dept of Info Technology
Management
1400 Washington Avenue BA-310
Albany NY 12222
USA

Ignacio J. Martínez-Moyano

im7797@albany.edu
University at Albany
Milne 318 Rockefeller College
Albany NY 12222
USA

Stephen H. Conrad

shconra@sandia.gov
Sandia National Laboratories
PO Box 5800 MS 1138
Albuquerque NM 87185
USA

Simulating Insider Cyber-Threat Risks: A Model-Based Case and a Case-Based Model

The growing reliance on technological infrastructures has made organizations increasingly vulnerable to threats from erstwhile trusted employees and clients. Recent research indicates that successful defense from these threats depends on both technical and behavioral solutions. In this paper, we report on our work to identify seemingly reasonable organizational actions that may inadvertently lead to increased risk exposure. We also consider how potential internal attackers may be encouraged or discouraged by monitoring the organizational responses to probes of the firm's security systems. Two interwoven work products are presented: A case study that presents a particular type of insider threat – long-term fraud – and a simulation model that supports the case, the underlying dynamic theory, and examination of policy options. The case and model combine to produce a motivating and useful exercise that illustrates the problems of insider cyber-threats. This material has been used in teaching of insider threat issues with satisfactory results.

Dawn M. Cappelli
dmc@cert.org
Carnegie Mellon University
Software Engineering Institute
4500 Fifth Avenue
Pittsburgh PA 15213-3890 USA

Andrew P. Moore
apm@cert.org
Carnegie Mellon University
4500 Fifth Avenue
Pittsburgh PA 15213 USA

Timothy J. Shimeall
tjs@cert.org
CERT Situational Awareness Team
Software Engineering Institute
4500 Fifth Avenue
Pittsburgh PA 15213-3890 USA

David F. Andersen
david.andersen@albany.edu
University at Albany
315A Milne Hall
135 Western Avenue
Albany NY 12222 USA

Jose J. Gonzalez
jose.j.gonzalez@hia.no
Agder University College
Faculty of Engineering and Science
Grooseveien 36
NO-4876 Grimstad Norway

Donald Robadue
don@robadue.com
Coastal Resources Center
220 South Ferry Road
Narragansett RI 02882
USA

Robert J. Ellison
ellison@sei.cmu.edu
Carnegie Mellon University
CERT/CC Software Eng Institute
4500 Fifth Avenue
Pittsburgh PA 15213-2613 USA

Howard Lipson
hfl@cert.org
Carnegie Mellon University
Software Engineering Institute
4500 Fifth Avenue
Pittsburgh PA 15213-3890 USA

David Mundie
dmundie@cert.org
Carnegie Mellon University
CERT/CC Software Eng Institute
4500 Fifth Avenue
Pittsburgh PA 15213-2613 USA

Jose Mari Sarriegi
jmsarriegui@tecnun.es
Tecnun - University of Navarra
TECNUN
Paseo Manuel de Lardizabal 13
20018 San Sebastian Spain

Agata Sawicka
agata.sawicka@hia.no
Agder University College
Grooseveien 36
NO-4876 Grimstad Norway

Thomas R. Stewart
t.stewart@albany.edu
University at Albany
Center for Policy Research
Milne 300
Albany NY 12222 USA

José Manuel Torres
jmtorres@tecnun.es
TECNUN University of Navarra
Paseo Manuel de Lardizabal 13
20018 San Sebastian Spain

Elise Axelrad Weaver
eweaver@wpi.edu
Worcester Polytechnic Institute
Dept Social Science & Policy Studies
100 Institute Road
Worcester MA 01609-2280 USA

Johannes Wiik
johannes.wiik@hia.no
University of Bergen
Stromgaten 32
5008 Bergen Norway

Understanding the Dynamics of Coastal Resources Management

System dynamics concepts and methods are rarely referenced in the field of coastal resources management, even though coastal systems and decision-making are dynamically complex and the SD literature offers a rich and relevant body of theory, practice and models. Recent work in the theory of ecosystem management calls for the use of modeling and is becoming of increasing interest to coastal managers. A simple stock and flow model of coastal management is presented that is drawn from the legislative design of one of the oldest and certainly successful U.S. state programs, Rhode Island's Coastal Resources Management Program. This model exhibits several dynamic behaviors intuitively familiar to coastal managers. Model runs are presented using parameters taken from the Rhode Island case, including runs with and without the coastal management program in place. These results are compared with performance data from the 35 year Rhode Island coastal program's permit data base, and closely reproduce long term trends in key variables. The forward-looking scenarios are utilized to suggest approaches for the state program as it enters the new century. Implications for newly emerging coastal programs in developing countries are also drawn.

Lewlyn Rodrigues

rodrigusr@yahoo.com
Manipal Institute of Technology
Dept of Mechanical & IP
Engineering
576 104 Karnataka
India

Morvin Savio Martis

oceanmartis@yahoo.com

G. R. Krishnamurthy

grkrishna_time@rediffmail.com

Modeling Engineering Competence Pool: System Dynamics Based Implications for KM & HRM Integration

This paper focuses on the application of system dynamics in the integration of knowledge management (KM) and human resource management (HRM) with specific reference to the determination of the optimum setting of time-based policy parameters. The integration of KM and HRM is w.r.t. the engineering competence pool development and deployment. The feedback as well as feed-forward loops were used in the development of the control loops, which govern the simulation carried out in two distinct stages. In both the stages, the influence of the governing time-based policy parameters has been studied to investigate the critical parameters, which significantly influence the effectiveness of the system. The simulation results envisage the effect of the policy parameters, based on which implications are drawn for better policy evaluation and control. Even though the study has a national context, the procedure adopted in this research has the potential to be extended to the global level.

Brent Ross

rross@uiuc.edu
Univ of Illinois at Urbana-Champaign
326 Mumford Hall MC-710
1301 West Gregory Drive
Urbana IL 61801 USA

Imputing Economic Returns to Entrepreneurial Behavior: A System Dynamics Model of Firm-Level Innovation and Arbitrage

Firms need to act entrepreneurially to compete in today ultra-competitive business environment. This requires firms to actively search for and exploit opportunities to increase revenues or decrease costs in an uncertain environment. Within a firm, these activities are the functions of the entrepreneur or the entrepreneurial resources. In return for their services, these resources receive payments known as entrepreneurial rents. These rents are the result of subjective judgments and the activities that generate them are subject to imitation. Thus, entrepreneurial rents are both ex ante non-contractible and temporary. These characteristics make their measurement difficult for managers. This paper is an attempt to measure entrepreneurial rents using a system dynamics framework. System dynamics models are uniquely positioned to capture the dynamic complexities of these rents. In doing so, I present a SD model of a three-site hog production operation and compute the entrepreneurial rents generated from several arbitrage and innovation activities.

Tommaso Rossi

trossi@liuc.it
Cattaneo University Italy
Corso Matteotti 22
Castellanza Italy

A Formal Method for Analyzing and Assessing Operational Risk in Supply Chains

This paper is aimed at formalizing an objective method to analyze and assess operational risk in supply chains. The proposed approach consists of exploiting the analogy among logistic networks and

Carlo Noe

carlo.noe@polimi.it
Cattaneo University Italy
Corso Matteotti 22
21053 Castellanza VA Italy

Fabrizio Dallari

fdallari@liuc.it
Cattaneo University Italy

dynamical systems; in particular, it proposes to identify the risky events characterizing a generic supply chain by studying its attributed Petri net and the corresponding coverability graph, whereas it suggests to assess the risky events effects by building the logistic network simulation model, experimenting on it and applying ANOVA to the experimental campaigns results. Finally, the method has been applied to a single-item, 3-stages supply chain to show how it can be practically used.

Santanu Roy

rsan58@yahoo.co.uk
National Inst of Science Tech and Dev
KS Krishnan Marg Pusa
New Delhi 110 012
India

Sunita Sharma

ruby_sonu@yahoo.com
National Institute of Sci Tech & Dev
9835 Fredericksburg Road #935
San Antonio TX 78240
USA

Vikrant Bhushan

Modelling and Analysis of the Indian Outsourcing Industry: A System Dynamics Approach

India is emerging as one of the biggest markets for offshore services. Business process outsourcing (BPO) is the delegation of one or more information technology (IT) intensive business processes to an external provider that, in turn, owns, administrates and manages the selected processes based upon defined and measurable performance metrics. Offshore outsourcing is an umbrella term covering a range of IT and business services delivered to companies in developed countries by personnel based in developing countries. Though Indian outsourcing industry is growing, the attrition rate is also rising in this sector. So is the backlash against outsourcing. In order to survive and grow in this scenario, Indian firms must ensure that their services are not only cost-effective but also qualitatively superior. The present study probes into these issues. The study aims to explore the structure of Indian outsourcing industry through the methodology of system dynamics. A system dynamics model has been developed, validated and simulated over time to understand the trends that characterize this industrial segment. The implications of the results of the study are discussed.

Alexander V. Ryzhenkov

ryzhenko@ieie.nsc.ru
Russian Academy of Sciences
Inst for Economics and Industrial Eng
17 Academician Lavrantiev Avenue
Novosibirsk 630090 Russia

Supposing a Control Law of Primary Income Distribution for the Modern US Economy

This paper defines a hypothetical Law (HL) of capital accumulation that includes a growth rate of supply of labour force as a non-linear function of capital intensity. The main state variables are the labour productivity, relative wage, employment ratio, and capital-output ratio. An application of an extended Kalman filtering to the US macroeconomic data 1969–2002 exhibits long wave as a viable pattern generated by capital accumulation. Applying the Structural Control Theory the present paper reveals closed loop control over a fractional growth rate of total profit and its advantages in comparison with an open loop control. The supposed control law of primary distribution of income for the macroeconomic oscillatory system is derived as a substantial modification of the initial HL. It is shown that the US state and business leadership has been pursuing pro-growth stabilization policy with a focus on primary income distribution at least since 2001.

Khalid Saeed

saeed@wpi.edu
Worcester Polytechnic Institute
Social Science & Policy Studies
Dept
100 Institute Road
Worcester MA 01609 USA

Classical Economics on Limits to Growth

Neoclassical economics seems to have rejected the concept of limits to growth by assuming that the market and the technological advances invoked by it will make it possible to tap new resources and create substitution of production factors, while it has outright excluded limitations invoked by the political, psychological and social institutions in its analysis. Classical economics, other the other hand, appears to have been cognizant of a multitude of limitations to growth, including demographic, environmental, and social. This paper reconstructs classical economic growth models using system dynamics method and demonstrates their behavior using computer simulation. A case is made for taking a pluralistic view of the growth process and reincorporating a multitude of institutions driving it into our models to arrive at realistic policy options.

Mohamed Mostafa Saleh

msaleh@idsc.net.eg
Egyptian Cabinet
Information and Decision Support
Ctr
1 Magless Al-Shaab Street
Cairo Egypt

Pål I. Davidsen

davidsen@ifi.uib.no
University of Bergen
Department of Geography 7th Floor
Hermann Fossgt 6
5020 Bergen Norway

Khaled Abdel Hakim Bayoumi

kbayoumi@iti-idsc.net.eg
Egyptian Cabinet
ITI IDSC
1 Magles El-shaab Street
Cairo Egypt

A Comprehensive Eigenvalue Analysis of System Dynamics Models

In this paper, we develop a comprehensive eigenvalue analysis for linear models, in order to identify the leverage points in models. The analysis is comprehensive as we develop a closed-form analytic function relating the behavior of any state variable to all parameters in the model. Moreover, by decomposing the behavior into several modes of behavior – each characterized by an eigenvalue and an eigenvector – it is possible to develop a closed-form analytic function relating a certain mode of behavior to all parameters in the model. In the first section of this paper, we explain the mathematical foundation of eigenvalue analysis. In the second section we identify the origin of the modes of behavior. This enables us to pinpoint the leverage points of the model. Finally, in the last section, for illustration purpose, we apply the method to a linearized version of the classical market growth model. The analysis of this linearized model enables us to explain the model behavior as a superposition of a number of behavior modes, and set the stage for analyzing the original, non-linear version of the model.

Markus Salge

salgem@is.bwl.uni-mannheim.de
Mannheim University
Schloss Industrieseminar
D-68131 Mannheim
Germany

Lessons from the Chernobyl Nuclear Power Plant Accident for the Design of Organizational Improvement Initiatives

This paper analyzes the design and functionality of the nuclear reactor, and the human failures on on-line operations, which had led to the accident at the Chernobyl power plant, In April 26, 1986. The paper finds that the combination of the Chernobyl-reactor characteristics and "freak infringements" of safety rules did cause the accident. The former aspect is due to the process of graphite-moderated uranium fission, which tends to increase in reactivity in the case of a malfunction or faulty operation. The latter is caused by the effect that infringements which did not cause accidents in the past lead to more violation of safety rules in the future. Transferred to

organizational improvement programs, a corporation has to redesign its structure in the vein that failures cannot spread quickly (i.e. loosely coupled system elements), and to generate an atmosphere in order to encourage and utilize the full benefits of employees' participation.

Mehmet Samur

samur@boun.edu.tr

Bogazici University
Ikieylul Caddesi Yediler Sokak
No 1/1
Superdorm Yurdu Od
Etiler Istanbul Turkey

Egzi Eren

ezgicaneren@yahoo.com

Texas A&M University
700 Dominik Drive #3206
College Sta TX 77840-3441 USA

Omer Hancer

omer@orie.cornell.edu

Cornell University
316 Highland Rd #C204
Ithaca NY 14850 USA

Belkis Tunakan

burcu@orie.cornell.edu

Cornell University

A Computerized Beer Game and Decision-Making Experiments

This paper has two goals: The first is to present a computerized version of "Beer Game" originally developed as a board game to teach managers the principles of supply chain management. The multiplayer interactive simulation game we develop is 100 percent faithful to the original game, so that experimental results from the physical and computerized environments can be safely compared. The simulation model used to represent the game also illustrates some subtleties that a model builder must be careful about while simulating a discrete and physical game. Secondly, the game was used as an experimental platform and experiments were done in order to analyze game medium (computer vs. board), demand pattern and learning effects on performances of players. One striking result is the fact that subjects who played the board game scored significantly better than those who played the computerized version under the same conditions.

Joerg Sandrock

joerg.sandrock@iw.uka.de

University of Karlsruhe
Englerstrasse 14
76137 Karlsruhe
Germany

Christof Weinhardt

University of Karlsruhe
Englerstr 16
76137 Karlsruhe
Germany

System Dynamics Business Models for E-Learning Content Providers

The quest for the right E-Learning business model is a strategic issue for E-Learning-companies' management. But like any new concept, it is not short of confusion and ambiguity. This article gives a short review of the controversial discussion of the value of E-Learning business models and presents a simulation model built on system dynamics concepts to analyse and evaluate formalized E-Learning business models. This simulation model has been initialized and validated by empirical data gathered from literature research and five structured expert interviews. The simulation for different pricing and licensing scenarios for E-Learning products reveals the complex feedback structures in the pricing setting process and their impacts on the performance of a E-Learning content provider.

Javier Santos

jsantos@tecnun.es

Tecnun - University of Navarra
Paseo Manuel Lardizabal 13
20018 San Sebastian Spain

Jose Mari Sarriegi

jmsarriegui@tecnun.es

Tecnun - University of Navarra
TECNUN
Paseo Manuel de Lardizabal 13
20018 San Sebastian Spain

Dynamic Aspects of an ERP Implementation Project

The implementation of an ERP (Enterprise Resource Planning) demands the development of a complex project. On one hand, the scientific literature presents some key factors which allow the project to reach the expected objectives. However, these researches do not consider the dynamic relationships that take place among these key factors, although interrelations can benefit or stop the project development. On the other hand, there are different useful strategies

Nicolas Serrano

nserrano@tecnun.es

Tecnun - University of Navarra
Paseo Manuel Lardizabal, 13
20018 San Sebastian Spain

for an ERP implementation that directly affect the project development. This paper develops a generic model to identify the relationships among the main key factors (best fit with current business process, resistance to change and training). The model has been validated by a company dedicated to ERP implementation in Spain. Finally, the model will also be useful to analyze the impact of the different strategies in the management of an ERP implementation project according with the project cost study.

Rachmini Saparita

saparita@lipi.go.id

Indonesian Instituite of Sciences
Ctr for Appropriate Technology Dev
Jl KS Tubun 5 Subang 41213
Jawa Barat Indonesia

Burhan Arief

Padjadjaran University
Faculty of Agriculture
Jl Raya Bandung Sumedang Km 21
Jatinangor Sumedang Indonesia

Ronnie S. Natawidjaja

Padjadjaran University
Faculty of Agriculture
Jl Raya Bandung Sumedang Km 21
Jatinangor Sumedang Indonesia

Muhammad Tasrif

ppeitb@bdg.centrin.net.id

Bandung Institute of Technology
Energy Research and Development
Group
Jl Ganesha 10
Bandung 40132 Indonesia

Agricultural Transformation Model in Indonesia Using a System Dynamics Approach

The aim of study was to know dynamics process of agricultural transformation in Indonesia in supporting a fair agricultural economic development. Computer model was built to comprehend the problem and look for appropriate solution. The result showed that various programs were performed to build a strong agricultural economic, but the programs could not drive agricultural transformation properly, which could brings Indonesian farmer to a better life. The Government is required to run agricultural development policies that push the income of farmer to a better condition. The proposed policy, which consists of intensification program, agricultural investment, technology adoption, and education progress, were expected could generate the improvement of farmer's income. However, the policy should be proceed together with land reform in order to get a fair distribution of land, so the farmer have a chance to carry out commercial activity after satisfying their basic needs. Key Words: agricultural transformation, agricultural development, system dynamics, models.

Jose Mari Sarriegi

jmsarriegui@tecnun.es

Tecnun - University of Navarra
TECNUN
Paseo Manuel de Lardizabal 13
20018 San Sebastian
Spain

José Manuel Torres

jmtorres@tecnun.es

TECNUN University of Navarra
Paseo Manuel de Lardizabal 13
20018 San Sebastian
Spain

Javier Santos

jsantos@tecnun.es

Tecnun - University of Navarra
Paseo Manuel Lardizabal 13
20018 San Sebastian
Spain

Explaining Security Management Evolution through the Analysis of CIOs' Mental Models

Information Systems are a key factor for firms' competitiveness. Thus, their efficient management has become a key concern and security management one of the most relevant issues. An empirical study has been developed to determine the characteristics of security management within Small and Medium sized Enterprises (SMEs). A summary of the main data from this study is presented. The results of this study have showed that the evolution of security management within firms has evolved through similar patterns of behaviour. Some phases have been defined to explain the evolution of security management within SMEs. The defined phases are: Growth, Integration, Formalization and Involvement. To explain these phases causal loop diagrams and behaviour over time graphs have been used. Both elements help to more accurately understand the mental models of the people in charge of managing the security of information systems.

Agata Sawicka

agata.sawicka@hia.no
Agder University College
Grooseveien 36
NO-4876 Grimstad
Norway

René Molkenthin

rene.molkenthin@uni-mainz.de
Johannes-Gutenberg-University of
Mainz
Jakob Welder-Weg 9
55128 Mainz
Germany

Cognitive Load Dynamics: How to Increase Effectiveness of System Dynamics-Based Learning Environments

A system dynamics (SD) model without an instructional overlay is not a sufficient learning tool (Spector and Davidsen 1997, Alessi 2000). We propose Cognitive Load Theory (CLT, Sweller 1988) as a theoretical framework for devising effective instructional context for SD models. Providing a systematic distinction between the several sources of cognitive load, CLT specifies what (and why) should be considered when the instructional overlay for a learning environment is designed. Having developed a simple SD model of the theory, we use it to explore how various instructional choices might impact effectiveness of the learning process. Finally, we consider the CLT recommendations in the context of SD-based learning environments and discuss how they may provide input to developing a set of guidelines for design of effective ways to communicate insights of SD models to a broader audience.

Agata Sawicka

agata.sawicka@hia.no
Agder University College
Grooseveien 36
NO-4876 Grimstad
Norway

Jose J. Gonzalez

jose.j.gonzalez@hia.no
Agder University College
Faculty of Engineering and Science
Grooseveien 36
NO-4876 Grimstad
Norway

Ying Qian

iris_qian@hotmail.com
Agder University College
Faculty of Science and Engineering
Groosvn 36
NO-4876 Grimstad
Norway

Managing CSIRT Capacity as a Renewable Resource Management Challenge: An Experimental Study

CSIRTs are security incident handling organizations serving a parent organization or a "constituency" of independent organizations. CSIRTs struggle coping with the increasing number and sophistication of incidents; staff is overloaded with work; managers 'over-utilize' their teams. The CSIRT 'mismanagement' problem can be framed as a case of natural resource management. Studies by Moxnes suggest that misperception of dynamics may contribute to natural resources mismanagement. We replicate experiments by Moxnes (2004), reframing the one-stock reindeer rangeland management task as a challenge in sustainable CSIRT management. Our results suggest: 1) The misperception of dynamics persists when the problem context changes; 2) people employ a simplistic anchoring-and-adjustment decision rule to deal with the problem; 3) our data do not support the version of the rule proposed by Moxnes. We hypothesize that the observed misperception might at least in part depend on the way in which the task was presented.

Burkhard Schade

burkhard.schade@iww.uni-karlsruhe.de
University of Karlsruhe
Kollegium am Schloss Bau IV
76128 Karlsruhe
Germany

KEYNEO – a KEYnesian and NEOclassical Model of the German Economy

The aim of the System Dynamics Model KEYNEO is to model the German economy over a long time period (40 years). Keynesian and neoclassical elements form the base of KEYNEO. In the first step a complex feedback structure was developed to model the main economic variables on an aggregate level. The equations for the supply and the demand side of the economy were defined in the second step. The results of different runs demonstrate that KEYNEO

mimics historic data quite good. With the use of optimization tools the parameters could be estimated. The statistical analysis of KEYNEO shows that the results are highly significant. This verification underlines the quality of KEYNEO to model an economy. In addition, the structure of KEYNEO may serve as input for much more sophisticated models.

Burkhard Schade

burkhard.schade@iww.uni-karlsruhe.de
University of Karlsruhe
Kollegium am Schloss Bau IV
76128 Karlsruhe Germany

Wolfgang Schade

w.schade@isi.fraunhofer.de
Fraunhofer Institute
Systems and Innovation Research
Breslauer Str 48
76139 Karlsruhe Germany

Assessment of Environmentally Sustainable Transport Scenarios by a Backcasting Approach with ESCOT

The aim of the System Dynamics Model ESCOT is to describe a path towards a sustainable transport system in Germany and to assess its economic impacts. ESCOT was developed within the environmentally sustainable transport (EST) project of the OECD that was designed to set-up the ecological and technical framework of a transition towards sustainable transportation. ESCOT comprises five models: the macroeconomic, the transport, the regional economic, the environmental and the policy model. The economic assessment for environmentally sustainable scenarios shows that the departure from car- and road freight-oriented transport policy is far away from leading to an economic breakdown. By expanding the time period for the transition we derived even more encouraging economic results. For the economic assessment it is important that ESCOT considers not only first round effects but also secondary effects. This ability makes ESCOT a powerful instrument for the assessment of such large system changes.

Martin Franz Georg Schaffernicht

martin@utalca.cl
Universidad de Talca
FACE
Avenida Lircay s/n
Talca Chile

Are You Experienced? – A Model of Learning Systems Thinking Skills

This paper proposes a contribution to the domain of systems thinking skills. Empirical studies have repeatedly shown surprising misperceptions and inabilities in subjects confronted with tasks involving very simple stock and flow systems. Here it is proposed to represent these skills as implicit integration, by which Polanyi modeled our ability to know. In this framework, Dreyfus and Dreyfus' five stage model of learning is used to construct three hypotheses concerning the learning of systems thinking and its importance for learning from modeling and interaction with models. The tests elaborated by Ossimitz are adapted for this purpose and some tasks are added, to serve in the experimental corroboration of the hypotheses. Since the empirical work is currently under way, only few results can be presented; consequently the main contribution is the conceptual construction of the hypotheses.

Tim Scheffmann

tim.scheffmann@web.de
An den Krautgärten 29
65760 Eschborn
Germany

Bank Management of Risk Dynamics

In banks decisions are made in a speedy and complex environment often with huge uncertainty. This risk must be managed proactively on an enterprise level. To accomplish this task, a systemic view of the bank is essential. Up to now there is no standardised approach for

analysing the overall risk dynamics of a bank that is capable of describing the forces inherent in risk management. Most risk models are constrained by their static view, so that they hardly capture the rapid and discontinuous changes. This paper examines the dynamics by applying system dynamics to enterprisk risk management, with the aim of understanding the banks' risk dynamics. In order to simulate the risk dynamics of a universal bank a dynamical enterprise risk model was developed. By combining the disciplines of enterprise risk management and system dynamics, this paper shows how a systemic view can improve structures in bank risk management and the need for large system thinking.

Nadine Schieritz

nadines@is.bwl.uni-mannheim.de
Mannheim University
Industrieseminar Schloss
D-68131 Mannheim
Germany

Agents First! – Using Agent-Based Simulation to Identify and Quantify Macro Structures

The agent-based simulation approach models social phenomena as resulting from local interactions of agents one level below the phenomenon. Compared to system dynamics studies this often requires a lower level of abstraction what can make agent-based models easier to quantify. This paper analyzes the potential of the agent-based approach (i) to quantify a known aggregate causal structure and (ii) to identify the unknown aggregate structure of a problem. The two cases are investigated using very simple models of population dynamics.

Marcus Schroeter

marcus.schroeter@tu-bs.de
Technical University of Braunschweig
Dept of Production Management
Katharinenstr 3
D-38106 Braunschweig Germany

Thomas Spengler

t.spengler@tu-bs.de
Technical University of Braunschweig
Inst for Economics and Business Admin
Dept of Production Management
38106 Braunschweig Germany

A System Dynamics Model for Strategic Management of Spare Parts in Closed-Loop Supply Chains

The strategy to recover components from discarded electrical and electronic equipment to obtain spare parts is promising, especially during the final service phase. In that phase, the original product is no longer produced and the sources of new parts are often limited. Controlling those closed-loop supply chains is challenging. Decision makers have to choose when to acquire discarded equipment, when to recover used parts, and when to produce new parts. We developed a generic system dynamics model that provides a test for various proposed policies to control closed-loop supply chains with parts recovery and spare-parts supply.

Maria Serrano

mserrano@unab.edu.co
Universidad Autonoma de Bucaramanga
Calle 48 Nr 39-234
Bucaramanga Santander
Colombia

Revealing the Colombian Government's Coherence in the Design of Food Security Policies

Studies made by the Swiss politician Jean Ziegler show that the world agricultural system is able to feed twice the population of the planet. However, 800 million people are hungry. During the last years, the Colombian Government has been designing policies oriented to

Ricardo Sotaquirá

rsotaqui@unab.edu.co
Universidad Autonoma de
Bucaramanga
Calle 48 Nr 39-234
Bucaramanga Santander
Colombia

provide solutions to the hunger problem and thus to decrease the number of Colombian families which lack this fundamental right, the food supply. However, the effects of these policies have not been the expected ones, on the contrary, lower class people is still plunged into poverty and hunger. Why have they not been effective? Which have been the consequences of implementing those policies? Considering the impact of economic liberalization during the 90's on the agricultural sector, a model has been constructed taking into account the national production, the cultivated area, the people working and the capital invested on the agricultural process. The simulation results of the implementation of the commerce liberalization policies seem to match with the results recorded in the Agricultural and Rural development Ministry. Finally, the model will be tested in a scenario that includes the policies that are part of the Development Plan proposed by the current Government 2002-2006 to observe possible consequences of this implementation.

Ravi Shankar

ravi1@dms.iitd.ernet.in
Indian Institute of Technology Delhi
Department of Management Studies
Hauz Khas New Delhi 110 016
New Delhi 110 016 India

V. Ravi

to_raviv@yahoo.com
Indian Institute of Technology Delhi
Department of Management Studies
Hauz Khas New Delhi 110 016
New Delhi 110 016 India

Scenario Building and Policy Experimentation of Reverse Logistics of an Automobile Supply Chain

The aim of this article is scenario building and policy experimentation of reverse logistics variables for an automobile supply chain. The reverse logistics operations are becoming a necessity with ever growing concern for the environment. There is a close inter-coupling of economic, technological, political, and social forces affecting reverse logistics practices in the automobile industry. In this context, it is important to understand the transition phases of market scenarios in reverse logistics practices. For this, one has to understand the complex interactions and dynamics of different variables affecting reverse logistics. Scenario building and policy experimentation would enable the top management to detect and explore alternative futures so that present actions can be fine-tuned. Results of simulation of the SD model indicate that there are a few reverse logistics variables, which are instrumental in triggering the other variables of the model so that the desired results could be achieved faster. Key words: Reverse logistics, system dynamics (SD), scenario building, policy experimentation.

Ritu Sharma

ritu.sharma@paconsulting.com
PA Consulting Group
One Memorial Drive
Cambridge MA 02142
USA

Tom Mullen

tom.mullen@paconsulting.com
PA Consulting
One Memorial Drive
Cambridge MA 02142
USA

Making Big Decisions Better

Most large development projects suffer overruns and delays, despite substantial effort spent on systems tracking risks and projecting performance. Managers have an especially difficult time making big decisions such as major project re-plans. Typical project management systems have key blind spots that limit their value for comprehensive decisions. Most project management tools are blind to project dynamics – variations in productivity and quality over time under different conditions. System Dynamics models have been used to address this weakness and capture project dynamics, but typically these models have their own blind spots as they omit key details. With many pressing decisions and little time, managers rely on intuition to supplement the limitations of management tools. The combination of

little time for major decisions, limited tools, and unreliable intuition is a key contributor to the poor results often achieved on major projects. This paper offers perspective on the challenges of making major decisions and describes a case using an integrated management tool -- a System Dynamics model linked to a database of project details. This management system was used to restructure a multi-billion dollar development program with detail and rigor – examining dozens of different options, sensitivities, and leverage points in one month.

William Siemer

wfs1@cornell.edu
Cornell University
119 Fernow Hall
Dept of Natural Resources
Ithaca NY 14853
USA

Peter A. Otto

ottop@dowling.edu
Dowling College
School of Business
150 Idle Hour Boulevard
Oakdale NY 11769
USA

A Group Model-Building Intervention to Support Wildlife Management Decisions

A variety of approaches are being developed to elicit knowledge from clients and develop that knowledge into conceptual maps and formal simulation models. We completed a project that provides a case example where the "standard method" was adapted for use in a group model-building intervention. We worked with a group of 10 wildlife managers to support system conceptualization, model formulation, and management response to an increase in negative human-black bear interactions in residential areas of New York State. This article discusses the procedural and conceptual steps, insights, and lessons learned from our model building intervention. Our paper focuses on model-building process and learning outcomes, rather than quantitative validation of a simulation model.

Gill Smith

gill.smith@olmgroup.com
OLM Consulting
Cairns House 10 Station Road
Teddington Middlesex TW11 9AA
UK

Eric F. Wolstenholme

e.wolstenholme@btinternet.com
Fieldings 12 Rivock Avenue
Steeton Keighley West Yorks BD20 6SA UK

Dean Repper

dean.repper@nimhenorthwest.org.uk
NIMHE North West
Hyde Hospital, 2nd Floor
Grange Road South
Hyde SK14 5NY
UK

Initial Experiences of Introducing System Dynamics through a Mental Health Project in North West England

The paper describes a partnership project between three parties, centred on the use of System Dynamics (SD) in a Mental Health Trust (MHT). The main learning experiences relate to the politics of introducing challenging concepts in a situation where participants prefer to avoid confrontation. The rigorous nature of SD modeling and simulation raises questions which operational managers may fear reflect badly on the organization and their own capabilities. They may be uncomfortable with questions about the evidence-base for current treatments, or the research to back their ideas for future developments. A further issue is the ambiguity inherent in definitions of SD and the likelihood that many managers prefer single-issue projects, based on their comfort zone of practice/expertise. A hypothesis is developed to describe the observed reactions in the project and suggest alternative approaches in carrying out SD projects in the UK public sector.

Birgitte Snabe

birgitte@snabe.net
Mannheim University
Schloss Industrieseminar
D-68131 Mannheim
Germany

Targeted Participative Modelling – Conceptual Discussion and Case Study Presentation

The purpose of the paper is to propose a modelling approach to be used in targeted organisational interventions focusing on strategic business objectives and change management. The approach builds upon prevalent participative modelling approaches with the extension

of increased focus on intervention planning, stakeholder management, and structured implementation. A single-site longitude case study regarding development of a balanced R&D location strategy served as inspiration for the development of the approach – and in the paper it also serves as a practical illustration of the approach. Interesting insights include successful observations of individual learning and group communication in a modelling study, which is more targeted on predefined business objectives than usually seen in the SD community. However, generic conclusions must await further research within the area.

Hae-Deok Song
hsong@uamail.albany.edu
University at Albany
Education 115B
Albany NY 12222
USA

Wei-Tsong Wang
ww8256@albany.edu
University at Albany
School of Information Science &
Policy
840 Washington Avenue
Albany NY 12203
USA

Chao-Yueh Liu
chaoyueh.liu@gmail.com
University at Albany
14 Niblock Ct Fl 2
Albany NY 12206
USA

Sehnaz Baltaci
sehnazb@hotmail.com
University at Albany
Dept of Educational Theory &
Practice
1400 Washington Avenue
Albany NY 12222
USA

Simulating the Impacts of Factors that Support Faculty Adoption of Web-Based Instruction

This article attempts to build a simulation model of the impacts of factors that facilitates faculty adoption of Web-Based Instruction (WBI) from the perspective of the faculty' stages of concerns. Faculty have different concerns as they integrate new technology into their teaching. Without reducing these concerns, WBI integration will not be successful. Four main stages of faculty concern (information, personal, management, and impact concern) were identified based on Hall's concern-based adoption model. Reviewing literature on the diffusion of on-line education, we have identified support factors that may decrease faculty's concerns for adopting WBI in their education settings. These factors were incorporated into the simulation model in order to test the potential impacts of the factors on faculty adoption of WBI. The current simulation model built in Stella® will aid educators or administrators to evaluate the impact of the factors on adoption of WBI.

Krystyna A. Stave
kstave@ccmail.nevada.edu
University of Nevada Las Vegas
4505 Maryland Parkway
Box 454030
Las Vegas NV 89154-4030
USA

Michael F. Dwyer
mdwyer@unlv.nevada.edu
University of Nevada Las Vegas
2109 Madagascar Lane
Las Vegas NV 89117
USA

A Group Model Building Process to Integrate Land Use, Transportation, and Air Quality Planning in Las Vegas, Nevada

This paper uses the framework proposed by Rouwette et al. (2002) to describe the group model building stage of a project to integrate land use, transportation and air quality planning in a rapidly growing metropolitan area. The purpose of the paper is twofold: to present a case of group model building in the public sector, and to test the framework for reporting about group model building interventions. The main goal of the intervention described is to evaluate the effect of potential land use and transportation policy changes on urban quality of life factors such as air quality and traffic congestion. A secondary

goal is to foster interagency and intergovernmental collaboration. After approximately 15 months, the project is at the end of its first stage. A quantitative model has been completed and is being tested by the modeling group. In the next stage, the model will be used by policy-makers for policy evaluation.

Krystyna A. Stave

kstave@ccmail.nevada.edu
University of Nevada Las Vegas
4505 Maryland Parkway
Box 454030
Las Vegas NV 89154-4030
USA

Michael F. Dwyer

mdwyer@unlv.nevada.edu
University of Nevada Las Vegas
2109 Madagascar Lane
Las Vegas NV 89117
USA

Modeling the Relationship between Population and Land Development under Changing Land Use Policies

This paper discusses a model developed to assess the effects of land-use changes on traffic congestion and air quality. The inputs are characteristics of development and the outputs are time in traffic per capita, and tons of carbon monoxide from vehicles. As previously developed urban dynamics models have done, the model includes a relationship between the output variables and the attractiveness of the area as a place to live. Particular attention is paid in this paper to challenges associated with modeling the relationship between population and land development in urban areas where alternative land-uses are being contemplated. The evolution of an approach to overcoming the challenges is presented.

Jeroen Struben

jjrs@mit.edu
MIT
750 Tremont Street Apt 9
Boston MA 02118
USA

Space Matters Too! Mutualistic Dynamics between Hydrogen Fuel Cell Vehicle Demand and Fueling Infrastructure

Pressures from human induced climate-change, pollution, and fossil fuel scarcity stimulate interest in alternative fuel vehicles, and in particular hydrogen fuel cell vehicles (HFCV's). The transition from internal combustion engine vehicles to HFCV's is complex as various 'chicken-egg' mechanisms interact in a highly integrated fashion, and the mechanisms are highly non-linear. This paper focuses on one of the most critical chicken-egg problems: the mutualistic dynamics of HFCV adoption and its fueling infrastructure. The effects of local demand-supply interactions on these dynamics are explored in depth. This paper develops a dynamic, behavioral model of vehicle adoption and fueling infrastructure with explicit spatial structure. Simulations are performed for a reduced version. A homogeneous market with strategically locating fuel-station entrants yields fast transition through the formation of adoption clusters (niches). However, under heterogeneous conditions the same micro-mechanisms can counteract the emergence of a sustainable market. Policy implications are significant. This spatial behavioral dynamic model (SBDM) can be used to compare targeted entrance strategies for hydrogen fuel supply. Insights can be used for an aggregate HFCV transition model that includes other mechanisms. Finally, the paper should stimulate a discussion on merits and limitations of spatial modeling as applied to more general socio-economic issues.

Toru Suetake

tohru.suetake@jp.kpmg.com
Chuo University
Soshigaya 1-11-23
Setagaya-ku
Tokyo 157
Japan

Makoto Ikeda

ikeda@itakura.toyo.ac.jp
Toyo University
Izumino 1-1-1
Itakura-machi Oura-gun
Gunma-pref 374-0193
Japan

Public Policy Evaluation using System Dynamics Group Modeling

Though evaluation of public policy and projects of government-to-government assistance are quite common in Japan, evaluator use logical model bases for evaluation that is simple tree type model without incorporate loop or feed back effects. Author has insisting that SD modeling is applicable for quantitative evaluation of public policy but find some difficulty with traditional group model building method. In this paper, we wish to discuss new style SD/ST model building for public policy evaluation.

Finn Olav Sveen

fosvee03@student.hia.no
Agder University College
Faculty of Engineering and Science
Grooseveien 36
NO-4876 Grimstad
Norway

Jose J. Gonzalez

jose.j.gonzalez@hia.no
Agder University College
Faculty of Engineering and Science
Grooseveien 36
NO-4876 Grimstad
Norway

Richard Sanders

dick.sanders@sca.com
SCA Packaging Coordination Center
NV
Twin Squares Business Park
Culliganlaan 1 D
BE-1831 Diegem
Belgium

Applying Generic System Archetypes to a 'Beyond the Core' Challenge

We describe an attempt to model an enterprise's expansion into business adjacencies within the scope of a Master thesis. It was crucial to define a strategy that would allow the Master student to grow with the task (gain experience with modeling), at the same time ensuring communication with the client and proving the ability of qualitative SD modeling to deliver insights. After identifying problem symptoms, the enterprise problem was explored with methods from Chris Zook: 'Beyond the Core'. Six cases from Zook's book offering points of entry for the enterprise problem were cast into generic archetypes and presented to the problem owner. Two archetypes belonging to the "Underachievement" class were identified as most relevant for the enterprise problem, viz. 1) underachievement due to long distance between the core and the adjacency, and 2) underachievement due to poor adjacency repeatability. We developed a preliminary system dynamics model embedding both archetypes. The model gives sensible results with basic policies affecting distance to the core and repeatability. The preliminary results have strengthened the client's interest in the modeling work. Further joint modeling sessions have been scheduled. Work is still in progress.

Yutaka Takahashi

takahasi@isc.senshu-u.ac.jp
Senshu University
2-1-1 Higashimita Tama
Kawasaki Kanagawa 214-8580
Japan

Influence of Free Version upon Pay Version of High Specialty Software Diffusion

Today software vendors have various ways to handle their products. In contrast to non-software products, software products' properties can be changed or controlled at a low cost; vendors do not need to extend their operations, and well-designed software can be customized systematically. Moreover, its diffusion is influenced by network externalities. The diffusion structures of software that have single user type, e.g. World Wide Web browsers, can be expressed mainly as a single reinforcing loop. This is because users can be considered as homogeneous. However, there are multiple possibilities of structure, which corresponds to business strategies for software which has

divided users. An example in this category would be highly specialized software, e.g. simulation software. We attempt to explain diffusion processes and characteristics concerning network externalities of software in this category using System Dynamics models. This paper shows that multiple editions can more effectively assist diffusion of main products than strengthening network externality effects.

Yutaka Takahashi

takahasi@isc.senshu-u.ac.jp
Senshu University
2-1-1 Higashimita Tama
Kawasaki Kanagawa 214-8580
Japan

Translation from Natural Language to Stock Flow Diagrams

Mental models are bases to recognise phenomena and make plans to improve situations. They can be expressed in model builders' natural language. It is also necessary to examine mental models using a computer simulation. The Computer simulation requires expressions, which can be translated into computer codes. Therefore, model builders need to translate their model from their own natural language to simulation-friendly language, i.e. stock flow diagrams in System Dynamics. It is widely recognised that this translation is sometimes difficult not only for people who are beginners of System Dynamics but also for people who are experienced in the field. This paper discusses a possible translation procedure and shows an application of it. The proposed procedure is designed to use a subset of a natural language as an intermediate language. This idea is applicable regardless of variety of natural language.

David Thompson

dt.home@comcast.net
Crescent Solutions
1102 Russell Drive
Highland Beach FL 33487
USA

B. Bush

bwb@lanl.gov
Los Alamos National Laboratory
PO Box 1663
Los Alamos NM 87545
USA

Software Practices Applied to System Dynamics: Support for Large Scale Group Development

The development of large software systems using systems dynamics languages has been hampered by the lack of application of, and support for, modern software techniques. Support is needed to handle the challenges of modular system dynamics model development. These development challenges include the handling of namespaces, linking separate modes, and maintaining clean logical separations among components. Most modern software patterns and languages support such a capability. This paper presents an approach to group, large scale, system dynamics model development that has proven valuable in our project. Our approach included the creation of a software tool, called Conductor, to facilitate our group development. The tool, Conductor, is generally applicable to other projects using Vensim®.

Warren W. Tignor

tignorw@saic.com
SAIC
472 Cornwall Court
Severna Park MD 21146
USA

Dynamic Unity – Theory U and System Dynamics

This paper explores Dynamic Unity between Theory U and System Dynamics as a way to generally illuminate the "blind spot" and create the setting for presencing. By describing the blind spot as a System

Dynamics process with a model and behavior, it is hoped that Dynamic Unity will facilitate recognition of the blind spot and produce better understanding of social actions. Dynamic unity between Theory U and System Dynamics will facilitate: identification of common assumptions, modeling of the current problem, producing repeatable results through simulation, and discovery of new insights from simulation results. The instance of presencing will remain the domain of social science, neuroscience and others to explain. Using System Dynamics to project policies through simulation, identify emerging phenomenon, accelerate the learning process, decrease dependence on past experience, change mental models into new insightful beliefs will take us to the threshold of Theory U presencing.

Igor E. Timchenko
timchenko@stel.sebastopol.ua
National Acad of Sciences of Ukraine
Marine Hydrophysical Institute
2 Kapitanskaya Str
Sevastopol 99011 Ukraine

Ekaterina M. Igumnova
National Acad of Sciences of Ukraine
Marine Hydrophysical Institute
2 Kapitanskaya Str
Sevastopol 99011 Ukraine

Irina I. Timchenko
National Acad of Sciences of Ukraine
Marine Hydrophysical Institute
2 Kapitanskaya Str
Sevastopol 99011 Ukraine

Systems Thinking and Dynamic-Stochastic Modeling of Educational Processes

In this work we bring in a concise form some basic ideas of systems management methodology for adaptive systems.It includes four component parts: systems principles, systems thinking, systems modeling and systems management. Systems principles must be used to project systems management technologies for a goal-seeking movement in any complex system based on systems thinking and systems modeling. In particular, the adaptive balance of causes principle serves as a ground for a new adaptive balance of causes (or ABC) modeling method discussed in this paper. Systems thinking concepts were also built on systems principles. In accordance with the principle of information unity of theory and experiment stochastic methods of observational data assimilation in ABC models were developed. By that way dynamic-stochastic models (DSM) of complex systems were built. The suggested systems methodology of management is examined on examples of educational systems. We aimed to show that dynamic-stochastic models of educational systems enable to give realistic development scenarios of such processes. Examples demonstrating possibilities of the systems methodology of student's teaching and forming student's communicative culture were presented.

José Manuel Torres
jmtorres@tecnun.es
TECNUN University of Navarra
Paseo Manuel de Lardizabal 13
20018 San Sebastian Spain

Jose Mari Sarriegi
jmsarriegui@tecnun.es
Tecnun - University of Navarra
TECNUN
Paseo Manuel de Lardizabal 13
20018 San Sebastian Spain

Javier Santos
jsantos@tecnun.es
Tecnun - University of Navarra
Paseo Manuel Lardizabal 13
20018 San Sebastian Spain

Searching for Preventive-Corrective Security Balance

Organizations are becoming more aware about the importance of economic, financial and risk management aspects of information system security. As a result, the balance between preventive and corrective security strategies must be studied. We understand Preventive Security as the ability of organizations to avoid the impact of an incident and Corrective Security as the ability of the firm to recover from the losses generated by an incident. This paper presents a model to analyze the Preventive-Corrective security balance. The main objective of this model is to simulate and analyze the impact that two security behaviors (security investments and strategy) can have one a given enterprise environment. After running 54 simulations, some interesting security behaviors called our attention.

Ya-tsai Tseng

yttseng@mail.thu.edu.tw

Tunghai University
Dept of Business Administration
407 Taichung Taiwan

Wei Yang Wang

wyang@cc.kuas.edu.tw

National Kaohsiung Univ of
Applied Sci
415 Chien-Kung Road
807 Kaohsiung Taiwan

Yi-Ming Tu

ymtu@mis.nsysu.edu.tw

National Sun Yat-Sen University
Dept of Information Management
Systems
70 Lian Hai Rd She-Tze Wan
Kaohsiung 804 Taiwan

The Utilization of Shared Demand Information in a Textile Supply Chain

The focus of this paper is information exploration using alternative utilization models to test how a supply chain responds to demand changes. From the feedback perspective, it is found that the echelon stock policy generates a more complex feedback structure than the installation stock policy; and has different time patterns of inventory adjustment actions. Considering the relative higher cost for small- and medium- size enterprises to adopt advance information technology in our textile supply chain case, this paper further examines the impact of information technology in the echelon stock policy and the installation stock policy. The findings show that information technology investment could be more beneficial for supply chains with the installation stock policy. Finally, this paper mixes the PID controller design concept with the two information utilization models and so suggests further development for information utilization designs.

Shigehisa Tsuchiya

tsuchiya@pf.it-chiba.ac.jp

Chiba Institute of Technology
Grad School of Mgt and Systems
Eng
2-17-1 Tsudanuma
Narashino-shi 275-0016
Japan

Koichi Sekimizu

sekimizu@aitel.toshiba.co.jp

Aitel Corporation
8 Shinsugita
Isogo-ku Yokohama-shi 235-8523
Japan

Noriko Tsuchiya

noriko28@jmail.plala.or.jp

Japan Women's College of Physical
Educ
10-21 Nibancho
Chiyoda-ku Tokyo 102-0084
Japan

Learner-Centered Communication on Nuclear Risk: Public Participation and Transparency through a Gaming/Simulation Approach

This paper discusses our project under a three-year research contract with the Japanese Government to gain public acceptance of nuclear facilities in local communities by improving risk communication through a gaming/simulation approach. Evidence suggests that nuclear public education programs are not communicating the critical safety information necessary to eliminate anxiety of people living around nuclear facilities. To most utilities and government, risk communication means persuasion. Based on the findings of our visits to several authorities, municipalities and nuclear facilities in Japan, Sweden, Norway and USA, we built a causal-loop model regarding nuclear risk communication. According to our model, the root cause of the problem is lack of trust, and the leverages are public participation and transparency which can create learner-centered two-way communication environment. "THE TREASURE HUNTING", one of our five gaming/simulations for this project, is intended to create such an environment so that local residents may deepen understanding of nuclear risk and build up a mutual trust relationship with disaster prevention experts. After many internal test runs, we have run this exercise six times so far with the nuclear disaster prevention experts and the local residents near nuclear facilities in various parts of Japan. The results have been quite satisfactory.

Akira Uchino

uchino@isc.senshu-u.ac.jp

Senshu University
School of Commerce
2-1-1 Higashimita Tamaku
Kawasaki 214-8580 Japan

Some Contributions toward Spatial Urban Dynamics

There was an interesting presentation at ISDC 2004 in Oxford. The title was "Spatial urban dynamics" presented by Peter Sanders and

Nobuhide Tanaka
770566@gakushuin.ac.jp
Gakushuin University
Faculty of Economics
1-5-1 Mejiro Toshima-ku
Tokyo 171-8588
Japan

Yutaka Takahashi
takahasi@isc.senshu-u.ac.jp
Senshu University
2-1-1 Higashimita Tama
Kawasaki Kanagawa 214-8580
Japan

Tetsuma Furihata
furihata@ms.kuki.tus.ac.jp
University of Shimane
2433-2 Nobara-cho
Hamada-shi Shimane 697-0016
Japan

Frank Sanders. They expanded Forrester's original urban dynamics model in terms of spatial point of view. While one of us has been studying Geographic Information Systems (GIS) and applying GIS to consumer spatial behavior. Recently we have got some research results, one of which explains how retailers agglomerate in a city, and the other shows one of the method of calculating relative attractiveness of retail areas. In this paper, we make some contribution toward spatial urban dynamics, firstly discussing the importance of the concept of "attractiveness" in social sciences, secondly showing latest research result on "the attractiveness" outside of system dynamics field and how to take it into spatial urban dynamics, thirdly making constructive comments on Sanders' approach, finally referring to a strong possibility of expanding spatial urban dynamics toward national models and world models.

Silvia Astrid Ulli-Beer
silvia.ulli-beer@ikaoe.unibe.ch
University of Berne
Roggenweg 7
4900 Langenthal
Switzerland

Birgit Kopainsky
birgit.kopainsky@iaw.agrl.ethz.ch
Swiss Federal Institute of
Technology
Agricultural Economics SOL F10
Sonneggstrasse 33
CH-8092 Zürich
Switzerland

Ueli Haefeli
haefeli@interface-politikstudien.ch
Interface Institute for Policy Studies
Seidenhofstrasse 12
CH-6003 Luzern
Switzerland

Ruth Kaufmann-Hayoz
ruth.kaufmann-hayoz@ikaoe.unibe.ch
University at Berne
Falkenplatz 16
CH-3012 Berne
Switzerland

Envisioning and Probing the Model for Policy Learning and Scenario Planning

This paper describes the process of a combined system dynamics modeling and scenario planning approach. It empirically investigates how envisioning and probing system dynamic modeling has the potential to raise effectiveness of scenario planning for organizational learning and improved decision making. The approach is illustrated by means of a case study that was used to explore the influence of social trends on dynamic interactions between transport behavior and spatial development in Switzerland. In this case study a system dynamics model was developed that served as a communication tool for strategy development and for enhancing goal alignment between different policy sectors at the national level. A qualitative content analysis illustrates how comments from participants of group modeling workshops can be opened up as empirical indicators of stimuli for improved learning. Additionally, it gives empirical evidence that the chosen approach contributes to mitigating four drivers of unexpected decision failure as discriminated by Chermack (2004a): bounded rationality, the tendency to consider only exogenous variables, stickiness and friction of information and knowledge, and mental model with decision premises.

Cornelia van Daalen
c.vandaalen@tbm.tudelft.nl
Delft University of Technology
Faculty of Tech Policy and Mgt
PO Box 5015
2600 GA Delft The Netherlands

Translating Insights from a Causal Loop Diagram into a Game

This paper concerns a project of limited scope to study why innovations in health care often fail to be adopted and how this may be improved. The project consisted of two workshops with participants from different areas of health care. The objective was to

Pieter W. G. Bots
p.w.g.bots@tbm.tudelft.nl
Delft University of Technology
Faculty of Technology Policy & Mgt
PO Box 5015
2600 GA Delft The Netherlands

Michelle J. A. Hendriks
m.j.a.hendriks@tbm.tudelft.nl
Delft University of Technology
Faculty of Technology Policy & Mgt
PO Box 5015
2600 GA Delft The Netherlands

Jill Slinger
Delft University of Technology
Faculty of Technology Policy & Mgt
Jaffalaan 5 PO Box 5015
2600 GA Delft The Netherlands

identify factors influencing adoption of innovations, relating the factors to each other, and looking for measures to stimulate the adoption of innovations. During the first workshop, possible effects of innovations and prerequisites for adopting innovations were identified and prioritised. This resulted in draft causal loop diagrams. During the second workshop, refined diagrams were used to identify measures for stimulating the adoption of innovations. In addition, a game incorporating the results of the workshops was developed. The main causal mechanisms were translated into the game which can be played by people who work in health care to improve their understanding of some of the dynamics involved.

Luc Van Den Durpel
vddurpel@listo.be
LISTO bvba
Groenstraat 35
B-9250 Waasmunster
Belgium

The Use of System Dynamics in Assessing Nuclear Energy System Futures

Modelling the worldwide nuclear reactor park including all supply chain details, i.e. the nuclear fuel cycle, demands for an integrated nuclear energy system model which also includes feedback loops representing physical feedbacks within the system as well as, and most prominently, socio-political feedbacks in the decision-making on the various available deployment pathways for nuclear energy. Argonne National Laboratory (ANL) started in 2000 with the development of such integrated nuclear energy system models, i.e. DYMOND and more recently DANESS. These models are based on system dynamics modelling used in various industry sectors and allowing to model the full mass-flow chain of time-varying mixes of nuclear reactor plants and associated fuel cycle options. Several other sub-models may then be coupled to the mass-flow kernel to calculate heat loads, economics, life cycle inventory, and several other parameters and feedback decision-making loops important in the assessment of nuclear energy futures.

Roel van der Sanden
Radboud University Nijmegen
Nijmegen School of Management
Nijmegen The Netherlands

Hayke Everwijn
Radboud University Nijmegen
Nijmegen School of Management
Nijmegen The Netherlands

Etiënne A. J. A. Rouwette
e.rouwette@fm.ru.nl
Radboud University Nijmegen
Th van Aquinostraat 5.0.64
PO Box 9108
6500 HK Nijmegen The Netherlands

Jan Gubbels

Balancing Supply and Demand for Dementia Care in the Netherlands

Health care in the Netherlands presents a unique mix of governmental and private responsibilities. Costs for long-term care, expensive treatments and uninsurable care for the complete Dutch population are covered by the Exceptional Medical Expenses Act (AWBZ), administered by 32 regional offices. Every health care provider operates under a contract with the regional administration office. Once contracted services are available, insurers are obliged to reimburse providers for these services even if they are not used by clients. In the coming years part of the Dutch health care will be deregulated and several types of care will be offered under market conditions. Whereas costs for care capacity are at present reimbursed by the government, this situation might change in the future. Regional care

offices in general have little insight into long-term developments in supply and demand for health care. This paper describes a system dynamics study on demand and supply for a specific type of nursing care, dementia. The model shows how feedback between waiting lists and volume of different types of demand for care, leads to fluctuations in required capacity. The feared overshoot in long term nursing capacity did not materialize in model runs under a range of environmental scenarios.

German Vargas

gevargasg@unal.edu.co
National University of Colombia
Cra 98 a no 33-67
Bogotá
Colombia

Systemic Effectiveness' Dynamics for Socioeconomic Development on National Innnovation System in Colombia

The effects and impacts associated and perceived with the implementation of National Innovation System – NIS Model have been broadly argued, each other, by different researches from National Planning Department in Colombia, that has advanced on the question, based on results of the national requests: Technological Development and Manufacturer. Pertinence of question was, then, justified; nevertheless, the emerging debate was triggered for the weakness of relations(hips) in the "system", where specifically the National Council of Socio Economical Policy advertises about both "suitable design and right conceived. Nevertheless is weak and denote deficiencies on operation, reflected in disarticulation of different sectors and entities in the system". This paper propose an approaching focus from systems point of view, and empirical observation from the social networks for the NIS, which one derivate a typological mapping and situational that illustrate the articulation degree of the system, which from build a system dynamics model for the policy exploration, pointed to stimulate systemic efficiency of NIS (seen as innovation as articulation).

Robert Verhaeghe

rjverhaeghe@hotmail.com
Delft University of Technology
Stevinweg 1
2628CN Delft
The Netherlands

Frank M. Sanders

f.sanders@citg.tudelft.nl
Technical University Delft
Postbox 5048
2600 GA Delft
The Netherlands

Investment Dynamics for a Congested Transport Network with Competition: Application to Port Planning

The planning of investments for the ports of the North Atlantic range (Hamburg, Rotterdam, Antwerp, Le Havre, Goia Tauro) face a strong growth of the market (double over the next 10 years), large economies of scale, congestion in ports and hinterland connections, and strong competition for parts of the European hinterland. Several investment strategies can be followed. The present strategy has resulted in overcapacity. Modeling allows to trace the dynamic impacts from alternative strategies.

Nuno Videira

nmvc@fct.unl.pt
New University of Lisbon
Ecoman Centre DCEA-FCT
Quinta da Torre 2829-516 Caparica
Portugal

Building up the Science in the Art of Participatory Modeling for Sustainability

Following several calls for participation in environmental policy, an increasing attention is being dedicated to the development of

Maria Paula Antunes

mpa@mail.fct.unl.pt
Universidade Nova de Lisboa
DCEA FCT
Quinta da Torre
2829-516 Caparica Portugal

Rui Santos

rfs@fct.unl.pt
New University of Lisbon
Ecoman Centre DCEA FCT
Quinta da Torre
2829-516 Caparica Portugal

deliberative platforms for the sustainable governance of our global village. In this paper, we start by adding perspective on the role of participatory modeling within a strong participatory vision for sustainability. We then explore how system dynamics and ecological economics worldviews interlock in promoting participatory modeling approaches to environmental decision-making. Focusing on the synergies between group model-building and mediated modeling, some lessons from two participatory interventions developed in Portugal are extracted. The evaluation of the case studies indicates positive outcomes at the individual and group level, with respect to learning, reaction, commitment, communication and consensus. The outcomes at the organizational level are still more limited. Further research is suggested on the comparison and complementarity between participatory modeling and other deliberative methods.

Karumanchi Vizayakumar

vizay@hijli.iitkgp.ernet.in
Indian Institute of Technology
Dept of Industrial Engineering and Mgt
Kharagpur 721302
India

Human Resource Development for the Agricultural Sector in India: A Dynamic Analysis

The paper describes a system dynamics model developed for dynamic analysis of human resource for the agricultural sector in different sources of employment, viz., government, private (including corporate), academic, financial institutes, non-governmental organizations, self employment, and others in India. Besides projecting an overall scenario for continuation of current agricultural education policy and trends, the paper analyses simulated results from the model for the current curriculum with 80:20 proportion of technical to soft skills. The analysis shows that in the coming years the private sector will emerge as a major employer for the graduates of agriculture and allied sciences.

John J. Voyer

voyer@usm.maine.edu
University of Southern Maine
School of Business
96 Falmouth Street PO Box 9300
Portland ME 04104-9300 USA

Susan Chinn

schinn@usm.maine.edu
University of Southern Maine
School of Business
96 Falmouth Street Box 9300
Portland ME 04104-9300 USA

Charlotte Pryor

cpryor@usm.maine.edu
University of Southern Maine
School of Business
96 Falmouth St Box 9300
Portland ME 04104-9300 USA

Adaptive Leadership Challenges at Smaller Nonprofit Organizations: A System Dynamics Approach

Dwindling government resources and demands for increased accountability have challenged nonprofit organizations to meet their primary missions while also creating efficient and effective back-office accounting and information systems. Even though many nonprofits say that accounting and information support systems are mission-critical, they tend to staff these systems weakly and to be less efficient than they could be. The present paper uses a system dynamics model to show how the "Limits to Growth" and "Shifting the Burden" systems archetypes help explain this situation. The model runs show that the exercise of leadership is the underlying issue—nonprofit managers must challenge organizational cultures and mindsets that act as limiting factors, causing the nonprofits to avoid implementing fundamental solutions to their problems. The paper discusses several action recommendations.

Khaled Wahba

khaled.wahba@riti.org
Cairo University
Faculty of Engineering
11A Hassan Sabry Street Zamalek
Cairo 11211
Egypt

Sherif M. Youssef

sherif_m_youssef@yahoo.com
Maastricht School of Management

Explaining Factors Restraining Egyptian Tourism Industry Growth & Required Course of Action: A System Dynamics Approach

The tourism industry is considered a very important factor that contributes to the economic development Egypt. The industry has shown growth in the recent years in the number of tourist arrivals to reach a maximum of 6 million in 2003. It could not be denied that government efforts contributed to the growth but nevertheless the devaluation of the pound had a significant influence on the number of visitors. The performance of the industry might look fine in general. But, this is if compared to previous performance only. However, if an in-depth look is taken it is realized that the Egyptian tourism is performing far below capacity. This paper aims at explaining the way to improve the performance of the Egyptian tourism industry using a system dynamics methodology. This will be done by defining the main factors affecting the industry, then explaining how the whole system works and finally proposing a new modified model and required course of action.

Khaled Wahba

khaled.wahba@riti.org
Cairo University
Faculty of Engineering
11A Hassan Sabry Street Zamalek
Cairo 11211 Egypt

Fissal Eissa

fisal.eissa@eg.schneider-electric.com
Schneider-Electric
Cairo Egypt

Mohamed Salama

mohamed.salama@alcatel.com.eg
Alcatel Egypt
Cairo Egypt

The Dynamic Effect of Cluster-Based Economic Policies on SME Clusters in Egypt

The researchers attempt to visualize the complexity and dynamic behaviour of SME clusters in Egypt throughout the process of transferring a cluster's state from static (idle) to dynamic (productive). This research constitutes the second of two complementary phases of a more comprehensive research that tries to quantify the qualitative measures of dynamic clusters through extending the application of the business dynamics tool to simulate the effect of different cluster-based economic development policy scenarios. After developing the mental model and during the conceptualization phase, the researchers highlighted the key-leverage causal loops showing feedback effects and uncovering the hidden cause effect relationships existing between the most important elements such as trust level inside the cluster, competition and the number of supporting industries. After validating the model, the researchers designed the policy analysis runs and undertook different scenario analysis over a time span of 50 years. Scenario analysis included studying the effect of elements such as institutions for collaboration (IFCs) on cooperation; effect of broker efficiency and success stories on trust building; and effect of trust on learning.

Wayne Wakeland

wakeland@pdx.edu
Portland State University
Systems Science PhD Program
PO Box 751
Portland OR 97207
USA

The Case for Thoroughly Testing Complex System Dynamics Models

In order to determine whether model testing is as useful as suggested by modeling experts, the full battery of model tests recommended by Forrester, Senge, Sterman, and others was applied retrospectively to a

Megan Hoarfrost

meganlh@stanford.edu

complex previously-published system dynamics model. The time required to carry out each type of test was captured, and the benefits that resulted from applying each test was determined subjectively. The resulting benefit to cost ratios are reported. These ratios suggest that rather than focusing primarily on sensitivity testing, modelers should consider other types of model tests such as extreme condition tests and family member tests. The study also finds that all of the different kinds of tests were either moderately useful or very useful--fully supporting the recommendations of the experts. An interesting diagram called a "tornado diagram" is used to portray the results of the sensitivity testing.

Wei Yang Wang

wyang@cc.kuas.edu.tw

National Kaohsiung Univ of Applied Sci

415 Chien-Kung Road

807 Kaohsiung

Taiwan

Ya-tsai Tseng

yttseng@mail.thu.edu.tw

Tunghai University

Dept of Business Administration

407 Taichung

Taiwan

The Dynamics of A Software House's One-Shot Growth

The pattern of one-shot growth is most seen in software industry. The purpose of this paper is to understand the growth dynamics of a software house and to facilitate the software house to manage its growth. This paper models a major domestic ERP software house in Taiwan that is experiencing the one-shot growth process. Business type-level packages and high quality service is the company's secrets for its success. With a good reputation for high quality systems and services, the company's growth strategy is to expand the market it serves by developing new kinds of packages for more business types. However, how to balance the human resources requirements of R&D and ERP is rather difficult when long delays exist everywhere in a software house. With the system dynamics model built, this paper identifies the archetype of limits to growth hidden inside the software house and illustrates how the problem is worsened by the company's intuitive reactions.

Wei-Tsong Wang

ww8256@albany.edu

University at Albany

School of Information Science & Policy

840 Washington Avenue

Albany NY 12203 USA

Chao-Yueh Liu

chaoyueh.liu@gmail.com

University at Albany

14 Niblock Ct Fl 2

Albany NY 12206 USA

The Application of the Technology Acceptance Model: A New Way to Evaluate Information System Success

In the modern era, the advances in information technology have been dramatically shaping the ways people live as well as the ways organizations manage their businesses in their professional business domains. Implementing various kinds of information systems, such as Decision Support Systems, has been recognized as one of the most crucial tasks for organizations in order to continue to be competitive or even to survive. Although considerable effort has been devoted to improving the performance of information system implementations, organizations are still constantly suffering from the failures of information system implementations. In this study an extensive framework that depicts the context of information system implementation is developed. A system dynamics approach is used to investigate the dynamic nature of information system implementations. By using the proposed system dynamics model, we contend, executives and information system professionals of organizations can gain comprehensive insights into organizational behaviors and substantial policy-making implications regarding information system implementations.

Elise Axelrad Weaver

eweaver@wpi.edu
Worcester Polytechnic Institute
Dept Social Science and Policy
Studies
100 Institute Road
Worcester MA 01609-2280 USA

Flynn's Case for a Different Approach to Homeland Security

In this paper, I will present relatively simple system dynamics models which capture some of the insights of a key critic of the U.S. policy for defending the country, Stephen Flynn. Flynn is especially concerned with the over-reaction to the attacks of September 11, 2001. He warns of the dangers of shutting down legitimate commerce and investing in overseas offensive measures as a knee-jerk reaction to the attacks. It is not that he is advocating a lax approach to security. Rather he is advocating a measured look at the implications of a draconian defense policy which may cause much more damage to our societal infrastructures than the attacks that triggered it. He also presents recommended solutions.

Lars Weber

lars.weber@tu-cottbus.de
Brandenburg Technical Univ.
Cottbus
Chair of Macroeconomics
PO Box 101344
03013 Cottbus Germany

A Contribution to Goodwin's Growth Cycle Model from a System Dynamics Perspective

The, for economists well-known Goodwin model was one of the first models which tried to combine cyclical behavior and economic growth. The basis for this is the predator-prey model – a basic structure for every System Dynamicists. The economic literature about the Goodwin model is enormous, but so far, it was mostly concentrate on the mathematical behavior or on some extensions that could be implemented. In addition, there are only two papers from R. Solow and D. Harvie about an econometrical verification of the model and none from a System Dynamics' perspective. This article provides therefore two System Dynamics models of Goodwin's theory and tests the enhanced one on the German economic situation and on the data provide by Harvie 2000. Additionally there are some suggested modifications of the Goodwin model, tested from different authors, which reveal surprising outcomes for the understanding of Goodwin's theory.

Henry Birdseye Weil

weilco@compuserve.com
MIT
Sloan School of Management
50 Memorial Drive Room E52-541
Cambridge MA 02142-1347 USA

Brice A. Dattée
dattee@ecp.fr
UC Dublin / Ecole Centrale Paris
96 avenue de Paris
94300 Vincennes France

Dynamics of Social Factors in Technological Substitution

Diffusion models of radical technologies are often based on an epidemic structure developed on the Bass principles of generic external and internal communications. However, in most cases such processes involve more complex communication and decision mechanisms. The diffusion processes should account for interdependences with other innovations and also the substitution mechanisms with regard to the technology in place. Substitution must be understood with a much broader scope than the analytical view of the Fisher and Pry model. As many diffusion authors have acknowledged (but partially excluded from their models), diffusion is a social process with innovation moving through interpersonal networks. We propose a model that accounts for the dynamics of

social factors in technological substitution. Based on the System Dynamics methodology, our model disaggregates most of the communication structure and individuals' characteristics that are implicitly embedded in traditional diffusion models. Our discussion starts with the characteristics of radical technological innovations. We then proceed with the theoretical basis of our social aggregation approach by presenting Kelly's personal constructs system theory, outlines of social psychology, decision making under uncertainty, and the interdependences between innovations' characteristics and human behavior. We also make an attempt at considering both sides (consumers adoption / competitors imitation) of a substitutive diffusion. Brice Dattée's research is funded by the National Institute of Technology Management in Ireland.

Henry Birdseye Weil

weilco@compuserve.com
MIT
Sloan School of Management
50 Memorial Drive Room E52-541
Cambridge MA 02142-1347 USA

James M. Utterback

jmu@mit.edu
MIT
Sloan School of Management
50 Memorial Drive
Cambridge MA 02142 USA

The Dynamics of Innovative Industries

This work captures and analyzes the fundamental dynamics of innovative industries with a System Dynamics model. We selectively reviewed the innovation literature, identified the dynamics to be modelled, formulated a conceptual model of these dynamics, and then developed the initial simulation model. By design the conceptual model is simple and generic. It is intended to apply to a broad range of products and services – assembled and process-based, complex and simple, physical and digital, business and consumer, early stage and mature, 19th century and 21st century. That is what we mean by the "fundamental dynamics" of innovative industries. In many variations and combinations they can explain the evolution of most markets. The initial simulation model was developed from the conceptual model. It represents products based on two generations of technology. At this stage the simulation model does not represent a specific market or industry. It is quantified with hypothetical inputs, parameters, and cause/effect relationships. The simulation model recreates well-documented reference modes of market evolution. We currently are building the information base which will enable the initial model to be applied to the photography and display markets.

David Wheat

dwheat@wheatresources.com
Virginia Western Community
College
PO Box 19234
Roanoke VA 24019
USA

Simplifying Learning Environments for Introductory Students

An interactive learning environment (ILE) appropriate for intermediate macroeconomics students has been simplified for students in introductory college and high school courses. Without changing the underlying model or the simulation options, the simplified instructional approach relies on feedback loop diagramming more than stock-and-flow diagramming. Interactive Vensim causal loop diagrams are embedded in a STELLA interface, using slide show and video software. In addition, students appear to learn more as model-users if they engage in preliminary model-building activities using simple word-and-arrow diagrams.

Anthony S. White

a.white@mdx.ac.uk
Middlesex University
School of Computing Science
Trent Park Bramley Road
Enfield London N14 4YZ UK

Michael Censlive

m.censlive@mdx.ac.uk
Middlesex University
School of Computing Science
Trent Park Bramley Rd
London N14 4YZ UK

Modelling Strategies for Vendor-Managed Inventory

This paper describes transform approaches to control Vendor-Managed Inventory (VMI). The effect of different modelling techniques and their significance is examined. Modelling was achieved with the Simulink package using the equations developed by Disney and Towill for a VMI system model. Analysis of several types of delay representation were compared to illustrate how the results depend on their formulation. The effect of using a discrete model is to deepen the stock-out and increase the required order rate. Analysis of the stability of the different models are discussed and evaluated. It is shown that the continuous model with an exponential delay is always stable and with a fixed delay can be made stable. The requirement for the system is also computed for a discrete model with exponential delay. Reduced inventory stock-out and a smaller WIP peak are achieved with different order smoothing function. This has special significance for e-manufacture.

Elin Whitney-Smith

elin@quaternary.net
Netalyst Inc
508 2nd St SE Suite 1
Washington DC 20003
USA

The Dynamics of Information Revolutions: A Causal Loop Model

Information revolutions change the world by taping into a positive feedback loop. If we can identify the loops we can understand where they might be going and what their limits might be. We need to know the difference between a short-term trend and a long term dynamic. We need to know where this information might be pushing us so we can know if it is where we want to go. Trying to look at a category, as broad as information revolutions, to identify patterns requires an approach that will give a broad but well specified picture – a way to understand the positive feedback loops that create the growth and also to understand the countervailing loops that come into play in various ways. I believe that causal loop diagrams can give us a clearer picture of this kind of broad, messy problem.

Johannes Wiik

johannes.wiik@hia.no
University of Bergen
Stromgaten 32
5008 Bergen
Norway

Jose J. Gonzalez

jose.j.gonzalez@hia.no
Agder University College
Faculty of Engineering and Science
Grooseveien 36
NO-4876 Grimstad
Norway

Limits to Effectiveness in Computer Security Incident Response Teams

In a constantly changing environment, a Computer Security Incident Response Team (CSIRT) has to evolve over time in order to sustain or improve its effectiveness. The main task of a CSIRT is to help victims mitigate the effects of computer security incidents. A frequently identified problem for a CSIRT is that they are overworked, understaffed and under funded. In this paper, we present a conceptual model of such conditions based on a case study. The model is a first attempt to understand the main factors influencing a CSIRT's ability to handle computer security incidents effectively, and to identify ways to improve their overall effectiveness. Based on theory from process

improvement and information from the case study, we have identified that short-term pressure from a growing incident workload prevents any attempts for developing more response capability long-term. Fundamental solutions to solve this problem will typically involve a worse-before-better trade-off for management.

Ines Winz

i.winz@auckland.ac.nz
University of Auckland
Tamaki Campus 723.312
Glen Innes Auckland
New Zealand

A System Dynamics Approach to Sustainable Urban Development

The two most important fundamental needs of towns and cities are a sufficient supply of adequate drinking water and the removal of polluted water. History has shown that if these needs cannot be met, cities rapidly become uninhabitable. New Zealand's current water systems were designed and built in the 19th century and have not been improved much since. Generally, infrastructure has been built on the assumptions of abundant water resources and the unlimited ability to treat and dispose of polluted waters. Especially in Auckland, New Zealand's largest city and one of the most rapidly urbanising cities in the world, there is increasing tension due to rapid urban growth and the costs associated with replacing old water infrastructure and extending it to new urbanised areas. The challenges of managing urban water systems in New Zealand today call for an application of system dynamics. Our proposed research is based on the hypothesis that systems thinking and modelling methodology can be applied to the question of urban development in the Auckland region and is a valid instrument to identify policies that effectively foster the sustainable development of urban structures, in particular urban water infrastructure. This paper discusses the current situation and challenges, and outlines the proposed research.

Ellen Wolfe

ewolfe@resero.com
Resero Consulting
9289 Shadow Brook Place
Granite Bay CA 95746
USA

Barriers to SD Deployment in Business and Policy Making: Lessons Learned in Assessing Electric Utility Restructuring Policy

Real-world policy analyses efforts indicate repeated behavioral patterns that inhibit systems approaches, such as the time and budget pressures, the trade-off of detail vs. high-level insights, and the tendency to dwell in the familiar rather than delve into the unrevealed. Examining "mainstream" (non System Dynamic) business and policy processes issues such as these seems critical to increasing the introduction of systems approaches. However, the perspective we as a community of modelers takes is critical to reinventing business and policy analyses. To the extent the barriers are seen as circumstances of the modeling environments there is little leverage towards resolution; if we can see the impediments as being a result of our behavior as analysts, the nature of the barriers change and there is much more opportunity for improvement. The paper examines a non–System Dynamics policy analysis for the electric utility industry from both these points of view.

Eric F. Wolstenholme

e.wolstenholme@btinternet.com
Fieldings 12 Rivock Avenue
Steeton Keighley West Yorks BD20
6SA
UK

David Monk

david.monk@olmgroup.com
OLM Consulting
OLM Group Cairns House
10 Station Road
Teddington Middlesex TW11 9AA
UK

Gill Smith

gill.smith@olmgroup.com
OLM Consulting
Cairns House 10 Station Road
Teddington Middlesex TW11 9AA
UK

Douglas McKelvie

douglas.mckelvie@olmgroup.com
OLM Consulting
Cairns House 10 Station Road
Teddington Middlesex TW11 9AA
UK

Coping but not Coping in Health and Social Care – Masking the Reality of Running Organisations beyond Design Capacity

This paper develops a hypothesis that the 'normal' mode of operation for many organisations is well beyond their safe design capacity and that many health and social care organisations in the UK are in this position. This situation arises from having to cope with demand, irrespective of their supply capability. The irony is that such organisations can appear to cope at the strategic level. This is because operational managers employ a variety of well-intended, informal, survival techniques to meet performance targets. However, such practices can perpetually mask the underlying reality and have serious unintended consequences . Evidence for the hypothesis has emerged from a number of studies carried out using system dynamics to identify and promote systemic practice in local health communities in the UK. The rigour of quantitative simulation model construction has identified mismatches between how managers claim their organisations work and the observed data and behaviour. The discrepancies can only be explained by surfacing informal coping strategies. Indeed, the data itself becomes questionable as it reflects more the actions of managers than the true characteristics of patient pathways. If proved wholly or even partially correct there are some important messages in the paper for Health and Social Care management, the meaning of data and for modelling.

Kaoru Yamaguchi

kaoru3@muratopia.org
Doshisha University
521 Minamidani Aihara
Goshiki-cho Hyogo 656-1325
Japan

Aggregate Demand Equilibria and Price Flexibility – System Dynamics Macroeconomic Modeling

This is a second paper of a series of macroeconomic modeling that tries to model macroeconomic dynamics such as the determination of GDP (Gross Domestic Product) and money supply from system dynamics perspective. Following the first paper on the money supply and creation of deposits, this second paper tries to model dynamic determination processes of GDP, interest rate and price level on the same basis of the principle of accounting system dynamics developed by the author. For this purpose, a simple Keynesian multiplier model is constructed as a base model to examine a dynamic determination process of GDP. It is then expanded to incorporate the interest rate, whose introduction enables the analysis of aggregate demand equilibria as well as transactions of savings and deposits, and government debt and securities. Finally, a flexible price is introduced to adjust an interplay between aggregate demand equilibrium and full capacity output level. A somewhat surprise result of business cycle is observed from the analysis.

Hakan Yasarcan

yasarcanh@yahoo.com
25 Sehit Sener Enver Sokak
Yenisehir Lefkosa
TR-09000 via Mersin 10
Turkey

Yaman Barlas

ybarlas@boun.edu.tr
Bogaziçi University
Dept of Industrial Engineering
34342 Bebek Istanbul
Turkey

Stable Stock Management Heuristics when the Outflow is Proportional to the Control Stock

In this paper, the typical anchor (expected value of the outflow or expected loss) used in the most popular decision rule of the stock management modeling, the "Anchoring and Adjustment Rule" is studied for structures including a decaying stock. A new anchor (equilibrium value of loss) is proposed and compared with the expected loss formulation. We demonstrate that equilibrium value of loss formulation helps bringing the control stock to its desired level more rapidly. In addition, we show that managing a decaying stock in a stable way is difficult when the supply line is discrete. Standard stock adjustment and supply line adjustment terms anchored around expected loss can yield highly unstable oscillations. Counter-intuitively, for some cases, ignoring the supply line adjustment term may completely eliminate unwanted oscillations. If equilibrium value of loss is selected as the anchor and when the decay time (life time) is small enough, management of the stock can even be done by ignoring all the adjustment terms.

William Young

b52ew@aol.com
US Air Force
5001-G Paddock Club Court
Montgomery AL 36116
USA

Understanding and Diagnosing Adversary System Behavior in 4th Generation Warfare: A Soft Approach to EBO Mission Analysis

Effects-based Operations (EBO) is becoming the centerpiece of Western military thinking. The concept is based on influencing the behavior of adversary complex adaptive systems (such as terrorist networks) in dynamic environments. Mission analysis is the foundation of campaign planning. This paper suggests a process to improve how campaign planners identify effects necessary to yield a desired endstate during EBO mission analysis. The process is based on using a modified version of Soft Systems Methodology to structure the problem by providing planners a high-level initial understanding of the dynamic complexity associated with 4th Generation Warfare threats. Planners use this understanding to identify and diagnose specific adversary behavior inconsistent with the directed endstate. Potential system changes to modify problematic behavior are next identified and debated. Finally, the changes are converted into "effects" that serve as the input into more detailed planning efforts. The process uses group learning and shared understanding as a "hedge" against the ambiguity associated with 21st Century military planning.

Gönenç Yücel

gonenc.yucel@boun.edu.tr
Bogaziçi University
Bebek Yolu Sok
Ozkan Polat Ap No 2/5
Etiler 80630 Istanbul Turkey

Sustainability in a Bipolar Global System: A Global Modeling Study with North-South Differentiation

Traditional global models address important global problems using highly aggregated measures, but it may be argued that the world is strongly non-homogeneous at least at some fundamental level:

developing (South) nations and developed (North) nations may have very different, asymmetric problems, goals and structures. This study aims to investigate these two distinct groups of economies in a context of global sustainability. We identified population, economic growth, welfare gap, energy supply and pollution as key issues and analyzed them in a systems perspective. A dynamic feedback model, which discriminates these two groups of nations, is constructed based on WORLD-3 model in order to study the dynamics of key parameters related to these issues for the period 1975-2050. Simulation experiments reveal that population characteristics of South and current mode of economic activity, which is extensively dependent on non-renewable energy resources constitute serious obstacles for the sustainability of the system. Hence, stabilizing the population growth in South, transition to alternative energy resources and investment support to South for this transition are vital for closing the welfare gap between blocks and sustaining the global system.

Dewi Yuliani

deyul05@hotmail.com
Local Government of West Java
Province
Jl Pajajaran 50
Bandung Indonesia

Muhammad Tasrif

ppeitb@bdg.centrin.net.id
Bandung Institute of Technology
Energy Research and Development
Group
Jl Ganesha 10
Bandung 40132 Indonesia

Towards the Understanding of Community Empowerment Process: Lessons Learned From a Rural Locality in Indonesia

In developing countries, many community empowerment efforts, which consist mainly of building the community's capability to fulfill its needs, failed to achieve the desired results. Counter-intuitively, sometimes the dependence to external agents grew even stronger. The paper is a preliminary attempt in elaborating a successful case of empowerment process using system dynamics modeling, which is a poor village in Indonesia that received an infrastructure aid from a UN-agent in the form of Microhydro Plant. The model shows that empowerment is a feedback process influenced by many factors, and that capacity building to manage the plant is a learning process to be gone through by the community itself. Nonetheless, once this capability is achieved, the resulted capacity and awareness play significant role to improve the community's life quality. This model is expected to evoke other efforts to build a more comprehensive understanding of community empowerment process, and hopefully will encourage the local government to try new approaches for higher rate of successful implementation.

Aldo A. Zagonel

aazagon@sandia.gov
Sandia National Laboratories
PO Box 5800 MS 0749
Albuquerque NM 87185-0749
USA

Stephen H. Conrad

shconra@sandia.gov
Sandia National Laboratories
PO Box 5800 MS 1138
Albuquerque NM 87185
USA

Modeling the Impact of Loss in U.S. Soybean Production Resulting from Soy Rust Disease

Our objective is to examine the consequences of soy rust to the U.S. agriculture in the next 2-5 years. In 2000, the U.S. harvested approximately 2.8 billion bushels of soybeans from almost 73 million acres of cropland, accounting for more than 50 percent of the world's production. The crop generated $12.5 billion dollars, $6.66 billion in exports. Soy rust established itself in the south last November and is expected to disseminate and deposit in the crops during this year's planting season. The extent of outbreaks depends upon climatic conditions. Early detection is crucial since soy rust is deadly to the

Paul G. Kaplan

pgkapla@sandia.gov
Sandia National Laboratories
Critical Infrastructure Modeling &
Sim
PO Box 5800 MS 1138
Albuquerque NM 87185-1138
USA

soy plant within 48 hours. Monitoring systems will warn farmers of the presence of the spores and farmers are instructed on how to identify and treat it. There is uncertainty regarding the sufficient and timely availability of fungicide. In addition to historical data, we incorporate observations of on going planting and harvesting. Parameter ranges in the model are narrowed as more information becomes available and existing uncertainties dissipate. The impact of soy rust is analyzed in aggregate, looking at overall production and market share contrasted against natural noise in the yields.

Agnieszka Ziomek

agnieszka.ziomek@ae.poznan.pl
Poznán University of Economics
Economic Policy & Development
Planning
Al Niepodleglosci 10
60-967 Poznan Poland

Foreign Direct Investment Impact on Polish Labor Market: The Case of Employment Fluctuation in GSK Pharmaceuticals in Poznan

Foreign direct investment has a strong impact on the level of employment and its structure in companies. The article presents the structure of factors regulating and adjusting the employment scale to real productivity needs. The presentation is based on one of the best examples of foreign direct investment in Poland - GlaxoSmithKline Pharmaceuticals, Joint Stock company. The privatization process is like a mirror of destabilized economy. The correction of employment structure inside the company reflects the overall employment fluctuation in economy and even the structural unemployment classification. The model built on the GSK example, describes the 8 years long process of employment adjustment and can be recognized as a benchmark for the employment transition in foreign companies in Poland.

Plenary Sessions

Plenary Monday AM - Dynamic Modeling for Public Policy

Kimberly Thompson

kimt@alum.mit.edu
Harvard University
School of Public Health
677 Huntington Avenue 3rd Floor
Boston MA 02115
USA

Radboud J. Duintjer Tebbens

rduintje@hsph.harvard.edu
Harvard University
School of Public Health
677 Huntington Avenue 3rd Floor
Boston MA 02115
USA

Modeling Global Policy for Managing Polioviruses: An Analytical Journey

The success of the Polio Eradication Initiative promises to bring the world the benefits of sustained improvements in quality of life (i.e., cases of paralysis and deaths avoided) and saved costs from cessation of vaccination. Obtaining these benefits requires that policy makers manage both the transition from the current massive use of oral polio vaccine (OPV) to a world without OPV and the risks of potential future reintroductions of polioviruses. In 2001, we began a case study on retrospective polio risk management to demonstrate the importance of using a dynamic disease model to correctly estimate the cost-effectiveness of vaccines. Discussions with the CDC about the case study led to an opportunity for us to develop a large model to support the prospective decision making process. This paper tells the story of our journey, emphasizing insights about the requirements for analysts to create tools that really help high-level decision makers.

William Manley

bmanley@hsc.wvu.edu
West Virginia University
Center for Rural Emergency Medicine
PO Box 9151
Morgantown WV 26506
USA

Jack B. Homer

jhomer@comcast.net
Homer Consulting
3618 Avalon Court
Voorhees NJ 08043
USA

Marna Hoard

mhoard@osophs.dhhs.gov
Office of the US Surgeon General
Center for Medical Preparedness
PO Box 9151
Morgantown WV 26506-9151
USA

A Dynamic Model to Support Surge Capacity Planning in a Rural Hospital

A system dynamics model was developed to help hospitals assess their ability to handle surges of demand during various types of disasters. The model represents all major flows of patients through a hospital and indicates how specific responses to a surge may ameliorate bottlenecks and their potentially harmful effects on patients. The model was calibrated to represent a specific hospital in West Virginia and was tested under three quite different surge scenarios: a bus crash, a chemical plant leak, and a SARS outbreak. Under the difficult conditions of the SARS scenario, avoidable deaths of patients awaiting emergency care could be effectively reduced by adding reserve nursing staff not in the emergency department, as might be expected, but in the overloaded inpatient wards. The model can help hospital planners better anticipate how patient flows may be affected by disasters, and identify best practices for maximizing the hospital's surge capacity under such conditions.

Sanjoy Roy
sroy@hsc.wvu.edu
West Virginia University
Center for Rural Emergency Medicine
PO Box 9151
Morgantown WV 26506
USA

Paul M. Furbee
pmfurbee@hsc.wvu.edu
West Virginia University
Center for Rural Emergency Medicine
PO Box 9151
Morgantown WV 26506
USA

Daniel Summers
dsummers@hsc.wvu.edu
West Virginia University
Center for Rural Emergency Medicine
PO Box 9151
Morgantown WV 26506
USA

Robert Blake
trblake@earthlink.net
St Joseph's Hospital
Center for Rural Emergency Medicine
PO Box 9151
Morgantown WV 26506
USA

Marsha Kimble
mkimble@stj.net
St Joseph's Hospital
Center for Rural
Emergency Medicine
PO Box 9151
Morgantown WV 26506
USA

Todd BenDor
bendor@uiuc.edu
University of Illinois
111 Temple Buell Hall
611 Taft Drive
Champaign IL 61820
USA

Sara Metcalf
ssm@uiuc.edu
Univ of Illinois Urbana-Champaign
Dept of Geography Rm 220 Davenport
607 South Mathews Avenue
Urbana IL 61801-3671
USA

Lauren E. Fontenot
University of Illinois
Department of Geography
Urbana IL 61801
USA

Brandi Sangunett
University of Illinois
Dept of Natural Resources and
Env Sci
Urbana IL 61801
USA

A Decision Support System for Emerald Ash Borer Eradication Using Spatial-Dynamic Modeling

Recently, an invasive Asian beetle known as the Emerald Ash Borer (EAB) (Agrilus planipennis Coleoptera: Buprestidae) has emerged as a threat to Ash trees in the Midwestern United States and Canada (McCullough and Katovich 2004). Significant infestations in Michigan and nearby areas have all but doomed nearly one billion native ash trees. This paper presents an argument for the establishment of a widely accessible knowledgebase of information on the EAB's spread capabilities. We argue that spatial dynamic modeling stands as a flexible and powerful decision support system platform. We present initial simulations of EAB spread scenarios constructed using tree information and land use data collected for DuPage County, IL, an uninfected suburban county in the Chicago metropolitan area. These simulations test policies focused on impeding the costly spread of the beetle. This analysis also presents a framework for further studies assessing the economic impacts on municipalities and counties due to tree removal costs and aesthetic damage. Our work points to human driven movement as the major vector for EAB spread throughout our study area. Here, the focus falls on the ability of state and county implemented firewood quarantines to act as effective policies for slowing EAB spread.

Plenary Monday PM - System Dynamics in Action
Mark Paich, Discussant

Nick Pudar
nick.pudar@gm.com
OnStar
Mail Code 482-D39-D68
400 Renaissance Center
Detroit MI 48265-4000
USA

Corporate Strategy Development – *Making OnStar Happen*

The chasm between great strategic ideas and the actual implemented results is littered with mountains of irrelevant Powerpoint presentations and the battle wounds of those who have

Vincent P. Barabba

vbarabba@sbcglobal.net
Market Insight Corporation
308 Cherry Avenue
Capitola CA 95010
USA

fought the organization's antibodies that resist change. Successful implementation of strategic initiatives requires the paradoxical alignment of a disciplined, sequential strategy development approach with a serendipitous, emergent, and iterative free flow of ideas. And, the larger and more complex an organization is, the more challenging the change efforts become. General Motors is one such large company, and is the setting for discussing successful strategy development through the OnStar case study.

At this luncheon, Nick Pudar and Vince Barabba will explore the challenges and opportunities organizations face in developing and implementing successful strategic initiatives. The early days in deciding whether to launch the OnStar business was fraught with uncertainty. After the initial launch, GM faced another big decision to significantly ramp up the business across the entire portfolio. Nick and Vince will identify the key factors that were addressed in maneuvering the complex, cross-functional strategic issues that GM faced. They will focus on the techniques that enabled creative solutions while at the same time maintaining implementation discipline.

Winston P. Ledet

wpledet@mfg-game.com
Ledet Enterprises Inc
7702 FM 1960 East
Suite 226
Humble TX 77346
USA

Paul A. Monus

monuspa@bp.com
BP Solar
Frederick MD 21701-5896
USA

Tony Cardella

tony@dpcf.com

Warren Burgess
BP Exploration
Aberdeen UK

Modeling Sustainable Organizational Change – Why Did Change at BP Lima Sustain While the Change at DuPont Faded Away?

We are attempting to create an agent based System Dynamics model of sustainable organizational change. A framework is proposed for comparing the experience of sustainable organizational change as a means of gathering other experiences to help create the model. A significant sustainable organizational change was created at BP's Lima refinery using The Manufacturing Game that was created at DuPont using a System Dynamics model of manufacturing reliability. While this change at BP Lima has survived for over 10 years, two changes of ownership and four sets of management, the changes at DuPont and another BP asset only lived 7 years and 1 year before losing the momentum of the change. At the conclusion of this talk, we will have a panel discussion on the reasons for sustainability with audience participation.

Plenary Tuesday AM – Learning From Experiments
Discussant to be announced

Shayne Gary

sgary@agsm.edu.au
University of New South Wales
Australian Graduate School of Mgt
PO Box 6576
Sydney NSW 1466
Australia

Mental Models, Decision Making, and Performance in Complex Tasks

Previous studies have used the mental models construct as an ex-post explanation for poor performance on complex tasks, but the effects have remained untested. This experimental study measured

Robert E. Wood
r.wood@econ.usyd.edu.au
University of Sydney
Sydney NSW 2042
Australia

and tested the role of mental models in a complex decision environment. Participants worked on a product lifecycle simulation under one of two levels of complexity for three blocks of 40 trials before measures of mental models were assessed. Immediately following the measures, participants completed another three blocks of 40 trials. Ten weeks later, participants completed another three blocks of 40 trials each. The results indicate that ability and task complexity are significant predictors of mental model accuracy, and that mental model accuracy and complexity are significant predictors of performance. Mental model accuracy is also related to the decision heuristics employed on the task, and the decision heuristics are related to performance. The results suggest there is potential to increase performance in complex decision environments by up to 50% through improving decision making. Validating these measures of mental model accuracy will enable researchers to incorporate this variable into their study designs in future research, and begin to identify levers for improving causal inferences, mental model accuracy, decision heuristics and performance.

Klaus-Ole Vogstad
klausv@stud.ntnu.no
Vogstadforskning
Osloveien 6
N-7018 Trondheim
Norway

Santiago Arango
santiago.arango@ifi.uib.no
University of Bergen
Information Science
PO 7800
N-5020 Bergen
Norway

Hans Ivar Skjelbred
Skjelbred Consulting

Experimental Economics for Market Design

This study reports of an experimental economics analysis of the new proposed Swedish-Norwegian tradable green certificate market (TGC). The green certificate market is a financial instrument to stimulate renewables within the context of liberalized, transnational electricity markets (a kind of market-oriented subsidy scheme). Green certificates are financial assets issued to green producers that can be traded freely. Previous system dynamics studies showed that trading- and investment behaviour were critical factors in analyzing the market dynamics. As a follow-up, this experimental economics study conducted 14 laboratory experiments with about 10 to 20 students per session. A particular feature is that participants handle both short-term trading and long-term investments, which allow us to analyze the interplay between these types of decisions without imposing behavioural assumptions on the model. The laboratory experiment shows that the market is likely to crash, due to the long time delays of supply side adjustment. The study provided new insights concerning agents trading and investment strategies, in particular the performance of various market designs. The mix of trading strategies employed in response to the experiments, are difficult to understand and capture in an SD model.

Plenary Tuesday PM – Growth, Wealth, and Sustainability
Discussant to be announced

Michael R. Goodman
hmichaelgoodman@yahoo.com
Michael Goodman & Associates
14 Church Street
Hopkinton MA 01748
USA

Special Moments - Special Places

Cormorant fisherman on the Li River, China…. Farmers tilling the rice terraces of Bali, Indonesia… A red seahorse in the waters of St Vincent in the Southern Caribbean… Alpenglow in the Dolomite mountains of Northern Italy… these are some of the remarkable

moments and amazing places that I have been privileged to photograph in my world travels and am delighted to share with you. They are all part of the wonderful but fragile systems that make up our world.

Eric Beinhocker
McKinsey & Company

The Origin of Wealth

"What is economic value?" and its corollary "how is value created?" are two of the oldest and most fundamental questions in economics. Yet the equilibrium based theories that have dominated economics for the past century have struggled to answer these questions. In particular, equilibrium theories have a difficult time accounting for the creation of novelty, complex structure, and knowledge in the economy. Eric Beinhocker will discuss how ideas from evolutionary theory and complexity science can be applied to these questions to yield new insights, and he will outline an evolutionary theory of economic design. He will also examine the strengths and limitations of the system dynamics perspective on this subject. The talk is drawn from Beinhocker's book, The Origin of Wealth: How Evolution Creates Novelty, Knowledge, and Growth in the Economy, forthcoming from Harvard Business School Press, spring 2006.

Dennis Meadows
lataillede@aol.com
Laboratory for Interactive Learning
PO Box 844
Durham NH 03824
USA

Sustainable Development System Dynamics

The phrase, "Sustainable Development," has been used to designate so many different goals and justify so many different policies that it has lost its meaning. Normally it is used to specify a destination or state of society. But in fact, it is much more related to how one makes the trip; to the long-term dynamics of a system. Dennis Meadows will draw on 33 years of research on the causes and consequences of growth in a finite world to talk about the features of a system that is developing sustainably and to describe the policy implications of modern society's addiction to unsustainable development.

Plenary Wednesday PM – Modeling for Development

Matteo Pedercini
matteo@threshold21.com
Millennium Institute
2200 Wilson Blvd Ste 650
Arlington VA 22201
USA

Gerald O. Barney
gbarney@threshold21.com
Millennium Institute
2200 Wilson Boulevard Suite 650
Arlington VA 22201
USA

Dynamic Analysis of MDG Interventions: The Ghana Pilot

The UN Millennium Project (MP) team has conducted a comprehensive cross-country analysis of the interventions and investments required to achieve the Millennium Development Goals (MDGs) . The MP needs-assessment focuses on a number of pilot developing countries, selected on the basis of their low per capita incomes, geographic and political diversity, and record of sound governance. In its analysis, the MP team developed a series of spreadsheet-based models that are used to calculate the cost for the interventions required to achieve the MDGs in the pilot

countries . MP methodology is very practical and rich in specific details, but since it relies on exogenous assumptions for economic and demographic growth, it cannot address two issues of interest: (1) the impact of the MDG-related interventions on the economic and demographic development of the country under study and (2) the possible synergies and dissynergies among different MDG interventions. The work described in this paper complements and builds on the work of the MP team by addressing these two important issues and evaluating their implications for MDGs costing and financing. The analysis for this paper was prepared using the Threshold 21 (T21) integrated development model from the Millennium Institute.

Gary B. Hirsch
gbhirsch@comcast.net
Creator of Learning Environments
7 Highgate Road
Wayland MA 01778
USA

Guy Stuart
guy_stuart@harvard.edu
Harvard University

Jay K. Rosengard
jay_rosengard@harvard.edu
Harvard University

Don E. Johnston
donjohnst@yahoo.com
Harvard University

SymBanc™: A Simulator for Microfinance Institutions

Microfinance institutions (MFIs) provide credit, savings, and other financial services to the poor and must successfully manage large volumes of small transactions. SymBanc™ is a system dynamics simulator designed to introduce students to the complexities of managing a Microfinance Institution (MFI) or to engage experienced practitioners in a discussion of the key determinants of success in such a dynamic environment. The simulator allows students and practitioners to grow an MFI from a single branch to a large network by making a variety of decisions about target market, staffing and facilities, loan and savings product design, and sources of external funding. Detailed feedback enables them to fine-tune their strategies during a simulation. This paper begins with some background on Microfinance Institutions and then presents the structure of the model underlying SymBanc™ and results of typical simulations. Initial experience using SymBanc™ and future enhancements contemplated for it are also described.

Special and Convened Sessions

Exhibitor Demonstrations

Exhibitor demonstrations will be held during the lunch breaks on Monday and Tuesday to showcase products and services in practice.

Users' Group Meetings

Fun and useful, informal meetings held by different software vendors to give users an opportunity to share ideas and ask questions.

Diversity Roundtable

Deborah Campbell

deborah-campbell@comcast.net
University of Bergen
1569 Vireo Avenue
Sunnyvale CA 94087
USA

Peter S. Hovmand

phovmand@wustl.edu
Washington University in St Louis
GWB School of Social Work
One Brookings Drive Campus Box 1196
Saint Louis MO 63130
USA

Society membership has grown by over 40% from 1999, but the representation of women has remained flat at 12%. Thus, in July 2004 the Policy Council unanimously approved the formation of a committee to work on tracking and improving the diversity of the System Dynamics Society. Last October, a pilot diversity survey was included in the annual membership renewals. In the course of developing the survey, members raised important questions about how diversity should be defined for the System Dynamics Society. More importantly, the initial results suggested potential solutions. Both issues raised questions that need to be discussed. How should diversity be defined with respect to the System Dynamics Society? How does diversity affect participation at conferences and in the society? What are some possible solutions? Please join us in this roundtable discussion on diversity in the System Dynamics Society.

Program Management Workshop

Kenneth G. Cooper

ken.cooper@paconsulting.com
PA Consulting Group
1 Memorial Drive 16th Floor
Cambridge MA 02142
USA

Thomas G. Kelly

tom.kelly@paconsulting.com
PA Consulting Group
One Memorial Drive 16th Floor
Cambridge MA 02142
USA

The aerospace, IT, and construction industries have seen a significant shift over the past few years from "cost-plus" contracts (where "every change is good", and means more revenue), toward "fixed-price" or "ceiling value" contracts (where the cost of every change must be negotiated with the customer or traded off against other work). The disruptive effects of these changes are substantial, but are universally poorly (and under-) estimated. The result has been unexpected cost overruns, lost profits, and disputes. This workshop will combine lecture and group exercise to teach valuable lessons about project disruption dynamics. In the session

Sharon A. Els

sharon.els@paconsulting.com
PA Consulting Group
One Memorial Drive 16th Floor
Cambridge MA 02142
USA

you will learn how change impacts spread to disrupt a project's performance and learn some mitigations to reduce or avoid the disruptive impacts of changes. For further information please contact Tom Kelly at tom.kelly@paconsulting.com.

Sharon A. Els

sharon.els@paconsulting.com
PA Consulting Group
One Memorial Drive 16th Floor
Cambridge MA 02142
USA

Business Roundtable

A panel of business and industry practitioners will describe how they have and hope to use system dynamics in their organizations. They will discuss which issues they have addressed with system dynamics and also share their perspective on what have been their biggest challenges and most significant successes.

Jose J. Gonzalez

jose.j.gonzalez@hia.no
Agder University College
Faculty of Engineering and Science
Grooseveien 36
NO-4876 Grimstad
Norway

Critical Infrastructure

The session consists of four papers: Real Time Diagnostics of Problem-Solving Behavior for System Dynamics-Based Business Simulations; Sensitivity Analysis of an Infectious Disease Model; Leveraging a High Fidelity Switched Network Model to Inform a System Dynamics Model of the Telecommunications Infrastructure; and Critical Infrastructure Protection Decision Support System. The first paper concerned supporting learning in and about complex problems. The paper describes the diagnostics of the problem solving process, i.e. of the information-retrieval and decision-making processes, as prerequisite for effective "feedback" to the learner. The second paper describes a model of infectious diseases that has been developed for integration within a larger simulation structure to assess the interdependencies of critical infrastructures. This paper presents the preliminary sensitivity analyses of the effects of inputs to the infectious disease model on the calculated consequences. The third paper summarizes the results of a collaborative effort with Bell Laboratories, Lucent Technologies to leverage a detailed switched network simulation to inform the telecommunications system dynamics model in a Critical Infrastructure Protection Decision Support System (CIP/DSS). The fourth paper describes CIP/DSS and simulates the dynamics of individual infrastructures and couples separate infrastructures to each other according to their interdependencies.

Jack B. Homer

jhomer@comcast.net
Homer Consulting
3618 Avalon Court
Voorhees NJ 08043 USA

Fifth Annual Modeling Assistance Workshop

Modeling assistance is available at the conference to enable modelers to discuss their specific modeling questions with modeling coaches. Modeling assistance opportunities include two

Roderick H. MacDonald

rod@isdps.org
Initiative for SD in the Public Sector
60 Oakwood Street
Albany NY 12208 USA

public workshops, as well as the possibility of assistance at any time during the conference. Assistance is available for modelers with all levels of modeling ability, from beginner to advanced, with questions about a specific model that modelers are developing or studying, or to better understand something in a book, an article, or a software package. Modeling questions may deal with problem articulation, formulation of a dynamic hypothesis, formulation of a simulation model, model testing, or policy design and evaluation. Modelers should bring whatever materials they need to describe their question,including pencil and paper, books, posters, or laptop computers. Spectators are welcome to observe modeling assistance during the two public sessions.

Jack B. Homer

jhomer@comcast.net
Homer Consulting
3618 Avalon Court
Voorhees NJ 08043
USA

HPSIG: Health System Reform Meeting

The members of the Health Policy SIG agreed at the Oxford conference in 2004 to begin a collaborative effort to examine national health care system reform from an SD perspective. The first product of this collaboration is a paper being presented at one of this year's parallel sessions, entitled "Achieving health care reform in the United States: Toward a whole-system understanding." The paper includes a series of causal loop diagrams laying out an initial theory of why reform efforts have largely failed in the U.S. and outlining the characteristics of more effective reform. This paper was recently distributed to all HPSIG members for their comments, and also to some U.S. health system experts from outside SD. During the special Sunday afternoon session we will review the comments we have received and also hear directly from a few of the outside experts who are able to join us in person. We will also look to non-U.S. HPSIG members for an international perspective, and talk about how we can best expand our collaboration both internally and externally during the year to come.

Dennis Meadows

lataillede@aol.com
Laboratory for Interactive Learning
PO Box 844
Durham NH 03824
USA

Systems Thinking Playbook Workshop

Many teachers and consultants have found that the 30 short games and exercises in the Systems Thinking Playbook provide an extremely effective way to illustrate important points about paradigms, system structure, and system behavior. Plus they are fun, and they help people become more comfortable working and talking together. This book by Linda Booth-Sweeney and Dennis Meadows has been translated into several languages, and it is used around the world. Now that it is accompanied by a two-hour DVD video, illustrating good practice in introducing and operating each exercise, the text has become useful even for those with no previous experience in the use of didactic games. In this special, evening session Dennis Meadows will describe principles for incorporating short games into more traditional teaching; he will prescribe criteria for using the games; and then he will demonstrate a number of the more useful exercises, playing them with workshop participants.

Oleg V. Pavlov

opavlov@wpi.edu
Worcester Polytechnic Institute
100 Institute Rd
Worcester MA 01609
USA

Economic Dynamics Roundtable

The economic roundtable will bring together people interested in the interface between economics and system dynamics. We will lay out a research agenda for the future, as well as share information and ideas about professional activities.

Morten Ruud

morten.ruud@sikt.net
SIKT AS
Eidesaasen 103
N-5750 Odda
Norway

Military Roundtable

The Military Roundtable is the arena for sharing ideas and experiences on the application of System Dynamics to military problems. The list of topics includes, for example: strategy development; force-on-force analysis; war-gaming; military decision making; training of military decision makers; including command-post exercises; preparedness studies; human resource management; development and management of military capability; management of materiel acquisition; military logistics modelling; in-service management. We suggest the following main topic for this year's meeting: "SDM as a tool to support training and exercise". Opportunities exist for participants to provide update on recent research and consulting activities, to discuss opportunities for the future and challenges that confront those working in or having an interest in system dynamics modelling (SDM) in military context. We will continue the work on assembling a compendium of models and readings on SDM in defence.

Peter M. Senge

psenge@mit.edu
Society for Organizational Learning
25 First St Ste 414
Cambridge MA 02141 USA

Lees N. Stuntz

stuntzln@clexchange.org
Creative Learning Exchange
27 Central Street
Acton MA 01720 USA

Diana Fisher

dfisher25@verizon.net
Wilson High School
7405 SW Cresmoor Drive
Beaverton OR 97008 USA

Mary Scheetz

orscheetz@aol.com
The Waters Foundation
2231 N Flint
Portland OR 97218 USA

Roundtable: Open Conversation with Educators Roundtable

Effective citizenship for the 21st Century calls for young people adept at understanding a world of growing interdependence and multiculturalism. This means new intellectual foundations for understanding complexity and new learning skills for building shared understanding of complex issues like sustainability. Yet most of our schools remain much as they have long been, with sharply demarked subject matters and public education policies that stiffen these disciplinary identities. The result is that even older students have little mastery of understanding of the critical problems shaping their world. New educational outcomes require new educational systems - not just "school systems" in the traditional bureaucratic use of the word but learning communities within and beyond the school that can affect all aspects of children's lives. Peter will share information and invite conversation around current work to develop a network of innovative school systems pioneering a multi-layer view of curricular, institutional and community innovation.

Birgitte Snabe

birgitte@snabe.net
Mannheim University
Schloss Industrieseminar
D-68131 Mannheim
Germany

Markus Salge

salgem@is.bwl.uni-mannheim.de
Mannheim University
Schloss Industrieseminar
D-68131 Mannheim
Germany

PhD Colloquium

The 5th International Ph.D. Colloquium is an event of the System Dynamics Student Chapter. The objective of the colloquium is to bring together Ph.D. Students working on foundations, techniques, tools, and applications of System Dynamics and give them the opportunity to present and discuss their research in a constructive and international atmosphere. The Colloquium will also provide an opportunity for student participants to interact with established faculty and others in the wider system dynamics community. The diversity and the interactive setting should provide a unique learning opportunity for all participants of the colloquium. This year, the all-day colloquium will open with a speech given by Professor Repenning. The colloquium will consist of number of sessions with oral presentations followed up by parallel workshops, as well as a large poster session in the afternoon. We have received more that 20 submissions and we believe and hope it will be an interesting day with many fruitful discussions.

Warren W. Tignor

tignorw@saic.com
SAIC
472 Cornwall Court
Severna Park MD 21146
USA

Peer Review Dialog

System Dynamics does an excellent peer review of articles. This year, eeing the reviewers' comments and suggestions online was especially welcomed feedback. The additional benefit of initiating a dialog with the reviewers was a bonus. However, there is always room for improvement. Your thoughts and ideas are welcomed to help us continue to improve our peer review process. Please consider joining a dialog at our Boston meeting to further explore the peer review process. Your presence and ideas are welcome. Some thoughts for consideration are as follows: 1. Need the peer review process start and end so abruptly? Should the reviewer and writer continue the dialog post the society meeting if mutually agreed? Should a reviewer mentor this process? 2. Are there submissions for review that could be enhanced and offered to other venues for publication, and thus improve recognition for the System Dynamics Society? Should a reviewer mentor this process? 3. Could a practitioners develop a business methodology from theory presented in a peer reviewed paper, or could academics proved theoretical underpinnings for a practical approach presented? Should a reviewer facilitate this process? If you are interested in discussing these peer review ideas or others, please consider joining an informal meeting!

Wayne Wakeland
wakeland@pdx.edu
Portland State University
Systems Science PhD Program
PO Box 751
Portland OR 97207 USA

Environmental Dynamics Roundtable: Environmental Dynamics -- What is it?

A discussion, with panelists representing different perspectives, facilitated to encourage full participation by everyone present. The field of inquiry dubbed environmental dynamics (ED) includes a broad range of interests, many with differing views of the ecological world. These include, for example, purely ecological studies involving the interactions of organisms and their natural environment, technical studies of the effects of human activities on the environment and different methods employed to limit or counteract those effects, big picture analysis of the human-influenced world and the direction it is headed, plus many others. Popular topics often associated with ED include: "environmental regulation," "the ecocosm dilemma," "the oil crisis," "global warming," "environmental limits [to growth]," etc. The roundtable will explore the relationships among these different topics, emphasizing the role of system dynamics. The goals will be to establish common ground, to create useful distinctions, and to help organize the ED endeavor.

Jeff Furman
Boston University

Scott F. Rockart
srockart@duke.edu
Duke University
Fuqua School of Business
Box 90120
Durham NC 27708 USA

Fernando Suarez
Boston University

Environmental Effects on Entry Decisions
Scott Rockart, Discussant

This and *Cognition, Innovation and Strategy* are designed to strengthen the connections between system dynamics research (and researchers) and the broader strategy research community. Two papers will focus on how the external environment influences a firm's strategy. Fernando Suarez will discuss research on how environmental dynamics influence first mover advantage; Jeff Furman, on how national regulatory environments and firm characteristics influence product entry in the global pharmaceutical industry. Scott Rockart, will discuss opportunities and approaches to connect and leverage these and other environmental perspectives from strategy research with system-dynamics-based research.

Giovanni Gavetti
Harvard Business School

Scott F. Rockart
srockart@duke.edu
Duke University
Fuqua School of Business
Box 90120
Durham NC 27708 USA

Alva Taylor
Tuck School of Business

Michael Tushman
Harvard Business School

Cognition, Innovation and Strategy
Scott Rockart, Discussant

This and *Environmental Effects on Entry Decisions* are designed to strengthen the connections between system dynamics research (and researchers) and the broader strategy research community. Three papers will focus on innovation and cognitive processes of strategists. Giovanni Gavetti will discuss research on the role of cognition in strategy; Alva Taylor, on innovation, learning and internal competition in new product development; Michael Tushman, on innovation streams. Scott Rockart, will conclude with an overview of opportunities and approaches for system-dynamics-based research and researchers to connect with and leverage the work of these strategy scholars and related work in strategy.

Workshops

Andrei Borshchev

andrei@xjtek.com
XJ Technologies
21 Polytechnicheskaya St Office 102
St Petersburg 194021
Russia

Nathaniel Osgood

nosgood@mit.edu
MIT
77 Massachusetts Ave Rm 1-376
Cambridge MA 02139
USA

Agent-Based Modeling: Why Bother?

There is increasing interest in combining agent based (AB) and system dynamics (SD) modeling methods. This workshop will demonstrate the differences between the AB and SD approaches using some popular examples from the Dynamics of Contagion and the Diffusion of Innovation, using the AnyLogic multi-method software. It will also walk through some practical examples of the use of combined methods in health, marketing and other industries. The workshop will conclude with a "warts and all" panel discussion involving experienced SD practitioners and academics who are adding AB methods to their work.

Geoff McDonnell

gmcdonne@bigpond.net.au
University of New South Wales
382 Bronte Road
Bronte NSW 2024
Australia

Mark Paich

m.paich@att.net
Decisio Consulting Inc
201 Linden Street 3202
Fort Collins CO 80524
USA

Hazhir Rahmandad

hazhir@mit.edu
MIT
Sloan School of Management
30 Wadsworth Street E53-354A
Cambridge MA 02139
USA

Mark Heffernan

mheffernan@evanspeck.com.au
Intl. System Dynamics Pty Ltd
20B/390 Eastern Valley Way
East Roseville NSW 2069
Australia

Sara Metcalf

ssm@uiuc.edu
Univ of Illinois Urbana-
Champaign, Dept of Geog.
Rm 220 Davenport
607 South Mathews Avenue
Urbana IL 61801-3671 USA

Christopher Johnson

johnsonch@crd.ge.com
GE Global R&D
PO Box 8 Room KWC 277
Schenectady NY 12301
USA

Jim Duggan

jim.duggan@nuigalway.ie
National University of Ireland Galway
Department of Information Technology
University Road
Galway Ireland

Exploring Optimal Trade-Offs in a Two-Actor Beer Game Model

Multiple Objective Optimisation (MOO) is a proven technique that can be employed by systems dynamicists as they seek to optimise parameters in simulation models. MOO employs genetic algorithms and Pareto-based ranking to find non-dominating sets of optimal solutions to problems that have more than one objective. The aim of this workshop is to: (1) Explain the multiple objective optimisation approach; (2) Show, though an interactive simulation model, how it can be applied to a popular system dynamics model (a two actor version of the beer game); (3) To explore with participants answers to a number of questions, including: (a) What kind of benefits can MOO bring over traditional optimisation approaches? (b) How do modellers decide on the appropriate payoff function? (c) How do decision makers approach the dilemmas of trading off two objectives? All participants will have access to a special purpose simulation application (Windows based) that will allow them to run simulations and optimisations on the two-agent beer game.

Diana Fisher
dfisher25@verizon.net
Wilson High School
7405 SW Cresmoor Drive
Beaverton OR 97008
USA

Modeling Dynamic Systems: Lessons for a First Course

"Modeling Dynamics Systems: Lessons for a First Course" provides a set of materials that enable educators at the secondary and college levels to teach a one-semester or one-year course in System Dynamics modeling. These lessons are also useful for trainers in a business environment. Developed for beginning modelers, the lessons contained in this book can be used for a core curriculum or for independent study. Systems Thinking software like STELLA offers an opportunity to create visual models that actively engage students in the study of a wide variety of problems. Creating a model allows for "real-time" analysis of dynamic behavior and a more stimulating environment in which to glean insight. The lessons include some of the classic System Dynamics problems (population change, resource sustainability, drug pharmacokinetics, spread of an epidemic, urban growth, and more). Developed over 14 years, the lessons in this book provide an easy-to-use set of teaching materials that are paced gently enough for novice modelers. Students learn to create progressively more sophisticated models, testing their structures as they proceed. Feedback analysis is integral to the lessons. Guidelines for an independent project and an outline for a technical paper explaining the creation process and structure of the final model, together with scoring guides for both the model and the paper, are included. A set of student lessons, a teacher's guide with all the answers to the student lessons (and additional comments to the instructor), as well as a CD containing all of the models, is provided with the book. Participants in the workshop will have a chance to build some simple models and gain a sense of the progression leading to a more sophisticated model. Student work will be demonstrated and a CD containing samples of student work and their technical papers will be provided to all participants.

Will Glass-Husain
wglass@forio.com
Forio Business Simulations
2320 Jones Street
San Francisco CA 94133
USA

Making your Simulation Run on the World Wide Web

This workshop discusses how advances in technology allow modelers to develop and share their own dynamic simulations on the web. New tools have made creating web interfaces to system dynamics models simpler and inexpensive, but model developers still face hurdles developing web simulations because of the design expectations of Web users. Simulations that run in web browsers have the advantages of global accessibility, simple distribution, and the ability to monitor simulation usage. However, simulations previously delivered in other formats need to be modified in order to effectively use the online medium. Simulations need to engage the user, be simple to navigate, and correspond to the user's learning objectives. This workshop will

consist of presentation and a hands on workshop. During the presentation, Will Glass-Husain will demonstrate how to create web simulations and discuss commonly occurring web simulation design challenges and potential solutions. The session will also include a hands-on session where participants will create a paper outline of potential simulation design for a model of their choosing.

Franc Grimm

grimm@consideo.de
Consideo GmbH
Seelandstrasse 1a
23569 Luebeck
Germany

Hördur V. Haraldsson

hordur.haraldsson@chemeng.lth.se
Lund University
Department of Chemical Engineering
PO Box 124
22100 Lund
Sweden

How to make System Dynamics Applicable for Business and Politics? - Best Practice Approach

System Dynamics is one of the most promising methods to solve complex problems in business and politics. In spite of the development of different simulation tools and approaches in the past, System Dynamics is still not in wide use. How come?? What are the main barriers for applying SD in business and politics?? How to overcome them?? This questions were the main driving forces for initiating a new international research & development project called "Decision Support" (carried out by Lund University, University of Luebeck, Technology Centre Luebeck and CONSIDEO; www.decision-support.info) aiming at building up a network in which researchers, educators, consultants, software engineers and providers, methodologist, and practitioners (political and entrepreneurial decision makers) interact to share ideas and experiences for improving policy-making-processes, and at developing a new best practice approach for applying System Dynamics in business and politics. For this, different users (mainly ministries and companies like Deutsche Bank or Daimler Chrysler) have been involved in order to define their requirements like easy to use (e.g. avoiding time and cost-intensive training or moderation services), transparency, workflow-oriented approach, integrating different approaches (e.g. the causal-loop-diagram concept and the stock-and-flow-view) as well as linking the qualitative analysis with the simulation part. As a results of the project a new, software-based best practice approach which can be used intuitively has been developed, tested, evaluated and improved in cooperation with different users in politics and business. Be invited to discuss and evaluate the best practice approach at our workshop.

James H. Hines

jhines@sloan.mit.edu
MIT
81 Hazard Avenue
Suite 1600
Providence RI 02906 USA

How to Visit a Great Model Like Yours

We were at the Lyon's Pub. Peterson walked in with a presentable young man.

"This is Randy," she said, pulling up a chair. "He's just back from Egypt." Ordering a beer, Peterson fished a photo from her pocket. "Doesn't Randy look grand in front of the Sphinx?"

Sedgewick turned to the young man "Tell us about your trip."

Randy smiled in recollection. "I stayed at Le Meridien in Giza. Costs a bloody fortune, but it's worth it. Has a swim-in bar, don't you know."

"And the Sphinx?" Sedgewick prompted.

Randy's expression turned weighty. "Big. Damn big."

"So you've never actually been to Egypt." Sedgewick said sadly. "And, never seen the Sphinx."

Like Randy, many of us return from a model without true insight.

In this workshop we'll deeply explore a model or two. You will see how eigenanalysis complements and speeds traditional approaches to understanding models. Math-phobics and math-lovers are equally welcome.

Gary B. Hirsch

gbhirsch@comcast.net
Creator of Learning Environments
7 Highgate Road
Wayland MA 01778
USA

Designing Simulation-Based Learning Environments: Helping People Understand Complex Systems

Simulation-based learning environments, often called management flight simulators or Microworlds, are excellent tools for giving people without modeling experience an intuitive understanding of complex systems. Learning environments let them experience the dynamics of complex systems without the hurdle of having to build models "from scratch". This workshop will deal with the design of learning environments, their user interfaces, underlying models, and workshop formats for experiencing with them. Special attention will be paid to methods of displaying information to help users understand causes of the behavior they encounter and thereby make better decisions and learn more quickly. The presenter will show a number of examples from his own work, but is also eager to make the workshop interactive and would like to hear about other people's experiences with learning environments and from people with models they are interested in turning into learning environments.

Robert Hoffman

rhoffman@robbert.ca
Robbert Associates Ltd
338 Somerset Street West 3rd Floor
Ottawa K2P 0J9
Canada

Bert McInnis
bert.mcinnis@robbert.ca

Lanhi Li
lanhi.li@robbert.ca

Methods and Software Tools for Expanding Perceptive Capacity: The Case of the Global Systems Simulator

The Global Systems Simulator addresses the issues of sustainability and carrying capacity at a global scale - the same issues addressed by the Jay Forrester's World3 model. The current version of the GSS is a prototype intended as proof of concept for a much different approach to modeling. Systems models are seen as explicit extensions of the mental models we use to interpret the signals received by our sensory apparatus and to navigate in the

real world - extensions that enable us to perceive the long term and systemic consequences of potential actions. The approach has its roots in the activity analysis of Koopmans, Leontief, and Georgescu-Roegan, the system dynamics of Forrester, the control theory of Mesarovic, the general system theory of Weiner and Laszlo, the principle of uncertainty of Prigogine, and the cognitive theory of Bateson, Maturana and Varella. The GSS is implemented using the whatIf? software technology, a platform developed by Robbert Associates for large scale simulation modeling. The workshop will demonstrate these concepts using the Global Systems Simulator.

Richard Langheim

richlangheim@yahoo.com
Ramapo College of New Jersey
37 Mary Lane
Waldwick NJ 07463
USA

Before the Model: Enhancing Dialogue with Semantica

The primary goal of this workshop is to improve the pre-modeling classroom dialogue of students and teachers through the use of Semantica, a semantic web-building tool. K-16 teachers, as well as consultants, may find this workshop useful. Research has noted that system dynamics modeling is "low [poor] on construction time, user prerequisites, and learning time."* The purpose of using Semantica is to enhance dialogue and thus improve the model building process. During the workshop we will examine the idea of semantic webs, create webs based upon the interests of participants, thoroughly explore the features of Semantica, illustrate the utility of semantic webs across disciplines and present a summary of research about using semantic webs. The workshop will conclude with dialogue about the reactions of the participants and the presentation of materials to enable participants to further explore this technology.

Winston P. Ledet

wpledet@mfg-game.com
Ledet Enterprises Inc
7702 FM 1960 East
Suite 226
Humble TX 77346 USA

Tony Cardella
tony@dpcf.com

Michelle Ledet
mrledet@mfg-game.com

The Manufacturing Game

By addressing the need for organizational change, The Manufacturing Game(r) has enabled manufacturing facilities around the world to vastly improve their reliability practices, resulting in enormous gains in a short period of time. Our unique, integrated approach, based on a System Dynamics model, helps organizations realize their full potential by encouraging front-line workers to better understand their role and take responsibility for their performance as it relates to the functionality of the entire plant. This bottom-up approach to organizational change has been effective at not only improving reliability, but more importantly, sustaining improvement. Over 27,000 people from companies like DuPont, BP, Honda, Whirlpool and ExxonMobil have used The Manufacturing Game(r) to reduce failures and lower costs. The game is a board game played with poker chips, play money, and dice. It is a fun way to learn as many have experienced playing the beer game.

Debra A. Lyneis

lyneisd@clexchange.org
Creative Learning Exchange
PO Box 121
Weston VT 05161 USA

Rob Quaden

rquaden@carlisle.mec.edu
Carlisle Public Schools
83 School Street
Carlisle MA 01741 USA

Alan Ticotsky

aticotsky@carlisle.mec.edu
Carlisle Public Schools
83 School Street
Carlisle MA 01741 USA

System Dynamics for K-12 Students

Workshop participants will engage in several games and abbreviated lessons designed to teach the basics of system dynamics to K-12 students. The workshop will conclude with a brief discussion of available curriculum resources and the strategies, challenges and pitfalls of implementing K-12 SD in schools.

Diana Fisher

dfisher25@verizon.net
Wilson High School
7405 SW Cresmoor Drive
Beaverton OR 97008 USA

Alan Charles McLucas

a.mclucas@adfa.edu.au
Australian Defence Force Academy
UNSW School of Aerospace
Civ & Mec Eng
Northcott Drive
Campbell ACT 2600
Australia

Group Model Building: A Modular Approach

Structure is a critically important determinant of system behaviour. The relationships between the most basic elements (accumulations, physical flows, information flows, feedback and delay) found in system dynamics models and the building blocks of system dynamics structure are examined. Complexity is explained. The complexity of models we might build, relative to real-world complexity is examined. Why we need to approach model building top-down rather than bottom-up is explained. How to design system dynamics group model building projects through a top-down approach is explained. How to decompose conceptual models developed top-down into appropriate modules to be constructed then synthesised bottom-up is explained. Attendees will design a group model-building project using this approach. The relationships between model functionality, verification, the model as a necessary and sufficient representation of the real world, and the real challenges of validation are explained. How to build models and design effective test to ensure those models work as intended is explained and demonstrated. How to build models using a methodology integrating aspects of systems thinking, system dynamics modelling and engineering is demonstrated. How to manage the complexity of the model through each stage of development is explained.

Hazhir Rahmandad

hazhir@mit.edu
MIT
Sloan School of Management
30 Wadsworth Street E53-354A
Cambridge MA 02139 USA

System Dynamics Boot Camp for PhD Students

How can we build dynamic models to effectively inform our research? The System Dynamics method offers established practices and principles to enable us to do so. This boot camp is

Gökhan Dogan

gdogan@mit.edu
MIT
30 Wadsworth Street
Building E53 Room 364
Cambridge MA 02139
USA

Jeroen Struben

jjrs@mit.edu
MIT
750 Tremont Street Apt 9
Boston MA 02118
USA

Imrana A. Umar

imrana.umar@powersimsolutions.com
Powersim Solutions
585 Grove Street Suite 130
Herndon VA 20170
USA

Ozgur Ozkan

oozkan@powersimsolutions.com
Powersim Solutions
585 Grove Street Suite 130
Herndon VA 20170
USA

directed to expose PhD students to the (iterative) SD modeling process. The workshop consists of two parts. In the first part participants will engage in the process of model building from a case and getting some basic insights. Issues that will be discussed include problem definition, model boundary, scope/level of aggregation, generating insights from modeling, as well as challenging the research question. The second part of the boot camp will address actual issues from participants' research based on the important themes discussed in the first section. For this we ask participants to submit a one/two page summary of their current research, comprising: abstract, research questions, motivation for model and two or three main issues. We encourage submitting models– in whatever stage of progress. The summaries should be in at latest on Monday of the conference (though earlier is strongly suggested!). The case material will be available upfront so that the participants read the case before hand. Note: this workshop does not involve one-on-one coaching that the modeling assistance workshop offers, nor has it the conference setup of the PhD colloquium. These sessions are complementary to each other and participants are encouraged to participate in all of them.

Strategy Communication with ExTrain®

System dynamics models are being used by more and more businesses to train employees from new hires to veteran managers, communicate strategic change within the company, share mental models between stakeholders and align business perspectives between business units. Advances in computer technologies help this process to a great extent by enabling users to interact with models more effectively and efficiently. This workshop will introduce you to ExTrain(r), one such technology that facilitates the use of simulation models in strategy communication and management training. The ExTrain(r) is a web-based application platform that serves as a virtual practice field for managers to exercise decision-making power under various business conditions in a risk-free environment. ExTrain(r) applications can be used in individual online simulation sessions or within a facilitated environment with interaction from trainers. Each application is also supported with a facilitation tool that allows trainers to monitor simulation progress, user performance and intervene if necessary. In this workshop, we will introduce you to the ExTrain(r) platform and its new features from a user perspective. You will also get a chance to learn more about the integration and maintenance of simulation models within ExTrain(r) environment. There will also be a hands-on demonstration of the system where participants will take part in a sample war-game application. Participants will be divided into four teams, each of which will take control of a virtual technology company. Starting on level ground, you will compete for revenue growth while maximizing profit through various business decisions. Facilitation will be provided to help you understand the key business dynamics and formulate your strategy.

Sanith Wijesinghe

sanithw@gmail.com

Agent-Based Models for Crowd Dynamics

The objective of this workshop is to provide participants an introduction to agent-based modeling of crowd dynamics. A summary of pedestrian socio-psychological egress behavior will be presented together with an outline of existing modeling techniques and software tools. A detailed description of a simple crowd model that can be implemented using MATLAB will be presented. Participants will learn how to develop a simple yet fully functional simulation and visualization of crowd dynamics. Skeleton Matlab scripts will be available for download from www.sanithw.org starting July 1st, 2005 but will also be available via PC/MAC compatible USB drives during the workshop.

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